Tsunami Hazard Preventing Based Land Use Planning Model Using GIS Techniques in Muang Krabi, Thailand

ABDUL SALAM SOORMO*, AND ABDUL QADEER KHAN RAJPUT**

RECEIVED ON 14.02.2012 ACCEPTED ON 18.09.2012

ABSTRACT

The terrible tsunami disaster, on 26 December 2004 hit Krabi, one of the ecotourist and very fascinating provinces of southern Thailand including its various regions e.g. Phangna and Phuket by devastating the human lives, coastal communications and the financially viable activities. This research study has been aimed to generate the tsunami hazard preventing based lands use planning model using GIS (Geographical Information Systems) based on the hazard suitability analysis approach. The different triggering factors e.g. elevation, proximity to shore line, population density, mangrove, forest, stream and road have been used based on the land use zoning criteria. Those criteria have been used by using Saaty scale of importance one, of the mathematical techniques. This model has been classified according to the land suitability classification. The various techniques of GIS, namely subsetting, spatial analysis, map difference and data conversion have been used. The model has been generated with five categories such as high, moderate, low, very low and not suitable regions illustrating with their appropriate definition for the decision makers to redevelop the region.

Key Words: Krabi, GIS, Land Use Planning, Spatial Analysis, Suitability Analysis.

1. INTRODUCTION

The great terrible devastating earthquake with 9 Richter scale [1] hit the Indian Ocean, 80 km western coast of northern Sumatra, Indonesia on 26th December 2004. This terrible earthquake split around more than 1000 km of the Andaman-Sunda channel approximately 12 minutes. This disaster generated the brutal killer tsunami disaster not only in Indonesia but also destroyed the entire southern Thailand especially Krabi province with various other coastal regions Phuket, Phang Nga, Phi Phi islands and kolanta [2]. This brutal natural disaster damaged the human lives and the infrastructure.

The epicenter of such great earthquake with magnitude 9.3 Mw was Banda Ache, west of Indonesia due to the subduction of Indian and Burman plates [3]. There were more than 6000 causalities due to tsunami disaster in south Thailand including Krabi province [4].

It is strongly needed to establish tsunami hazard preventing based land use planning model for preservation of the natural environment for the sustainable development of the regions. As these occurred phenomena in past has emphasized for investigation because these type of natural calamities develop the most severe losses of human lives and infrastructure [5].

* Assistant Professor, Department of Industrial Engineering & Management, Mehran University of Engineering & Technology, Jamshoro.
** Professor, Department of Computer Systems Engineering, Mehran University of Engineering & Technology, Jamshoro.

This type of pro active land use planning based on tsunami preventing model is preferred on both types of the scales such as large or small scale in the different sectors e.g. private or public [6]. This model can be generated by applying any of the approach such as quantitative, qualitative or semi-quantitative [7] based on Heuristic method [8].

This research study aims to generate the tsunami hazard preventing land use model using GIS techniques in Krabi, south Thailand where the tsunami hit on 26th December 2004.

The triggering force for developing such model was the danger of calamity of tsunami diasater. It is believed that this type of tsunami hazard preventing model can be utilized in such coastal regions where there is always threat of tsunamis so as to save human lives and infrastructure.

2. METHODOLGY

2.1 Study Area

Krabi is one of the province of Southern Thailand on Andaman seaboard as shown in Fig. 1.

It contains different districts administratively such as Amphoe Muang (Krabi Town), Khao Panom, Khlong Thom, Plai Phraya, Ko Lanta, Ao Luk, Lam Thap and, Nua Khlong. The case study of this research is Munag krabi which contains mainly three tambons e.g. Tambon Nong Thale, Tambon Aonang, Tambon Sai thai and Krabi Municipality. The northing of Krabi along Andman sea is between 7' 30" and 8' 30", easting is between 98' 30" and 99' 30" west longitude enfolding the entire area 4,709 square kilometers. Krabi contains more than 130 islands with plenty of mangrove forests and cassia trees while Phi Phi islands are very famous. The famous product of Thailand including krabi is palm oil which was harvested about 0.43 million hectares in 2007 and the average of yield production was 16.5 tons/hectare within 2003-2007 only [9]. The map of study area, Muang krabi is shown in Fig. 2.

