# Literature Review on Tsunami Evacuation System on Coast of Diu

**Dhaval M Patel**
*Assistant Professor*
*Shankersinh Vaghela Bapu Institute of Technology*

**Kushal Shah**
*UG Student*
*Shankersinh Vaghela Bapu Institute of Technology*

**Patel Yagnik**
*UG Student*
*Shankersinh Vaghela Bapu Institute of Technology*

**Radadiya Avadh**
*UG Student*
*Shankersinh Vaghela Bapu Institute of Technology*

**Smit Sardhara**
*UG Student*
*Shankersinh Vaghela Bapu Institute of Technology*

## Abstract

Severe natural Hazard, like e.g. tsunamis or earthquakes, often lead to catastrophes with spectacular consequences. In these days natural disasters caused loss hundreds of thousands of human, damage to infrastructure, disturbance of financial activity and loss of billions of money worth of material. This presents the hazard mapping for Tsunami and strategy for Tsunami evacuation for Diu (20.4283° N, 72.8397° E) and western coast of Gujarat state on Indian subcontinent. The purpose of this study is to develop tsunami hazard maps by analyzing the coastal inundation characteristics of Gujarat. The need for the study is to aware people for the hazard of tsunami and saving maximum lives when tsunami occurs there. The overall goal of this study is preparing a tsunami evacuation map for Diu city and western cost of Gujarat state. The past historical earthquakes of Tsunamigenic source of Makran subduction zone which was responsible for causing tsunami on western coast of Gujarat. The outcomes of this study can be utilized by public policy and decision makers in developing disaster management strategies.
**Keywords: Earthquake, Tsunami Evacuation Map**

## I. INTRODUCTION

Tsunami is a Japanese word meaning harbour wave. Tsunami is a phenomenon of gravity waves produced in consequence of movement of the Ocean floor that as a result of earthquakes, landslides, volcanic eruptions and large meteorite impacts.(1) Time between crests of the wave can vary from a few minutes to over an hour, but generally are in the range of 15 to 25 minutes.(2) Tsunami is a very long-wavelength wave of water that is generated by earthquakes that cause displacement of the seafloor, but Tsunami can also be generated by volcanic eruptions, landslides and underwater explosions that causes displacement of water column vertically upward. Many large underwater, whose epicenter are dislocated at the bottom of ocean or sea, are able to generate tsunami waves. These events, so called tsunamigenic earthquakes (i.e. Tsunami-making), an characteristics by high energy, and the magnitude on the richer scale are M>7.0. (3) The horizontal size of the zone of the strongest bottom oscillations for such an event may be as great as 100 KM or more.An earthquake can be considered to be produced by rupturing of part of the earth's crust with a relative displacement of its two sides and the release of the accumulate elastic strain that had been produced by tectonic processes. A landslide motion process is usually caused by long term acculumulation of sediments at the some ocean bottom area, submarine slopes of basins, into the river deltas. Volcanic eruptions represent also impulsive disturbances, which can displace a great volume of water and generate extremely destructive tsunami waves in the immediate source. For a given location on the Earth's surface, the risk of a "direct" hit from an asteroid is light, researchers realized that an ocean impact had the potential to be much more destructive due to the additional hazard of tsunami.

There are 2 types of evacuation system:

- Horizontal Evacuation System
- Vertical Evacuation System

A vertical evacuation refuge from tsunamis is a building or earthen mound that has sufficient height to elevate evacuees above the level of tsunami inundation, and is designed and constructed with the strength and resiliency needed to resist the effects of tsunami waves. Vertical evacuation refuges can be stand-alone or part of a larger facility. They can be single purpose refuge-only facilities, or multi-purpose facilities in regular use when not serving as a refuge.

Fig. 2: Vertical Evacuation System (Source: Google images)

Fig. 3: Horizontal Evacuation System (Source: google images)

A horizontal evacuation refuge from tsunami is a type of building or area covered near or on the seashore in order to rescue at the time of hazard or vulnerability. A horizontal structure or passage is created to rescue the people to the safe or vertical structure.

