Dear Referee 1,

We would like to thank you for the time spent on our manuscript. We are very pleased that you highly evaluated our work. We highly appreciate your constructive comments and suggestions. You also pointed out the clarifications required to improve the original manuscript. We modified the manuscript according to your recommendations. Please find our answers and corrections below (all changes are highlighted in red in the manuscript).

- **Major comments**

Reviewer comments	Our answers	Corrected manuscript
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 soil mass? A figure would be useful addition for this section.	The flux Q1 is water while the flux Q2 is granular material (soil). We added more explanations and Fig. A1 to better understand the meaning of each term.	Line 167: ρ_1 and ρ_2 are the densities of the seawater and the landslide. The fifth term of the momentum equations (Eqs. 2, 3, 5, 6) represents the interaction between the two layers. The tsunami model… Line 170: …, respectively (Fig. A1 - Appendix A) **Please, see Fig. A1 below (Appendix A).**
Equation (7): please specify the units.	We thank the reviewer for pointing this out. We added the units as well as more explanations.	Line 189: n_o corresponds to the Manning's roughness coefficient (n_o = 0.025 s.m$^{-1/3}$), C_D represents the drag coefficient (C_D = 1.5 (Federal Emergency Management Agency (FEMA), 2003)) and the constant d signifies the horizontal scale of buildings (~15 m). θ is the building occupation ratio in percent (0-100 %) for each computational cell of 20 x 20 m^2 and 1 x 1 m^2 resolutions for Sunda Strait and Palu areas, respectively. θ is obtained by computing the building area over each pixel using GIS data. The computational cell corresponding to buildings can be inundated by the n Manning coefficient through the term D, which represents the simulated flow depth (m). In the urban areas of Sunda Strait and Palu, the average occupation ratios are 24 % and 84 % respectively (Fig. 2b,d). In non-residential area, we set the Manning's roughness coefficients inland and on the seafloor to 0.03 and 0.025 respectively, which are typical values for vegetated and shallow water areas (Kotani, 1998).
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.	The computational cell corresponding to buildings can be inundated by the n Manning coefficient through the last term of Eq (7): D, which represents the simulated flow depth (m).	Line 193: …using GIS data. The computational cell corresponding to buildings can be inundated by the n Manning coefficient through the term D, which represents the simulated flow depth (m). In the urban…
In Section 3.2: could you comment on the vertical accuracies of the DEM/DSM used for the	Corrected.	Line 180: BATNAS and DEMNAS, Indonesia, provided the bathymetric and topographic data with 180 and 8 m-

investigations? How were they derived? I would guess local LiDAR data?		resolutions, respectively. The data was established from SAR images (http://tides.big.go.id/DEMNAS/index. html). Both datasets were resampled to three computational domains with a grid size of 20-m resolution (Fig. 2a,b). In Palu-City, the bathymetric and topographic data with 1-m resolution were obtained through Lidar images and supplied by the Agency for Geo-spatial Information (BIG), Indonesia (Fig. 2b,c). For tsunami inundation… Line 211: To correct the Digital Surface Model (DSM), we removed the vegetation, buildings and infrastructures elevations based on the linear smoothing method and used the resulting Digital Elevation Model (1^{st} DEM) as topography in the tsunami inundation model (Fig. 3). The vertical accuracy of the DSM/DEM is about 4 m. The 2018 Sunda Strait…
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.	We agreed with the reviewer. The tsunami inundation model is now part of the discussion (Section 6.1). Contrary to Sunda, we took into account tidal effects in Palu. As mentioned by Pakoksung et al. (2019), TUNAMI-N2 does not reproduce the effect of seismic deformation. So, we considered that the 2018 Palu tsunami was triggered by subaerial/submarine landslides only (TUNAMI two-layer model). Furthermore, some observed and simulated flow depths are very different in Palu. To tackle this issue, we decided to set a confidence interval of 1 m to develop accurate curves. The observed and simulated curves based on the flow depth are relatively similar, so it shows the consistency of the 1-m confidence interval.	Line 233: We increased the mean sea level (MSL) by 2.3 m to reproduce the high tide during the 2018 Palu tsunami. As shown by Pakoksung et al. (2019), the observed waveform at Pantoloan tidal gauge does not fit the simulated one with the Finite Fault Model of TUNAMI-N2. Although recent studies show that seismic seafloor deformation may be the primary cause of the tsunami (Gusman et al., 2019; Ulrich et al., 2019), in this study, the main assumption is that the 2018 Sulawesi-Palu was triggered by subaerial/submarine landslides. According to Heidarzadeh et al. (2018), a large landslide to the north or the south of Pantoloan tidal gauge is responsible for the significant height wave recorded. Arikawa et al. (2018) also identified several sites of potential subsidence in the northern part of Palu-Bay. Based on these previous studies, we assume two large landslides: L1 and L2. Small landslides (S1-S12) also occurred in the bay; their location stands on observations from satellite imagery, field surveys and video footage (Arikawa et al., 2018; Carvajal et al., 2019) (Fig. 6). The trial and error method aims to achieve the volume of the landslides (Table 3). In Figure 7, the submarine landslides model reproduces well the tsunami observations at Pantoloan. The calibration …

