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Natural Hazards and Earth System Sciences Discussions

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

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**Abstract.**

The towns of Pasni and Ormara were the most severely affected by the 1945 Makran tsuami. The water inundated almost a kilometer at Pasni, engulfing 80% huts of the town while at Ormara tsunami inundated two and a half kilometers washing away 60% of the huts. The plate boundary between Arabian plate and Eurasian plate is marked by Makran Subduction Zone (MSZ). This Makran subduction zone in November 1945 was the source of a great earthquake (8.1 Mw) and of an associated tsunami. Estimated death tolls, waves arrival times, extent of inundation and runup remained vague. We summarize observations of tsunami through newspaper items, eye witness accounts and archival documents. The information gathered is reviewed and quantized where possible to get the inundation parameters in specific and impact in general along the Makran coast. The quantization of runup and inundation extents is based on a field survey or on old maps.

## 1 Introduction

The recent tsunami events of 2004 Indian Ocean (Sumatra) tsunami, 2010 (Chile) and 2011 (Tohoku) Pacific Ocean tsunami have highlighted the vulnerability of coastal areas and coastal communities to such events. Credible vulnerability assessment of a coast depends upon reliable geoscientific data on past tsunami events. The data from past events is crucial as it forms the basis for numerical models that simulate tsunami and tsunami hazard assessment (Hoffmann et al., 2013) which in turn can be used for planning and mitigation and most importantly it can serve as an input for development of tsunami early warning systems (TEWS).

The tsunami hazard of a coast is dependent upon the tsunami sources among many other parameters. The coast of Pakistan lies in close proximity of Makran subduction zone. The historical tsunami events known in the region are sparse but have been reported by several studies (Dominey-Howes et al., 2006; Heidarzadeh et al., 2008) with the oldest one being in 325 BC (Pararas-Carayannis, 2006). The evidences of Paleo-tsunami by MSZ are debatable (Dominey-Howes et al., 2006) as the

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only instrumentally recorded tsunamigenic earthquake from MSZ was in November 1945, a 8.1 Mw thrust event that occurred almost 8 km southeast of Pasni (Quittmeyer and Jacob, 1979). Other probable source of tsunami can be landslides such as the one triggered by the 24th September 2013 inland earthquake (Baptista et al., 2020; Hoffmann et al., 2014) or from the landslide on Owen ridge (Rodriguez et al., 2013).

The 1945 event being the only recorded event serves as the basis for modelling of tsunami in the region (Heidarzadeh et al., 2008; Neetu et al., 2011; Rajendran et al., 2008) but the event itself is poorly recorded because of the aftermath of world war II and political situation of then India. We have summarized the historical accounts, eyewitness accounts and newspaper items to come up with the impact of the 1945 tsunami along the coastal cities of Pakistan while quantizing the data where ever possible. A field survey is carried out along the three coastal cities of Gwadar, Pasni and Ormara during which inundation parameters along the three cities are identified using the landmarks reported in eyewitness accounts and newspaper items. Similar efforts have been carried out in different areas of the world over many years going back to at least 1960 Chile tsunami. More recent ones include post tsunami field surveys of 1992 Nicaragua tsunami (Satake et al., 1993), Srilankan field survey of 2004 tsunami (Goff et al., 2006), 2010 Chile tsunami (Tsuji et al., 2010) and 2018 Sulawesi tsunami (Mikami et al., 2019; Widiyanto et al., 2019). All these surveys were carried out immediately after the tsunami event but the study presented here connects a field survey carried out recently with the tsunami event that took place approximately 70 years ago. A similar study That assess the inundation parameters several years after the event has been conducted in Chile for the 1960 tsunami by (Atwater et al., 2013).

An effort was made by Hoffmann et al. 2013 to review and summarize historical accounts, eyewitness accounts, newspaper items and previously published work for the four countries connected by the Arabian Sea; Oman, Iran, India and Pakistan. According to the study inundation and losses were greatest along what is now the coast of Pakistan. However, the study of Hoffmann et al. 2013 did not report the runups and inundation extents or depths. Here, we report these parameters for the first time, for Gwadar, Pasni and Ormara. The findings are based on the information provided in the eyewitness accounts and newspaper items, a ground survey is conducted to locate the landmarks and come up with the runups and inundation extents along the coast of Gwadar, Pasni and Ormara.

## 2 Makran Earthquake of 1945 and Tsunami

The 1945 tsunami was result of a thrusting event of 8.1 Mw at MSZ (Daniele E. Byrne and Dan M. Davis 1992). The earthquake was felt at Muscat, along the entire coast of Makran and many other places of now Pakistan which were far inland, e.g., Montgomery, Dadu, Dera Ismail Khan. The earthquake was widely recorded at different stations around the world (Hoffmann et al., 2013). The earthquake was followed by five aftershocks (Daniele E.Byrne and Dan M. Davis 1992). The event generated a tsunami that hit the countries in the north-western Indian Ocean.

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## 3 Impact of the 1945 Makran Tsunami

The aftermath of the 1945 Makran tsunami is not very well recorded due to the political situation of the region. The study reports the impact of the tsunami in general and inundation parameters in specific along three coastal cities Gwadar, Pasni and Ormara. For assessing the inundation parameters that is runup and inundation extent, a ground survey was conducted to locate the landmarks reported in various newspaper items and eyewitness accounts published in a UNESCO booklet by Kakar et al. 2015. The lat/long of these landmarks were used to extract the inundation parameters using Google Earth.

### 3.1 Gwadar

The city of Gwadar is one of the major coastal cities along the coast of Pakistan. Recently built deep water port has added to the importance of the city. Gwadar is also the hub of Gwadar district today that in itself consists of four sub-districts; Gwadar, Pasni, Ormara and Jiwani.

In 1945 Gwadar district consisted of only Peshkan, Sur, Nigor and Pleri along with Gwadar city (see **Fig. 1** (b)). According to 1931 census report of India (Vol. I, Part I), chapter 1, page 13, Gwadar had been excluded from census of India because of being in possession of Sultan of Muscat. Gwadar was in possession of Sultanate of Oman from 1734 to 1958. In 1945, the population of Gwadar town was 5875 according to Records of Oman 1867 – 1947 (see **Fig. 1** (a)). For the same reason, no information on the damages was found in Government reports of Baluchistan nor much was reported in Indian newspapers regarding Gwadar. According to a hand written letter by the Sultan of Oman (Sa'eed Bin Taimoor), Gwadar suffered estimated financial damages of approximately 70,000 rupees and four lives were lost (**Fig. 1** (c)).

The main source of information at Gwadar is eyewitness accounts

Table 0.1) because of absence of written history. The eyewitnesses along the coast were interviewed at the beginning of this decade and are compiled and published in the form of a UNESCO booklet by Kakar et al. 2015. These eyewitness accounts form the basis of assessing the approximate runup and inundation extents at Gwadar town. From eyewitness accounts the places and landmarks that were reported as the inundation extent or being inundated are mapped and shown in Fig. 0.2. Mulla Band and Shadu band, the two dams are the highest landmarks that were identified to be inundated by eyewitness accounts. The maximum runup elevation is found at Mulla Band, approximately 56 m at a distance of 1 km from the eastern shore. Apart from the two dams, all the points indicate a runup elevation of 5 to 11 m approximately and inundation extent to be in between 200 to 750 m from the eastern bay (**Fig. 2**) whereas none of the eyewitness accounts report inundation along the western bay this might be partly because the western bay might not be populous at that time. The wave was reported to be as high as minaret or to be 3– 3.6 m by the eyewitnesses.

