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POSSIBILITY OF TSUNAMI AND TSUNAMI HAZARD MAPPING FOR SURAT CITY BY USING GIS SOFTWARE

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Abstract: This paper presents based on possibility of tsunami hazardous area surat cities located at south coast of Gujarat. The need for the study is to aware people for the hazard of tsunami and saving maximum lives when tsunami occurs there. After the great earthquake of Sumatra on 26 December 2004, tsunami waves were generated that affected coast of Indian coast. Because of this tsunami large amount of property and lives were lost. Studies show that if proper protective measures are adopted, this damage can be reduced. For saving property in coastal area during tsunami is very difficult task. But the most important task is to save lives during such events and maximum saving of our environmental beauty. In this paper the past historical earthquakes of Tsunami-genic source of Makaran Subduction zone which is responsible for causing tsunami on western coast of Gujarat are studied. The time of arrival of tsunami on the cities of interest is known and the area according topography developed by DEM (Digital Elevation Model) is shown. The elevation of coastal region are heights is indicated by different colours in the map and according to distance from shoreline and topography of the ground evacuation maps are prepared. On that research we are also cover contour map with topography detail by using global Mapper software

Keywords: Earthquake, Tsunami, Evacuation system, GIS Image, coastal region

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INTRODUCTION

Tsunami is a Japanese word meaning harbour wave also call Death water wave . A tsunami is an anomalous sea level height seen some times as a series of waves with a long wavelength and period (time between crests) generated by a large, precipitate displacement of sea water (1) The 2004 catastrophe of the Indian Ocean tsunami prompted engineering researchers to develop better guidelines for design of buildings those are capable of withstanding tsunami forces (6). 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).

Identification of these potential hazards along evacuation routes, evacuees might be routed through areas where they could become injured while moving away from potential tsunami inundation areas. The state tsunami program provides assistance to jurisdictions that request help preparing or reviewing evacuation plans to address local-source tsunamis (4). However, for local jurisdictions that would like to evaluate these potential evacuation hazards

In India for coastal construction there are no any exact guidelines available for tsunami loadings. Even today most of the structures are design according to earthquake loading but none of these is design for tsunami loading. Local authorities, local engineers and common people are also confused regarding tsunami resisting structure design, location and construction. Surat which is falling on south coast of Gujarat is having highest risk of tsunami. Tsunami generated from MSZ will hit Surat . Also the run up height in this region is considerable one for worst damage. For stated target run up height of tsunami waves, arrival time and inundation map of city is most important. The tsunami modeling will based on a historical event, particularly the deadliest historical tsunami, 27th November 1945 far field tsunami generated by a submarine earthquake. Modeling will also consider potential events based on probable to possible earthquakes for far sources associated with the Makran Subduction Zone. Seismic gap area along the subduction zone of Makran is possible site of future great earthquake, which could generate tsunamigenic condition along western Indian coast (AP Singh,et al 2007).

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) (7). 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 (Jaiswal, R. K, 2009). 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. The earthquake's Richter Magnitude (Ms) was 7.8 (Pendse, 1948) & the Moment Magnitude (Mw) was revaluated to be 8.1 (7). Different points of bathymetry from Makran Subduction Zone to Cities of interest are shown in figure 1. Different points indicating depth of sea floor is prepared by using global mapper. This profile is shown in figure 1. This profile is prepared using World Bathymetry data of 30 grid SRTM Data (Jaiswal, R. K, 2008).

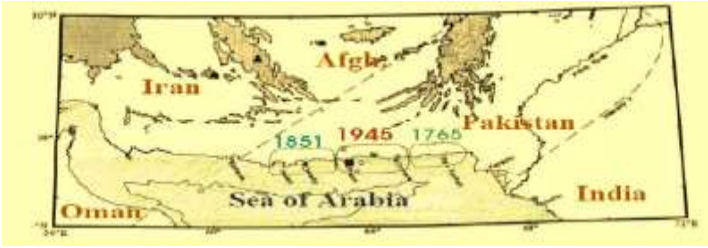
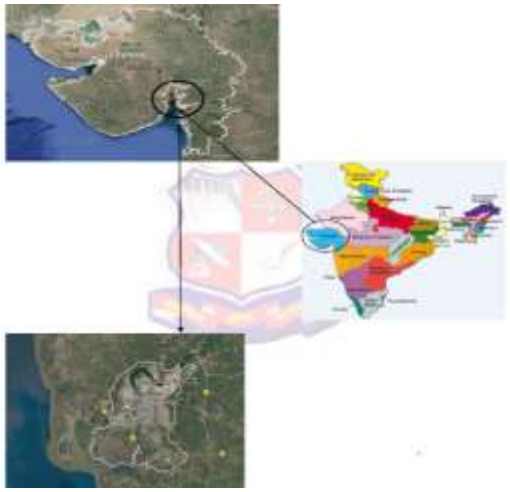


