Natural Hazards
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Discussions

Interactive comment on "Post-event Field Survey of 28 September 2018 Sulawesi Earthquake and Tsunami" *by* Wahyu Widiyanto et al.

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Referee 1 – Authors Interaction We would like to thank Anonymous Referee 1 for the constructive comments and suggestions towards improving our manuscript. Our response was also uploaded in the form of a supplement. We summarize comments from Referee 1, author's response, and author's changes in manuscript as follows.

Comment 1: Overall This is an interesting paper that describes the results of field work after the2018 Sulawesi tsunami. The paper follows the general pattern of field work papers,and is important that such events are properly documents, so that modellers can then attempt to reproduce them. However, the paper suffers from lower than expected writing quality. The English is ok in some places, and poor in others. Also, the

authors often repeat themselves. The more serious problem, however, comes from its unclear focus. Most of the paper deals with the tsunami damage, but at times the authors randomly include other information relating to aftershocks or landslides that are not related to the tsunami. Thus, several parts of the paper should be deleted, and the message should become more focused. Instead, the authors might want to describe the mechanisms of tsunami damage in more detail at each location (currently they only superficially describe some locations).

Response 1: Thanks for very detailed and constructive comments from Referee1. We are improving our writing quality, including English. An native at an English proof-reading service center would handle our manuscript. That's right we often repeated ourselves,now we reduce it. We modify the writing in order to more focus by removing several parts you suggest, e.g aftershock and earth-surface landslide. Nevertheless, we preserve part about coastal landslides since we feel to have contribution on it. We strongly agree with your advice on description of the mechanism of tsunami damage. So that we add description on runup, inundation, and damage at each site in our text. It could be seen on uploaded supplement file for final response.

MAJOR COMMENTS

Comment 2: By now a number of other field work papers have been published. Please find these,and cite them. Also, please explain what differences there are between your work and other papers.

Response 2: Alright. We are adding other field work papers, i.e Omira et al (2019),Mikami et al. (2019), Muhari et al. (2018),Yalciner et al. (2018), Putra et al. (2019), Sassa & Takagawa (2019), Takagi (2019), Arikawa et al. (2018). The last three papers focus on coastal landslides, while Putra et al. evaluate runup based on tsunami deposit. Muhari et al. was probably the first team coming in disaster area. They gave early report as direction for other team coming later. Their results are preliminary and limited around Palu City, in the end of Palu Bay. The most close topic with us is by

Omira et al. (UNESCO international team) and Mikami et al.. They measured more points than ours. Our several points intersect with their points. Nevertheless, they did not measure inundation distance as done by our team. We cite them and explain it in the manuscript.

Change in manuscript 2: P3 L5-12 supplement Many groups have carried out field surveys of the Sulawesi tsunami event or also known as Palu tsunami. Muhari et al. (2018) investigated wave height and inundation depth at several points with a focus around the end of the bay. A UNESCO international tsunami survey team surveyed 125 km of coastline along the Palu Bay up to the earthquake epicentre region. The team performed 78 tsunami runup and inundation height measurements throughout the surveyed coastline (Omira et al., 2019; Yalciner et al., 2018). Putra et al (2019) focus more on tsunami deposits. Meanwhile, Arikawa et al. (2018), Sassa and Takagawa (2018), and Takagi et al. (2019) each conducted a survey related to coastal subsidence, coastal liquefaction or submarine landslide detected in Palu Bay. This survey data can be combined with data from other groups, especially we contribute to provide data of runup height, inundation distance, flow depth, and damage at different points and coordinates.

Comment 3: P3, L24. In what way did the authors do this? How can they choose one point that can be representative for a tsunami that was as complicated as the one in this case?

Response 3: P3 L24 We modify the sentence. We mean that we chose some sites (not only one point) which had significant impact caused by the tsunami. We measured runup, inundation, and flow depth at 18 sites. On the first day of our survey we recorded situations along the Palu Bay. From these recordings we can roughly estimate sites with high runup and the long inundation. These points usually also have a severe level of damage. Besides, important places such as ports and densely populated areas are our priority. Measuring a coastal cross section at each certain distance, for example, every 1 km along 70 km of Palu Bay, might provide more representative data, but we

have difficulty doing that mainly because it will take a long time. In addition, the areas affected by the tsunamis were also fragmented, not connected.

Change in manuscript 3: P3 L25-26 supplement ..... 2) tracing the road along the coast in Palu Bay to get an overview of the affected area; 3) choosing some sites that had significant impact of the tsunami; 4) looking for evidence of runup boundaries .....

Comment 4: The English in the paper needs to be improved. In places the sentences are correct, and in others they are pretty poor.