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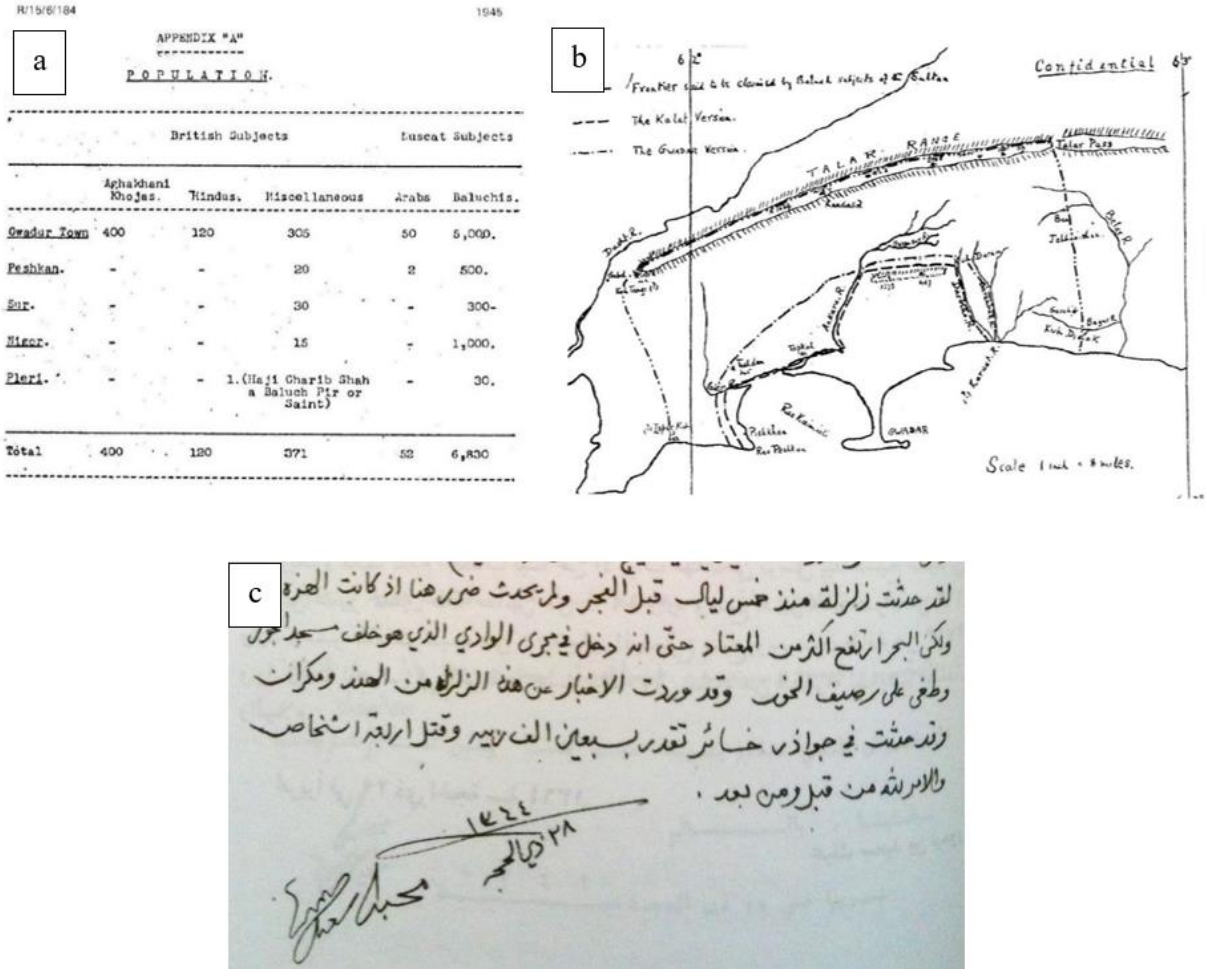


**Fig. 1 (a) Population of Gwadar in 1945 from Records of Oman 1867 – 1947. (b) Old map of Gwadar from a letter written by Lieut. Col. J. Rasmay, agent to the Governor General and Chief Commissioner in Balochistan to mark the boundary of Gwadar and Kalat in 1913, printed in Records of Oman 1867-1947. (c) An excerpt of a letter by Sultan of Oman, Sa'eed bin Taimoor.**

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92 **Table 1 Summary of eyewitness accounts. Here EQ stands for earthquake. Wave heights are not from some datum**
93 **but are personal interpretation of the interviewee.**

| Name | Age in 1945 (yrs) | Age at the time of interview (yrs) | No. of waves | Largest wave | Reported wave heights | Reported arrival times of waves | | Inundation extent/depth |
|---|---|---|---|---|---|---|---|---|
| **Eyewitnesses at Gwadar** | | | | | | | | |
| Amina | 20 | 100+ | – | – | High as minaret | – | – | Mulla Band, Shadu band, ashkoki, Chanali were completely inundated. Waja Khizer, area infront of Koh e Batil was also inundated. |
| Mulla Murad Mohammad* | – | 63 | – | – | 10-12 feet | – | – | – |
| Hassan Ali* Souhail | – | ~75 | – | – | – | – | – | Water Jammat Khana (15 feet deep), WAPDA house was inundated and area where Agha khani community lived was also inundated. |
| Master Abdul Majeed | 7-8 | 76 | – | – | – | – | – | Water came from east and crossed to the other side. The water also went southward to graveyard near Koh-e-Batil. |
| Hasan Ali* | – | 71 | – | – | – | – | – | Water came from east and went towards Mulla Band. Jammat Khana was used as shelter as the building was strong. |
| **Eyewitnesses at Pasni** | | | | | | | | |
| Shamsi Mai | 16-17 | 85 | – | – | 20-25 feet | – | – | 2-3 km inland |
| Master Abdul Rasheed | 12 | 80 | – | 2nd | – | Before 6:00 am | Around 6:00 am | Few km inland |
| Sakhi Dad | 10-12 | 85 | 3 | 3rd | 20-25 feet | 6:00 am | – | – |
| Qadir Buksh* Kushesh | 5 | 74 | – | – | 14-15 feet | – | – | – |
| Ajyani Guli | 11 | 90+ | 3 | – | – | – | – | – |
| Khudi Dost | 10-15 | 80 | – | – | – | 30 min after EQ | – | Part of Wadsar drowned. |
| Karim Buksh | 13 | 80+ | 7 or 8 | – | – | 6:00 | – | Father's boat was placed by tsunami on the top of mosque. |
| Haroon* | ~1.4 | 70 | 3 | – | 60,40,30 feet for 3 waves | – | – | – |
| Rabuk (Rabia) | 5-6 | 74 | – | – | – | – | – | Water damaged many houses and a mosque. |

