Nat. Hazards Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/nhess-2018-348-AC4, 2019

Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Numerical Simulations of the 2004 Indian Ocean Tsunami Deposits Thicknesses and Emplacements" *by* Syamsidik et al.

Syamsidik et al.

syamsidik@tdmrc.org

Received and published: 9 March 2019

Dear Referee #3,

We sincerely appreciate your extra effort to comment on our paper in two stages. These support our objective to disseminate our research result with scientific evidence and solid process of discussion. Your second stage comment is divided into eight comments followed by our response to each of your comment. Now, permit us to respond to your second stage of comments.

COMMENT 1:

Printer-friendly version

Discussion paper

The selected four areas in this study are not interfered by human, which is a reasonable criteria after more than a decade. The author mentioned that several prior studies have been conducted in the general study area. Apart from these four areas, is there any other conserved areas which can represent obvious coastal features, such as plain and ria?

RESPONSE 1: Thank you for confirming our reasons in selecting our study area. The area, Lhoong of Aceh Besar, has been part of the study area for paleotsunamis by Rubin et al. (2017) and Jaffe et al. (2006). The two studies have also motivated our team to select the study area. Data collected by Jaffe et al. (2006) were also used to compare our numerical simulations and their data. As Jaffet et al.'s data were collected after some months of the 2004 Indian Ocean tsunami, therefore, they could provide the closest data to the event without being significantly altered by other processses, either natural or anthropogenic processes. There is no significant area of Lhoong that can be categorized as ria coast. At the north of Saney, there is an area where it could be classified as plain coast with about 3 km long. However, this area has undergone a heavy anthropogenic intervention after the tsunami as it was paddy field and settlement area. Therefore, we determine the four study sites as the most tsunami deposit conserved area. Similar explanation could be found in our present manuscript in Page 3 Lines 15 – 32 (Section 2 Study Area).

COMMENT 2: What did you find out during the area survey before the beginning of this study?

RESPONSE 2: We interviewed some local people to understand whether any significant intevention has been made after the tsunami that could disturb the tsunami deposit. We confirm again this by conducting preliminary observation of the area to clarify the earlier information received from local people. The area where we did pit tests and trenches were largely deserted from any settlement and farming activities. This helped us to exclude the anthropogenic influence. On the other hand, surface run-off or other natural process could interfere the area.

COMMENT 3: For numerical simulation, what if the author use only Delft3D for both hydrodynamic and morphodynamic models? I don't think that the multi-fault scenario is a reasonable reason. In addition, why don't the author perform COMCOT with NSWEs for layers 1 to 3? Please clarify more on this point.

RESPONSE 3: The version of DELFT3D that we operate does not allow us to put the offshore multi-fault scenario that could reconstruct the 2004 Indian Ocean tsunami case. The multi-fault scenario for the 2004 Indian Ocean tsunami is more valid than the single fault (Piatanesi and Lorito, 2007; Koshimura et al., 2009 ; Syamsidik et al., 2015; Romano, 2009). All these study have validate the tsunami waves generated using tsunami poles (inland), measured water marks on buildings, and water level measured offshore by Satellite Jason 1. Therefore, we confirm that the use of multi-fault scenario of the 2004 Indian Ocean tsunami is reliable. Using NSWE for layers 1 to 3 provide insignificant different to the wave generated around the offshore area. On the other hand, applying non-liner SWE on Layers 1 and 3 will reduce computational time without overseeing the accuracy of the simulation results. Thank you for commenting on these. We will also add similar explanation in Section 3 (Methods) in our revised manuscript.

COMMENT 4: What is a novelty in this paper for numerical modeling?

RESPONSE 4: Coupling a numerical hydrodynamic module with a numerical sediment transport module in the case of tsunami wave studies is an important part of this study. In addition, reliablity of the study have been revealed using field data collected from four locations. We also demonstrate the use of the numerical simulation combined with the understanding on geological settings to locate the tsunami deposits. Similar explanation could be found in the Introduction part (Section 1). More statements will be added in the section to strengthen the novelty side of our research in our revised manuscript.

COMMENT 5: The author verified tsunami inundation area from numerical simulations with satellite images. Please provide more explanation and clarification for the verifica-

tion results.

RESPONSE 5: We redigitize the tsunami inundation area based on Landsat Satellite Images captured on February 2nd, 2005 or about 1 month after the disaster. This allowed us to clearly identify the extend of the damaging area based on the images and compared them with the tsunami inundation area produced by Delft3D-Flow. Please see the satellite image at Fig. 1 of this response.