Response 4: Thanks for the assessment. We are trying to meet referee's suggestion, improving English in the manuscript thoroughly, and it would be checked by English proofreading service center.

Comment 5: P4 L4-5 what kind of camera was used?Did the authors obtain a 360 degree view? Otherwise, in what way is this similar? Is this going to be opened to other researchers? (if not, what is the point of writing this?)

Response 5: P4_L4-5 We delete "This method is similar to that used by Google Street View$^{\circledR}$, but we used simpler equipment." The idea may be same with Google Street View$^{\circledR}$ but the method and camera used was not same. However, we think our video collections are useful. We plan to put them in the supplement in order to be opened to other researchers. We use Google Street View$^{\circledR}$ for comparing with our videos to evaluate damage along Trans Sulawesi Road.

Changes in manuscript 5: P4 L6-7 supplement ..... A camera on a moving car was operated to record the situation around the coastal area. It produced a number of videos describing the damage (contained in supplement). P5 L6-7 response supplement .....Video recorded along trans Sulawesi Road were compared to Google Street View, Google Map, and Google earth in order to assess the distance of damage from coastline. ....

Comment 6: P4 L19 and on wards. What is the point of talking so much about the rain,

if the authors then dismiss the importance of it?

Response 6: P4_L19 We replace "Fortunately, from the point of view of conducting a survey, surface runoff due to rain seems insignificant and does not erase the tsunami footprint." with "It was a challenging work to look for tsunami footprint on surfaces that were exposed to surface runoff." In addition, we also shorten the paragraph containing about rain.

Change in manuscript 6: P4 L14-19 supplement ..... October is the beginning of the rainy season in Indonesia, including Sulawesi. Palu City is located near the equator, as shown by latitudes in Table 1. It is one of the driest areas in Indonesia, with rainfall recorded at the Mutiara Meteorology Station in 2017 of 774.3 mm. Since the earth-quake incident until the date of the end of the survey, it rained four times, three of which occurred during our survey period, with a duration of less than 2 hours and with low to moderate intensity. It was a challenging work to look for tsunami footprint on surfaces that were exposed to surface runoff caused by rains. .....

Comment 7: P5 L2. Where all these measurements corrected for tide? Using which software? Are the data sets given in this paper those corrected for tide, or the original measurements? Also P5 L7-9, the location of these tidal stations needs to be shown in some figure. See also P5 L22, which indicates both corrected and uncorrected, making it unclear what the other numbers in the paper actually are.

Response 7: P5 L2 Runup heights were corrected to calculate heights above sea level at the time of survey by using WXTide software version 4.7, available at www.wxtide32.com/index.html. We used Donggala station listed in the software for correcting and assume no significant variations on the sea level inside Palu Bay.We modified that all number (runup and inundation) shown in the paper are corrected for tide.Thanks for rigorous comments. P5_L7-9 Authors ploted Donggala (replacing Ma-muju) and Pantoloan stations in some figures. P5_L22 We modified that all number (runup and inundation) shown in the paper are corrected for tide.

Changes in manuscript 7: P5 L1-3 supplement ..... Runup heights were corrected to calculate heights above sea level at the time of survey by using WXTide software version 4.7, available at www.wxtide32.com/index.html. We use Donggala station, the closest station listed in the software, for correcting and assume no significant variations on the sea level inside Palu Bay.

P5 L11-13 supplement ..... The measurement results are shown in Table 1 and Figs. 3-5. The measurement values in the table has been corrected with tides. Runup height and inundation distance vary from site to site.

P5 L28-29 supplement ..... A total of 4 cross sections of these coast were measured by our team. The measured runup heights were 10.73, 7.97, 10.14, and 8.50 m, respectively, as shown in Table 1. .....

Comment 8: P6 L16. What is the point of this section? You are talking about earthquake damage,but this paper up to now is mostly about tsunami damage. Hence, it feels rather odd. I suggest just focusing on the damage by the tsunami, and delete this section. P6 L24 If the bridge was shifted, it was damaged. Not sure what the authors are trying to say here: : : Also, how can the authors say the area is only 3.4m2, given the description earlier? This part feels rather confusing.

Response 8: P6_L2-6 and L12-16 We delete these parts and try to focus on the damage by tsunami as you suggesting. P6_L24 We revise its area = 244.7 m2, thanks for the precise comment. We measured size of bridge which moved from original position with intention to give data about bridge dimension that may be used by modeler to assess tsunami force (drag force, lift force, etc.). We could provide sketch of the bridge and put it in on supplement if it is needed.

Change in manuscript 8: P9 L2-3 supplement ..... Based on these dimensions, the surface area of the bridge was 244.7 m2, the volume was 23.4 m3, and the mass was approximated to be around 56 tons. .....