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| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Ganj Buksh | 14-15 | 82 | _ | _ | _ | _ | _ | destroyed houses, boats, and debris nearly as far inland as Paraag. Many houses and boats were stranded beside Jaddi Hill |
| **Eyewitnesses at Ormara** | | | | | | | | |
| Dildar Sahab | 12 | 79 | 3 | _ | _ | _ | _ | Naik Noor Mohammad Dargah inundated with 4 feet deep water. |
| Qadir Buksh | 15-16 | 84 | _ | _ | _ | 1-1.5 hrs after EQ | _ | Water went about as far as the present high school and reached the Naik Noor Mohammad Dragah. |
| Madni | 10-11 | 76 | _ | _ | 14 feet | 30 min after EQ | _ | _ |
| Shamsu din | 6 | 73 | _ | _ | _ | 30 min after EQ | _ | _ |
| Master Fateh Moham mad Baloch | 15 | 84 | 3 | 3rd | _ | 5 a.m | _ | Water reached Naik Noor Mohammad Dargah. *Gaali*, an Indian cargo boats wreckage was carried to Soorani Stream. |
| Guli | 8 | 75 | _ | _ | _ | _ | _ | Water reached Naik Noor Mohammad dargah (knee deep). Family took refuge where now is Teshil Municipal Office. |
| Lari | 11 | 78 | _ | 1st | _ | _ | _ | Water reached Naik Noor Mohammad Dargah. Water reached the area where present Fisheries Office is. |
| Sualeh | 12-14 | 87 | _ | _ | _ | 30 min after EQ | _ | _ |

*learnt about the event through their elders.

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| LOCATION | SHORE LINE (m) | ELEVATION (m) |
|---|---|---|
| Mulla band | 1056 | 56 |
| Chanali | 236 | 9 |
| WAPDA | 370 | 5 |
| Jamat Khana | 219 | 11 |
| Graveyard | 727 | 10 |

**Fig. 2 Locations as identified by eyewitness accounts to have been inundated by the 1945 tsunami, plotted on © Google Satellite image. The line shows a crude estimate of inundation extents.**

### 3.2 Pasni

The City of Pasni still remains small even today. It lies on the Makran Coast on Arabian Sea about 450 km from Karachi. Administratively, Pasni is the headquarter of the Pasni sub-division of Gwadar district that includes Pasni and Ormara Tehsils (tehsil - county) as well as Astola Island which lies 40 km ESE of Pasni, in the Arabian Sea. According to census of India, Volume IV, Baluchistan (pp. 12) in 1931 total population of Pasni was 1989 (Male: 1090 and Female: 899) which grew to3616 (Male: 1852 and Female: 1764) in 1941 (Census of India, Volume XIV, Baluchistan, pp. 14). Therefore, it is estimated that the population of Pasni in 1945 would have been in 4000s.

The Baluchistan Agency Administration Report 1945-46 in many of its sections described the devastation caused by a tidal wave that was preceded by an earthquake. Part I of Baluchistan Agency Administration Report 1945-46, reports of a severe earthquake on the coast of Makran and Lasbela on 28th November, 1945 at 3:30 am. It further reports that Ormara and Pasni suffered substantial damages. According to the report around 7:00 am, 30 feet high tidal wave struck Pasni, submerging the entire town while claiming 47 lives (Fig. 3).

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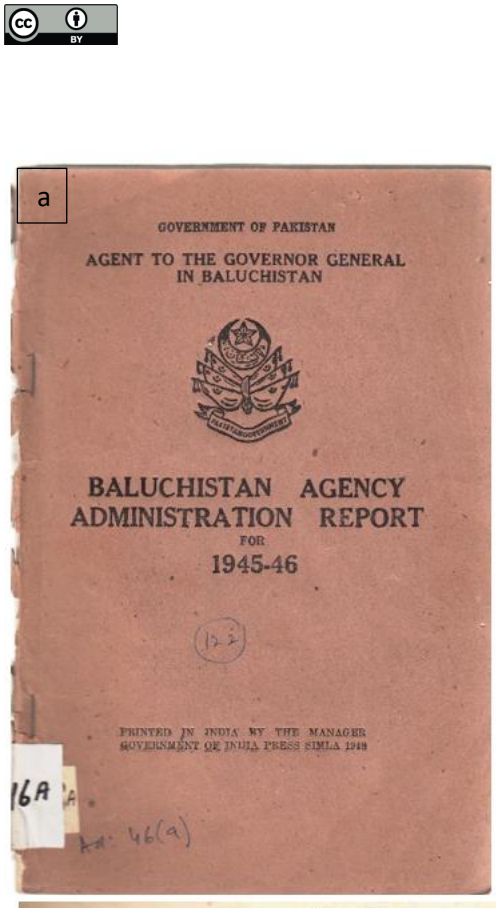
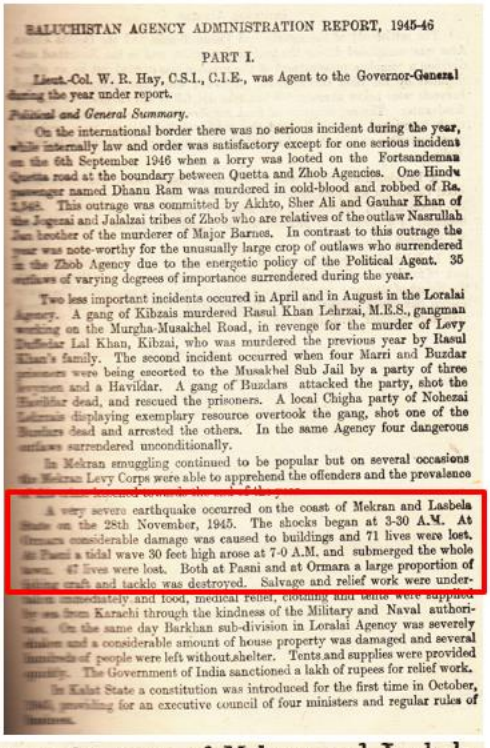




BALUCHISTAN AGENCY ADMINISTRATION REPORT, 1945-46

PART I.

Lieut.-Col. W. R. Hay, C.S.I., C.I.E., was Agent to the Governor-General during the year under report.

*Political and General Summary.*

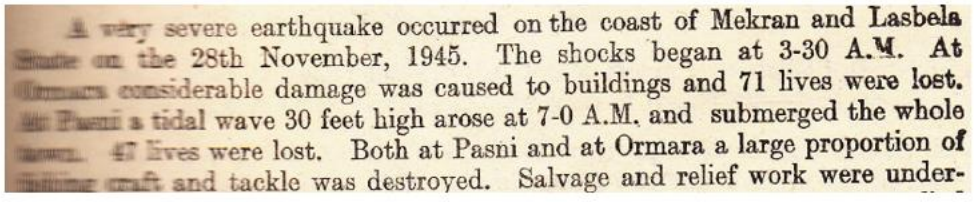
On the international border there was no serious incident during the year, while internally law and order was satisfactory except for one serious incident on the 6th September 1946 when a lorry was looted on the Fortsandeman Quetta road at the boundary between Quetta and Zhob Agencies. One Hindu passenger named Dhanu Ram was murdered in cold-blood and robbed of Rs. 1,346. This outrage was committed by Akhto, Sher Ali and Gauhar Khan of the Isgazai and Jalalzai tribes of Zhob who are relatives of the outlaw Nasrullah Jan brother of the murderer of Major Barnes. In contrast to this outrage the year was note-worthy for the unusually large crop of outlaws who surrendered in the Zhob Agency due to the energetic policy of the Political Agent. 35 outlaws of varying degrees of importance surrendered during the year.

