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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Approach for combining faults and area sources in seismic hazard assessment: Application in southeastern Spain" *by* Alicia Rivas-Medina et al.

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The Cornell method (1968) is a zoned probabilistic method, based on the consideration of seismogenic zones with homogenous seismic potential, which was raised precisely by its author in view of the difficulty of modeling the faults as independent seismic sources. It has been a method of widespread use in the last decades. Although in recent years, with the increasing increase of fault information, combined methods of zones and faults have begun to be proposed, such as those referenced in our current version of the manuscript. Obviously there may be many other works in this methodological line not mentioned in our work, but we are not presenting a paper on

the state of the art in the subject. We present a methodological approach that aims to be a contribution in this line of hybrid methods, and we say so in the manuscript. Some representative references have been cited by way of example. The qualification of "unethical issue related to the lack of recognition of other work" b is therefore unacceptable. We raise the following question: does each time a paper on a specific topic is published consider a lack of ethics not mentioning all the existing works on that topic? Where is the limit considered? The hybrid FSBG model presented by Woessner et al (2015) and applied in Europe resolves the distribution of the seismic potential between zones and faults adopting a Mc cutoff magnitude of Mw 6.5, above which earthquakes associated with faults are considered, taking as a background seismicity the one corresponding to magnitudes in the MW range (4.5-6.4), which is associated with the zone, that is, the method of Woessner et at (2015) considers a fixed cut magnitude, and precisely our approach is aimed at avoiding the adoption of a fixed Mc value, based on an essential question that is formulated on page 2 of the manuscript, where it is literally indicated: By not fixing this magnitude, the approach to distribute the seismic potential is obviously complicated and what we propose is a procedure that we detail in the paper, including its formulation. Therefore, our methodology differs substantially and essentially from that of Woesner et al (2015), both in the initial hypothesis and in the procedure to be followed. It must be added that a value of M = 6.5 is practically the Mmax that can generate the active faults in Spain, therefore it would not make sense to establish this value as Mc, but it is not easy to establish another alternative value either. It is surprising that the reviewer describes the methodology proposed here as "surprisingly similar to the Fault Source and Background (FSBG)" and denotes the lack of grasp of the essential aspects of both methodologies. To this we must add the notable difference of results in the application to the south of Spain. The comment: "The only difference being the fact that Rivas-Medina and coworkers present their approach as if they have just (re) invented the whee" is also offensive. Obviously, we are not trying to invent the wheel, but rather to propose an approach in an open line of research that is not based on the consideration of a Mc to distribute the seismic potential between zones and faults. This is, in fact, a recognized problem among all the experts that work on seismic hazard towards which considerable efforts are being devoted, and our work is intended to be a contribution in this regard. So we have raised it humbly and repeatedly in the manuscript. In the work of Woessner et al. (2015) three source models implemented in a logical tree are presented: Area source (AS); Sismicity + fauts (SEIFA) and Fault souce (FS) & BackGroup (BG). Of the three previous models, only the last one deals with a hybrid model of faults and zones. The authors consider a cutoff magnitude (Mc = 6.5) between the faults and the zone (background seismicity). This idea, which is not novel in that work either, was proposed by Frankel et al. (1996), is the most important difference between the presented here and the work of Woessner et al. (2015). In fact, this issue is addressed in the introduction to this paper, since our approach is precisely not to use a previous cut magnitude. The approach presented in this paper is part of the PhD thesis of Alicia Rivas Medina, the first author of the paper. The public defense of the thesis was on March 2014. The pdf of the thesis was uploaded to the institutional, open repository of UPM on April 2014. It is accessible in http://oa.upm.es/23328/. P3L18: The completeness period was mistakenly referenced as Stepp (1972). The correct reference is provided in the text. P4L16: The seismic moment associated with an earthquake of M = 0, (M0 = 1.27E + 09 Nm), is a completely insignificant value when compared to the seismic momentum rate accumulated in a failure annually. For example, if we assume a slow failure with slip rate = 0.1 mm / year and a failure plane size of 45x10 km, the cumulative annual seismic moment rate is 1.35E + 22 Nm. This means that the moment released in an earthquake of magnitude M = 0 supposes 0.00000000001%, a completely insignificant value in a year, even more so in the periods of recurrence associated with slow faults. There should be many earthquakes of magnitude M = 0 to modify the result very slightly. Figure 5: There is no case in which zones cut faults, in fact the author of that zoning is also the author of the fault database (Garcia Mayordomo et al, 2010), and this zoning was designed to avoid that case. Maybe it is a misperception by the projection of the image Table 3 and Table 4:

The values shown in tables 3 and 4 are not values of b, but values of Beta, as clearly indicated in these tables. Do not confuse these two parameters, although there is an equivalence between them (Beta = b * ln (10)). Values of b (0.7 - 1.3) are equivalent to beta values (1.6 - 3.0). These equivalences are well known among those who work on issues of seismic hazard P7L15: It is a subjective opinion of the reviewer that it is preferable to use the relationships of Leonard (2014) to Stirling et al's (2002). The latter has been, together with that of Well and Coppersmith (1996), one of the most used for the purpose in question. P8L5: The Campbell and Bozorgnia model (2014) uses 15,521 records from 322 earthquakes of $3.0 \leq M \leq 7.9$. The total selected database comprises 11,125 records from 245 earthquakes of $3.0 \leq M < 5.5$. The work of Delavaud et al. (2012) is prior to the model of Campbell and Bozorgnia (2014), so this model can not be assessed in that article. In addition, the GMPEs proposed (in the first places) Delavaud et al. (2012) do not consider the source effect with as much detail as the model of Campbell and Bozorgnia (2014), in this application it does not make sense to define the sources precisely if simpler models are later employed in the GMPEs. Nevertheless, the focus of the paper is the definition of the source model and the distribution of potential between zone and faults. The choice of the GMPE is a secondary issue in this regard. P9L27-28. The problem, precisely in a hybrid model of zones and faults, is to identify which earthquakes are associated to the zone and which to the fault. The events of the seismic catalog are not classified between zones and faults, but that a recurrence is established for the faults from the slip rate and another for the residual zone from the Catalogue. But this in turn will contain earthquakes that will have occurred in the fault, and if they are not easily identified they will be counted twice: one explicit in the area and another implicit in the fault. Most of the hybrid models, including that of adopting a solution to identify the events in the two types of sources: establish a Cut Magnitude Mc and consider Mw <Mc for the zone and Mw> Mc for the fault. But as we have already indicated, our approach tries to avoid this simplification and proposes a procedure for sharing, avoiding duplication. This question is key. The results: We include an annex containing a table with the fault parameters included in the study. These data are taken from the QAFI database. Including in this table all the intermediate results for each fault would be too lengthy. English: English has been corrected by a native person in this version.

Please also note the supplement to this comment:
https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2018-28/nhess-2018-28-AC4-supplement.pdf

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