

**“Tsunami heights and limits in 1945 along the Makran coast estimated from testimony gathered seven decades later in Gwadar, Pasni and Ormara”**

a manuscript by Hira A. Lodhi, Shoaib Ahmed and Haider Hasan  
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The revised manuscript contains minor changes that address the concerns of the two reviewers. Appended below, in italics and indented, are the full comments from both reviewers. Our responses follow each of the comments and new text added to manuscript is in bold. Revised manuscript being the file named <nhess-2021-53\_Revision5.doc>

**RESPONSE TO COMMENTS FROM RC1:**

*A major conclusion of this study seems to be that the number of fatalities was at most 150 (Table 2). This is in contrast to the figure of 4000 reported by the NOAA Tsunami Database. The discussion in the present paper would suggest populations of about 6000 in Gwadar (Line 72), 4000 in Pasni (Line 104, even though a newspaper reports 7000 people homeless) and perhaps 1000 in Ormara (Line 160), for a total of 11,000. The rest of the coast was probably very scarcely populated. A death toll of 4000 would amount to 1/3 of the total population, and would be an extremely high rate with long-lasting consequences on the economy of the province. It would probably have been mentioned repeatedly during the interviews of the (then very few) survivors. In this context, the NOAA figure is most probably grossly overestimated.*

*\* Some discussion of this finding should be provided in the paper.*

According to Times of India, 5<sup>th</sup> Decemeber 1945, the reports of 4000 casualties came from party of nine congressmen. It was reported for only for the 100 miles coast from Karachi to Ketibunder (a region in Indus Delta). These reports, according to an express letter written by the Chief Secretary to the Government of Sind, to the Secretary to the Government of India were “greatly exaggerated.”

Moreover, according to the comment of the Chief Secretary to the Government of Sind on estimates of loss of lives by congressmen, published in Times of India, 10<sup>th</sup> December 1945, “They were highly exaggerated. The coastline is sparsely populated. The sub-divisional officials have asked for only small grants for relief, indicating that the damage caused is not as heavy as reported.”

This is reported in the revised manuscript through the text added to the conclusions section (Pg. 19, lines 271–281) as:

**The total number of estimated fatalities associated with the Makran earthquake and ensuing tsunami vary between 300 (Ambraseys and Melville, 1982) to 4000 ([https://www.ngdc.noaa.gov/hazards/tsu\\_db.shtml](https://www.ngdc.noaa.gov/hazards/tsu_db.shtml)). More widely reported number of fatalities is 4000 (e.g., Heck, 1947; Heidarzadeh et al., 2008; Rajendran et al., 2008) but this figure is actually associated to only the region of Karachi and Indus Delta rather than the Makran coast of Pakistan. According to Times of India, 5th December 1945, the reports of 4000 casualties came from party of nine congressmen. It was reported only for the 100 miles coast from Karachi to Ketibunder.**

bunder (a region in Indus Delta). These reports, according to an express letter written by the Chief Secretary to the Government of Sind, to the Secretary to the Government of India were “greatly exaggerated.”

Moreover, according to the comment of the Chief Secretary to the Government of Sind on estimates of loss of lives by congressmen, published in Times of India, 6th December 1945, “They were highly exaggerated. The coastline is sparsely populated. The sub-divisional officials have asked for only small grants for relief, indicating that the damage caused is not as heavy as reported.”

*The newspaper clipping on Figure 3 contains an extremely important datum, namely that the tsunami reached Pasni around 07:00. The earthquake is known to have taken place at 21:57 GMT (on 27-NOV-1945), which agrees with the felt report at 03:30 (28-NOV) given IST (in use in 1945) = GMT + 5:30. There is therefore a delay of about three hours in the arrival of the tsunami. This is in line with the delay of ~2.5 hours reported by witnesses on the Iranian side [Okal et al. 2015], and also with the famous observation of the tsunami in the Seychelles [Beer and Stagg, 1946]. This provides one more piece of evidence that the tsunami (or at least its main component) was generated by an ancillary phenomenon, most probably a landslide triggered by the earthquake, but with a significant time gap. Arguably, the report on Line 171 suggests a shorter time gap, but it has been our experience that the perception of time by witnesses oftens lacks precision. The fundamental point here is that the earthquake was felt in the middle of the night and the tsunami arrived by daylight.*

→ At any rate, this point should be discussed in the paper.