Two less important incidents occured in April and in August in the Loralai Agency. A gang of Kibzais murdered Rasul Khan Lehrzai, M.E.S., gangman working on the Murgha-Musakhel Road, in revenge for the murder of Levy Duffadar Lal Khan, Kibzai, who was murdered the previous year by Rasul Khan's family. The second incident occurred when four Marri and Buzdar prisoners were being escorted to the Musakhel Sub Jail by a party of three levymen and a Havildar. A gang of Buzdars attacked the party, shot the Havildar dead, and rescued the prisoners. A local Chigha party of Nohezai Lehrmais displaying exemplary resource overtook the gang, shot one of the Buzdars dead and arrested the others. In the same Agency four dangerous outlaws surrendered unconditionally.

In Mekran smuggling continued to be popular but on several occasions the Mekran Levy Corps were able to apprehend the offenders and the prevalence

A very severe earthquake occurred on the coast of Mekran and Lasbela State on the 28th November, 1945. The shocks began at 3-30 A.M. At Ormara considerable damage was caused to buildings and 71 lives were lost. At Pasni a tidal wave 30 feet high arose at 7-0 A.M. and submerged the whole town. 47 lives were lost. Both at Pasni and at Ormara a large proportion of fishing craft and tackle was destroyed. Salvage and relief work were under-taken immediately and food, medical relief, clothing and tents were supplied by air from Karachi through the kindness of the Military and Naval authorities. On the same day Barkhan sub-division in Loralai Agency was severely shaken and a considerable amount of house property was damaged and several hundreds of people were left without shelter. Tents and supplies were provided quickly. The Government of India sanctioned a lakh of rupees for relief work.

In Kalat State a constitution was introduced for the first time in October, 1946, providing for an executive council of four ministers and regular rules of business.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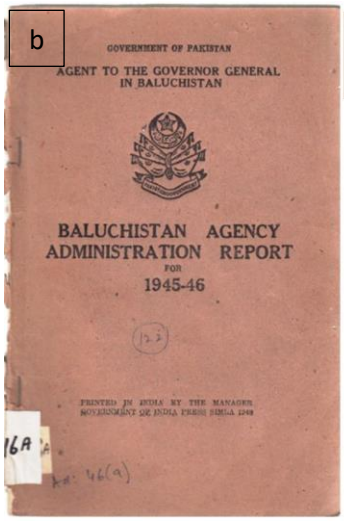


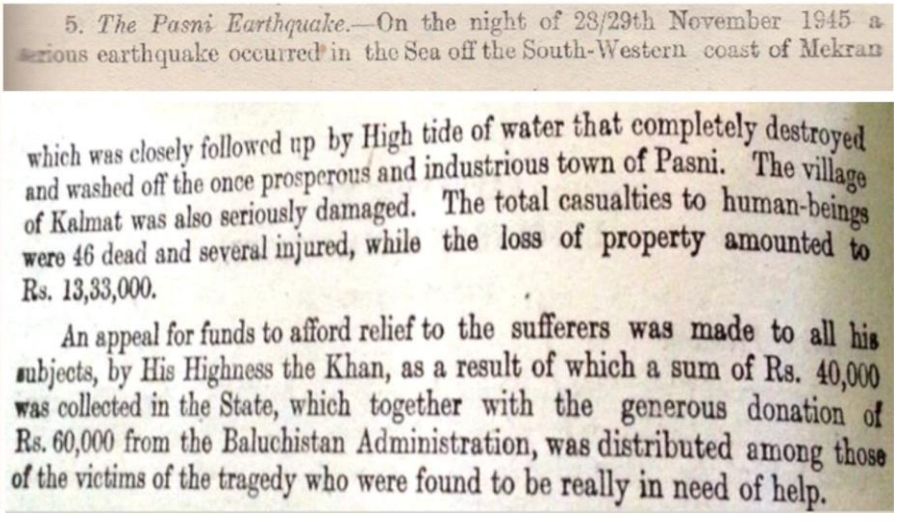
5. *The Pasni Earthquake.*—On the night of 28/29th November 1945 a serious earthquake occurred in the Sea off the South-Western coast of Mekran which was closely followed up by High tide of water that completely destroyed and washed off the once prosperous and industrious town of Pasni. The village of Kalmat was also seriously damaged. The total casualties to human-beings were 46 dead and several injured, while the loss of property amounted to Rs. 13,33,000.

An appeal for funds to afford relief to the sufferers was made to all his subjects, by His Highness the Khan, as a result of which a sum of Rs. 40,000 was collected in the State, which together with the generous donation of Rs. 60,000 from the Baluchistan Administration, was distributed among those of the victims of the tragedy who were found to be really in need of help.

**Fig. 3 (a) Excerpts of Baluchistan Agency Administration Report, 1945 – 1946, Part I. (b) Excerpts of Baluchistan Agency Administration Report, 1945 – 1946, Appendix XI, pp. 59 and 60.**

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Appendix XI Kalat State, of the same, reports, "A serious earthquake occurred in the Sea off the South-Western coast of Makran which was closely followed up by a High Tide of water that completely destroyed and washed off the once prosperous and industrious town of Pasni." The financial damages and relief efforts at Pasni are also mentioned. It further states that the Khan of Kalat, made an appeal for funds to provide relief to the sufferers which resulted in substantial amount that was afterwards distributed among the people at Pasni (**Fig. 4**).

This unfortunate event was widely reported by many newspapers around the world but it was most extensively covered by "Times of India." Times of India on Friday, 30th November 1945 reported sea water rushed into the town of Pasni and washed away a good number of people. Government buildings including Post and Telegraph office and rest house were washed away. Times of India on Saturday, 1st December 1945 reported, "the town of Pasni is a vast sheet of water with only housetops being visible….Custom House is reported to have been damaged". Times of India on 6th December 1945 reported that Mr. J. L. Jerath, Director Posts and Telegraphs, Sind and Baluchistan, who had been on H.I.M.S. Hindustan, a naval ship sent to Pasni and Ormara for relief work, upon his return from Pasni and Ormara said that the 80% of the huts at Pasni and 60% of the huts at Ormara are estimated to be washed away by the tidal wave (**Fig. 4**). Sind Observer on 6th December 1945 reported for Pasni, "The whole village has been totally razed to the ground…..Customs goods and other properties including furniture were carried away by the tidal wave to the other extreme of the village. About 7,000 people here are homeless."