Comment 9: P7 L2. From which sites? What is the point the authors are trying to make here? P7 L4-10. What is the point of this talk of aftershocks? I suggest all this is deleted, and the authors focus just on the tsunami damage.

Response 9: P7_L2 We mean it from our measuring sites, Palu bay area. Additional data were documented beside runup and inundation measurement. But, we deleted it. P7_L4-10 We deleted section about aftershock in order to be more focused. Thanks.

Change in manuscript 9: Please see the supplement Comment 10: Same for P8 L10-19 P8 L20-30 What is the point the authors are making here? The authors don't seem to conclude anything, and merely state conjecture. This might be ok if it was in the discussion section of the paper, but this is not it.

Response 10: P8_L10-19 and P8 L20-30 has been removed to make more focused.

Change in manuscript 10: Please see the supplement.

Comment 11: P9 L1-5 What is the point in a scientific paper of stating that surveys are being carried out? The authors should provide details or analysis, or let others do so. Reporting that something is happening is journalistic. P9 L19-22. There are already papers that are describing the location of landslides. Also, it is strange that the authors conclude this when they did not talk about this at length in their own paper (they should focus on the conclusions that can be derived from their own work).

Response 11: P9_L1-5 Thanks for the advice. We deleted "Therefore, the Indonesian Navy deployed the KRI Spica Ship, ... to conduct a bathymetry survey of Palu Bay after the tsunami." . P9_L19-22 We modified this part "Land subsidence in Donggala City (10,068 m2) and Lero Village (22,971 m2) gives evidence for underwater landslides. However, it does not mean there were only two underwater landslides; more landslide locations may be found in the disaster area. " to be "Coastal landslides detected by our team in Donggala City (lost surface area of 10,068 m2) and Lero Village (lost surface area of 22,971 m2) gives additional evidence towards coastal landslides

found by other team as reported by Arikawa et al. (2018) and Omira et al. (2019)."

Change in manuscript 11: P10 L2-5 supplement ..... Coastal landslides detected by our team in Donggala City (lost surface area of 10,068 m2) and Lero Village (lost surface area of 22,971 m2) gives additional evidences towards coastal landslides found by other team as reported by Arikawa et al. (2018) and Omira et al. (2019). .....

MINOR COMMENTS

Comment 12: P2 L26 "Most of the victims came from": : : P2 L30 astonished should not be used in academic literature. P2 L30, by now you said many times that the earthquake took place due to an active strike-slip fault in Indonesia. Please delete P2 L32, again, you repeated many times that the earthquake destroyed many buildings.

Response 12: P2_L26 We revised it to be"Most of the victims came from..." P2_L30 We replaced "astonished" with"surprised" P2_L30 We removed "The Palu-Koro fault which divides Sulawesi into two parts, has quite active tectonic activity...." ; Moved "the movement of ..." ; and "This is the second most active fault in Indonesia after the Yapen fault in Papua." ..... P2_L32 We deleted it and reduce repeated words or sentences.

Changes in manuscript 12: P2 L19 supplement ..... Most of the victims came from this city. .... P2 L23 supplement This disaster in Central Sulawesi has surprised scientific community. For a strike-slip fault, the plates move horizontally and thus do not usually cause enough vertical deformation to trigger a huge tsunami. It is still in discuss whether the tsunami caused by co-seismic deformation or non-tectonic sources. Field surveys play an important role to support seeking answer for question arised. ..... P2 L5 supplement The movement of rock formations is 35-44 mm/year (Bellier et al., 2001)

Comment 13: P3 L11 "for a numerical model" P3 L12 "rebuilding of the affected areas by the 2018: : :" P3 L30 what is the point of saying that the authors took videos. Are these provided in the present research or any additional information? Otherwise delete: : :

Response 13: P3_L11 "for a numerical model"... P3_L12 We change "..... rebuilding the affected areas of the 2018 Sulawesi Tsunami" with "rebuilding of the affected areas by the 2018..." P3_L30 We deleted "We also recorded videos and took photographs."

Changes in manuscript 13: P2 L34 - P3 L1 supplement ..... For instance, Lynett et.al (2003) employed the field survey data of the 1998 Papua New Guinea tsunami as validation for a numerical model, ... P3 L3-44 supplement ..... rebuilding of the affected areas by the 2018... P3 L31-32 supplement ..... Therefore, our team searched for video recordings and photographs made by local residents while conducting the measurement survey.

