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Comment on nhess-2021-87

Anonymous Referee #2

Referee comment on "Equivalent hazard magnitude scale" by Yi Victor Wang and Antonia Sebastian, Nat. Hazards Earth Syst. Sci. Discuss.,
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Review of the paper
Equivalent Hazard Magnitude Scale
Yi Victor Wang, and Antonia Sebastian

The paper introduces a new magnitude scale (the Gardoni scale) to describe the impact of different types of natural events and to facilitate the comparison.

Although I do agree with the main idea of the paper, i.e., hazards cannot be compared but we can compare their effects, I have several doubts about this paper.
I will describe below only the most important ones (omitting other minor points), with the hope that they can be of some usefulness for the authors.

1. As just said, hazards cannot be compared but we can compare their effects; this is exactly what the risk analysis is meant to do. There is an extensive scientific literature on the comparison of the risks caused by different events (e.g., comparing the individual risk of death caused by different events), or comparing the risk with the acceptable risk that has been defined by decision makers. It is not clear why the authors dismiss completely all these efforts, which have eventually their same goal. Why do they think that their method is more effective that the classical risk and multirisk assessment?

2. The authors based their analysis on a 120-year-long database. I think that the length of this database is clearly too short to get a realistic estimation of the impact of some natural threats, which have a longer average inter-event times (for instance super-eruptions with VEI7 or 8). That's important because the effect of one of such events can largely overcome the cumulate effects of all other events. As a matter of fact, for some of the hazard considered in this paper, the most impacting events at worldwide scale have a return time that is much higher than 100 years.
This is also the reason for what the risk is almost never empirically calculated using

databases of this time length, at least for the most damaging events.

3. I think that the exposure and vulnerability are strongly changing through time. Conversely, the authors are assuming that these quantities remain constant in the past 120 years. This assumption may introduce a significant bias in the ranking of the events; for instance, it may be argued that the same tsunami in 2004 would have caused much less casualties if it happened in 1904 (by the way, to my knowledge the number of casualties caused by the 2004 tsunami is much less than 2 millions as reported by the authors). Not less important, as also acknowledged by the authors, some of the data may be severely incomplete; incompleteness has to be carefully checked because it can introduce an important additional source of bias in the analysis.

4. I am puzzled by the inclusion of synthetic data to fill the "missing" data. This may be very dangerous, because the 'new' data have been generated assuming that the model used to generate them is correct. To sum, I do not understand the need to generate synthetic data and not using only the ones available. (but I may be missing something here)

5. The results of the correlation between impact metric and hazard (Figures 3 and 4) are largely not statistically significant (maybe except in a very few cases case, but we need also to take into account that the statistical significance has to take into account also the multiple tests). It is difficult for me to understand how we could use these relationship to rank the hazards in a meaningful way.
Figure 4 shows that, on average, the smaller the event the lesser the impact. This is already very well known but the large scatter of the logarithmic quantities implies that, for example, a large earthquake can cause no victims whereas a smaller one can cause a huge number of casualties. It depends on where the earthquake occur. For example, on average about 20 earthquakes of magnitude 7 or above occur worldwide per year, but only a very few of them in the last century caused more than 100,000 casualties, whereas most of them do not produce any casualty, or very few; the scatter in terms of casualties spans about 5 orders of magnitude for such a kind of events. This is a consequence of using an 'agential' approach, whereas the risk is intrinsically 'locational' (de facto, the exposure is strongly spatially clustered over the earth).

6. The example reported in the discussion highlights the problem with this method. The authors say that the cold wave in Oklahoma city in 2021 has the same hazard magnitude in the Gardoni scale as an earthquake of magnitude 7.5. I do believe that a magnitude 7.5 in Oklahoma city would have caused an impact that is several orders of magnitude larger than the impact caused by the cold wave; and no impact (or very limited) if the same earthquake occurred in a remote area.