		Please, see the added Section 6.1.
Also note that 'Figure 9' is misspelled.	Thank you very much. We corrected it.	Figure 9. Comparison between observed and simulated flow depths at damaged building for a S8 ratio of 1.2; a confidence interval is set at 1-m flow depth.
Page 13: Can other link functions other than probit be used?	We thank the reviewer for this request. We decided to include the sensitivity analysis of the statistical model based on the link function. Following the GEM guidelines, we considered overall three functions: the probit, logit and cloglog. Overall, the choice of link function does not change the discussion. It was found that the probit function fits the Sunda data best. The logit function fits the Palu and Thailand data best. The change in the link function does not notably change the shape of the fragility curves.	**Please, see the revised Sections 4.1 and 4.2, and the updates in Appendix C and Appendix D.**
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.	We thank the reviewer for this comment. Figures 10-12, which we believe the reviewer refers to, are part of the exploratory analysis. The sole aim is to show trends in the data which will be useful to construct the statistical model in the following section. All we need to see is whether the intercept and/or the slope of a best estimate curve changes for different variables. For this reason, we use the inverse of the cumulative standard normal distribution in the y axis and the natural logarithm of the tsunami intensity in the x axis. To present the data points will mean to estimate the inverse standard normal cumulative distribution function of the probability that a given building will experience a given damage state or above. For our case, we have building-by-building damage data therefore this probability (e.g., P(DS ≥ ds_1|Flow depth)) is either 0 or 1 for which the inverse of the standard normal cumulative distribution function is not defined. For this reason, we did not present the data points. Instead, we updated the text to avoid confusion.	Line 319: … curves. The confidence in the exact shape of the mean curves is estimated and presented in terms of the 90 % confidence intervals around the best-estimate curves.
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	We understand the point of view of the reviewer. We highlighted the benefits of the simulated fragility curves in the abstract and the introduction. The main reason is	**Please, see the revised abstract and the last paragraph of the introduction.**