Fig. 1: Great Earthquakes in MSZ.(V.M Patel et. al., 2013)

Study area



Surat, is a port city previously known as Suryapur, economical capital Gujarat, and former princely state in the Indian state of Gujarat. A moat divides the older parts of the city, with their narrow streets and historical houses, from the newer suburbs. Surat had a population of 4.5 million at the 2011 census, making it the second largest city in the state of Gujarat, after Ahmedabad. It is the eighth largest city and ninth largest urban agglomeration of India. Surat is the 34th-largest city by area and 4th-fastest. Coast line 36km (22mi)

Co-ordinates 21.18°N 72.83°E
seismic zone-III, in a scale of I to V (in order of increasing vulnerability to earthquakes)
Elevation 13m(43ft)
Area about 326.515 km2(126.068 sq. mi)

MODELING AND PREDICTION

Numerical modelling of tsunamis is commonly carried out to better understand events that have occurred either during or before historical times. Numerical modelling can also help to predict the effects of a future tsunami.

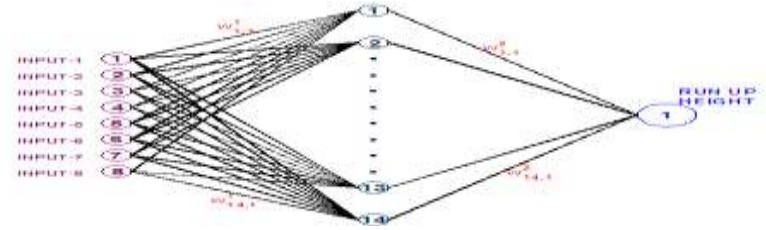
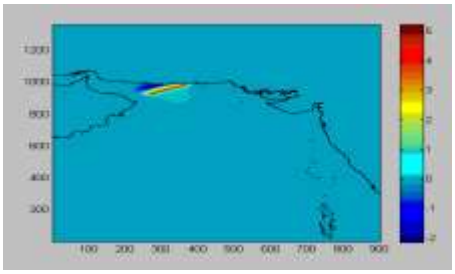


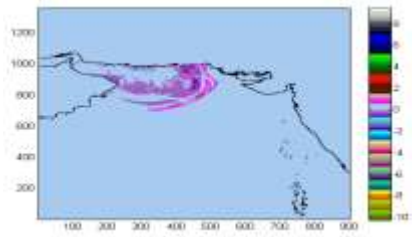
Fig.2. ANN structure used for predicting Run-up Height of Tsunami Wave (Dr. V. M. Patel, 2013)

Tsunamis which are mainly generated by the movement of sea bottom due to earthquakes belong to long waves. In the theory of such waves, the vertical acceleration of water particles are negligible compared to the gravitational acceleration except for an oceanic propagation of tsunami [9]. As the problem under study that requires the approximation to be very accurate, feed-forward, back-propagation networks are used for the modelling purpose. The Levenberg-Marquardt algorithm is well suited to functionalize approximation or prediction problems with networks of moderate size and number of parameters [10].

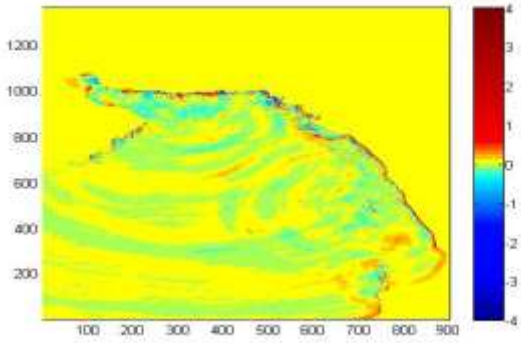
Figure 2 shows the ANN structure used for predicting the run-up height of Tsunami wave. The simulated model was trained for 76 test data and tested for 10 data sets. The conclusions on the actual data for this problem were validated. The propagation of tsunami wave at different time over parts of Gujarat state are shown in Fig. 3.