## II. POSSIBILITY OF TSUNAMI IN GUJARAT

Five of the great earthquakes in Makran may have ruptured the plate boundary in four different rupture segments of lengths of about 200 km each in 1483 (58–60°E), 1851 and also 1864 (61–63°E), 1945 (63–65°E), and 1765 (65–67°E) .Out of all these earthquakes only the 1945 earthquake is known to have caused a large tsunami, followed by a large aftershock in 1947 immediately to the south. The western Makran zone has no clear record of historic great earthquakes. Absence of frequent earthquakes indicates either that seismic subduction occurs or that the plate boundary is currently locked and experiences great earthquakes with long repeat periods. One of the most deadly tsunamis ever recorded in the Arabian Sea occurred with its epicenter located in the offshore of Pansi in the northern Arabian Sea, about 100 km south of Churi (Baluchistan), Pakistan , at 21.56 UTC (03.26 IST) on November 28, 1945. More than 4000 people lost their life along the Makran coast of Pakistan by both the earthquake and tsunami. The tsunami was responsible for great loss of life and destruction along the coasts of India, Pakistan, Iran.

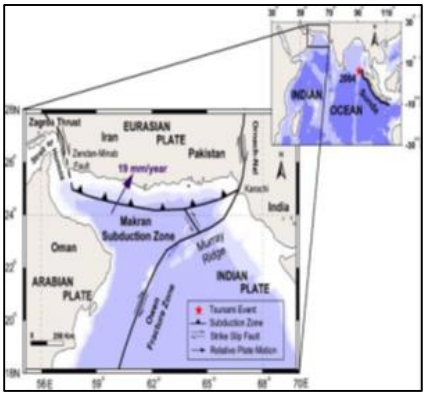


Fig. 4: Makran Subduction Zone

Source: Dhaval.M.Patel, et al, 2014

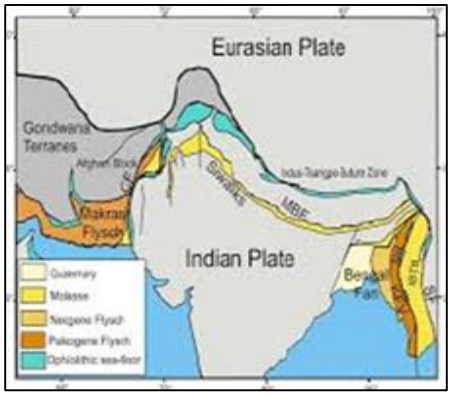


Fig. 5: Makran Plate in Eurasian Plate

Source: Dhaval. M. Patel, et al, 2014

## III. AIM AND OBJECTIVES

1) The main aim of our project is to suggest tsunami evacuation map for Diu and its surrounding region and to find out tsunami hazardous zones in that region.
2) To find tsunamigenic sources for west coast of Gujarat
3) To find Tsunami risk for cities of west coast of Gujarat
4) To analyze the site conditions from the map and to suggest type of evacuation system for the same region.
5) The main objective of our project is to save as many people as possible by guiding them to safer zones in quickest time and zones that will least affected by tsunami during tsunami conditions with the help of the tsunami evacuation maps that will be suggested by us.
6) To prepare Hazard map of different Diu of west coast of Gujarat.
7) To prepare a Tsunami Evacuation Plan for Coastal Diu city of Gujarat.

8) Propose sites of vertical evacuation structures
9) The emergency evacuation plans are important to ensure the safest and most efficient time to evacuate.

## IV. NEED OF STUDY

1) To reduce the loss of life and property.
2) To increase the stability of structure.
3) Tsunami evacuation map is made for the local public in order to save maximum lives.
4) Study provides the basic knowledge of different methods of resisting tsunami and it also provides reducing of tsunami risks.

## V. PROBLEMS DUE TO TSUNAMI

- Tainted water supply
- Death
- Disease
- Environment impact
- Cost
- Psychological problems
- Lack of Fresh water
- Injury
- Millions of dollars in financial loss

## VI. STUDY AREA

- Name of place: Diu
- Latitude: $20^{0}41'N$
- Longitude: $70^{0}58'60"E$
- Area : 40 km²
- Total population: 52,074
- Major river : Chasi
- Diu has plain topography, the hillocks are at a maximum height of 30m above the sea level.


Fig. 6: Study Area (Source: (http://diu.damandiuonline.in/city-guide/geography-of-diu)

## VII. IMPORTANT LOCATION

### *A. Ghogla Beach*

Ghogla beach is the most popular beach.it is the largest beach on the island of the diu.