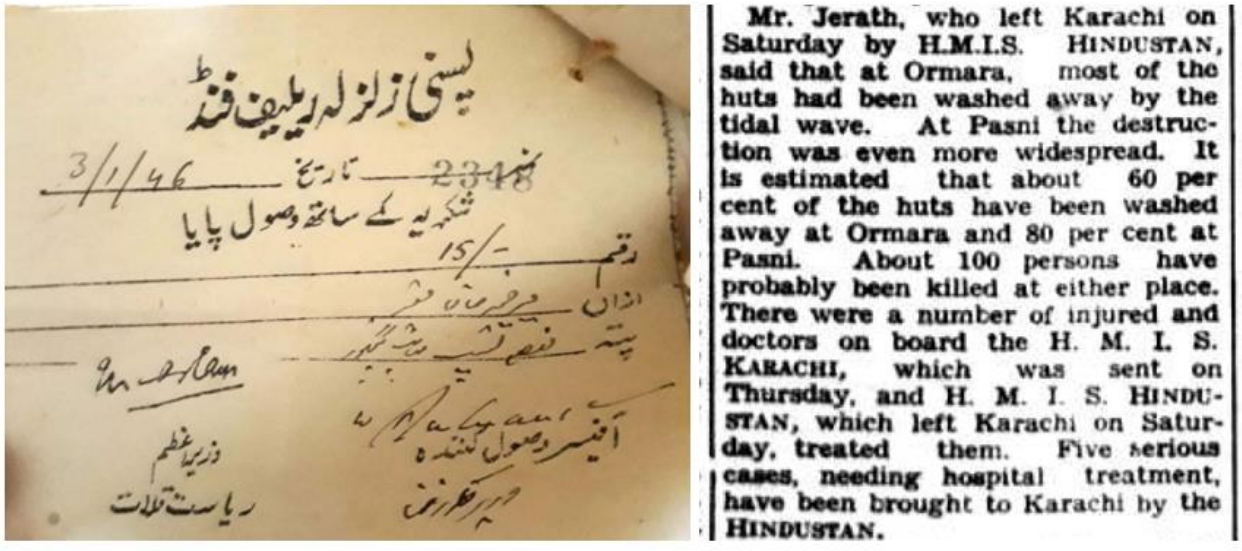


**Fig. 4 Relief efforts at Pasni and Ormara. Slip for an amount of 15 PKR of Pasni Relief Fund received by a survivor of 1945 tsunami (on the right). Times of India clipping showing that Director Post and Telegraph went on the H.M.I.S. Hindustan to Pasni and Ormara (on the left).**

The inundation extents and runups were not reported in any of the government reports and newspaper items. The places, Rest House and Post and Telegraph office reported by Times of India as being washed off by the tsunami; were located

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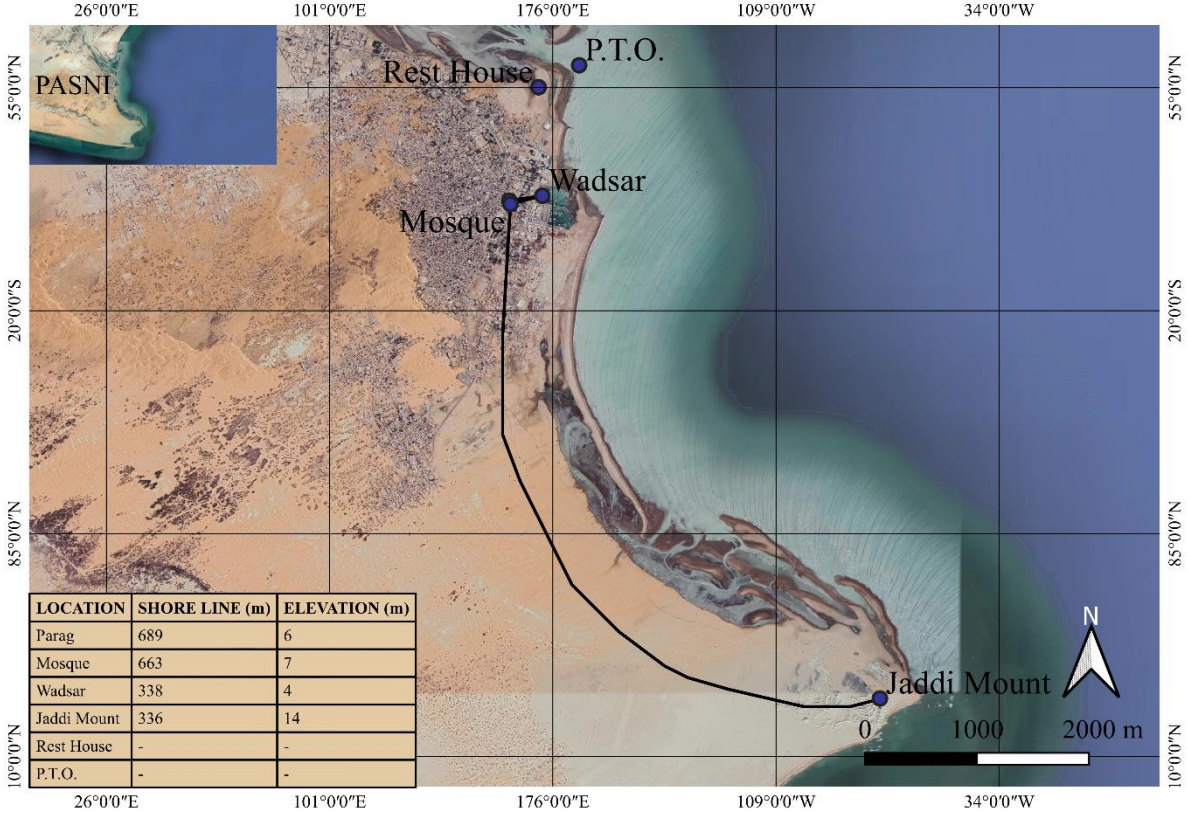
through an old map of the Pasni city, from 1943 (a quarter-inch sheet of by the Survey of India. G41-P Turbat, interim edition 1941, reprinted April 1943, scale 1:253,440), (**Fig. 6**). PTO was found to be approximately 460 m and Rest House at 570 m from the shoreline at that time. The shoreline of Pasni has changed since 1945, not only as a result of erosion and deposition of sediments but also because of the event itself as it is reported by many eyewitnesses that part of Pasni slid underwater.

The extents of inundation based on field survey following the eyewitness accounts and reported landmarks therein, are approximately 300 to 700 m from the shoreline whereas the runup elevations are between 4 – 14 m (**Fig. 5**). Among these points, Wadsar is the one closest to shore and also has minimum runup elevations but as this area was reported by several eyewitnesses to have been drowned or slid under water because of the event therefore we expect that location of Wadsar is not the actual inundation extent but it is rather an area which was inundated (see **Fig. 5**). Moreover, the number of waves as per the eyewitness accounts were three.




| LOCATION | SHORE LINE (m) | ELEVATION (m) |
|---|---|---|
| Parag | 689 | 6 |
| Mosque | 663 | 7 |
| Wadsar | 338 | 4 |
| Jaddi Mount | 336 | 14 |
| Rest House | - | - |
| P.T.O. | - | - |

**Fig. 5 Locations as identified by eyewitness accounts to have been inundated by the 1945 tsunami, plotted on © Google Satellite image. The line shows a crude estimate of inundation extents. The points which have not been joined through the line were identified from newspaper accounts.**