The temperature of Muang Krabi varies from the range of 16.9 and 37.3 degrees Celsius and the yearly rainfall is about averages 2,569.5 millimeters.

2.2 Data Used

The data layers for developing the tsunami hazard-preventing land use planning model in GIS were; elevation, population density, distance from shore line, Mangrove, Forests , streams and roads, topographic sheets and digital camera.

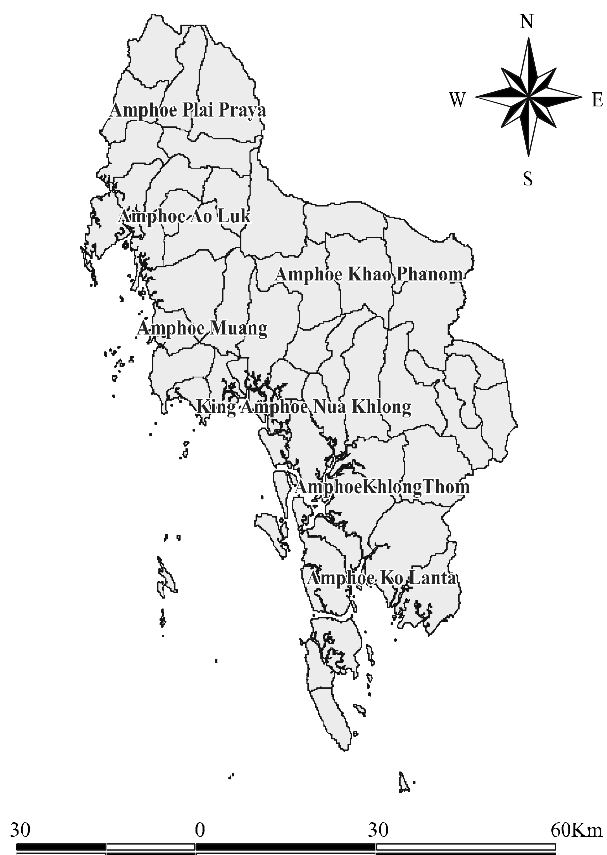

FIG. 1. MAP OF KRABI PROVINCE, THAILAND

2.3 Methods

The flow chart of Tsunami hazard based land use planning map has been shown in below Fig. 3.

This methodology contains the different steps which are explained as below; first of all Tsunami hazard-Preventing Land use Planning Criteria has been developed by detecting the required parameters for this model. After identifying the required suitable parameters, GIS was utilized by using spatial analysis. The various sub-techniques using GIS during spatial analysis were benefited such as sub setting the data layers for making suitable them for case study application, converting the data themes into grid format, reclassifying the different data themes into various classes, and using map algebra technique for developing final out put map as tsunami hazard resistant land use planning model using GIS software with datum WGS- 84, UTM projection, zone 47.

3. RESULTS

3.1 Tsunami Hazard Criteria

The tsunami hazard criteria was developed based on experts opinions, questionnaires, literature review, topographic and individual situations of the beaches, is shown as:

(1) The open coastline directly exposed to the ocean including the different areas such as Tup Kaek beach, Phulay beach, klong Muang beach, Siew bay, Noppharat Thara bay, Nammao bay,