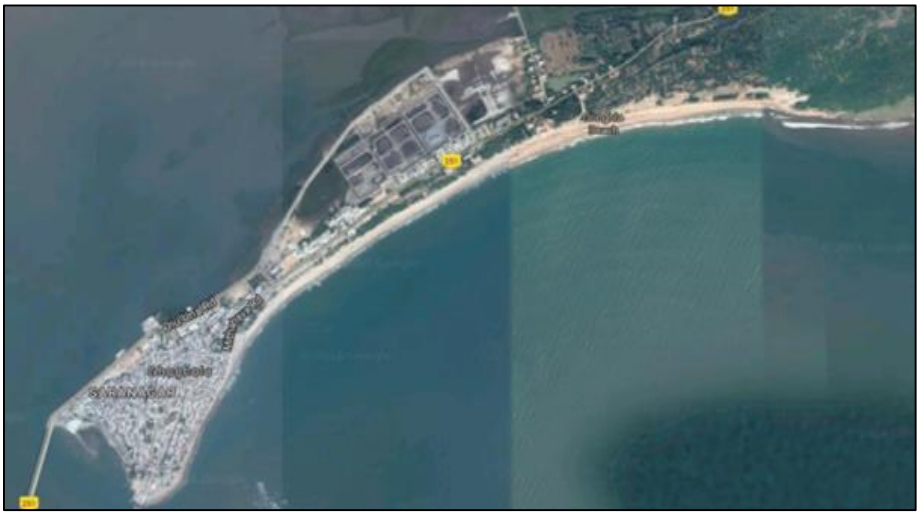

Fig. 7: Ghogla Beach (Source: Google images)

### *B. Jallandhar Beach*

This beach is also famous for the Jalandhar shrine, perched on a small, beautiful hillock and the temple of Goddess Chandrika. It is believed to be the face of a demon by the name of Jalandhar, who was killed by Krishna. This beach 6.7km away from the diu airport.

Fig. 8: Jallandhar Beach (Source: google images)

### *C. Chakratirth Beach*

The chakratirth beach is Located in the South West region of Diu.The chkratirth beach is third most populae beach on island of diu. This is 5.8km away from the diu airport.

Fig. 9: Chakratirth Beach (source: google images)

### *D. Naida Caves*

Naida caves are Located outside the city wall of the Diu fort. The history of the caves suggests that the Portuguese hacked off building materials during their region, which resulted in the formation of the caves.


Fig. 10: Naiad Caves (source: google images)

### *E. Diu Fort*

The Fort of Diu occupies a prominent position. It is an expansive and imposing structure, situated on the coast of the island.The fort is skirted by the Sea on the three sides. On the fort stands a giant Light House.

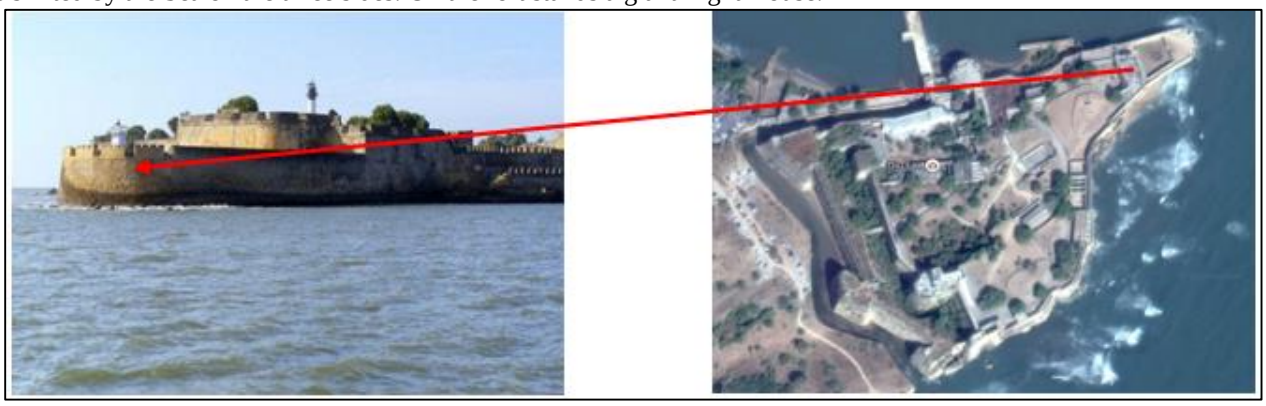

Fig. 11: Diu fort (source: google images)

### *F. Airport of Diu*

Diu Airport is a domestic airport situated at Diu in the Union Territory of Daman and Diu, India. Apart from Diu, it also serves the adjoining regions of Gujarat, including Veraval and Jafrabad. Diu airport was established in the year 1954.


