Natural Hazards and Earth System Sciences Discussions

Nat. Hazards Earth Syst. Sci. Discuss., referee comment RC2
https://doi.org/10.5194/nhess-2021-375-RC2, 2022
© Author(s) 2022. This work is distributed under
the Creative Commons Attribution 4.0 License.

Comment on nhess-2021-375

Anonymous Referee #2

Referee comment on "Tsunami scenario triggered by submarine landslide offshore of northern Sumatra Island and its hazard assessment" by Haekal Azief Haridhi et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-375-RC2, 2022

This paper presents original seismic and bathymetric data off north Sumatra, showing active tectonic features and possible landslides scars. This dataset combined with numerical modeling allows to carry out tsunami simulations for selected scenarios defined on steep slopes where factor of safety is computed as low. This paper deserves a publication provided a minor review a made to address some of the questions raised below.

The form of the manuscript consists of a first part basically on data and methods used, then a following part describes the main results, and the final discussion addresses again some results (for instance on the ground motion prediction models). Thus the authors could state more clearly at the end of introduction, how it is organized, and a number of repetitions could be avoided, especially at the beginning of section 4. Another plan could have been to first address the whole section on stability (including analysis of acceleration threshold), and then a whole section on tsunami models which is rather independent. Finally the highlight on the need of an early warning system is very necessary and this paper provides elements supporting possible related initiatives.

1 Introduction

In addition to Haiti in 2010, Palu in 2018, the review of the tsunamis produced by strike slip earthquakes may also mention the case of the Izmit, 1999 (Turkey) quake that probably triggered submarine slides, and a tsunami observed at several coastal points.

Moreover, there is no mention of landslide triggering in the area, after the 2004 earthquake. The accelerations must have been very large enough to trigger some slides in the area, and it should be commented.

Other comments

l.34: the details of the largest M 7.7 earthquake should be more explicit in the text. Was it the one that occurred in 1892? Another one in 1943 seems also to be of same importance.

l.52-55: the Dec 2018 tsunami in the Sunda Strait was not triggered by an earthquake-triggered event (l.55), but by the Krakatau volcano collapse. This Dec 2018 example is thus a good example of volcano-triggered tsunami, following a flank collapse. The end of the sentence l.55 should be modified accordingly, or the whole section.

2 Tectonic setting of the northern SFZ

The setting is well explained and illustrated by Figure 1. It could be interesting to comment on the focal mechanisms plotted on the Figure 1, exhibiting diverse rupture modes for selected quakes (which magnitudes?), in the general complex tectonic frame of the area.

3 Collected data and analysis methods

3.1 Single-channel seismic reflection data

Figure 2: captions (b) and (c) have to be switched

3.2 Community-based bathymetric survey data

The Community-Based Bathymetric Survey was an interesting initiative following the 2004 tsunami to collect data from fishing boat tracks, that allowed to build a 20 m resolution bathymetric grid. This reveals four shear faults associated with significant scarps possibly associated with historical landslides. Is it this grid which is directly used later in Comcot models?

3.3 Slope stability analysis and input parameter assessment

The stability analysis is modelled with the Scoops3D tool assuming uniform earthquake

loading, and with parameters taken from other contexts (New Jersey, California). Maybe it could be commented how trustful these comparisons are, or not, and how they can be applied to north Sumatra. Are there any uncertainties that could be influent?

3.4 Simulation of tsunami wave propagation from earthquake and landslide sources

The well-established COMCOT model is used for tsunami simulation. The authors should specify more clearly the bathymetric grid and the numerical parameters that are used, on top of the seismological parameters in Table 2. Has it been used with the 20-m bathymetric grid, or was it too costly to run it which such an accuracy?

Second, the landslide hypothesis implies the use of rigid block as the source. It should be stated that it is a very maximizing approach since a real landslide is more like a submarine deforming avalanche, much more complex to simulate than a simple rigid block. The Manning coefficient probably does not influence the results at the same order, or it should be more clearly explained and quantified.

Is the initiation computed in 2D horizontal coordinates or simply in 1D XZ section?

4 Analysis and results

4.1 Evidence of paleo-landslides

This section takes up some points presented in section 3 to recall the S2 fault activity, associated with chaotic facies possibly linked to landslide deposits. It is said that the bathymetric resolution is too low to localize the landslide site, however the 20 m x 20 m resolution mentioned earlier should theoretically help. Or is it insufficient because the original data are much sparser and interpolation makes them inadequate? In addition, there is at least one mound identified on Figure 5 while it is stated l.196 that any evidence of mound type structure is limited. It should be reformulated.

4.2 Stability evaluation of seafloor morphology

The correlation between the slope stability and the seismic data is summarized on Figure 6, allowing to define possible landslide sources. The area east of the Aceh islands displays a very low FS and indeed it has to be considered. The fact that no landslide deposit has been identified there is not against the chance of having one triggering, following a large

quake on the active branch nearby.

By the way, it would be interested to define the equivalent earthquake magnitude needed to obtain the acceleration thresholds defined, depending on the distance to the rupture and ground motion prediction equation. A very large rupture on the Aceh fault is probably sufficient also to trigger distant destabilization.

4.3 Tsunami model

Two earthquakes with magnitude 7.0 are considered in the tsunami model, but the obtained amplitude of 0.3 to 0.5 m are considered as negligible (l. 246). The authors should specify if these heights are obtained at the coastal level or offshore. A coastal 0.3-0.5 m tsunami is not strictly negligible; it corresponds to the first degree of warning, allowing large debris and vulnerable people to be washed away. In addition, it could be also interesting to have a 7.5 scenario as a possible worst-case.

Landslide scenarios using rigid block produce much higher amplitudes than for these earthquake scenarios, as displayed on Figure 7. The caption should mention that the distance of the X-axis is towards offshore to the right. The scenario 3 exhibits a quite different behavior with a relative peak towards the shore: this could be indeed explained by the localization of the slide, but it should be also explained, depending how the cross section is computed? Along a perpendicular to the coast? Or is the initiation purely in 1D?

Are the following results computed along the shore with refined models? The Figure 7 seems to indicate a spatial sampling of about 500 m in the initiation model. Was it the same sampling throughout the modeling?

l.261: typo: landslide rather than landside

5 Discussion

In the discussion again, the earthquake source is considered as negligible, but the authors should be more cautious. As stated previously in the paper, landslide tsunamis produce high local run-up. Earthquake tsunamis, even with 0.5 m amplitudes, can produce such heights at larger distances. As in Palu, the consequences are thus due to the combined effect of earthquake and several landslides.

In this discussion, it could be also interesting to have a comparison between the numerical

models used for these scenarios in Sumatra, and for those used in Palu, since the situation could be very similar. Has the COMCOT tool been used in Palu too? Which hypotheses have been considered in Palu?

The final discussion on the risk posed by such landslide-triggered tsunamis is very necessary since the awareness is indeed very poor, and monitoring systems are not very efficient to provide warning at short distance. The authors could stress that the preparedness also relies on a better awareness among the populations, including the proper reaction after a strong shaking. This requires for instance to conduct frequent drills among the population to practice self-evacuation, has it been set up in Indonesia since 2004?