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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.

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Dear Referee #4,

Thank you very much for your time to review our paper. Your scientific input to our paper have driven us to modify and revise our paper in order to ensure our research has been performed rigor and solid process. Our research was performed to provide answers to a complex system in determining locations of tsunami deposit prior to field investigation. We agree with your comments on this and we have been working at our best to address all your inputs in our revised manuscript. After carefully reading your comments, it took some time for us to revise and modify our paper as suggested. Now,

permit us to offer our response to your valuable comments.

COMMENT 1:

Thank you for the efforts to understand the process of sediment accumulation by the tsunami a decade ago. The following are more detailed comment for the improvement of the paper 1. Fig. 15-18 are not readable

RESPONSE 1: Thank you for your appreciation on our research. Fig. 15-18 have been modified and increased their resolutions to make it more readable. Combining Comments we received from other Referees, we have joined Fig. 15-18 and place them into one figure. Please see Fig. 1 of this response. The figure will replace Figs. 15-18. Furthermore, after being suggested to run more models, we have simulated the sediment transport models in DELFT3D using Engelund-Hansen 1967, Meyer-Peter-Mueller 1948, and Soulsby 1997. The original result presented in our previous manuscript was based on van Rijn 1984. Complete explanation of the mathematical formulae of the sediment transport can be find at Delft Hydraulic (2009). More detailed explanation of the additional simulation results for the sediment transport formulae can be seen at our Responses to Referee #1.

COMMENT 2:

2. How to treat the open boundary conditions in D3D-flow model. Fig. 12 shows the boundary input for D3D-flow. Where this time series is obtained? How the others look like? Riemann or Neumann type conditions applied?

RESPONSE 2: The Open Boundary condition here was placed about 14.5 km from shoreline. The hydrodynamic boundary condition was obtained from COMCOT numerical simulation at Layer #3. Here, the boundary condition was set to follow "Water Level". The water level boundary condition is a modified Riemann boundary condition where Stelling has added the time-derivative to water level and and velocities (Stelling, 1984). It was meant to reduce reflection process caused by the eigen frequency of the simulation.

COMMENT 3: 3. Please elaborate the data used for the simulation. Page 6, line 6: .. and other nautical charts? How details? Data resolution? This is very important also to be included in the conclusion due the fact that the geometry of the beach is quite complex, especially for the smallest model domain.

RESPONSE 3: Yes, we certainly agree that the resolution of the data used in the simulation is important. Bathymetry data for Layers 1-3 were adopted from GEBCO data, with 0.5 minutes resolution. Meanwhile bathymetry data for Layer 4 were re-digitized from Nautical Charts released by Indonesian Navy (PUSHIDROSAL) with Map No. 15-2014. Topography data for Layer 4, where all of the sediment deposition and erosion were mapped, were adopted from topography map released by Indonesia Agency for Geospatial (BIG) interpreted from DEM data with resolution of 5 m. Some area around the transects sampling areas were also measured using handheld GPS, water pass, and staffs. The measured data were also corrected to local tide data. Similar explanation will be added to Subsection3.2 Field Measurement.

COMMENT 4: 4. Page 9, line 20. Where are these observation points located? Figure 13 does not show the location.

RESPONSE 4: Please see three red circles in upper figure of Fig. 13, showing Obs 1, Obs 2, and Obs 3. Obs 1 is the closest observation point to the coastline. Meanwhile Obs 4 is the farthest point from the coastline and it is just before the wall of the hill.

COMMENT 5: 5. Still in page 9, please define the steep and mild slopes discussed in this paper. In fig. 13, why the obs no. 2 and 3, after 09.00, the sediment accumulation keep increasing?

RESPONSE 5:

Here, we define the slope larger than 0.02 is steep and smaller than that was classified as mild. The topography condition at Birek can be seen at upper left part of Fig. 2 (part

of figures in this response) showing topography contour. As it can be inferred from Fig. 2 of this response or Fig. 13 in the previous version of our manuscript, the dense contour lines represent the steep slope of the area. Here, the slope of the area about 0.015 for the first 250 m from coastline (mild). Suddenly, after the point, the slope were between 0.05 until 0.1 (steep). The land area slope at Pasie Janeng was about 0.05 (steep). At Saney the slope of the land area was about 0.013 (mild). At Obs 2 and Obs 3, the sedimentation accumulation keep increasing due to weakening of shear stress generated by the tsunami waves after the second waves. The decrease of the shear stress drove the sediment to settle at the points. Similar explanation will be added into 4.4 Model Hindcast in our revised manuscript.

COMMENT 6: 6. Fig. 5: I think the authors would like to show readers that the points (observation or survey locations) should be within/inside the inundations limits. Point for Birek is outside the limits.

RESPONSE 6: Yes, thank you for your suggestions. We have modified Fig. 5 by moving all the points inside the inundation limits. Originally the points represented the administratif location of the each villages, which pointed the location of the Office of the Village Administration. Since here we do not deal with the administrative issue, we agree to follow the suggestion as can be seen in the Attachment (see Fig. 3 of this response).

COMMENT 7: 7. As it was discussed in page 2, it would be better also to produce and discuss extent of sediment deposition from the coastline (spatial distribution). The discussion on this topic is more meaningful and can also be used for disaster risk reduction related issues.