Fig. 12: Airport of Diu (source: google images)

## VIII. SRTM IMAGE AND BOUNDARY REGION OF GUJARAT

The following images are the image showing SRTM data of Gujarat region. This image will be used in global mapper software for geo referencing in order to generate tsunami evacuation map of that region

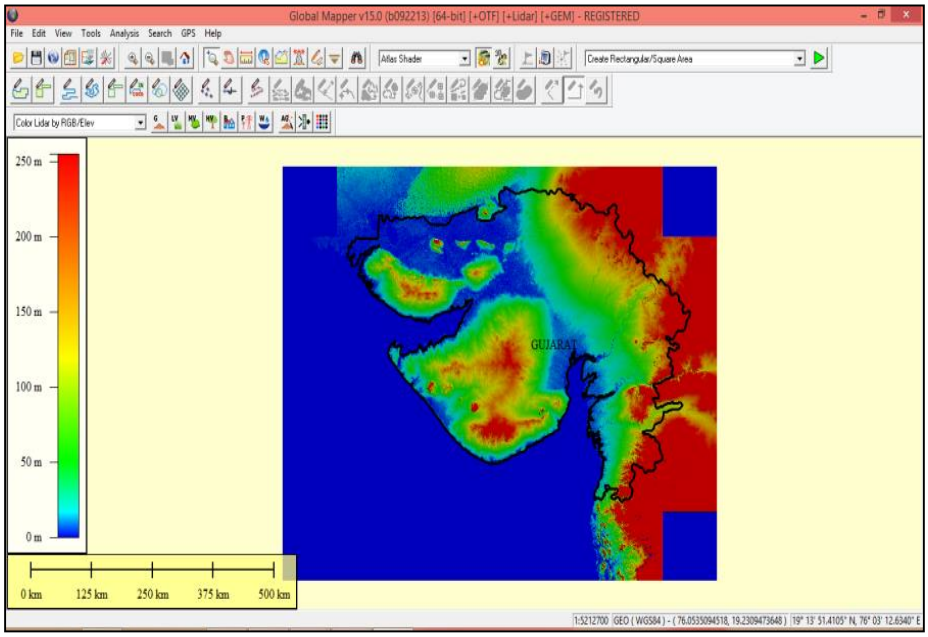


Fig. 13: Boundary data and SRTM data of Gujarat

## IX. BATHEMTRIC DATA

This data saw depth of water

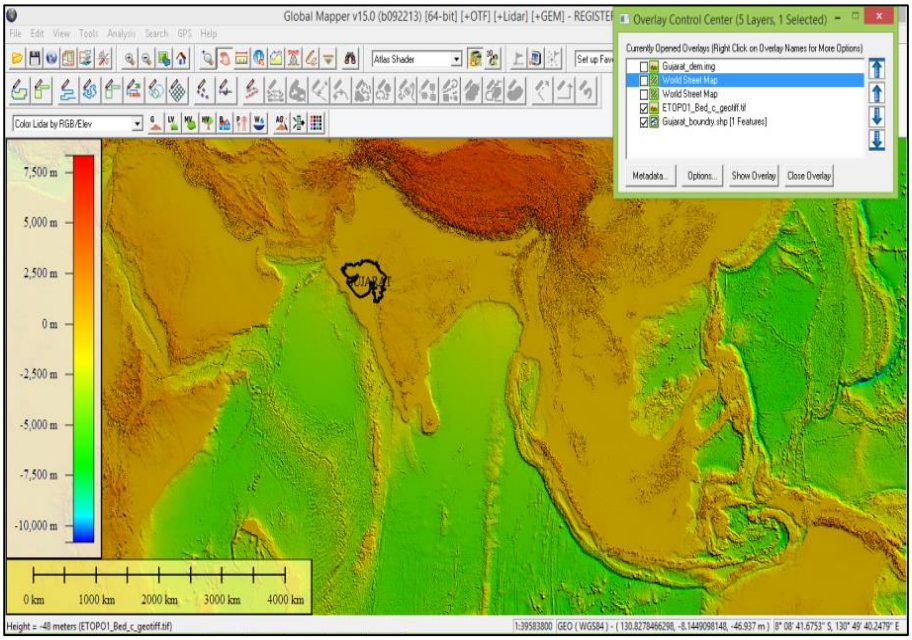


Fig. 14: Major Location of Gujarat

## X. METHODOLOGY

The stepwise procedure is as follows:

- Step 1: selection of project
- Step 2: problem definition
- Step 3: literature review
- Step 4: reports & objective finalization
- Step 5: collecting tsunami data
- Step 6: analysis of the data
- Step 7: suggesting horizontal – vertical system
- Step 8: conclusion

## XI. SOFTWARE USE

- Autocad 2016, Global mapper

## XII. CONCLUSION

Evacuation is the most important and effective method to save human lives during a tsunami. An important factor in establishing evacuation measures during a tsunami is an accurate representation of the timing of people's responses to the emergency. In this study, with the help of satellite technology tsunami evacuation map is generated for western coast of Gujarat state of for Indian subcontinent. In this study evacuation map of study area is generated in an open source map digitalization tool. Vertical Evacuation Suggestions of study area are derived from further analysis of geo referenced map. These Vertical Evacuation Suggestions are provided based on various parameters related topography and geology of study area. These results of this study can be utilized by public policy and decision makers in developing disaster management strategies.

