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TSUNAMI EVACUATION STUDY FOR COASTAL REGION OF GUJARAT STATE- A CASE STUDY

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Abstract: The devastating tsunami's that occurred in the past has disseminated the significance of tsunami resisting structures as well as tsunami evacuation maps. Along the western coast of Gujarat, large earthquakes are generated around the Makran coast. As a result of which massive tsunamis are generated in this zone. The most catastrophic and calamitous tsunamigenic earthquake was that of 28 November, 1945 with a magnitude of 8. In this paper an attempt is made to study the possibilities of tsunami hazardous zones and suggest the tsunami evacuation plans to overcome the catastrophic effects of tsunami. Also in this paper an attempt is made to suggest the methods of evacuation as per the possibility of tsunami along that zone. The past historical earthquakes of Tsunamigenic source of Makran subduction zone which was responsible for causing tsunami on western coast of Gujarat state of for Indian subcontinent are studied. The outcomes of this study can be utilized by public policy and decision makers in developing disaster management strategies.

Keywords: Social Networking Sites (SNSs), Integrated marketing communications (IMC), Attitude, Demographics

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INTRODUCTION

Tsunami is a Japanese word meaning harbour wave. A tsunami is an anomalous sea level elevation seen some times as a series of waves with a long wavelength and period (time between crests) generated by a large, impulsive displacement of sea water

(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. One of the major hazards due to tsunamis, even of small amplitudes, are the very strong currents that can be generated, that can rip the tie lines and moorings of vessels and cause serious damage to piers and docks (2). For anyone in tsunami evacuation zones, strong ground shaking from an earthquake is the natural warning that a tsunami might be coming. People on the beach or in harbour areas should evacuate for any felt earthquake and, if strong shaking lasts for 20 seconds or more, all people within evacuation areas should move inland or to higher ground. However, strong earthquake shaking can also cause additional hazards, such as landslides or downed power lines, which can inhibit or prevent safe evacuation (3). The state tsunami program provides assistance to jurisdictions that request help preparing or reviewing evacuation plans to address local-source tsunamis (4). Western coast of Gujarat, which is having many historical & religious places, is not being studied by any researcher. In last few years on western coast of Gujarat population is going on increase. Lot many new industrial projects are coming up with very vast financial capacity in this area in recent times. Hence, the accurate modelling of tsunami hazard from the earthquake and early warning system of tsunamis for a coastal community is of great importance in this area. (Patel et al, 2013)

Therefore, local evacuation plans and warning arrangements are needed. To achieve this, it needs the involvement of many stakeholders, from local authorities to different elements in the community

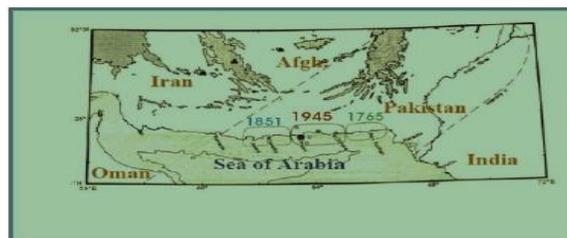


Fig. 1: Great Earthquakes in MSZ.

(V.M Patel et. al., 2011)

II. TSUNAMI EVACUATION PLAN& ITS OBJECTIVE

Tsunami evacuation plan is a plan that will be invoked if a tsunami alarm has been triggered. Hence a tsunami evacuation plan will affect a variety of awareness measures to be activated in the case of tsunami alert. (S. Scheer , A et al , 2011)Tsunami evacuation plan is prepared on the basis of various parameters like population of that particular region, road patterns, accessibility to roads, time for arrival of wave, height of tsunami, velocity of wave, etc. The only desideratum of tsunami evacuation plan is to evacuate the people as soon as possible that would get affected by the tsunami wave. It aims to guide people in reaching safe zones by the shortest route. We cannot relocate the locations of buildings and other properties but we can definitely save people with the help of tsunami evacuation plans.

III. METHODOLOGY

The Step wise procedure of evacuation mapping is as following:

Step 1: The mapping is stepwise process. In mapping of tsunami first the satellite image showing population is geo-referenced with the SRTM data of Gujarat.

Step 2: The contours are generated in the geo-referenced image. Than the coastal regions are shown using different colors and hazard map is prepared by showing 1 to 6 m heights by different colors.

Step 3: The details of topography and colors indicated is shown in maps. Step 4: The evacuation maps are then prepared according to recommendations.

