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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Characteristics of building fragility curves for seismic and non-seismic tsunamis: case studies of the 2018 Sunda Strait, 2018 Sulawesi-Palu and 2004 Indian Ocean tsunamis" *by* Elisa Lahcene et al.

Anonymous Referee #1

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The paper systematically evaluates tsunami hazard and damage data from three Indonesian tsunami events to develop tsunami fragility functions and compares the developed tsunami fragility functions for different events as well as for different building typologies. The significance of this work lies in this systematic comparison based on rigorous statistical techniques and, as the authors claimed, this has not been done in the literature. This is a useful research contribution and thus, eventually, this work should be published. Having mentioned that, I found that several clarifications are necessary to appreciate the significance of this work. I suggest the following points to be

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Discussion paper

considered during the revision.

Major comments: In Section 3.1.1, the two-layer model is explained. Can the authors explain more on how physically the layer 1 and layer 2 interact? From the equations, the interacting aspects of the two layers are expressed in terms of the water level gradients Z1 and Z2. So the flux Q1 in layer 1 is fluid, while the flux Q2 in layer 2 is s.oil mass? A figure would be useful addition for this section. Equation (7): please specify the units. Figure 2 and Section 3.1.2: It is not clear how the computational cells that correspond to buildings (Figure 2d) can be inundated or not in tsunami simulation. In Section 3.2: could you comment on the vertical accuracies of the DEM/DSM used for the investigations? How were they derived? I would guess local LiDAR data? Throughout the investigations, were the tidal effects taken into account? For the 2018 Palu earthquake, the tidal levels have important contributions (e.g. Goda et al., 2019). In Section 3.2.3, how credible the landslide source model for the Palu event? For example, a detailed seismic source model can explain the majority portion of the observed tsunami in Palu Bay (e.g. Ulrich et al., 2019). How were the effects due to the coseismic deformation and tidal level considered (e.g. Goda et al., 2019)? In light of the missing elements in the tsunami source model, the landslide source model may be considered to be biased. I think this discussion is important for the NHESS journal audience. This is a comment: the scatter plot shown in Figure 9 is not well correlated (i.e. simulation vs observation), which may be due to mis-specified tsunami source. Also note that 'Figure 9' is misspelled. Page 13: Can other link functions other than probit be used? Figure 10 (and other figures as well): Can the data also be displayed? Can the authors clarify the confidence interval indicates the confidence interval of the regression line or the prediction interval of the prediction model? I think by including the data points in Figure 10, this becomes obvious. I think this clarification is important because the number of data is small. Section 5, Line 430: I do not understand the intention of showing the tsunami fragility models based on simulated intensity values? When the tsunami simulations are calibrated reasonably well with the observations, using the same damage data, the fitted fragility models are expected to be similar (as demonstrated in Figure

13). But I do not see the benefit of using the simulated tsunami intensity values unless the authors use the damage data where the observations are not available and thus the tsunami intensity values need to be estimated. But this work does not investigate this aspect. Altogether the simulated cases can be removed. Figure 13: as discussed by the authors, the fragility functions based on flow velocity and (probably) hydrodynamic force do not show realistic features and thus not really useful. It may be useful to show such results for one case but for other cases, they are not really useful, especially for flow velocity. My concern is that careless readers may attempt to use such models as black box models. Figure 14: why the data are only shown for x values greater than 1? Should they start with the theoretical constraints that zero fragility for zero hazard values? My concern is again that careless users may take such unrealistic models as they are. Figure 15: I understand that the results are based on statistical fitting but these curves do not look realistic. Are they reliable? I think the reliability of the curves should be a part of the discussion (beyond the statistical confidence level etc). Can one use these functions reliably? Figure 16: From my perspectives, the comparison of the curves based on flow velocity and hydrodynamic force is not robust. I would suggest focusing on the flow depth based models which show some realistic fragility features.

Goda K, Mori N, Yasuda T, Prasetyo A, Muhammad A and Tsujio D (2019) Cascading Geological Hazards and Risks of the 2018 Sulawesi Indonesia Earthquake and Sensitivity Analysis of Tsunami Inundation Simulations. Front. Earth Sci. 7:261. doi: 10.3389/feart.2019.00261 Ulrich, T., Vater, S., Madden, E. H., Behrens, J., van Dinther, Y., van Zelst, I., et al. (2019). Coupled, physics-based modeling reveals earthquake displacements are critical to the 2018 Palu, Sulawesi Tsunami. Pure Appl. Geophy. 1–41. doi: 10.1007/s00024-019-02290-5

Minor comments Page 1, Line 18: cumulative distribution functions -> delete cumulative distribution. Strictly speaking, the fragility function is not the cumulative distribution function and this expression is confusing. I would suggest deleting ‘cumulative distribution’. There are a few places that have the same expression. Page 1, Line 28: ‘lique-

faction events . . .' The majority of the damage and loss during the Palu earthquake was due to slope failures (which involve liquefaction as physical failure mechanism). It is not clear (especially in the abstract), this 'liquefaction' refers to the slope failure cases (e.g. Petobo) or the flat coastal area along Palu Bay. Given the nature of this event, it would be better to rewrite this sentence to be more specific which area/incidences the authors are referring to. Page 1, Line 38: vertical -> vertical and horizontal. Page 1, Line 41: period -> periods. Page 2, Line 44: were -> was. Page 2, Line 49: few -> a few. Page 2, Line 50: delete finally. Page 2, Line 60: reported to -> reported at. Page 2, Line 60: what is 'largely exceeded'? The meaning is not clear. Page 2, Line 62: assumption -> hypothesis (I think hypothesis is more appropriate). Page 2, Line 68: The sentence 'Koshimura et al. . . .' reads strangely in a sense that the tsunami fragility concept existed before this work. I agree that the work by Koshimura et al. was very influential. Page 2, Line 69: delete 'cumulative distribution'. Page 3, Line 86: treated -> analyzed. Page 3, Line 93: exposed -> investigated. Page 5, first line: are -> is. Page 14, Line 284: appear -> appears. Page 19, Line 384: depicted -> listed or summarized. Page 20, Line 398: identical curves -> identical slopes?

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