## REFERENCES

[1] Abhijitsinh Parmar, Bhupesh Katariya, Dhaval M. Patel, Gautam Dadhich, V.M. Patel Tsunami Evacuation System For Western Coast Of Gujarat In Okha City,2014
[2] Van Dorn, W. G. "Tsunamis." Contemporary Physics 9.2 (1968):145-164.
[3] Dawson, Alastair G., and Iain Stewart. "Tsunami deposits in the geological record." Sedimentary Geology 200.3 (2007): 166-183.
[4] Synolakis, Costas E., and Laura Kong. "Runup measurements of the December 2004 Indian Ocean tsunami." Earthquake Spectra 22.S3 2006): 67-91.
[5] Rufener, Karl A. Developing a River Flood Evacuation Plan for the City of Renton. National Fire Academy, 2008.
[6] Tinti, S., et al. "Handbook of tsunami hazard and damage scenarios." JRC scientific and technical reports. EUR 24691 (2011).
[7] Spahn, Harald, et al. "Walking the Last Mile: Contributions to the Development of an End-to-End Tsunami Early Warning System in Indonesia." Early Warning for Geological Disasters. Springer Berlin Heidelberg, 2014. 179-206.
[8] Byrne, Daniel E., Lynn R. Sykes, and Dan M. Davis. "Great thrust earthquakes and aseismic slip along the plate boundary of the Makran subduction zone."Journal of Geophysical Research: Solid Earth (1978–2012) 97.B1 (1992): 449-478.
[9] Rani, V. Swaroopa, et al. "Spatial and temporal variations of b-value and fractal analysis for the Makran region." Marine Geodesy 34.1 (2011): 77-82.
[10] Byrne, D.E.,L.R. Sykes And D.M. Davis, (1992). Great Thrust Earthquakes And A Seismic Slip Along The Plate Boundary Of The Makran Subduction Zone, J. Geophys. Res., 97, 449-478.
[11] Dimri, V. P., (2007). Presentation on Solid Earth Research in India:Contribution to International Year of Planet Earth, http://www.iypeinsa.org /iype_ws2007/ ws_papers/ dimri.pdf.
[12] Pendse, C. G., (1948). The Mekran Earthquake Of The 28th November 1945, Scientific Notes, Vol. X. No. 125.
[13] V. m. patel, H. s. patel, A. p. singh tsunami propagation in arabian sea & its [13] effect on dwarka city of gujarat, india, Mar 16, 2011.
[14] Guidelines for Design of Structures for Vertical Evacuation from Tsunamis FEMA P646 / June 2008
[15] Byrne, D. E., Sykes, L. R. and Davis, D. M., Great thrust earthquakes and seismic slip along the plate boundary of the Makran subduction zone. J. Geophys. Res., 1992, 97, 449–478.
[16] Prof. (Dr.) V. M. Patel, Prof. Bhavesh Jaiswal, Dr. A. P. Singh, Tsunami Hazard and Alert System for Western Coast of Gujarat, 2013 IEEE Global Humanitarian Technology Conference: South Asia Satellite (GHTC-SAS) | 23-24 August 2013
[17] R. K. Jaiswal, B. K. Rastogi, Tad S. Murty, TSUNAMIGENIC SOURCES IN THE INDIAN OCEAN, Science of Tsunami Hazards, Vol. 27, No. 2, page 32 (2008)
[18] Jaiswal, R. K., A. P. Singh, B. K. Rastogi, (2008), Simulation Of The Arabian Sea Tsunami Propagation Generated Due To 1945 Makran Earthquake And Its Effect On Western Parts Of Gujarat (India), Natural Hazards, 2008
[19] Christian Meinig, Scott E. Stalin, Alex I. Nakamura, Frank González, NOAA, Technology Developments in Real-Time Tsunami Measuring, Monitoring and Forecasting, Pacific Marine Environmental Laboratory (PMEL), Hugh B. Milburn Oceanographic Engineer
[20] Shuto, N., T. Suzuki, K. Hasegawa, and K. Inagaki, (1986). A Study of Numerical Techniques on the Tsunami Propagation and Run-up. Science of Tsunami Hazard, Vol. 4: 124.