RESPONSE 7: Erosion areas (negative sedimentation/erosion accumulation as in Fig. 2 of this response) were located at nearshore area where energy of the tsunami waves was still large. This implies that any structures or objects that could reduce shear stress by increasing roughness coefficient could help to mitigate impacts of tsunami.

Here, the some of the higly eroded area did not have sufficient coastal vegetation that could increase manning coefficient. Deposition were largely found farther from coastline where energy of the tsunami wave decreased. Similar explanation will be added at Section 5 Discussion in our revised manuscript.

COMMENT 8: 8. Please consider in the conclusion about the quality of the bathymetry/topography data that significantly influence the model results.

RESPONSE 8: Thank you for your suggestions. We acknowledge the resolution of the bathymetry/topography data are crucial in the simulation. For pre-survey estimation of the location of the tsunami deposit, our simulation offers scientific basis to decide where sampling should be done. It is certain that detail bathymetry data, especiall at nearshore area, could increase the reliability of the estimation. Similar explanation will be added in at Section 6 Conclusion in our revised manuscript.

Again, allow us to reiterate our sincere appreciation for thoughts and time given by the referee to ensure our paper meet the standard of the journal. Thank you very much.

REFERENCES

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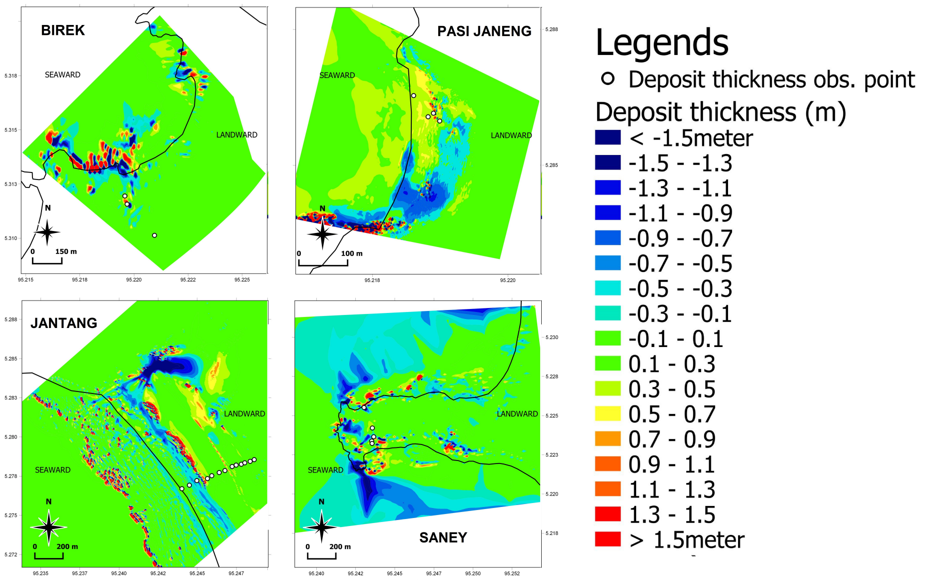

Fig. 1. Accumulative sedimentation and erosion at Birek, Pasie Janeng, Jantang, and Saney. Negative values represent erosion and positive values represent sedimentation thicknesses.

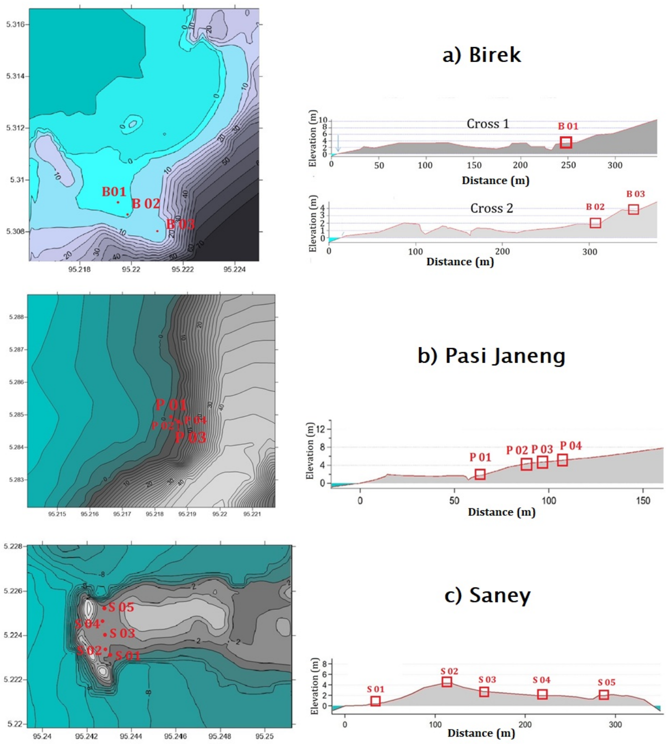

Fig. 2. Topography condition of Birek, Pasie Janeng, and Saney.

Fig. 3. The 2004 tsunami inundation limit at Lhoong based on numerical simulation (black dashed lines) and satellite image digitization (red dashed lines).