IV. CASE STUDY OF TSUNAMI EVACUATION PLANS

Gray'sharbor:

Given below is the evacuation map of GRAYS HARBOR which is vulnerable to tsunami mostly due to two main reasons Tsunamis from distant earthquakes on the Pacific rim, such as the 2011 magnitude 9.0 earthquake near Japan. This type is the most common. Because the waves arrive hours after the quake, they are less likely to cause loss of life, but may inflict damage. Local tsunamis caused by a M8.0 (or greater) earthquake on the Cascadia subduction zone. This type poses the greatest danger: catastrophic wave much larger than those from a distant

quake, will strike the coast within 25–30 minutes, causing loss of life and widespread damage to possessions. (Sources: www.OregonTsunami.org)

The map includes tsunami hazard zone highlighted by yellow color which indicates the area that will be affected the most in case of occurrence of tsunami. It also includes higher ground zones highlighted by green color which indicates the areas that will be safe in case of tsunami occurrence. Besides this it also contains driving evacuation routes highlighted by thick red lines and walking evacuation routes highlighted by thin red lines that would guide people to reach the safer zones in quick time as per their feasibility.

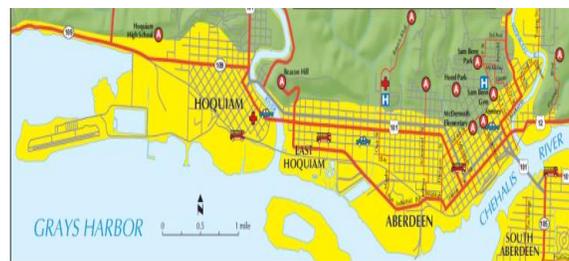


Figure:2 Gray's harbor city evacuation map

(Source :<http://www.osp.state.or.us/oem>)

V. POSSIBILTY OF TSUANMI IN WESTERN COAST OF GUJARAT

In Western Coast of Gujarat destructive tsunamis have been generated from large earthquakes along the Makran Coast, Chagos Ridge and Kutch Region in the past. Although the historical record is incomplete, it is believed that such Tsunamis were destructive on the coasts of India, Pakistan, Iran, Oman and Sri Lanka and possibly had significant effects on Islands. The most significant tsunamigenic earthquake in recent times was that of 28 November 1945 21:56 UTC with a magnitude of 8. In this paper an attempt is made for an alert system for tsunami warning system for the possible tsunami risk from Makran Subduction Zone (MSZ). (A. P. Singh et al., 2009). It is observed from the results that the simulated arrival time of tsunami waves at the Western Coast of Gujarat is in good agreement with the available data sources. In this study more importance has been given to the run up height of tsunami waves, arrival time and inundation map. Also in this paper an attempt has been made to develop efficient user friendly tsunami warning system along with study of evacuation options for the western coast of Gujarat. (V.M patel et al., 2013)

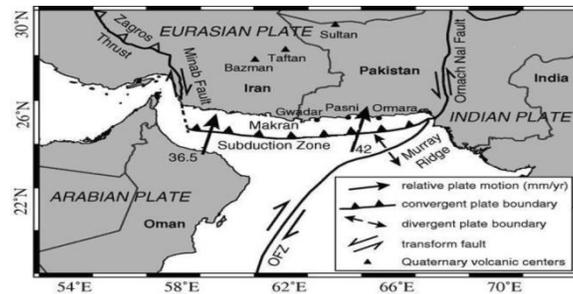


Figure 3 Makran Subduction zone (Source:V.M.Patel, 2013)

VI. PROPOSED STUDY AREA

Mandvi located at Gulf of Kutch in Kutch district of Gujarat. .population of entire Kutch district is a round 42355. Kutch district is located at following Coordinates: 22.86°N 69.39°E Gujarat state as shown in figure.



VII. Basic data required for evacuation map

- 1) Population distribution map This map shows how the population is usually distributed within an inhabited area. For practical reasons, a maximum of persons (including temporarily residing as people at work or tourists) is taken as basis (S. Scheer, A et al., 2011) .2) The population distribution map will indicate the magnitude of evacuees potentially to be expected. 3) Road and major paths map to provided evacuation horizontal path for evacuate people easily. 4) Classified buildings map near to the ocean region for use vertical evacuation .5) Map of special places This map shows all those places and buildings that may be subject of special care procedures. In particular, schools and hospitals very frequented places .6) Hazardous and dangerous areas: All industrial facilities or installations that are located within the area of concern may be marked separately in a map.

VIII. Types of evacuation in coastal region

Based on the location and type of tsunami wave, there are basically two types of evacuation methods which are explained as below.1) Horizontal evacuation .2) Vertical evacuation.

Horizontal evacuation method can be used in case when you have sufficient time to evacuate people and also when there is availability of sufficient routes for horizontal movement. In this method, evacuation plan is prepared which highlights the main roads and other routes which can lead people to safer zones by means of horizontal movement.(S. Scheer, A et al., 2011).

Vertical evacuation methods can be used when you do not have sufficient time to evacuate people as well as when there is shortage of routes for horizontal evacuation. In this method, tall vertical structures are built up which can help people to survive during the occurrence of tsunami. Also in this method, evacuation plan is prepared which highlights the places which have tall structures and also highlights the places which are at higher altitudes so that people can reach areas which are at higher altitudes and survive from tsunami.

IX. 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. As per topography we can provide suggestion of vertical as well as horizontal evacuation map. Through we can suggest evacuation map to more and more people life save.

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