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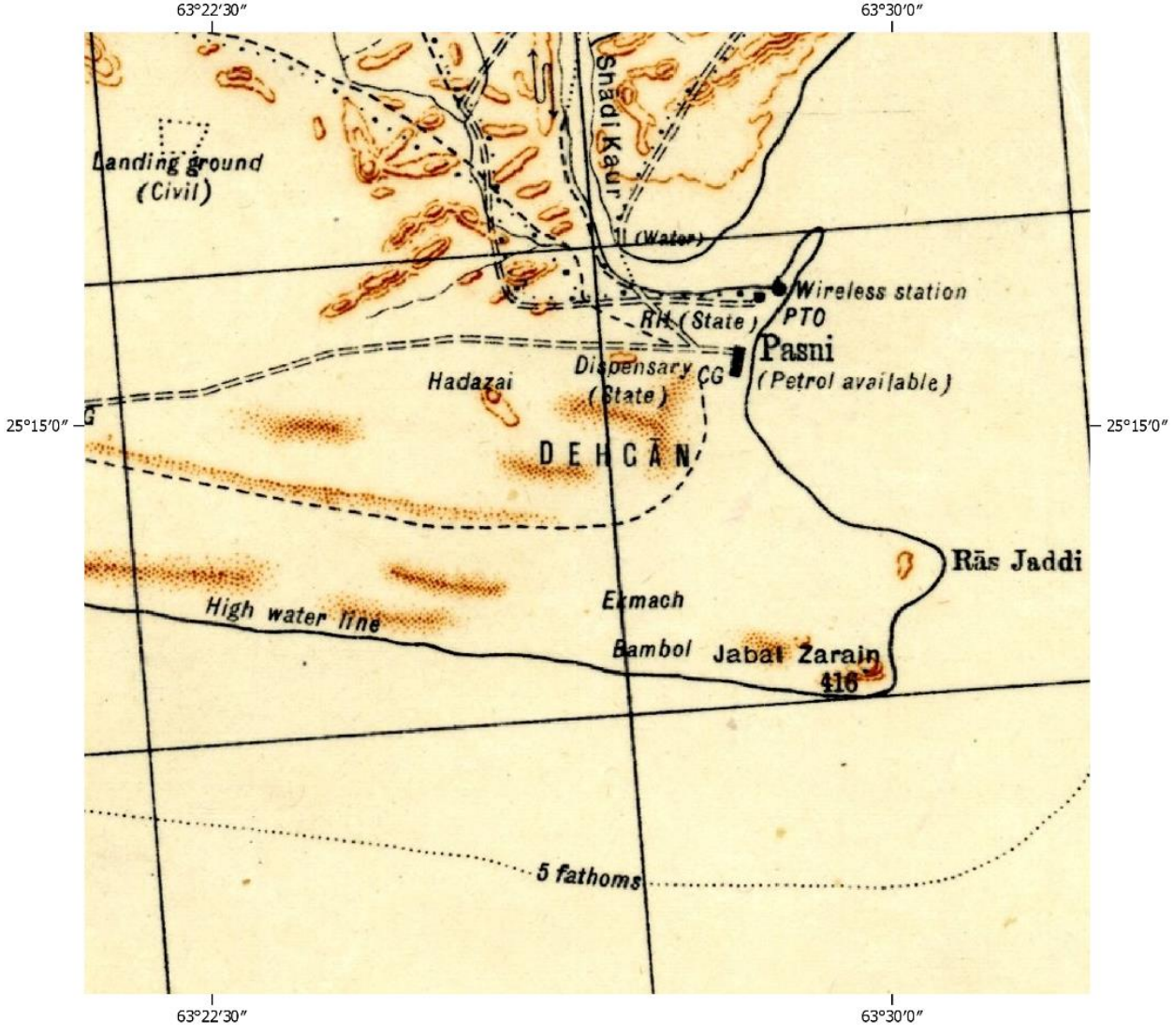


**Fig. 6 Old map of Pasni. An excerpt from a quarter-inch sheet by the Survey of India. G41-P Turbat, interim edition 1941, reprinted April 1943, scale 1:253,440.**

### 3.3 Ormara

Ormara, still is not very populous but it is an important city of Gwadar district along the Makran coast. Ormara in 1945 came under the Las Bela state and was part of British Balochistan. The first year for which the population for the city of Ormara could be found during the study is 1981. According to a report of Pakistan bureau of statistics in 1981 total population of Ormara was 8265. Therefore, it can be speculated that the city of Ormara had population in only 1,000s in 1945.

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In the Baluchistan Agency Administrative Report Appendix XII, the damages by the 1945 event are reported stating that it resulted in 78 deaths and 165 people were injured though it is unclear whether the tsunami caused the fatalities or the earthquake itself caused the deaths (**Fig. 7**).

Devastation at Ormara, was not much less than the devastation at Pasni. As reported in Times of India, 6th Decemeber, Mr. Jerath, Director Posts and Telegraph estimated 60% of huts to have been washed away by tsunami at Ormara. Dawn reported on 2nd December 1945 that the town of Pasni was completely flat and the condition at Ormara is no different from Pasni.

APPENDIX XII.

ADMINISTRATION REPORT OF LAS BELA STATE FOR THE YEAR 1945-46.

CHAPTER I.—*General and Political.*

4. A severe earthquake occurred at Ormara on the 27th November 1945 resulting in 78 deaths and injuries to 165 persons. In addition, 12 persons were found missing. The loss of property is estimated to range between three to four lakhs of rupees. Relief measures were taken at the time.

**Fig. 7 Excerpts of Baluchistan Agency Administration Report, 1945 – 1946, Appendix XII**

Eyewitnesses remembered arrival of three waves after the earthquake and destruction of an Indian cargo boat, *Gaali* and the wreckage being carried to Sorani stream. The waves arrived either an hour or an hour and a half after the earthquake. The accounts have been quantified to get inundation extent and runup at Ormara, through ground survey. It is found that the maximum runup elevation is approximately 11 m and maximum inundation extent is almost 2.5 km (**Fig. 8**).

The Post and Telegraph Office that was reported by Times of India to have been inundated was located through an old map of the city (a quarter-inch sheet of by the Survey of India. Metadata in Kakar et al. 2015, p. XVII: G41-Q Ormara, second edition 1937, scale 1:253,440) and was found to be approximately 1 km from the shoreline.

Interviews of local fishermen at Ormara in the 1970s, reported in (Page et al., 1979) provided evidence of uplift at Ormara due to the 1945 earthquake which is interpreted by the author to be around 2m. The same is evident by the interview of Qadir Buksh, “The shoreline shifted. Before the event the shore was inland of where it is today.” (Kakar et al., 2015a).

