Natural Hazards and Earth System Sciences
Discussions

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# Comment on nhess-2022-59

Anonymous Referee #1

Referee comment on "Time-dependent Probabilistic Tsunami Hazard Analysis for Western Sumatra, Indonesia, Using Space-Time Earthquake Rupture Modelling and Stochastic Source Scenarios" by Ario Muhammad et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2022-59-RC1, 2022

The manuscript “Time-dependent Probabilistic Tsunami Hazard Analysis for Western Sumatra, Indonesia, Using Space-Time Earthquake Rupture Modelling and Stochastic Source Scenarios”

by Muhammad et al. presents an important application of time-dependent probabilistic tsunami hazard analysis (PTHA) to the central Sunda subduction zone. The method involves several novel components, such as stochastic tsunami simulation and space-time interactions among earthquakes, developed in previous publications but integrated in this applied study. The time-dependent component may be particularly important for regions that have recently had a large magnitude earthquake (see comment 1, however) and for short design exposure times. Several minor comments are indicated below, primarily related to unstated assumptions and parameter uncertainty. Upon revision, this paper should be a valuable contribution to Natural Hazards and Earth System Sciences.

General Comments

(1) The study is based on the idea that a BPT or other time dependent rupture model more accurately represents earthquake behavior along the Sunda subduction zone. Given numerous papers refuting the seismic gap hypothesis for subduction zones in general (e.g., Rong et al., 2002 who cite Matthews, 2002), it seems that a logical first step for any study region is to falsify a Poisson null hypothesis.

(2) Although the definition of fault segments is based on 450 years of earthquake occurrence, there still might not be sufficient to determine if these segment boundaries are persistent (cf., Jackson et al, 2011).

(3) The earthquake occurrence model is based on a 1D (along strike) representation of the subduction zone. For the Sunda subduction zone, as with other subduction zones with a broad shelf, however, tsunami generation is critically dependent on the dip extent of rupture as was notably observed in comparisons of the 2004 and 2005 earthquakes (e.g., Geist et al., 2006). The limitation of the 1D approach should be mentioned.

(4) It seems that it would be straightforward to estimate uncertainties in mu, alpha, and gamma from the posterior distributions (confidence intervals). These uncertainties could then be used as part of the probabilistic calculations.

(5) My impression is that the maximum magnitude earthquake considered is from the 450-year record and essentially is an event that spans segments 1-6. Even though the tsunami from an Mmax event would have a low probability, such an event may pose a more significant component of the aggregate hazard for longer exposure times than considered in this study. It should be clarified how Mmax is determined and whether a penultimate event could extend beyond the study region.

(6) Tsunami heights seem to "saturate" at nearly 10m (Figure 13). Is this dependent on the largest magnitude earthquake or is this caused by a hydrodynamic effect?

In-line comments

L42: Vere-Jones' stress release model (cf., Bebbington and Harte, 2001) could also be mentioned—more relevant to this study.

Eqn. 3 is a cumulative distribution function, not a frequency-magnitude distribution.

L141: I couldn't find in the manuscript where the specific magnitude-area relation used was mentioned. Since this is often a contentious choice, especially for subduction zone earthquakes, the specific relation and its justification should be indicated.

L257: How is distance D determined?

L316: Same variable D used for slip here and distance in L257.

Fig. 3: "occurred scenarios" is awkward. Could just say "scenarios".

References

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