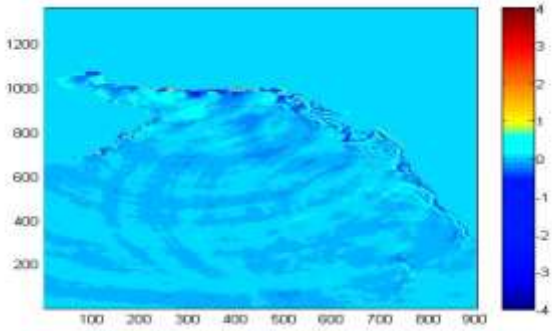
(a) Propagation of wave after 0min.



(b) Propagation of wave after 60 min.



(c) Propagation of wave after 230 min.



(d) Propagation after 300 min.

Figure 3: propagation of wave and tsunami wave height

Contour mapping and Tsunami affected area of surat city

As per the figure 4 is indicated the contour mapping of the surat city. For This mapping we can identify the topography height and as per the topography height we can easily indicate tsunami hazard area . in the surat city basically height of Tsunami is up to 1 m but tsunami wave resonance height of tsunami is increasing after touch sea shore line .contour line also indicate the 1 to 10 m height of topography and as per the topography height we can easily identify the land portion that can be inundate after the tsunami. Due to the tsunami highly affected area is nearby coastal area and also the Tapi river water goes back. The height of tapi river is increasing during the tsunami and water overflow in to the city area. Due the tsunami numbers of area affected like agricultural land, residential area, industrial area etc. Details of contour map and georeferance image are sawn at below. With the making of georeferance images we can used the SRTM data.

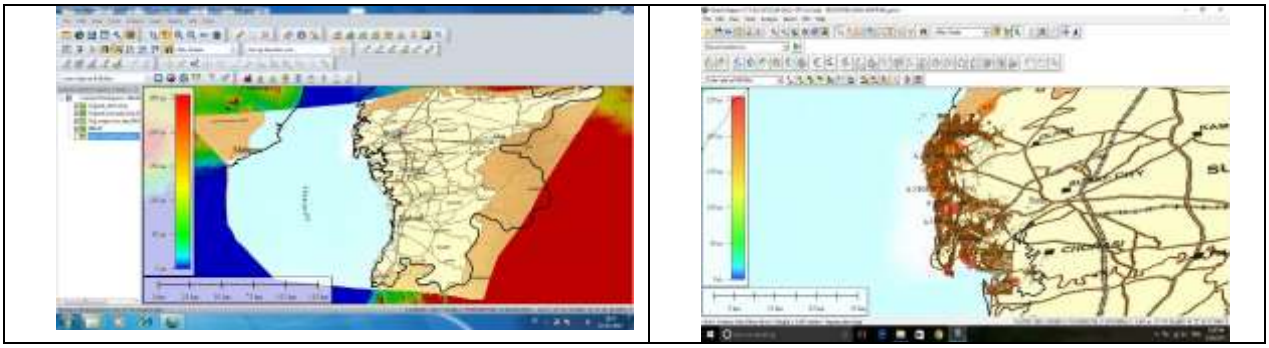


Figure 4: georeferance and contour mapping of surat city

hazard mapping for surat city in the surat city, near by the sea shore line area is much effected for the tsunami because of this area is lower line area compare to the inside area. With the using of the SRTM data modelling, we can easily identifying the topography of the area and height indication. The height indication are indicated by using the different colour in the global Mapper software. Also the all detail image is indication is below. In the first image is indicated the topography of the area with the different colour. The height of the topography is below the 10 m is first inundated due the Tsunami and inundation is more. In the second image are indicated the most sensitive point due the topography. This point are lower lying area and tsunami wave are first effected the area as per the topography.

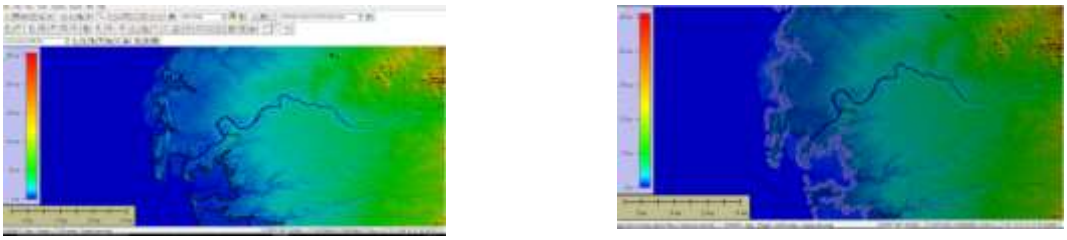


Fig: 5 SRTM map with sensitive point of surat city

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