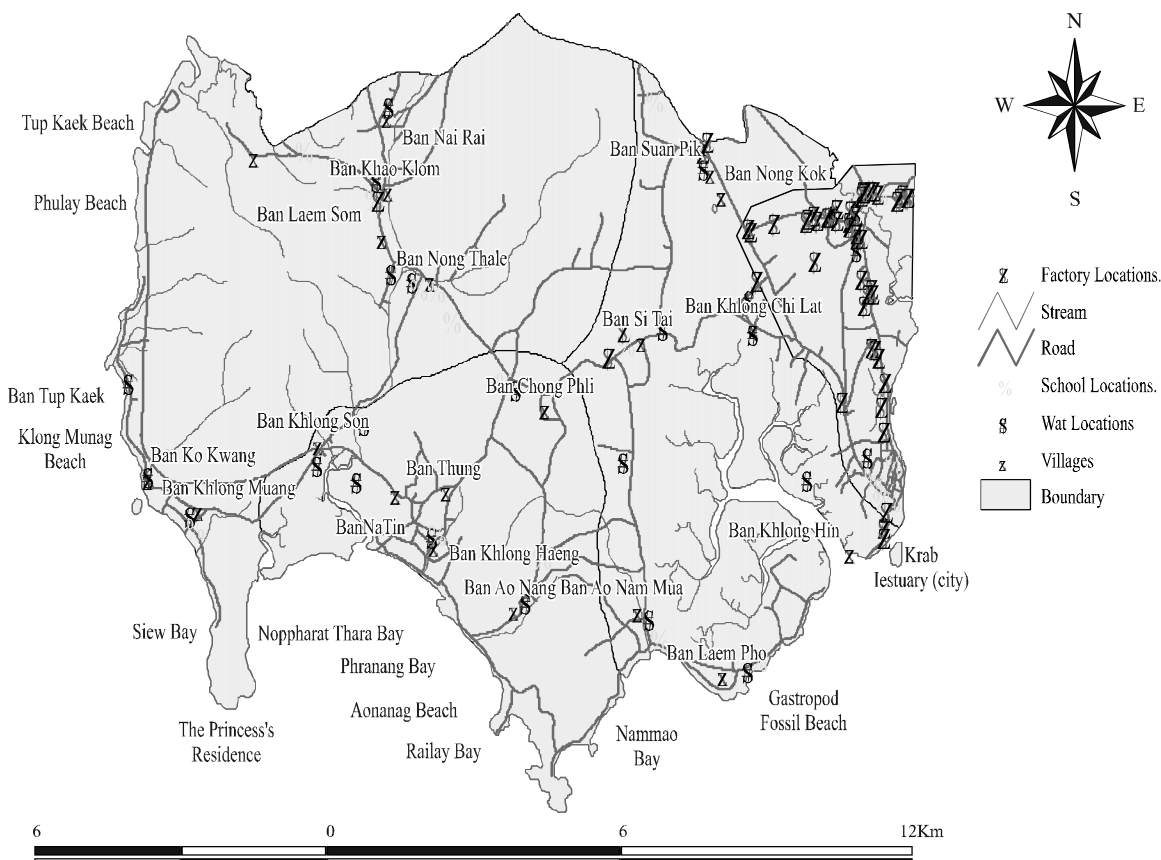

FIG. 2. THE CASE STUDY MUANG KRABI COASTLINE

Gastropod fossil beach and krabi city areas near krabi estuary are at high risk within 50m distance from shore line, moderate risk except krabi city areas are with 500m distance from shore line. Tup Kaek beach, Phulay beach, Klong Muang beach, Siew bay are at low risk at the 1.5 km while Ao Nang bay, Phranang bay, railay bay are within 1 km at low risk and all areas far from the beaches at 2 km are safe from tsunami hazard including elevation of 35m or above.