The text added to the manuscript on Pg. 18 & 19, lines 257–270, as below:

The time of arrival of waves at Pasni as reported by multiple survivors was around 6 a.m. whereas only Khudi Dost reports the waves to have arrived almost half an hour after the earthquake (Table 1). It is reported in Baluchistan Agency Administration Report (Fig. 4), “At Pasni a tidal wave 30 feet high arose at 7-0 A.M. and submerged the whole town.” Therefore, it is evident that there is a time difference of 2–3 hours between the earthquake and arrival of largest wave. This finding is in concordance with the eyewitness accounts from Iran and the finding is reported in (Okal et al., 2015) and with the observation of (Beer and Stagg, 1946). This time delay in arrival of tsunami is suggestive of some secondary mechanism such as landslide, associated with the earthquake. This can also be the reason why most of the witnesses reported that the 2<sup>nd</sup> or the 3<sup>rd</sup> wave as being the highest of the waves that attacked the coast.

The majority of the eyewitnesses along the Makran coast of Pakistan had reported the time of arrival of tsunami as half an hour after the earthquake. (Beer and Stagg, 1946) reported, “The first tidal observation was made at 9 hr. 47 min. local time, but it was then noted that the tidal-levels were well above their normal value, suggesting that an earlier wave may indeed have arrived by that time.” Therefore, the time reported here by the eyewitnesses as thirty minutes after the earthquake might be the time of arrival of first wave associated with the earthquake whereas the larger wave generated by an ancillary phenomenon arrived 2–3 hours after the earthquake.

*The authors fail to mention the quantitative compilation carried out across the border in Iran by Okal et al. [2015].*

Point taken. This study is mentioned in the revised version, on Pg. 2, lines 50–53.

**A study by Okal et al., (2015), also based on field survey and eyewitness accounts quantizes the runup data along a 280 km long segment of Iranian shore. The study reports runup between 2.3–13.7 m and a time delay in the arrival of tsunami, indicating a secondary mechanism such as a landslide.**

*The authors mention Atwater et al. [2013] as a reference to tsunami surveys conducted for historical tsunamis many years after the event. However, this technique was pioneered a decade earlier for the 1946 Aleutian tsunami by Okal et al. [2002], which should probably be referenced.*

Reflected in the revised manuscript on Pg. 2, lines 45 & 46.

**However, this technique was pioneered by Okal et al., (2002) and was applied first for the Aleutian tsunami.**

*The authors fail to reference the authoritative work of Ambraseys and Melville [1982] from which most of the information in Dominey-Howes et al. [2006] and Pararas-Carayannis [2006] is derived.*

Reference included Pg. 19, lines 271–272.

*Page 2, Line 54*

*The reference to Byrne and Davis [1992] should not include first names (by the way, Dr.*

*Byrne's is misspelt), and should really be Byrne et al. [1992] since the full authorship of*

*that paper includes Professor L.R. Sykes, whose name has been reduced to his initials*

*(L.R.S.) in the reference list.*

Corrected on Lines 57 and 60 also on line 233. The reference list has also been corrected.

*The coordinate scales on Figures 2, 5, 8 are completely out of range. Note that the longitude scales from 26°E through 176°E to 34°W. The latitudes are similarly extravagant.*

*\* The captions for these figures should name the specific cities.*

The figures have been corrected and replaced.

*There are some obvious discrepancies in the ages quoted for the witnesses. Notwithstanding*

*the difficulty of obtaining their ages (as discussed, e.g., Okal et al. [2015], the latter should be consistent.*

*Note for example the case of Ms. Amina on Table 1. She is quoted as being  $\geq 100$  yrs. old*

*at the time of the interview*

*(Note that 100+ is not a proper scientific notation. Use the symbols  $>$ ,  $\geq$ , etc.)*

*but only 20 in 1945. She would then have been born in 1925, which would make her at*

*most 90 in 2015 or 95 in 2020.*

*Similarly, Ajyani Guli cannot have been 11 in 1945 (b. 1934) and already  $\geq 90$  at the time of*

*the interview.*

*All information should be metric. Convert feet to meters throughout.*

Agreed that there are discrepancies in age. The ages in 1945 and at the time of interview, were quoted directly from “Remembering the 1945 Makran Tsunami; interviews with survivors beside the Arabian Sea”. We should have been more skeptical towards the ages and should have discussed the discrepancies and the reasons for it in the paper. Table 1 has been updated to eliminate the column with ages at the time of interview.

The revised manuscript now uses metric system for the units throughout.

*Page 2, Line 32*

*The authors should emphasize the difference between the 2013 event for which a definitive*

*tsunami requiring a landslide was observed, and the landslide on the Owen Ridge [Rodriguez et al., 2013] which is well documented, but for which the tsunami attacking*

*Oman can only be inferred.*

Change made.

