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Discussions

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Reply on RC1

Jean Roger et al.

Author comment on "Potential tsunami hazard of the southern Vanuatu subduction zone: tectonics, case study of the Matthew Island tsunami of 10 February 2021 and implication in regional hazard assessment" by Jean Roger et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2022-157-AC1, 2022

In the following we are answering (in bold writing) the comments/suggestions of the reviewer RC1 (in italic writing):

The results of the proposed paper by Jean Roger & al; on the case study of the Matthew Island tsunami of 10 February 2021 are relevant to be considered to assess the potential tsunami hazard of the southern Vanuatu subduction zone.

The objectives of this paper are clear and reached. Nevertheless to assess the level of the potential tsunami hazard, as indicated in the title of the paper, some modifications should be considered by the authors.

The two main parameters considered in the tsunami threat and hazard are the estimated arrival time of tsunami waves after the earthquake and the level of threat, directly related to the tsunami height value observed or computed along the coastline, in particular at sea level station location.

In this paper, several specific material are describing the tsunami threat in particular : figure 4 : tide gauge and DART records, table 2 arrival time and amplitudes ; Figure 11 and 12 Maximum tsunami height.

Several modifications would be needed to help to improve those figures, modifications that will be considered separately (next chapter minor revisions and modifications).

Considering the tsunami hazard , it is internationally well known that several thresholds are considered in tsunami hazard assessment and warning system : 30 cm for the first level of threat, 1m for the second , 3 m for the third…

In table 2, it should be noticed that the maximum tsunami amplitude recorded is higher than 28 cm at 8 locations, and higher than 1 m at one location (Lena).

- **Table 2 will be improved highlighting these 8 specific locations according to the international levels of threat as indicated.**

The authors should highlight that this M 7.7 quake in that region resulted with a tsunami threat that need people evacuation for at least Height different sites, and probably many more (without tide gage records), considering the maximum amplitude modeled at Figure 11.

- **A paragraph will be added to part 4.2.1 (Coastal gauge records) in agreement with this comment and the international levels of threat.**

On Figure 11 at each tide gage the maximum tsunami height records should be indicated on the map, circle with the scale color considering the value of maximum amplitude.

- **White circles will be replaced with colored-scaled circles depending on the maximum amplitude of the tsunami at those locations.**

Minor revisions and modifications:

L37 missing : tsunami height records of Mw 7,7 highlight that 30 cm tsunami waves amplitude were recorded at height different tide gages , included one raising more than 1m. The tsunami threat of that event should be considered for evacuation of the shoreline (coastal marine threat) at those locations.

- **This sentence will be added in the abstract.**

*L43 add : **tsunami hazard, sea level records***

- **This is a good idea, the keywords will be added in the updated version of the manuscript.**

Figure 1 : add one major seismic and tsunami event - yellow star - Mw 7.0 : 19-11-2017

- **We agree with the reviewer that the 19/11/2017 earthquake was one of the recent major events in the South Vanuatu subduction zone. Anyway, as shown by Roger et al., 2021, there have been several other tsunamigenic earthquakes of magnitude Mw < 7.5 occurring in the region. The objective of figure 1 was to highlight the seismotectonic context, without showing all the tsunamigenic events, but just the main ones, and the 1926 rupture having occurred east of the 2021 one. If we add the 2017 ones (3 earthquakes have been tsunamigenic during this crisis), we have to add a few others, leading to a reading problem of the figure.**

This explanation will also be added in the figure caption.

*L146 … and **7.0**..*

- **Typo mistake; it will be corrected in the updated version of the manuscript.**

*L198 which is generally **more accurate** …*

- **“Better than” will be replaced with the reviewer’s suggestion.**

After P 9 Line number is missing !

- **It is because line numbering breaks when there is a section break (next page) in the text. It will be fixed in the revised version of the manuscript.**

P10 : which is ***1.6*** *smaller than those calculated*

- **"1.6" will be added in the updated version of the manuscript.**

P14 : Figure 4 : the blue line of the signal should be blue dark

- **It will be changed.**

Several stations records have disturbances, in particular LIFO, LENA, GBIT, probably not related to tsunami waves

What is the origin of these sea level disturbances ?