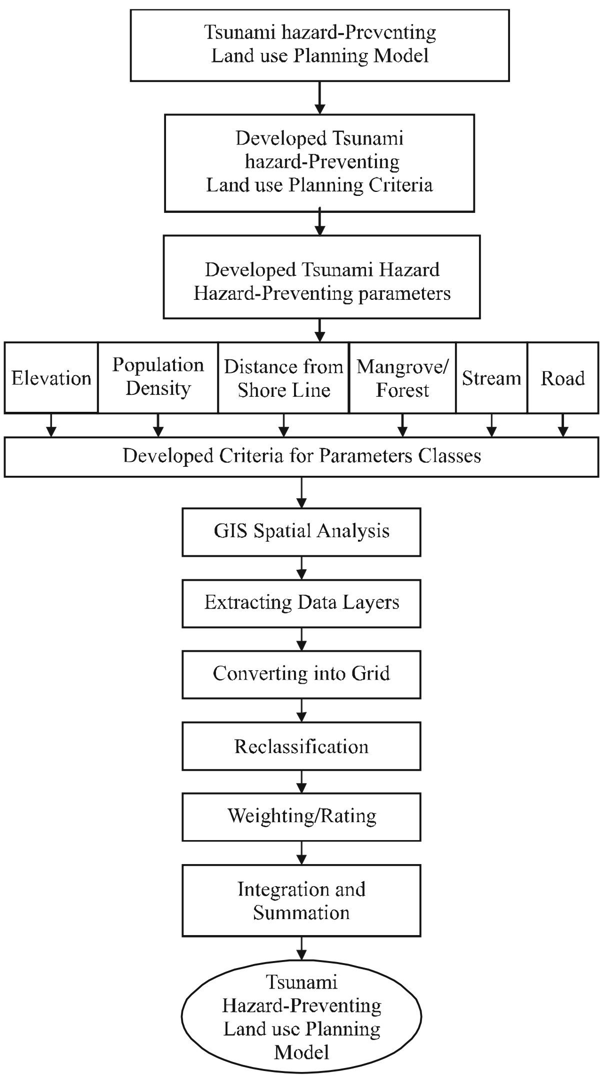

FIG. 3. METHODOLOGY FOR TSUNAMI HAZARD PREVENTING LAND USE PLANNING MODEL

(2) Tsunamis occurred in past in affected areas are very high risky areas.

(3) Open Coast areas within 2km with 0-3m elevation are at high hazard, 3-10m elevation are at moderate hazard, 10-35m elevation are at low hazard and above 35 elevation are no hazardous area.

(4) Degree of protective forestation and mangroves at high quantity reflects low risk, moderate quantity reflect, moderate risk and low quantity reflects high risk within areas of coast line.

(5) Disperse areas with sparsely dispersed population densities e.g. rural areas farer from the declared risk areas are safer from the risk.

(6) Water bodies e.g. stream, canals. estuary distances reflect 50m high risk, 500m low risk and more than 500m from the shore line at low risk with respect to inundation and flooding.

3.2 Tsunami Hazard-Preventing Land Use Planning Model

The result of this paper has been shown in Fig. 4, titling as tsunami hazard-preventing land use planning Model into five classes such as high suitable, moderate suitable, low suitable, very low suitable and the no suitable.

4. DISCUSSIONS

The land use planning model based on the consideration of the natural disasters' prevention vary from one disaster to another disaster, however it is very important to consider them in that perspective for minimizing the threats of such probable hazards. The traditional land use planning has been done in past. However, it is required to develop hybridized based land use planning equipped with different latest technological tools and software for finding the appropriate suitable areas for various development purposes.