*Page 2, Line 57*

*The earthquake was followed by five **recorded** aftershocks. There probably were many more.*

Point taken and the word “recorded” added to the sentence on Page 2, Line 57.

*Section 3.1*

*There are references to Table 0.1) and Fig 0.2. This needs to be corrected.*

Corrected.

*Figure 1*

*Part (a) of the figure is hardly legible. I had to use a magnifying glass to decipher it. Translate the material in Arabic (or is it another language?) in Part (c), which will otherwise be completely useless to most of the readership.*

Figures have been revised to address the specific comments.

*Page 14, Table 2, Last Column*

*The figure 13,33,000 makes no sense (even though it seems to be quoted directly from the Baluchistan Agency Administration Report on Figure 3). Does this mean 1,333,000 or 13,330,000 ? At any rate, if a proper rendition of this number is given, then an exchange rate to a more universal currency should be included (e.g., Rp. XXXXX, equivalent to present-day YYYYYY £ or US \$ ZZZZ or TTTT \_).*

At that time the system used in the region would count as ten lac lac, ten thousand thousand, hundred ten unit so the figure 13,33,000 would be read as thirteen lac and thirty-three thousand. For the convenience of the readers the commas have been replaced to match the more renowned number system. The number now reads as **1,333,000**.

A column to the extreme right of the table has been added that shows the present-day equivalent of financial damages in US \$.

*The English of the paper should be improved throughout. There are articles, occasionally verbs, missing. Dr. Brian Atwater's name is misspelt in the Acknowledgments, etc.*

The revised manuscript has been checked for the language using a commercial software.

Spelling for Dr. Brian has been corrected.

#### RESPONSE TO COMMENTS FROM RC2:

*I would like to have seen a map showing the EQ location as well as the three town locations so that the reader see the relative distances between them.*

An index map showing the three towns and epicenter location as reported by different studies has been added to the revised manuscript as Fig.1.

*Figure 1, a, and b may need to redraw while keeping the original copy so that the reader would be able to see what is written in them, also translate c.*

Figures (now Fig. 2a and 2b) have been resized for readability and a transliteration of figure 1c (now Fig. 2c) has been added to the revised manuscript.

*Figure 3, authors may need to write the fuzzy words at the beginning of the paragraph to be able to understand the meaning (besides keeping the original).*

Point taken. Figure has been improved and includes a text box with the “fuzzy text” typed out.

*The authors may need to say why the runup at Gwadar is very high relative to the wave height (ten times), is there energy focusing here? or eyewitness exaggeration? Or mixing with other flood events?*

Upon interviewing we came to know that there are two old neighborhoods in Gwadar by the names of Mulla Band/ Mohalla Band and Shadu Band which were the sites mentioned by Amina and not the exact locations of the dams. These new locations give runup elevations of 6 m (Mohallah Band, area adjacent to cricket stadium) and 6 m (Shadu Band, area adjacent to new football ground). Therefore, maximum runup at Gwadar turns out to be 11 m, that was for Jamat Khana. The revised manuscript contains new estimates and text to describe this (Pg.17, lines 213–226) and a figure (Fig. 3) to reflect on this. The text added to the manuscript is below:

**At Gwadar, although there was not much damage the maximum runup is found to be 11 m and the maximum inundation extent is around 900 m. These extents have been derived from the landmarks identified by the eyewitnesses but one of the eyewitnesses (Master Abdul Majeed) also reported, “Water came from the east and crossed to the other side” which is indicative of tsunami engulfing the entire landmass along the east to west stretch. None of the other eyewitnesses reported such inundation, The study does not use this account to conclude that the water might have swept across the entire tombolo as many other survivors had reported water reaching up to certain landmarks only. Another survivor of the event, Amina reported that the “huge wave” did not enter the city. She further reported the water reached the mosque; water was everywhere with no place to go but the water went further than the mosque. She also named some places that were inundated by the tsunami, such as the Mulla band and Shadu band (Kakar et al., 2015b). The water reaching the Mulla Band, reported by Amina and Hasan Ali might be that they were reporting “Mohalla Band” rather than “Mulla Band” or “Mohalla Band” is the new name of the neighbourhood just beside the Gwadar Miniport which was previously called as “Mulla Band”, an area that is very likely to be inundated during the 1945 event. Shadu Band is another neighbourhood beside the new football stadium of Gwadar. In order to be sure if the interpretation of the locations was right, interviewers of the Amina were interviewed as Amina had passed away.**