- **These sea level disturbances are certainly linked to the interaction of the tsunami waves with the semi-enclosed water body in which the coastal gauge is located. LIFO and LENA are located within small harbors, and GBIT is located within a bay. The period of the incoming waves can be equal or close to the harbor/bay eigenperiod and these could result in strong oscillations which represent a resonance behavior. Note that this phenomenon has already been discussed for LENA in Roger et al. (2021): the December 2018 tsunami led to strong oscillations in Lenakel's harbor.**

P16 : Table 2 :

- how tsunami wave amplitude is measured ? Tide filtering, 0- crest; .....

- **The explanation is briefly written in 3.3: "**The tsunami arrival times and amplitudes at each coastal gauge and DART station are summarized in Table 2. They have been obtained through de-tiding and filtering of the data using the methodology presented in Roger (Subm.)." **As the referenced paper is still under editor's decision, a description of the process will be added to the updated version of the manuscript, including the type of filtering (bandpass) helping to remove both the tide signal and high frequencies related to other phenomenons like storms or large vessels. We measured the amplitude of the wave between 0 and the crest.**

- for the stations LIFO, LENA, GBIT, due to the sea level disturbances, how did you measure the tsunami amplitude ?

- **For the purpose of this study, we measured the largest amplitude of the whole signal: it means that the maximum amplitude indicated in Table 2 could be related to the resonance of the tsunami waves within a harbor and not the tsunami itself. In terms of risk management, it is worth it to consider the resonance as it could result in mooring breaks, whirlpools, enhancement of the inundation, etc. In fact, it is well known that catastrophic wave behaviors are often linked to nonlinear dynamics of which some resonances belong.**

In particular at LENA, the behavior of the record (higher than the tide) would provide doubt about the accuracy of the tsunami amplitude measurement of the record.

- **We agree that the appearance of the record in Lenakel is uncommon. An explanation would be that LENA tide gauge is located at the far end of a small bay, next to a concrete pier on one side and the mangroves on the other side (JICA report, 2013 - https://openjicareport.jica.go.jp/pdf/12129177.pdf) in a very small water depth (< 5 m according to nautical charts and probably much less according to J. Roger's own observation in 2019). Arrival of tsunami**

waves can results in a massive amount of water added in the bay rising up the mean water level (called wave setup), on which the next waves occur. This could lead to additional nonlinear behaviors and explain the records as shown on figure 4.

Unfortunately, neither testimonials nor additional measurements have been collected after the event to validate the record with certainty.

Only specific analyses of Lenakel's Bay behavior to a range of incoming waves would help to understand the process occurring during tsunami events, but also during storms but is off topic in this study.

P21 three scenarios first wave at too early… other it is too late. Authors should specify how early or late it is (a few minutes… more ?) Are those delays negligible or not. Please specify.

- **The time delay between simulations and records will be detailed.**

P23 Figure 9 the quality of the line of the records should be improved

- **The quality will be improved in the updated version of the manscript.**

P28 Figure 11 : at each tide gage, change the white color of the circle with the color corresponding to the maximum of the tsunami measured at the specific tide gage (maximum amplitude color scale)

- **As previously indicated, the white circles will be updated with colored-scale circles according to the maximum amplitude.**

Change the color scale of the maximum amplitude : the current color scale is green from 5 cm to 25 cm. This scale color is not helping to visualize where and how the tsunami height is growing from 5 to 25 cm : the largest surface of the sea.

- **Many tests of colors have been tried, but this was the most relevant we found. Anyway, we will try to update it a better way to underline the amplitude differences.**

P29 Figure 12 same remark as figure 11 regarding the maximum amplitude scaling color.

- **Same answer as previous point.**

P32 Contribution to regional tsunami hazard assessment

The comments and proposed modification made above on the threat level should be added in that chapter.

- **This will be added.**

P33 The results of the tsunami hazard assessment of the 8.2 scenario should be added, and in particular that such earthquake would generate tsunami waves height at shoreline higher than 1 m in many places at New Caledonia, Vanuatu, Fiji, New-Zealand, …

- **That is true, it should be added in the conclusion.**

P34 L 112 : and ***wrote*** *the…*

- **This grammar comment will be considered during the review of the English-native co-authors.**