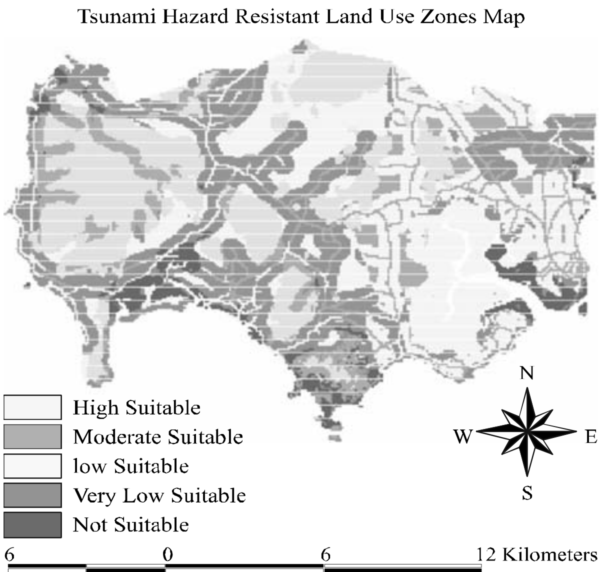

FIG. 4. TSUNAMI HAZARD PREVENTING LAND USE PLANNING MODEL

5. CONCLUSIONS

The class one entitled as high suitable in the tsunami hazard preventing land use planning Model is appropriate for the residences which is very safe from the tsunami threats. Furthermore it is also recommended to construct the commercial shops and malls as this type of land is possessing high elevation ranging almost above or equal to 25m, has no any tsunami hazard threat. The moderate suitable class in this developed model is suggested for constructing only the commercial purposes as this type of land is possessing high elevation ranging from 3-10m,far from stream and shore line with dense vegetation of forest and mangroves. While the low suitable class land with moderate elevation ranging from 11-25m is suitable for tourism and eco-tourism activities, with the construction of the hotels. The very low suitable classes are risky and hazardous from the tsunami threats and are recommended not to construct the residential and the commercial infrastructures in that region. However, this land is recommended for rest houses for high authorities, tsunami rescue residences and government administrative authorities' accommodation. It is also feasible for the agriculture and to some extent for recreation such as swimming, boating etc.The no suitable class is declared as very risky region and is recommended only for the adventurism, constructing tsunami towers , tsunami warning centers, tsunami evacuation boats, tsunami rescue centers, for the shrimp farming, and fishing.

ACKNOWLEGEMENTS

This research has been done by the first author during conducting the M.E Degree in AIT (Asian Institute of Technology), Thailand, during 2003-2005. The authors are very thankful to Mehran University of Engineering & Technology, Jamshoro, Pakistan, and RTG (Royal Thai Government), for providing the scholarships to conduct this research work.

REFERENCES

[1] Lau, G., Tan, W., and Tan, P., "After the Indian Ocean Tsunami: Singapore's Contribution to the International Disaster Victim Identification Effort in Thailand", Annals Academy of Medicine, Volume 34 No. 5, Singapore, 2005.

[2] Ioualalen, M., Asavanant, J., Kaewbanjak, N., Grilli, S., T., Kirby, J.T., and Watts, P., "Modeling the 26th December, 2004 Indian Ocean Tsunami: Case Study of Impact in Thailand", Journal of Geophysical Research Volume 112, USA, 2007.

[3] Zobel, R., and Tandayya, P., and Duerrast, H., "Modeling and Simulation of the Impact of Tsunami Waves at Beaches and Coastal Lines for Disaster Reduction in Thailand", International Journal of Simulation, Volume 7, Nos. 4-5, UK, 2006.

[4] Thanawood, C., Yongchalermchai, C., and Densrisereekul, O., "Effects of the December 2004 Tsunami and Disaster Management in Southern Thailand", Science of Tsunami Hazards, Volume 24, No. 3, pp. 206, USA, 2006.

[5] Nistori, I., Palermo, D., Al-Faesly, T., and Cornett, A., "Modeling of Tsunami-Induced Hydrologic Forces on Buildings", 33rd IAHR Congress Water Engineering for a Sustainable Environment, International Association of Hydraulic Engineering & Research, Spain, 2009.

[6] Leventhal, A., and Withycombe, G., "Landslide Risk Management for Australia", The Australian Journal of Emergency Management, Volume 24, No. 1, pp. 42-52, Australia, 2009.

[7] Cardinali, M., Reichenbach, P., Guzzetti, F., Ardizzone, F., Antonini, G., Galli, M., Cacciano, M., and Salvati, P., "A Geomorphological Approach to the Estimation of Landslide Hazards and Risks in Umbria, Central Italy", Natural Hazards and Earth System Sciences,Volume 2, pp. 57-72, Copernicus Publications, Germany, 2002.

[8] Van Westen, C.J., Van Asch, T.W.J., and Soeters, R., "Landslide Hazard and Risk Zonation-Why is it Still so Difficult?", Journal Bulletin of Engineering Geology and the Environment, Volume 65, No. 2, pp. 167-184, 2006.

[9] Papong, S., Chom-In, T., Noksa-Nga, S., and Malakul, P., "Life Cycle Energy Efficiency and Potentials of Biodiesel Production from Palm Oil in Thailand", Energy Policy, Volume 38, pp. 226-233, Inderscience Publishers, Switzerland, 2010.