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Reply on RC1

Sasan Motaghed et al.

Author comment on "A non-extensive approach to probabilistic seismic hazard analysis" by Sasan Motaghed et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2022-214-AC1, 2022

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Response to the respected reviewer

Dear professor Vallianatos,
Thank you for giving us the opportunity to submit a revised draft of the manuscript "A non-extensive approach to probabilistic seismic hazard analysis" for publication in the Natural Hazards and Earth System Sciences. We appreciate the time and effort that you and the respected reviewer dedicated to providing feedback on our manuscript and are grateful for the insightful comments on and valuable improvements to our paper. We have incorporated most of the suggestions made by the reviewer. Those changes are highlighted within the manuscript. Please see below, in blue, for a point-by-point response to the reviewer' comments and concerns.

Reviewer' Comments to the Authors:
Moatghed et al. in their paper "A non-extensive approach to probabilistic seismic hazard analysis" present a new approach for the probabilistic seismic hazard analysis (PSHA), in which they use the fragment-asperity model of Sotolongo-Costa and Posadas (SCP) to describe the frequency-magnitude distribution of earthquakes, instead of the well-known Gutenberg-Richter (GR) scaling law. Various studies during the last two decades have demonstrated that the SCP model, based on the concept of Tsallis entropy, it provides a physical model for the energy distribution of earthquakes. In addition, it provides in various cases a better fit to the observed frequency-magnitude distribution over a wider range of magnitudes compared to the GR law. Nonetheless, the well-known b-value can be deduced as a particular case in the SCP model. In this framework, the generalization of the classic PSHA by using the SCP model may provide better results regarding the estimation of seismic hazard. The paper presented by Moatghed et al. aims to contribute to this field and clearly falls within the scope of Natural Hazards and Earth System Sciences. The paper is generally well written and structured, but it needs some revisions before it can be further considered for publication. Some points that require further clarification are listed below. The main issue concerns the application of PSHA in the Tehran region in Section 4.
Authors' reply: Thank you for reaching out and providing us with valuable feedback. We found your comments extremely helpful and have revised accordingly.
1. The spatial distribution of earthquakes used in the analysis should be shown in a Figure, perhaps Fig.1.
Authors' reply: Fig. 1 has been modified by adding the suggested content.

2. The authors use earthquakes since 1900AD. Which is the magnitude of completeness of the catalogue during this period?
Authors' reply: The year 1900 is the beginning of the instrumental recording of earthquakes, and for this reason, it has been of fundamental importance in the past researches of the seismicity of the Tehran region. Based on the observations, the first event in this period was recorded in 1930, which definitely indicates incomplete data recording. For this purpose, the Kijko method that provided some considerations to solve this problem, are also included in these calculations. However, since the purpose of this article is to present the methodology, local issues have not been described much in order to summarize.
It is reminded that the advantage of the SCP relationship is in better matching with the range of low magnitudes (which GR relation probably does not show a good compatibility with them due to its incompleteness) and high magnitudes (which probably does not have an accurate recording due to the saturation of the instrument), which in this example also shown this problem.
3. Present a Figure showing the cumulative number of earthquakes used in the analysis and the cumulative number after declustering to show its effectiveness.
Authors' reply: Thank you for your creative thinking. Fig. 2 has been modified by adding the ECDF of the decluttered data.
4. Which method was used to estimate the GR parameters? Obviously, in Fig.2 the GR law is not well implemented.
Authors' reply: Thank you for your consideration and accuracy. The GR parameters have been estimated based on the Kijko's maximum likelihood method. So, the following sentences are added to the main text (lines 168 and 169)
"The GR seismicity parameters (i.e., the rate of seismicity and b-value) are computed using the Kijko's maximum likelihood method (Kijko and Sellevoll 1989;Kijko, 2004). For this end, a MATLAB program (HA3) written by Kijko et al. (2016) has been utilized."
Also, you carefully point out the Incompatibility of GR parameters to observed data in Fig. 2. You are absolutely right. This is because we have mistakenly reported the value of a instead of b in this figure the α and β values α=aGR×ln(10) and β=b-value×ln(10) values instead of aGR and b-value in figure 2 (and also in the Table 1). This mistake has led to the incorrect drawing of the GR curve. Accordingly, this figure was modified.
5. Provide confidence intervals for the parameter values in Table 1.
Authors' reply: We have added the suggested content to the manuscript on Table 1.
6. Revise all calculations of PSHA based on the better estimation of the GR parameters. Show in Fig.3-5 the revised calculations and the corresponding confidence intervals.
Authors' reply: Thank you for your accuracy. Based on your comment, we revised both PSHA and NEPSHA based on modified parameters. It should be noted that in the revised analyses, a better local attenuation relationship, i.e., Yazdani and Kowsari (2013) is used (instead of Ramazi and Schenk (1994)). Accordingly, the results of probabilistic seismic hazard analyses (in figures 3 and 4) were updated.
7. Provide more information on how the uniform hazard spectra are calculated.
Authors' reply: Based on your comment, the following sentences are added to the main text (lines 179-181):
"These spectra are essentially derived from hazard curves, and cover a broad range of spectral periods. To construct UHS from a set of hazard curves, one can conceptualize this process as simply extracting from multiple hazard curves all of the intensity measure levels for a given APE."
8. Some minor comments concern:
Correct to "Posadas" in Line 185.
Correct to "NEPSHA" in Line 135.
Refer to other relevant studies that use the Tsallis entropy approach to identify precursors in the earthquake generation process, such as Vallianatos et al. (2014), Physica A.
Refer to other relevant studies that review the non-extensive approach in earthquakes and tectonics, such as Vallianatos et al. (2016), Proc. R. Soc. A.
Authors' reply: Thank you for your kind interest. The corrections were done and the

mentioned references were cited in the paper.

thanks

Please also note the supplement to this comment:
https://nhess.copernicus.org/preprints/nhess-2022-214/nhess-2022-214-AC1-supplement.pdf