

Public justification (visible to the public if the article is accepted and published):

Dear Authors,

Thank you for the submission of your revised paper “An internally consistent framework for calculating cascading probabilistic earthquake risk and its application to a case study in New Zealand” to NHESS.

I carefully examined your revised manuscript. I think that the manuscript has been substantially improved during the revision process. However, I identified a few remaining issues that should be addressed in the revised version. I summarized them below.

Along with the revised manuscript, please include the following:

- A detailed author’s response to the comments and corrections
- A version of the manuscript with tracked changes, highlighting all modifications made in response to the reviews.

I look forward to receiving the revised version of your manuscript.

Kind regards,

Seda Yolsal-Çevikbilen
NHESS Editor

Additional private note (visible to authors and reviewers only):

In the revised manuscript:

Line 50: Please carefully revise the figure caption. The blue vectors and numbers shown on the map should be explained in the figure caption by giving suitable references.

Thank you for the suggestion. We have revised the figure caption accordingly. The revised caption is provided below:

Figure 1: Seismotectonic setting of New Zealand, showing the subduction boundary between the Pacific and Australian plates. Grey circles indicate earthquakes with moment magnitudes of $5.0 \leq M_w < 7.0$ since 1970, whereas coloured circles indicate $M_w \geq 7.0$ earthquakes since 1900 (USGS catalogue). Blue arrows show the relative plate convergence rates (cm yr^{-1}), and red triangles indicate the orientation of the subduction zones. The blue star marks the location of Napier. HSZ and KSZ denote the Hikurangi and Kermadec subduction zones, respectively. Convergence rates are adapted from Clark et al. (2019).

Line 58, 98: Please write the citations in the text correctly. There is no reference of Zhakirova et al. (2019).

Thank you for pointing this out. We have corrected the citation to Zharikova et al. (2019).

Line 62: Please also read the study of Yolsal-Çevikbilen et al. (2019) for the source model of the 2018 Mw7.5 Palu earthquake.

Thank you for the suggestion. We have incorporated this reference into the Introduction and added it to the reference list.

Line 68-70: Please check the sentence as it appears to be not completed.

Thank you for pointing this out. We have revised the sentence, which now reads:

New Zealand has also experienced the disruptive effects of multi-hazard and cascading events. For example, the 2010–2012 Canterbury earthquake sequence resulted in widespread ground shaking, landslides, and liquefaction, while the 2016 Kaikōura earthquake triggered a cascade of hazards, including strong ground shaking, landslides, tsunami, landslide dam formation, and floodplain subsidence (Hughes et al., 2015; Robinson and Rosser, 2017).

Line 199: Please check "(H SZ)"

Thank you for pointing this out. We have corrected the formatting.

Line 275: Is the title of "3.1. Introduction" necessary? There is a same title (1. Introduction) in the text.

Thank you for the suggestion. We have renamed the subsection to "3.1 Overview of the study area", which we believe better reflects its content and fits the paper structure.

Line 117, 190, 205, 298, 302, 357, 361: Please ensure that all abbreviations are defined at their first occurrence in the manuscript (e.g., PGA, HSZ, LDI, GMPE, DS as such).

Thank you for the suggestion. We have carefully revised the manuscript and identified one abbreviation that had not been defined at its first occurrence. We have corrected this by defining KSZ (Kermadec Subduction Zone) in the updated caption of Figure 1.

Line 251: There is no reference of FEMA (2020) in the references section.

Thank you for pointing this out. We have included the missing FEMA (2020) reference in the reference list, as it provides the methodology for the HAZUS earthquake risk model, including the damage state–mean damage ratio definitions.

Line 317: Please provide a suitable citation for COMCOT in the manuscript.

Thank you for the suggestion. We have incorporated the recommended reference (Wang and Power, 2011) into the manuscript and added it to the reference list.

Wang X, Power W. 2011. COMCOT: a tsunami generation, propagation and run-up model. Lower Hutt (NZ): GNS Science. 121 p. (GNS Science report; 2011/43).

Line 332: Please check the sentence.

Thank you for the suggestion. We have revised the sentence by adding the necessary commas.

Line 341: 2017 maps?

We have clarified the sentence, which now reads:

To enhance the confidence in the Rosser and Dellow (2017) maps, seventeen additional cone penetration tests (CPTs) were analysed for liquefaction susceptibility, using the existing parameters from the 2017 work and new knowledge gained since then (Griffin, 2024).

Figure 4: Please explain LVC1, 2-7 and V1, 2-7 runoff in the figure caption. Furthermore, the authors may consider adding the names of some nearby cities/locations on the map to provide a clearer indication of the study area. Loggerhead Rd?