COMMENT 6: Where is the location of boundary flow input in Figure 12? I feel that the discussion part should be limitation of this study. Please clarify this.

RESPONSE 6: The location of the boundary can be seen in Fig. 2 of this response where a blue line was drawn inside Layer 4. Later, Layer 4 was transformed into Delft3D-FLOW's simulation domain. We agree to further discuss in in Subsection 3.1 Numerical simulations. Limitation of the study will also be discussed in Section 5 (Discussion) in our revised manuscript.

COMMENT 7: In the conclusion part, the author mentioned that this coupling method of COMCOT and Delft3D provide a better understanding. How can the author conclude this? The method would be able to repeat sediment transport in these study areas.

RESPONSE 7: In the present form of COMCOT, it is unable to simulate sediment transport module. There have been several attempts to include the sediment transport modules in COMCOT (Li et al., 2012 ; Rasyif et al., 2019). However, they are in preliminary stage of the application. This research offers results where spatial distribution of the sedimentation and erosion with transient process can be investigated by coupling it with Delft3D-FLOW. Here, we could understand wheter backwash play significant role on the process and whether shear stress corellate to the accumulation of the sediment deposit transported by the tsunami waves.

COMMENT 8: Lastly, what is the main benefit or contribution of this study?

RESPONSE 8: This study contribute to explain the spatial distribution of sedimentation

and erosion generated by the 2004 Indian Ocean tsunami. Such study that uses the 2004 Indian Ocean tsunami by numerically reconstruct the sedimentation and erosion spatial distribution are rare (Li et al., 2012; Gusman et al., 2012). This study also offers the use of the numerical simulation coupled with understanding of geological setting of the study to estimate locations of the tsunami deposits after12 years of the event (field data collected in 2015 and 2016).

We would like to reiterate our gratitude to the Referee for commenting our research. The comments support us to leverage our study for having a better understanding on tsunami hazards. Thank you very much.

REFERENCES

Gusman, A.R., Tanioka, Y., and Takahashi, T.: Numerical experiment and a case study of sediment transport simulation of the 2004 Indian Ocean tsunami in Lhok Nga, Banda Aceh, Indonesia. Earth, Planets and Space 64, 3, 2012.

Jaffe, BE, Borrero, JC, Prasetya, GS, Peters, R, McAdoo, B, Gelfenbaum, G, Morton, R, Ruggiero, P, Higman, B., Dengler, L., and Hidayat, R.: Northwest Sumatra and offshore islands field survey after the December 2004 Indian Ocean Tsunami. Earthquake Spectra 22, 105-135, 2006.

Koshimura, S., Oie, T., Yanagisawa, H., and Imamura, F.: Developing fragility functions for tsunami damage estimation using numerical model and post-tsunami data from Banda Aceh, Indonesia, Coastal Engineering Journal, 51(3), 243-273, 2009.

Li, L., Qiu, Q., and Huang, Z.: Numerical modeling of the morphological change in Lhok Nga, west Banda Aceh, during the 2004 Indian Ocean tsunami: understanding tsunami deposits using a forward modeling method. Natural Hazards 64, 1549-1574, 2012.

Piatanesi, A. and Lorito, S.: Rupture process of the 2004 Sumatra- Andaman earthquake from tsunami waveform inversion. Bulletin of the Seismological Society of Amer-

ica 97, 223-231, 2007.

Rasyif, T. M., Kato, S., Syamsidik, and Okabe, T.: Numerical Simulation of Morphological Changes due to the 2004 Tsunami Wave around Banda Aceh City, North Sumatra, Indonesia. Geosciences, 2019 (accepted for publication).

Romano, F.: The rupture process of recent tsunamigenic earthquake by geophysical data inversion. Doctoral Thesis, Universita Degli, Bologna, Italy, 2009.

Rubin, C.M, Horton, B.P, Sieh, K., Pilarcyk, J.E., Daly, P., Ismail N., and Parnell A.C.: Highly variable recurrence of tsunamis in the 7,400 years before the 2004 Indian Ocean tsunami. Nature Communications 8, 16019, 2017.

Syamsidik, Rasyif, T.M., and Kato, S.: Development of accurate tsunami estimated times of arrival for tsunami prone cities in Aceh, Indonesia. International Journal of Disaster Risk Reduction 14, 403-410, 2015.

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2018-348, 2018.

