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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Tsunami evacuation modelling as a tool for risk management: application to the coastal area of El Salvador" *by* P. González-Riancho et al.

Anonymous Referee #2

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Review of "Tsunami evacuation modelling as a tool for risk management: application to the coastal area of El Salvador" (P. Gonzalez-Riancho et al.)

The manuscript "Tsunami evacuation modelling as a tool for risk management: application to the coastal area of El Salvador" (P. Gonzalez-Riancho et al.) addresses relevant questions in the field of tsunami science, and is within the scope of NHESS. The authors contribute a framework for assessment of tsunami evacuation potential and the need for additional evacuation facilities, and apply this framework to a case study in El Salvador. The methods presented in the manuscript are transferable and have value for application in other areas internationally.

The title is clear in its reflection of the manuscript contents. The abstract provides a clear summary of the methodology and framework, but the reader would benefit from the abstract also containing a summary of results from the case study, or at least acknowledgement of the application to the case study in the abstract. Both title and abstract are easy for a diverse audience to understand. The length of the paper is adequate.

The number and sources of references are adequate. The English language is generally of good quality, although I have made a number of suggestions below related to language. The scientific language is generally precise, although there a few instances where terms used do not reflect the commonly-accepted terms in this field – see comments below. There are several areas that require further clarification of the method to help the reader gain a full understanding of the work. I suggest that the manuscript would be suitable for publication once the following corrections have been made.

Abstract:

Please include a sentence to indicate that the framework has been applied to the El Salvador case study, demonstrating application to locally-specific response times and population to determine optimal evacuation locations for the study area.

Manuscript text –required corrections:

P.2171 ln20: Section 2.1 would benefit from the inclusion of a sentence to explain why hazard assessment is not dealt with in more detail here. It is fine that this paper focusses on the evacuation planning method, not the hazard assessment, but please clarify this point and direct the reader to a methodology for the hazard assessment, for example earlier papers in the same project that are related to this El Salvador analysis.

P.2172 ln.8: Please provide some further explanation of 'illiteracy'. Do you mean illiterate specifically for not understanding written materials or illiteracy in terms of hazard awareness and protective appropriate actions?

P.2173 ln.1-8: Please clarify whether the 'security level' in the medium and high security zone descriptions is defined by elevation, distance from the coast, or both.

P.2175 ln.22: The reaction time of 15min for the whole population is an over-simplification – the whole population would not evacuate at the same time. This should be acknowledged as such in the text, with an explicit justification of the use of this value. (also clarify at p.2183 ln18)

P.2177 ln.9: Please include clarification of whether the slope calculation accounts for direction of travel. I.e., does slope slow evacuation regardless of whether the evacuee is travelling uphill or downhill. You should provide the equation to show how you adjust the speed to account for effect of slope.

P.2176 ln.20: Clarification is required on the use of 'evacuation origin points'. Are all people from one community assumed to originate at a single point or does each point represent an individual or family/instutional group?

P.2178 ln.21: Please explain the reason for choosing a response time of 30 minutes. As this is part of the paper is presenting the framework, it should be made clear here that this value should be altered according to the context / case study area based on modelled tsunami arrival time or minimum potential response time for the local area. This is required to avoid readers assuming that 30 minutes is a suitable time threshold in all cases. It is then appropriate in your case study section to use a particular response time based on the local context.

P.2178 ln22: Please include a more detailed explanation of the 'iterative location' process. In order to properly optimise the tower locations, steps 2, 3 and 4 (and an additional step: calculating the number of people who can travel to the tower given the calculated distance) should all be carried out for each iteration (each potential tower location) in order to optimise the location of towers in each area. As it stands, the text does not fully explain the method used so it is difficult for the reader to understand whether optimisation is carried out correctly. Do you a) choose one tower location per

area and iteratively add more tower locations in that until evacuation demand is satisfied (i.e. let the optimisation determine the number of towers and their location), or b) iteratively alter the location of a single tower in each area until evacuation demand is satisfied (i.e. pre-determine that only one tower should be located in each area)? State the basis on which you determine the optimal location – presumably by the tower location that can be reached by maximum number of people in the area, but you should state this explicitly.

P.2178 ln23: The use of tsunami arrival time at the location of the vertical evacuation shelter neglects the fact that the population located seaward of the evacuation shelter have less available evacuation time than quoted for the tower. For example, shelter 3 in figure 12: the majority of evacuation origin points are located seaward of the arrival. For a more conservative estimate of the available travel time, the arrival time at the coast should be used. The justification of using arrival time at the tower location, rather than arrival time at the coast should be stated.

P.2179 ln10: Section 2.6 reads as though it is a summary of section 2. Please update the title to make it clearer that this is a summary. The modelling phase should be included in this section, to give a complete summary of the section.