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.	that 2018 Sunda Strait and Sulawesi-Palu tsunamis are uncommon events still poorly understood compared to the 2004 IOT. The flow depth is the only tsunami intensity measure recorded during the field surveys. So, to improve our understanding of the structural damage caused by the Sunda Strait and Sulawesi-Palu tsunamis and to discuss the impact of wave period, ground shaking and liquefaction events, we reproduce their tsunami intensity measures (i.e., flow depth, flow velocity and hydrodynamic force). Moreover, this is the first attempt to develop fragility curves as functions of the flow depth, the flow velocity and the hydrodynamic force for the 2018 Sunda Strait and 2018 Palu tsunamis based on TUNAMI two-layer model.	
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.	We thank and agreed with the reviewer. In the discussion, we discussed whether the tsunami intensity measures are efficient predictors of damage (Section 6.1). The flow velocity and the hydrodynamic force (please, see the drag force formula) are not providing a good description of the tsunami damage, compared to the flow depth. This is a valid contribution to the field. Therefore, the 2nd part of the discussion (Section 6.2) is based on the curves function of the flow depth only. Careful readers should rather use fragility curves based on observation as they are of higher quality.	Line 172: … during the tsunami inundation. The hydrodynamic force acting on buildings and infrastructure is defined as the drag force per unit width of the structure (Koshimura et al., 2009). $$F = \frac{1}{2} C_D \rho u^2 D$$ C_D represents the drag coefficient (C_D = 1.0), ρ is the water density (ρ = 1000 kg/m^3), u stands for the current velocity (m/s), and D is the inundation depth (m). **Please, see the added Section 6.1 and the revised Section 6.2.**
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.	We thank the reviewer for pointing this out. It does not mean that there is no potential damage between 0-1 m flow depths or 0-1 m/s flow velocity. The reason is that we do not have data to predict the shape of the curves.	Line 469: …DB_Sunda2018'. In Fig. 14a,b, there is no data to predict the shape of the curves between 0-1 m and 0-1 m/s. The curves….
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	We agreed with the reviewer. The reliability of the curves is discussed in Section 6.1. Compared to the flow depth, the flow velocity and the hydrodynamic force are not good predictors of damage. For this reason, we are not discussing the building damage probability based on these tsunami intensity measures	**Please, see the added Section 6.1.**

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.	for the 2018 Sunda Strait and Palu tsunami.	

- **Minor comments**

Reviewer comments	Our answers	Corrected manuscript
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.	We are very sorry for this confusing expression and we corrected it.	These ~~cumulative distribution~~ functions express the likelihood of a structure reaching or exceeding a damage state in response to a tsunami hazard intensity measure.
Page 1, Line 28: 'liquefaction 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.	We are very sorry and cleared this part. Here, we mentioned liquefaction events related to ground failures in the waterfront of Palu-City. We also made the distinction with the slope failure cases observed inland in Section 6.2 (e.g., Petobo, Jono and Balaroa).	Abstract: Similar to the Banda Aceh case, the Sulawesi-Palu tsunami load may not be the only cause of structural destruction. The buildings susceptibility to tsunami damage in the waterfront of Palu-City could have been enhanced by liquefaction events triggered by the 2018 Sulawesi earthquake. **Please, see the revised Section 6.2.** Conclusion: The Sulawesi-Palu tsunami is a complex event as it may not be the only cause of structural destruction. The 2018 Sulawesi earthquake caused minor damage to buildings and most importantly could have triggered liquefaction events in the waterfront of Palu-City (e.g., coastal retreats) increasing the building susceptibility to tsunami damage.
Page 1, Line 38: vertical -> vertical and horizontal.	Corrected	...causing horizontal and vertical movement of the ocean floor…
Page 1, Line 41: period -> periods.	Corrected	…longer wave periods attacking the coast …
Page 2, Line 44: were -> was.	Corrected	…strong ground shaking was reported …
Page 2, Line 49: few -> a few.	Corrected	After a few months …
Page 2, Line 50: delete finally.	Corrected	…the Anak Krakatau Volcano ~~finally~~ erupted …
Page 2, Line 60: reported to -> reported at.	Corrected	…the wave height reported at the Pantoloan tidal gauge…
Page 2, Line 60: what is 'largely exceeded'? The meaning is not clear.	Corrected	… The fault mechanism did not suggest that the tsunami would be so destructive. The wave reached rapidly Palu (~8 min), implying that its source was inside or near the bay

		(Muhari et al., 2018; Omira et al., 2019). Its short wave…
Page 2, Line 62: assumption -> hypothesis (I think hypothesis is more appropriate).	Corrected	… the main hypothesis is that …
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.	Corrected	The term "tsunami fragility" is a new measure to estimate structural damage and casualties caused by a tsunami, as mentioned by Koshimura et al., 2009b.
Page 2, Line 69: delete 'cumulative distribution'.	Corrected	Tsunami fragility curves are ~~cumulative distribution~~ functions expressing
Page 3, Line 86: treated -> analyzed.	Corrected	… are analysed separately …
Page 3, Line 93: exposed -> investigated.	Corrected	… are investigated.
Page 5, first line: are -> is.	Corrected	… is ignored …
Page 14, Line 284: appear -> appears.	Corrected	… as the two curves appears to …
Page 19, Line 384: depicted -> listed or summarized.	Corrected	… are listed in …
Page 20, Line 398: identical curves -> identical slopes?	Corrected	… identical slopes …

