Natural Hazards and Earth System Sciences Discussions

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Comment on nhess-2022-95

Anonymous Referee #1

Referee comment on "Nearshore Tsunami amplitudes across the Maldives archipelago due to worst case seismic scenarios in the Indian Ocean" by Shuaib Rasheed et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2022-95-RC1, 2022

This reviewer would like to commend the authors on their work. Efforts associated with quantifying tsunami hazards/vulnerability is a welcome addition and this work represents first of its kind tsunami simulations for the Maldives archipelago. Further, I would particularly like to commend their efforts on providing an online server to access the results, as stated by the authors this will be of great benefit to the wider community.

However, before I can recommend this paper for publication I would encourage the authors to engage with the feedback and comments provided below.

Main Comments

- Aside from the detailed feedback below my main critique of the work is related to the numerical modelling and would recommend some additional efforts in this regard. The main issue is the use of coarse (50m) \`fine-resolution' grids. The authors themselves repeatedly state the necessity of high resolution bathymetry/meshes to capture the complex wave patterns of tsunami waves around and within Atolls. They state that their high resolution mesh has a minimum mesh element size of 50m however in their referenced work [Rasheed, 2021 (a)] it appears that bathymetry data on a ~10m resolution is available. If high resolution information is key to capturing the complex tsunami wave patterns, something which this reviewer agrees with, why have the authors not used a finer resolution mesh? Is there an issue with computational resources? Please expand on this.
- The authors state that the model Thetis can capture wetting/drying using the algorithm described in Eq. 3, however they have chosen a minimum water depth of 0.1m. From this reviewer's experience this minimum depth is overly conservative. If a higher resolution mesh is used than I would encourage the authors to reduce this value.

Otherwise the overtopping of low-lying islands may not be captured accurately and thus the influence on the resultant wave pattern will be missed. Further comparisons to run-up and inundation measurements from the 2004 survey could also be made. It should be noted that despite the recognised absence of additional terms in the non-linear shallow water equations (NSWE) for capturing inundation, numerous NSWE solvers have been validated against inundation and runup tasks, [Macias 2017] is one such example.

Line by Line Comments

Section 1.

Line 25: Rephrase ``These data imply …”

Line 30 - 35: It might be worth mentioning the return periods of some of the findings

Line 38: Please expand on the ``safe island concept” for those who are unaware of it.

Line 41-42: Rephrase ``impacted less and others being impacted more”

Lines 50-55: Please make reference of [Xie 2019], where a tsunami hazard assessment of the Xisha Archipelago was carried out.

Section 2.

Line 102: Typo ``Boxing Day even” should be ``Boxing Day event”

Line 113: Typo ``Table 1” should be ``Table 2”

Line 113: Rephrase ``worst most-likely”

Section 2.2: It would be good to make reference to Figure 1, which showcases the location of the various sources

Section 2.3: It appears that this section is a direct copy of a section in the authors previous works [Rasheed, 2021 (a) and Rasheed, 2021 (b)].

Line 150: Units for kinematic viscosity

Line 152: I would suggest introducing tau and rho here instead of on Line 160. Please also make reference to that fact that the value of n will be discussed in section 2.3.4.

Line 153: Please provide a further explanation for the P^{DG}_1 - P^{DG}_1 term.

Comment: Has the Thetis model in this set up been validated against traditional tsunami benchmark problems? If not I would suggest taking a look at the problems outlined in [https://nctr.pmel.noaa.gov/benchmark/].

Line 166: ``Each simulation was run in a full simulation which spatially extended ..” It is not clear from this sentence how the nested simulations were carried out, please clarify this.

Line 166-167: Reorder the Figure numbers, ``Figures 2 (a) and 1 (a)” and ``Figures 2 (b) and 1 (b)”.

Line 171-173: The authors state that the tidal variation of 1m is ``very small” and can therefore be discounted however in later sections they state ``If combined with a high tide, tsunamis generated from scenario 2a would likely have an impact across locations predicted to have higher amplitudes”. I would agree with the later and state that tidal forcing can play a role in inundation levels. Not including tidal forcing in the study is acceptable but please correct this section and make note of the limitation in section 4.3 (Limitations of the Study and Recommendations for Improvement).

Figure 1: Please increase the size of Figure 1 (b). It is difficult to make out the high resolution features. Please also ensure that all x and y axis are labelled.

Figure 1: Typo in the caption ``13 orth Nilandhe” and ``20. ddu Atoll”.

Figure 2: Please make the subplot (b) larger and label the axis correctly.

Section 2.3.5: How are the full and higher resolution mesh merged? From reading it appears there is a mismatch in mesh resolution at the boundaries, with the full mesh having a resolution of 5km to 7.5km while the nested mesh has a resolution of 10km at the boundaries. Please provide some details on nested procedure.

Section 3.

Figure 3: Please make subplots (a) and (b) larger. There appears to be an artefact of the nesting in the bottom right of both subplots (a) and (b). The bottom right corner exhibits some high wave heights which exhibit a discontinuous drop-off when moving in a north western direction. Is this physical or an artefact of the nesting?

Section 3.1.2: Why have you chosen a Pearson correlation coefficient? Would a RMSE value be more appropriate? Please explain.

Lines 260 -266: This appears to be a one sided comparison. What about the areas of low impact? Do the simulated and observed areas of low impacts also match up? This is an equally interesting comparison.

Figure 4. It might be useful to provide a map showing where these subplots are located in the Maldives. Please provide a wave height scale and label the axis for each subplot.

Figure 6 and 7: Typo ``worst case fault case”

Section 4.

Lines 347-349: Are the refraction, diffraction and reflection patterns repeated across different simulated sources? Please comment on this.

Figure 8: Mark the Atolls (South Nilande, Mulaku and Kolhumadula) in subplot (a). Please

re-plot with the wave height coloring centred on 0m. It may be interesting to see reflections etc.

Line 352: Please reference the work of [Reymond, 2012], where the role of reef systems on the amplification of tsunami waves is captured as a site specific amplification parameter.

Lines 353-357: Please rephrase this sentence.

Line 372: Can you please qualify ``with high tsunami flow velocities across the shallow and narrow channels”, as there are no plots explicitly showing this behaviour.

Section 4.2: As stated above I highly commend the authors for providing the online explorer. However the links do not work and I was unable to access the server. Please correct this.

Line 450: The following work should be cited as an additional approach for investigating uncertainties [Giles, 2021]. In that work the uncertainty on the source is propagated to maximum wave heights using cheap statistical emulators.

Section 5.

Line 456-457: The statement ``variability in the resulting tsunami amplitudes due to the development of complex refraction and reflection wave patterns” should be qualified with further results such as those shown in section 4.1

To finish I would like to reiterate my commendation of the authors efforts and appreciate that my main comments listed above may be deemed harsh. However, if the high resolution data is available I would encourage the authors to re simulate at a higher resolution.

References

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- Xie, 2019: Xie, X., Chen, C., Li, L., Wu, S., Yuen, D. A., Wang, D.:“Tsunami hazard assessment for atoll islands inside the South China Sea: A case study of the Xisha Archipelago”, Physics of the Earth and Planetary Interiors, 290, 2019
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- Reymond, 2012: Reymond, D. and Okal, E. A. and H{\'{e}}bert, H. and Bourdet, M.: “Rapid forecast of tsunami wave heights from a database of pre-computed simulations, and application during the 2011 Tohoku tsunami in French Polynesia”, Geophysical Research Letters, 11, 1—6, 2012
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