Review of manuscript SE-2018-98 "From mapped faults to earthquake magnitude: a test on Italy with methodological implications" by F. Trippetta, P. Petricca, A. Billi, C. Collettini, M. Cuffaro, D. Scrocca, G. Ventura, A. Morgante, F. Chiaravalli & C. Doglioni

Main comments

This manuscript describes an approach to evaluate the maximum possible earthquake magnitude from the geometry of active faults in Italy. The topic has a broad interest, in particular for fault-based seismic hazard modelling, because the correct evaluation of the seismic potential of a seismogenic source is one of the main required parameters for seismic hazard studies. The use of active faults in seismic hazard assessment has become extensive in the last decades due to efforts of data compilation and analysis. Active faults provide the information to extend the observational time of large magnitude earthquakes, which often is not captured by the existing catalogues of observed seismicity.

The authors apply one empirical scaling relationship (not correctly defined by the authors as scaling law!) between fault length and expected magnitude, to a clearly incomplete and inhomogeneous fault database, to evaluate the maximum possible earthquake magnitude in Italy. The manuscript is mostly well written and the figures are clear but, from my point of view, the approach has several misconceptions and incompleteness and the conclusions are not supported by the results.

For these reasons, the manuscript does not represent a substantial contribution to scientific progress in seismic hazard assessment and seismic risk reduction, as required by a high-level Journal as Solid Earth. The applied methods are valid but too simplistic and applied to incomplete and inhomogeneous data with consequently a poor scientific significance of the manuscript. Moreover, the references used for the fault database compilation is largely incomplete.

Recommendation

I recommend that this manuscript is not suitable in its present form for a publication on a regular issue of the Solid Earth. In the following detailed comments I describe more in details the main improvements needed, from my point of view, to re-submit the manuscript.

Detailed comments

1. Fault database: the database is largely incomplete and inhomogeneous, with an incompleteness variable in space. The suggestions to improve the database are:
    a. Consider the abundant literature in the compilation of active fault database for Italy, mostly more recent than the used one (in the following references a partial and not yet complete list of papers not considered in the manuscript);
    b. Separate in the database the recognized active faults to the not clearly active ones. In literature are available several definitions of fault activity, taking into account the age of the involved deposits, the associated earthquakes, the continuity and kinematics compatibility, and many others, and the authors need to consider it. In this way the authors could define more classes of faults (more than the two defined in the manuscript) based on the goodness of data and

recent activity and need to treat separately the classes in the approach to evaluate the seismogenic potential;
    c. Evaluate and handle with the spatial variable incompleteness of the database;
2. Consider the fault segmentation variability in the correct evaluation of the seismogenic potential, essential in fault-based seismic hazard approaches, as confirmed by recent complex coseismic ruptures (e.g., 2010 M 7.1 Canterbury, 2012 Mw 8.6 Sumatra, 2016 Mw 7.8 Kaikōura, 2016 Mw 6.5 central Italy);
3. Organize a table with earthquake-fault associations, in order to avoid the double counting or the source missing. There are several examples of 'problems' in the *kmz of the authors, as the missing of the Paganica fault, responsible of the M6.3 2009 L'Aquila earthquake, the double counting of some faults in the Fucino area where the M7 1915 earthquake occurred, and the not correct definition of the total length of the fault responsible in the Irpinia region of the M6.8 1980 earthquake;
4. Consider also the seismogenic depth and the length of the faults along dip, to better define the total potential rupture area, better linked to the seismogenic potential of the sources;
5. Deal with greater accuracy the empirical scaling relationships, by:
    a. Compare the results of the approach using the different available relationships;
    b. Handle with the uncertainties, both inter- the different relationships and intra- the single relationships (sometimes the authors define very large standard deviation in the empirical relationship not treated in the manuscript);
    c. Compare the results using different geometrical parameters, e.g. the surface rupture length, the subsurface rupture length, the rupture area (and so considering the seismogenic thickness) together with the different kinematics, treated separately in the different scaling relationships;
6. Handle with the uncertainties in the results, comparing the differences between the seismogenic potential of the faults estimated by the empirical relationships and the earthquakes in the historical catalogue, in terms of seismic moment and not only magnitude. Magnitude is a logarithmic quantity and so a simple comparison as done by the authors in the conclusions has a clear bias;
7. Treat the probability of occurrence in the conclusions. In seismic hazard models is necessary to define the seismic rates for the different magnitude classes and so the probability of occurrence of a defined magnitude depends on the average recurrence time of that value in a specific area. The conclusions of the authors show the largest expected magnitudes in areas with very low seismicity, like Sardinia, suggesting there high seismic hazard values. Such conclusions have to be more strongly supported by considerations in terms of probability of occurrence.

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