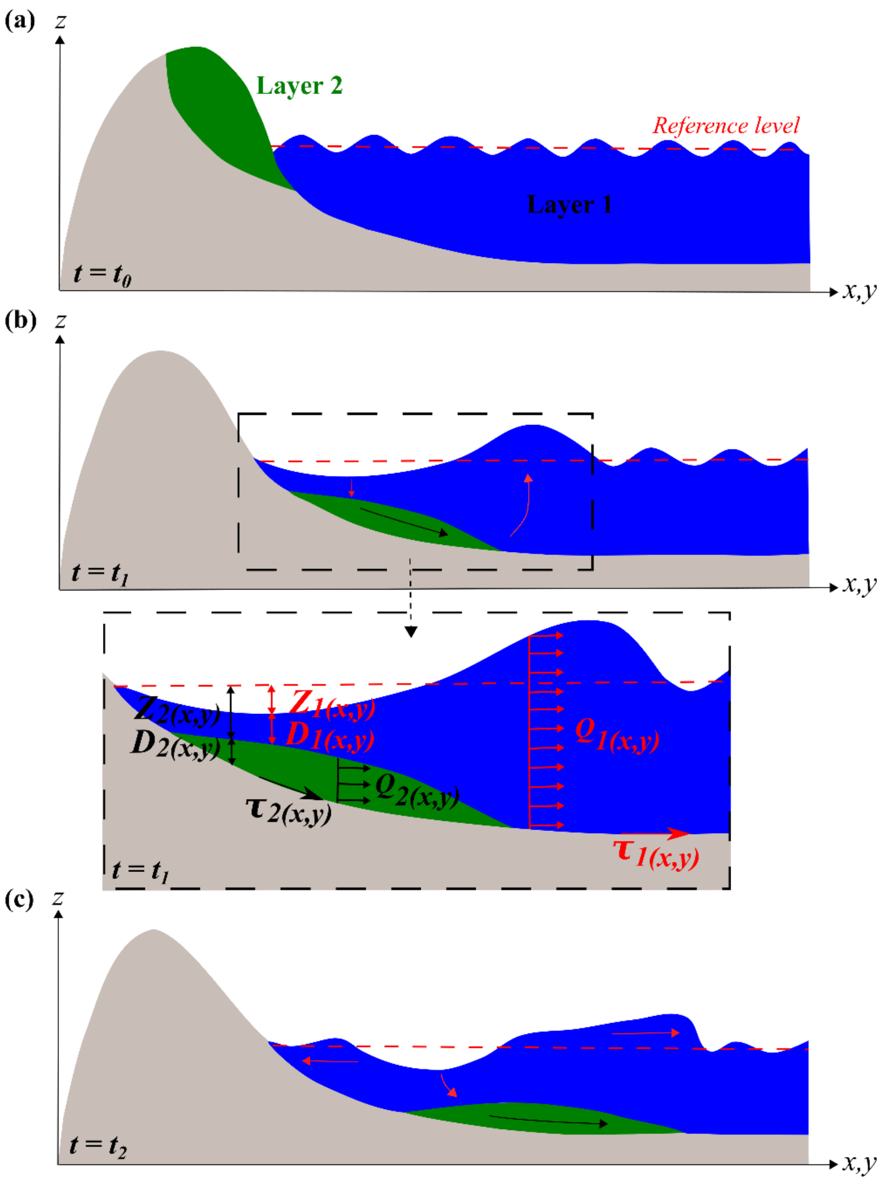

Figure A1. Two-layer modelling of a subaerial/submarine landslide (from the original sketch of Pakoksung et al., 2019), (a) pre-failure, (b) generation of negative and positive waves due to the landslide and (c) landslide in progress and wave propagation.

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