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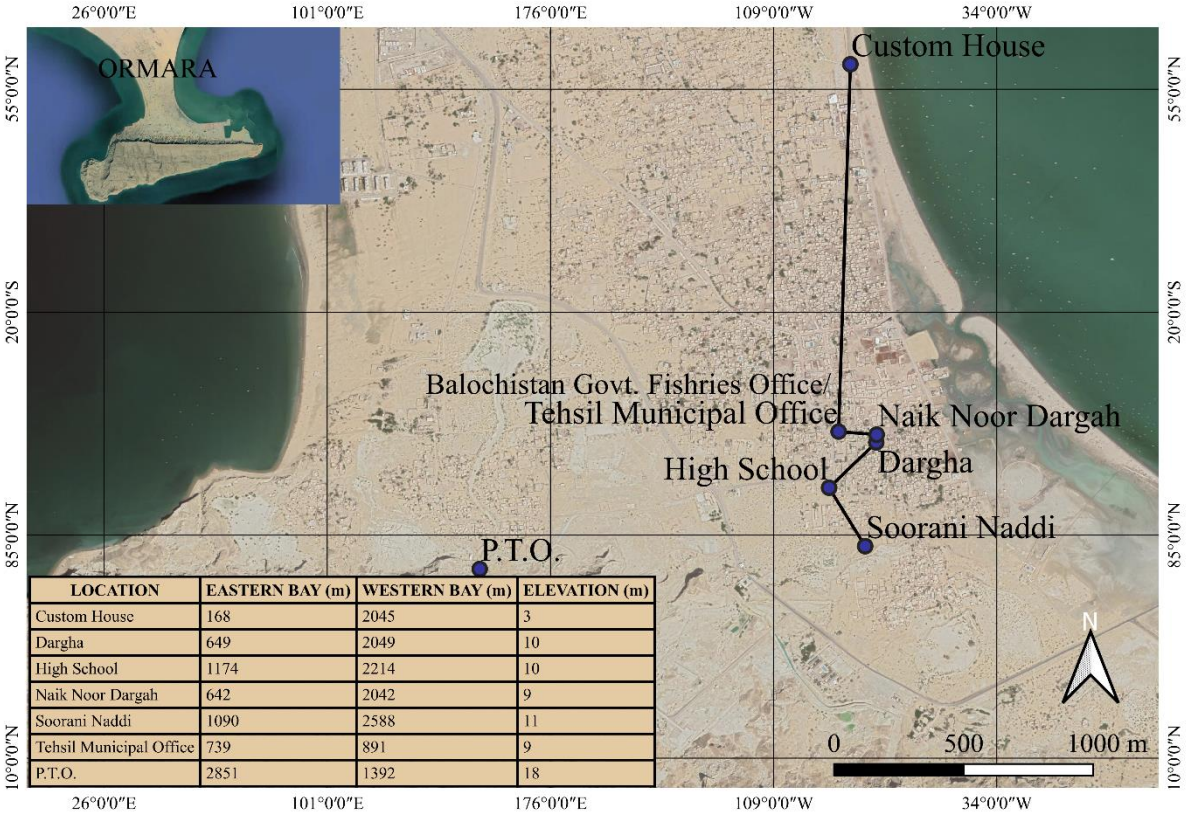


| LOCATION | EASTERN BAY (m) | WESTERN BAY (m) | ELEVATION (m) |
|---|---|---|---|
| Custom House | 168 | 2045 | 3 |
| Dargha | 649 | 2049 | 10 |
| High School | 1174 | 2214 | 10 |
| Naik Noor Dargah | 642 | 2042 | 9 |
| Soorani Naddi | 1090 | 2588 | 11 |
| Tehsil Municipal Office | 739 | 891 | 9 |
| P.T.O. | 2851 | 1392 | 18 |

**Fig. 8 Locations as identified by eyewitness accounts to have been inundated by the 1945 tsunami, plotted on © Google Satellite image. The line shows a crude estimate of inundation extents. The point which has not been joined through the line was identified from newspaper accounts.**

## 4. Results and Discussion

The historical accounts for large earthquakes along the Makran Suduction zone are sparse and disputable. Nevertheless, the possibility of large earthquakes cannot be ruled out. With Mega cities such as Karachi (Pakistan) and Mumbai (India) and many other growing coastal cities such as Gwadar (Pakistan), Chabahar (Iran) and Batinah (Oman), the seismic hazard from Makran Suduction Zone and risk of ensuing tsunamis cannot be over looked. The growing population and large investments in infrastructure along the coasts bordering the Arabian Sea demands of reliable risk assessment for tsunami in the region but not enough data is available for the same.

In many cases historical accounts are a valuable source of information for reconstruction of past tsunami events (Atwater et al., 2013; Dominey-Howes et al., 2006) where scientific data is not present. We first summarize the description of the 1945 event in newspaper items, historical reports and eyewitness accounts and then use eyewitness accounts and newspaper items

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combined with a field survey to extract the runups and inundation extents for coastal cities of Pakistan through the reported tsunami observations there-in.

At Gwadar although there were not much damages but the maximum runup is found to be 56 m and maximum inundation extent is around 700 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 east and crossed to the other side" which is indicative of tsunami engulfing the entire landmass along the east to west stretch. 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 go further than the mosque. She also named some places that were inundated by the tsunami, such as Mulla band and Shadu band (Kakar et al., 2015b). If these two dams (Mulla band and Shadu band) were inundated, it can be expected that the water might have swept across the entire tombolo.

The maximum runup and inundation extent at Pasni as measured are approximately 14 m and 0.6 km, respectively. The inundation extents are not the actual extents for every point marked on **Fig. 2** but in some cases mark the landmarks that were identified as inundated. Moreover, the shoreline at Pasni has changed drastically since 1945 and the inundation extents for most of the points have been extracted using the recent imagery from Google Earth. Therefore, these two factors can contribute to the fact that the actual inundation extent in 1945 could have been greater than reported here.

At Ormara the maximum runup and inundation extents are approximately 11 m and 2.5 km (from Western Bay after the epicenter from (Daniele E.Byrne and Dan M.Davis, 1992)) (see **Table 2**). The inundation extent at Ormara, is the greatest among all the cities considered in the study although Pasni was much closer to the epicenter. This might be contributed by the fact that Pasni had sand dunes near the town which according to many eyewitnesses saved their lives as it was a place of refuge whereas at Ormara no such natural defense was present beside the town.

**Table 2 Impact of 1945 Makran tsunami along the coastal cities of Pakistan.**

| City | Maximum runup (m) | Maximum Inundation extent (m) | Number of Waves | Maximum Wave Height (m) | Casualties | Financial Damages (Rs.) |
|---|---|---|---|---|---|---|
| Gwadar | 56 | 700 | – | 3–6 | 3–4 | 70,000 |
| Pasni | 7.6 | 1000 | 3 | 9.1 | 47 | 13,33,000 |
| Ormara | 11 | 2500* | 3 | – | 76 | 300000-400000 |

*from Western Bay

If we take the same population as 1941 (1939) and find the percentage of people who lost their lives to the 1945 tsunami event at Pasni, it is found to be approximately 1.3% (considering the population of 1941 as the nearest estimate of population in 1945). The town of Ormara had an estimated population of nearly 1000 and sustained 76 casualties that gives approximately 8% of the population wiped off by the event.

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## 5 Conclusions

This paper draws on the eyewitness accounts and newspaper items to estimate the runup and inundation extent at Gwadar, Pasni, Ormara and Karachi. Pasni and Omara were the most severely affected cities. The inundation extent at Ormara, is the greatest among all the cities considered in the study although Pasni was much closer to the epicenter. The uncertainity is inherent to the parameters derived here due to reasons such as, personal interpretation of the event of the survivors and survey being conducted after 70 years of the event. Therefore, the inundation parameters presented here may be crude approximation of the actual parameters but it still paints a picture of the wreck-havoc caused by the 1945 Makran tsunami. The data collected in the form of eyewitness accounts, archival reports and newspaper accounts from countries bordering the Arabian Sea should be used to draw reliable limits on the source of the earthquake and ensuing tsunami. Similar studies in the neighbouring countries can further facilitate the cause and contribute in reliable risk assessment of the coasts along the Arabian Sea.

## Author Contribution

Hira Ashfaq Lodhi prepared the manuscript, identified the landmarks from eyewitness accounts and newspaper items for the field survey. Shoaib Ahmed conducted the field survey. Haider Hasan searched for archival documents.

## Competing Interests

The authors declare that they have no conflict of interest.