Printer-friendly version

Discussion paper

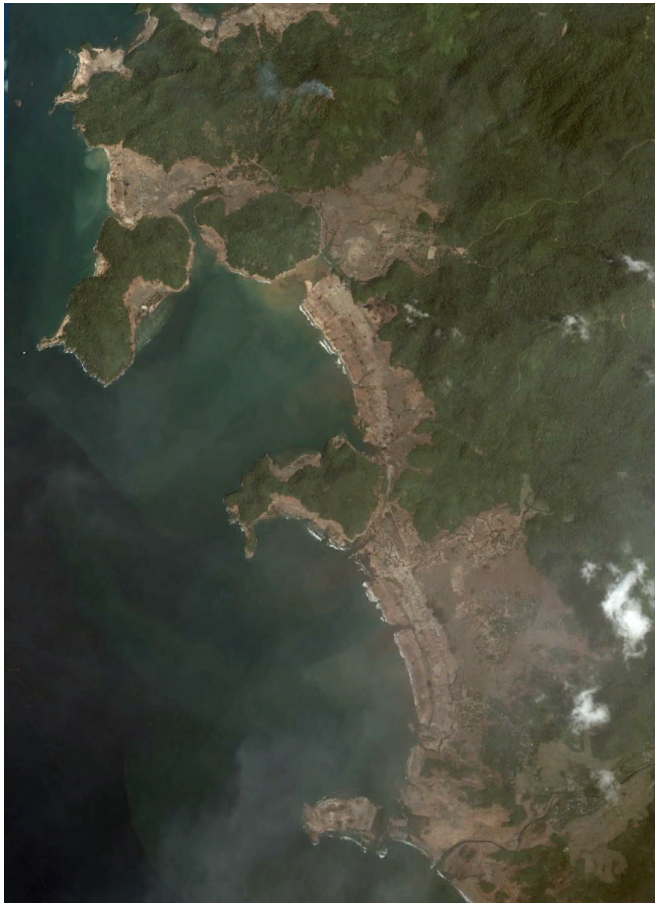

Fig. 1. Landsat satellite image captured on February 2nd, 2005 showing the tsunami inundation area (DigitalGlobe, 2019).

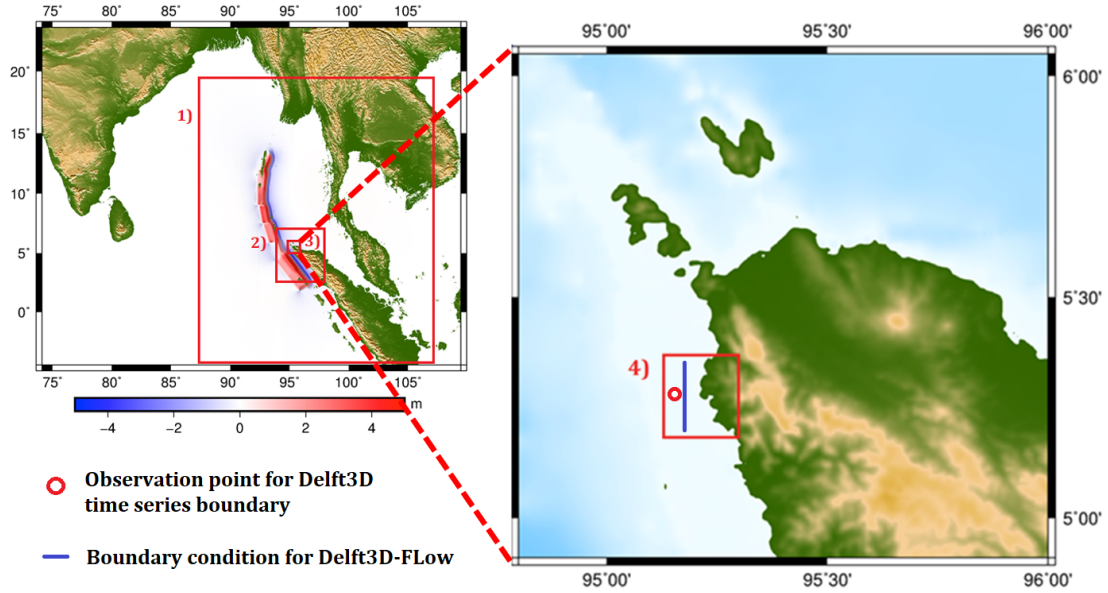

Fig. 2. Layers 3 and 4 of the COMCOT simulation domain. Blue line represents the open boundary location for Delft3D-FLOW. Red circle for the observation point for boundary.

Printer-friendly version

Discussion paper