P.2179 ln20: please provide a reference for the catalogue of historic tsunami to have affected this area. What proportion of tsunami that have affected the coastline been local, regional or distant?

P.2180 ln18-24: A reference is required for the work on the deterministic hazard analysis. Please state more earthquake parameters to describe the source earthquakes – as a minimum state the range of magnitudes used, and whether are these local /regional / distant events

P.2180 ln22: Please make it clear that drag is calculated as: flow depth * velocity, and that the maximum potential drag is the required parameter for the analysis.

P.2180 ln22: (and figure 4). Maximum wave height elevation is useful for empirical estimation of run-up from wave height at the coast when no inundation modelling has been conducted, but in this case, the presentation of flow depth makes this measure somewhat redundant. Figure 4 would be more useful to the reader if maximum flow velocity was shown, rather than maximum wave height level. Please amend the legend to clarify that the bottom map shows maximum drag.

The case study presented does not incorporate any estimation of the number of people in the hazard zone. It does not present any discussion of the numbers that can be saved at each shelter site, therefore the required capacity of the shelters (although this general concept is mentioned in the text). In order to complete the case study, such values should be cited.

Manuscript text – additional suggested corrections:

P.2164 Ln.22-23: suggested change 'identifying' to 'identification of'

P.2166 Ln.23: A reference for FLOODsite project (2009) is not included in reference list

P.2167 ln.6: 'Bc Hydro' should read 'BC Hydro'

P.2169 ln.10-17. I would argue that this is surplus to requirements, particularly the final sentence, which is too vague.

P.2169 ln.22: There seems to be a word missing – should this read '. . .therefore translates into benefits. . .'?

P.2171 ln.23: The phrase 'tsunamis with greater or lesser affection to the study area's coast' should be changed to something like 'tsunamis that affect the coast to a greater or lesser extent' or 'tsunamis with variable impact on the coast'. Please update all instances of this in the paper.

P.2171 ln.24: 'distant, intermediate and close sources' are usually referred to as 'distant, regional and local sources'. Please consider amending this.

P.2172 ln.19: Please consider changing 'not-flooded areas' to 'areas that are not flooded'

P.2173 ln.16: Change 'epigraphs' to 'paragraphs'

P.2179 ln3-4: Please update your subscript notation to English for consistency.

P.2180 ln3: A map of El Salvador indicating the location of the western coastal plain would benefit international readers unfamiliar with the country location, coastal orientation to local fault zones and epicentres of past local earthquakes.

P.2180 ln12: Please change 'affection to the country's coast' (see earlier comment)

P.2180 ln14-16: Consider altering 'intermediate' and 'close' sources (see earlier comment)

P.2181 ln13: Please change 'below 10' to 'below the age of 10' or 'below 10 years old' for clarity

P.2183 ln6: Please update 'time' to 'response time' for clarity

P.2184 ln11: To be consistent with previous terms used in the manuscript, evacuation time (not evacuation speed) is a function of a person's speed and distance travelled.
P.2185 ln1: Use 'arrival time' instead of 'arrive time'

Conclusions:

The conclusions should refer somewhere to the application of the framework to the case study.

P2186 ln17-27: This section introduces several new personal characteristics to the vulnerability analysis, which were not mentioned previously in section 2.2. The full list should be presented in section 2.2 and a brief list presented in the conclusion.

References:

Please include web addresses to direct readers to the source of: Aboelata and Bowles

2005, BC Hydro 2004, Cano 2011, OECD 2008, Scheer 2011a.

Figures/Tables:

Figure 2: The caption should be more descriptive, with respect to describing the components of total evacuation time and the difference between the top and bottom images

All maps: The scale is not legible on your maps, even when looking at a zoomed-in electronic colour copy. These should be made larger for inclusion this manuscript if at all possible.

Figures 4-5: The legend text on maps in the top row is difficult to read and should be enlarged if possible. I appreciate the time required to update some maps, so if it is not possible in this case please consider this for future publications

Figure 8: Please include in the caption, the event used to determine the arrival times. What does the '(5 min.)' refer to in the legend? The legend is missing value between 20 and 25 minutes.

Figure 10: Should 'T45' be 'RT45' as it is referred to in-text?

Figure 11: Caption requires further description to explicitly explain what this is showing.

Figure 12: While location of shelter 2 and 3 makes sense given the concentration of evacuation origin points, the reception area for shelter 1 has only 1 evacuation origin point in the reception area, therefore I struggle to see why this is an optimal location. This relates to the iterative location method / statement of population values in the study area. In-text explanation of the iterative process of choosing an optimal location should also include an explanation of how shelter 1 came to be the optimal location for this area. This figure would benefit greatly from reporting the number of people estimated to be in the reception area for each shelter.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 1, 2163, 2013.