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## References

Atwater, B. F., Cisternas, M., Yulianto, E., Prendergast, A. L., Jankaew, K., Eipert, A. A., Fernando, W. I. S., Tejakusuma, I., Schiappacasse, I. and Sawai, Y.: The 1960 tsunami on beach-ridge plains near Maullín, Chile: Landward descent, renewed breaches, aggraded fans, multiple predecessors, Andean Geology, 26, 2013.

https://doi.org/10.5194/nhess-2021-53
Preprint. Discussion started: 5 March 2021
© Author(s) 2021. CC BY 4.0 License.

Baptista, M. A., Miranda, J. M., Omira, R. and El-Hussain, I.: Study of the 24 September 2013 Oman Sea tsunami using linear shallow water inversion, Arab J Geosci, 13(14), 606, https://doi.org/10.1007/s12517-020-05632-z, 2020.

Daniele E. Byrne, L. R. S. and Dan M. Davis: Great thrust earthquake and aseismic slip along the plate boundary of the Makran subduction zone, journal of geophysical research, 97(B1), 449–478, 1992.

Dominey-Howes, D. T., Humphreys, G. S. and Hesse, P. P.: Tsunami and palaeotsunami depositional signatures and their potential value in understanding the late-Holocene tsunami record, The Holocene, 16(8), 1095–1107, 2006.

Goff, J., Liu, P. L.F., Higman, B., Morton, R., Jaffe, B. E., Fernando, H., Lynett, P., Fritz, H., Synolakis, C. and Fernando, S.: Sri Lanka Field Survey after the December 2004 Indian Ocean Tsunami, Earthquake Spectra, 22(3_suppl), 155–172, https://doi.org/10.1193/1.2205897, 2006.

Heidarzadeh, M., Pirooz, M. D., Zaker, N. H., Yalciner, A. C., Mokhtari, M. and Esmaeily, A.: Historical tsunami in the Makran Subduction Zone off the southern coasts of Iran and Pakistan and results of numerical modeling, Ocean Engineering, 35(8–9), 774–786, https://doi.org/10.1016/j.oceaneng.2008.01.017, 2008.

Hoffmann, G., Rupprechter, M., Balushi, N. A., Grützner, C. and Reicherter, K.: The impact of the 1945 Makran tsunami along the coastlines of the Arabian Sea (Northern Indian Ocean) – a review, Zeit fur Geo Supp, 57(4), 257–277, https://doi.org/10.1127/0372-8854/2013/S-00134, 2013.

Hoffmann, G., Al-Yahyai, S., Naeem, G., Kociok, M. and Grützner, C.: An Indian Ocean tsunami triggered remotely by an onshore earthquake in Balochistan, Pakistan, Geology, 42(10), 883–886, https://doi.org/10.1130/G35756.1, 2014.

Kakar, D. M., Naeem, G., Usman, A., Mengal, A., Beni, A. N., Afarin, M., Ghaffari, H., Fritz, H. M., Pahlevan, F., Okal, E., Hamzeh, M. A., Ghasemzadeh, J., Al-Ballushi, N. S., Hoffmann, G., Roepert, A., Srinivasalu, S. and Andrade, V.: Remembering the 1945 Makran Tsunami: Interviews with the Survivors Beside the Arabian Sea, UNESCO/IOC., 2015a.

Kakar, D. M., Naeem, G., Usman, A., Mengal, A., Baksh, D., Nisar, M., Baloch, A., Warr, M. B., Beni, A. N., Afarin, M., Ghaffari, H., Fritz, H. M., Pahlevan, F., Okal, E., Hamzeh, M. A., Ghasemzadeh, J., Balushi, N. A., Hoffmann, G., Roepert, A., Srinivasalu, S., Andrade, V., Alharti, A. R. and Bhatt, N.: Remembering the 1945 Makran Tsunami: Interviews with the Survivors Beside the Arabian Sea (in Urdu), UNESCO IOC., 2015b.

Mikami, T., Shibayama, T., Esteban, M., Takabatake, T., Nakamura, R., Nishida, Y., Achiari, H., Rusli, Marzuki, A. G., Marzuki, M. F. H., Stolle, J., Krautwald, C., Robertson, I., Aránguiz, R. and Ohira, K.: Field Survey of the 2018 Sulawesi Tsunami: Inundation and Run-up Heights and Damage to Coastal Communities, Pure Appl. Geophys., 176(8), 3291–3304, https://doi.org/10.1007/s00024-019-02258-5, 2019.

Neetu, S., Suresh, I., Shankar, R., Nagarajan, B., Sharma, R., Shenoi, S. S. C., Unnikrishnan, A. S. and Sundar, D.: Trapped waves of the 27 November 1945 Makran tsunami: observations and numerical modeling, Natural Hazards, 59(3), 1609–1618, https://doi.org/10.1007/s11069-011-9854-0, 2011.

Page, W. D., Alt, J. N., Cluff, L. S. and Plafker, G.: Evidence for the recurrence of large-magnitude earthquakes along the Makran coast of Iran and Pakistan, Tectonophysics, 52, 533–547, 1979.

Pararas-Carayannis, G.: The potential of tsunami generation along the Makran Subduction Zone in the Northern Arabian Sea. Case study: The earthquake and tsunami of November 28, 1945, Science of Tsunami Hazards, 24(5), 27, 2006.

Quittmeyer, R. C. and Jacob, K. H.: Historical and Modern Seismicity of Pakistan, Afghanistan, Northwestern India and Southeastern Iran, Bulletin of the Seismological Society of America, 69(3), 773–823, 1979.

https://doi.org/10.5194/nhess-2021-53
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Natural Hazards and Earth System Sciences
Discussions

Rajendran, C. P., Ramanamurthy, M. V., Reddy, N. T. and Rajendran, K.: Hazard implications of the late arrival of the 1945 Makran tsunami, CURRENT SCIENCE, 95(12), 5, 2008.

Rodriguez, M., Chamot-Rooke, N., Hébert, H., Fournier, M. and Huchon, P.: Owen Ridge deep-water submarine landslides: implications for tsunami hazard along the Oman coast, Nat. Hazards Earth Syst. Sci., 13(2), 417–424, https://doi.org/10.5194/nhess-13-417-2013, 2013.

Satake, K., Bourgeois, J., Abe, K., Abe, K., Tsuji, Y., Imamura, F., Lio, Y., Katao, H., Noguera, E. and Estrada, F.: Tsunami field survey of the 1992 Nicaragua earthquake, Eos Trans. AGU, 74(13), 145–157, https://doi.org/10.1029/93EO00271, 1993.

Tsuji Y., Ohtoshi K., Nakano S., Nishimura Y., Fujima K., Imamura F., Kakinuma T., Nakamura Y., Imai K., Goto K., Namegaya Y., Suzuki S., Shiroshita H. and Matsuzaki Y.: Field Investigation on the 2010 Chilean Earthquake Tsunami along the Comprehensive Coastal Region in Japan, Journal of Japan Society of Civil Engineers, Ser. B2 (Coastal Engineering), 66(1), 1346–1350, https://doi.org/10.2208/kaigan.66.1346, 2010.

Widiyanto, W., Santoso, P. B., Hsiao, S.-C. and Imananta, R. T.: Post-event Field Survey of 28 September 2018 Sulawesi Earthquake and Tsunami, preprint, Sea, Ocean and Coastal Hazards., 2019.