Comment 14: P4 L1 you repeated already that this road runs parallel to the coastline. P4 L9-10, delete these lines. P4 L17 "until the date of the end of the survey: : :" P4 L28 "The authors obtained important information from the surveys": : : P4 L31 "The first wave acted as a trigger for evacuation, with many people starting to escape from the coastline". The technical word is "trigger". Please read other papers about evacuation triggers for tsunamis

Response 14: P4_L1 We reduced the repeated phrase "parallel to the coastline" and now only one. P4_L9-10 We deleted these lines "Many locations with steep cliffs and tsunami trails were not easily visible. We did not take measurements in such locations. Likewise, we did not measure places not significantly affected by the tsunamis." P4_L17 We modified "Since the earthquake incident until the date of our team's return " to be "Since the earthquake incident until the date of the end of the survey" P4_L28 We modified"We got some important information from the interviews to be"The authors obtained important information from the surveys" P4_L31 We modified"The first wave was a warning so many people went away from the coastline immediately" to be "The first wave acted as a trigger for evacuation, with many people starting to escape from the coastline".

Changes in manuscript 14: P4 L2-3 supplement ..... The road connecting the provinces

on Sulawesi island, called the Trans Sulawesi Road, is mostly parallel to the coastline of the bay. ..... P4 L16 supplement ..... Since the earthquake incident until the date of the end of the survey. ..... P4 L26 supplement ..... The authors obtained important information from the surveys, ... P4 L29-30 supplement ..... The first wave acted as a trigger for evacuation with many people starting to escape from the coastline. .....

Comment 15: P5 L5 "is recorded at the maximum horizontal inundation distance". (Delete "the horizontal distance flooded by the wave) P5 L10 what do the authors mean by tsunami border? P5 L 12 Delete sentence starting by "The items scattered" P5 L17 what is "tsunami creeping"? run-up? P5 L23 "This area was flattened by the tsunami (Fig 6a), with no buildings surviving"? P5 L26 Rephrase "being quite nimble" P5L27 what exactly is this important observation? Be specific. P5 L32 tsunami risk managers know they can use this data for run-up modelling. Please delete this sentence, it is obvious.

Response 15: P5_L5 Done. We deleted"the horizontal distance flooded by the wave" P5_L10 It is meant limit of inundation. We deleted "from coastline to tsunami border on land", and made new sentences. P5_L12 Done. We delete the sentence and made new sentences in part 5 about damage observation. P5_L17 Right. We mean "creeping" was runup. We replaced "creeping" by "runup". P5_L23 We deleted "This area was flattened by tsunami (Fig. 6a), buildings collapse." And added "caused a few building surviving" in part 5 about damages. P5_L26 We replaced "being quite nimble" by "have agility to save ..." P5_L27 We deleted "This is an important observation for future mitigation efforts."

Changes in manuscript 15: P5 L10-11 supplement ..... In the simplest case, the runup value is recorded at maximum horizontal inundation distance (IOC Manuals and Guides No. 37, 2014). ..... P6 L1-2 supplement ..... Because of this sloping topography, the tsunami wave reached as far as 488 m inland. It was the longest distance among others. ..... P8 L15-16 supplement ..... This site is a trade complex that supports the economic activities of Palu City in particular and Central Sulawesi Province in general.

The buildings damaged at this site functioned as shops, warehouses, and corporate offices.

P5 L29-30 supplement ..... The runup height of 10.73 m is the highest in this survey (Fig. 5) caused a few building surviving. P8 L13-14 supplement ..... This is likely due to most of the young residents have agility to save themselves when the tsunami arrived.

Comment 16: Same for P6 L31-32. P6 L18 check reference, not shown P8 L23 the words "impacted areas with a relatively narrow width" are unclear. Revise. P8 L28 "Ulrih et al. (2019) assume that a: : :"

Response 16: P6 L31-32 We deleted "This phenomenon can be further analyzed to determine the tsunami force." P6 L18 OK, it refers to Fig 6b. P8_L23 We removed part 5.5 about underwater landslides so that we deleted paragraph contained "This suspected source should be located near the impacted areas with a relatively narrow width (Muhari et al., 2018).". P8_L28 We revised and move this part "Ulrich et al. (2019) assume that a ..." to introduction part.

Changes in manuscript 16: P9 L8-9 supplement ..... The position of this bridge is at the end of Palu Bay (-0.88123°S 119.83907°E). ..... P8 L32response supplement ..... A detail measurement was conducted to a reinforced concrete bridge on Cumi-cumi Road, Palu City (Fig 6b). It gives a clue regarding the tsunami's strength. .... P2 L25-26 supplement ..... Ulrich et al. (2019) assume that a source related to earthquake displacements is probable and that landsliding may not have been the primary source of the tsunami. .....

Please also note the supplement to this comment:
https://www.nat-hazards-earth-syst-sci-discuss.net/nhess-2019-91/nhess-2019-91-AC1-supplement.pdf

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2019-91, 2019.