We have revised the Figure 4 caption to define the abbreviations. LVC refers to landslide volume class and V refers to volume. Because the volume of a potential future landslide within each source region is uncertain and could span a range of values, we modelled a series of landslide volume classes up to a credible maximum volume. The revised caption clarifies that LVC1-LVC7 represent the landslide volume classes considered, and V1-V7 runoff refers to the corresponding runout associated with each volume class.

Revised Figure 4 caption:

Figure 4: (a) Example of the seven landslide volume classes (LVC1-LVC7) within a single source region. As the volume of a future landslide is unknown, a range of landslide volume classes were modelled up to a credible maximum volume. (b) Example runout associated with each of the seven landslide volume classes (V1-V7).

Line 397: I think that it should be "Table 1".

We have corrected it and referenced Table 1 instead.

Line 400: In table caption, please provide a citation for the data given in Table 1. We have updated the table caption to indicate that the values are derived from the building exposure model described in Sect. 3.3 and Supplementary Material S3.

Table 1: Number and percentage of buildings exposed to each hazard in the Napier case study, derived from the building exposure model described in Sect. 3.3 and Supplementary Material S3.

Line 439: Table 3 or Table 2? Please check it.

Thank you for pointing this out. We have corrected the reference to Table 2.

Line 571: Please define DS0, DS1, ...DS4 in the figure caption.

We have revised the Figure 8 caption to define the damage states (DS0–DS4).

Figure 8: a) Total mean damage ratios (TMDR) and b) Relative mean damage ratios (RMDR) expected in Napier City disaggregated for earthquakes on the HSZ for each peril considered in this study. Damage states are defined as DS0 = no damage, DS1 = slight, DS2 = moderate, DS3 = severe/extensive, and DS4 = complete damage or collapse.

Line 664: I suggest that the limitations can be given before the Conclusion section as a subsection (e.g., 4.1. Limitations).

We agree and have revised the manuscript accordingly by moving the limitations to a separate subsection preceding the Conclusions.

Line 679: Please do not number the Acknowledgements, Author Contributions, and References sections.

We have updated the manuscript accordingly.

For References

Line 699, 738, 768: The format of the references should be the same.

Thank you for the suggestion, we have updated the references to follow the same format as the rest:

*Behrens, J., Løvholt, F., Jalayer, F., Lorito, S., Salgado-Gálvez, M. A., Sørensen, M., Abadie, S., Aguirre-Ayerbe, I., Aniel-Quiroga, I., Babeyko, A., Baiguera, M., Basili, R., Belliazzi, S., Grezio, A., Johnson, K., Murphy, S., Paris, R., Rafliana, I., De Risi, R., Rossetto, T., et al.: Probabilistic Tsunami Hazard and Risk Analysis: A Review of Research Gaps, *Front. Earth Sci.*, 9, 628772, <https://doi.org/10.3389/feart.2021.628772>, 2021.*

*Goda, K., and De Risi, R.: Future perspectives of earthquake-tsunami catastrophe modelling: From single-hazards to cascading and compounding multi-hazards, *Front. Built Environ.*, 8, 1022736, <https://doi.org/10.3389/fbuil.2022.1022736>, 2023.*

*Lin, S. L., Moratalla, J. M., Uma, S. R., and Lukovic, B.: Development of vulnerability functions for multi-storey (3 storeys and above) residential buildings in New Zealand, *GNS Sci. Rep.* 2022/49, GNS Science, Lower Hutt, New Zealand, 53 pp., 2023.*

Line 715: Please carefully review all citations in the manuscript and ensure that each reference listed in the reference section is appropriately cited in the text. For example, the citations for Callaghan (1933), Dellow et al. (1999, 2003), Dowrick et al. (1998), Fairless and Berrill (1984), Komar (2010), Lin et al. (2024) appear to be missing in the text, although they are in the reference list.

We have carefully reviewed the citations throughout the manuscript and made the following revisions:

- Callaghan (1933) has been cited in the introduction to the case study area.
- Dellow et al. (1999) and Fairless and Berrill (1984) have been cited in Section 3.1 to support the evidence of liquefaction potential in the study area.
- Dellow et al. (2003) has been removed from the reference list, as the Supplementary Material now cites more relevant sources for the landslide modelling input data.
- Dowrick et al. (1998) has been cited in Section 3.1 as a reference for the 1931 Napier earthquake.
- Komar (2010) has been removed from the main manuscript, as it is only cited in the Supplementary Material.
- Lin et al. (2024) has been cited in the text to support the liquefaction fragility modelling.

Additionally, we identified an incorrect reference to Czado et al., which has now been removed.