CHAPTER 1
INTRODUCTION

1.1 GENERAL

Natural hazard or disaster is an event causing damage to human lives and property (S.L. Geol, 2007). An alarming increase in the occurrence of natural disasters has been reported over the past few years. Munich Re Group (2004) reported that the number of natural hazards occurred in the year 2004 is around 650. In that, approximately half of the natural catastrophic events recorded were severe windstorms and weather events, while 80 due to geological hazards (70 damaging earthquakes and 10 volcanic eruptions). An earthquake of about 9-9.3M occurred in the Indian Ocean and has been recorded to be the largest in the past five decades. This event led to the Tsunami generation on 26th December 2004 which killed around 16,000 human lives and rendered thousands of people homeless in India alone (Ministry of Home Affairs, India). Further, the Indian Ocean Tsunami puts an end to 320,000 lives roughly and left millions of people displaced, especially in the South and Southeast Asian countries (Nunes et al., 2009). Quite apart from these series of catastrophic disastrous events occurred; the distinct features pay more attention to the researchers to evaluate the broader concepts in the field of disaster management for a better outlook. Though the number of disasters has been tripled since 1970’s, the reported death toll has almost been reduced by half as a result of increasing effective measures. This paved way to study the concept behind the impact of Tsunami on different aspects and to analyse Tsunami vulnerability of the community and buildings and to identify the weakness in existing Tsunami Warning and Evacuation Process (TWEP).
1.2 RESEARCH BACKGROUND

Natural hazards drastically affect the lives, assets and the development of emerging nations like India. Especially the weaker groups in society suffer a lot by these disasters. Hence disaster reduction strategies are considered to be the most important ones in order to readdress the future disasters.

Over the last decade India, China, United States, Philippines and Indonesia are the top five countries that were most frequently affected by natural disasters (Debarati Guha et al., 2013). Throughout the history, Tsunamis have seriously affected many regions in the world. But particularly the 2004 Indian Ocean Tsunami that affected several countries including India has drawn enormous attention towards the importance of studying the phenomenon in order to minimize its damages (Nunes et al., 2009).

Tsunami is a set of ocean waves caused by any large, abrupt disturbance of the sea surface (Bernard et al., 2006). After its passage, a Tsunami may leave behind severe losses. Tsunamis may cause massive loss of life, destruction of coastal infrastructure and disruption of economic activity (Papathoma et al., 2003). In India the 2004 Tsunami caused a major damage along the coast of Tamilnadu, Andhra Pradesh, and Kerala. In particular most of the damages and death toll recorded in Tamilnadu state indicates Nagapattinam to be the worst affected district where the water transgressed up to 1 km into the mainland of Nagapattinam (Alpa et al., 2006; Srinivasulu et al., 2009). The present study mainly focuses on disaster management and hence classifies the natural disaster into three phases:

1. Pre-disaster stage
2. During disaster stage
3. Post-disaster stage
To explain further, (i) the key components in the pre-disaster stage are prediction, planning and prevention and installation of detection or warning systems. (ii) Detection, communication, confirmation, decision making, issue of warnings, evacuation of people and other rescue operation occur during the disaster. (iii) Post-disaster management ranges from the mitigation of human suffering to the recovery of the infrastructure (Ruwanpura et al., 2009).

Tsunami hazard management was given a low priority by local governments without being strongly pressed in local plans before the 2004 Tsunami. In part, this negligence was due to lack of public concern (Johnston et al., 2005). The 2004 Tsunami significantly raised public awareness about the hazard of Tsunamis and the need for Tsunami early warning in the Indian Ocean (Rudloff et al., 2009).

This event led to broad international efforts to design and implement the Tsunami early warning system in the Indian Ocean on one hand, and on the other, to urgently strengthen community based disaster management strategies (e.g. awareness raising, preparedness strategies) so called “last mile” (Taubenbock et al., 2009).

In order to set up an effective disaster management strategy, it is essential to assess and monitor the Tsunami hazard, population’s risk and the population’s vulnerability on a continuous basis especially with regard to and in the context, of early warning (Rynn and Davidson, 1999; UN/ISDR, 2004; Bird and Dominey-Howes, 2008; UNESCO IOC, 2009; Taubenbock et al., 2009). Studies of the Tsunami concluded that there is a need for more effective warning and preparedness to evacuate threatened populations (Cyranoski, 2005; Kintisch, 2005; Bhattacharjee, 2005; Kerr, 2005; Danielsen et al., 2005; Krishna, 2005; Levy and Gopalakrishnan, 2005; Lorch, 2005 and Marris, 2005).
1.2.1 Risk and Vulnerability

Risk is defined as the probability of worst consequences or expected losses (deaths, injuries, loss of property and livelihoods, disruption of economic activity, environment damaged) resulting from interactions between natural or human-induced hazards and vulnerable conditions (UN/ISDR, 2004). This is simply expressed by the formula (Wisner et al, 2005).

\[ \text{Risk} = \text{Hazard} \times \text{Vulnerability} \]  

Risk assessment is two-dimensional such as the hazard assessment (external) and the assessment of vulnerability (internal) (Chambers, 1989). In this regard, two important elements in the assessment of risk such as hazard and vulnerability have been predicted.

Hazard is defined as the possibility of occurrence of a specific natural event at a specific severity level in a specific future time period (Peduzzi et al., 2005). In the context of disaster risk reduction, the hazard component is unpredictable because of its nature. Thus, vulnerability analysis plays a vital role in the Tsunami risk reduction.

The term vulnerability covers a wide field of research, encompassing many techniques, applications and disciplines. Thywissen (2006) stated that the term vulnerability is an envelope for complex and interconnected parameters and processes. ISDR defines Vulnerability as “the set of conditions and processes resulting from physical, social, economic, and environmental factors, which increase the susceptibility of a community to the impact of hazards” (UN/ISDR, 2004).

The vulnerability factors include weakness of community’s warning and evacuation system and living environment. Since risk is a function of hazard and vulnerability, the community and building vulnerability are considered to be the most important parameters in the framework of Tsunami risk reduction. The decreasing community vulnerability to Tsunami
defines clearly that the present warning and evacuation process is not sufficient or crucial. (UNESCO IOC, 2009; Dall'Osso and Dominey-Howes, 2010; Spahn et al., 2010).

Regarding disaster risk reduction, scientists often consider buildings as potential element for vertical evacuation and hence building vulnerability is also considered as an important parameter in disaster management. The building vulnerability factors include weakness of location and the site environment. Such information about buildings is usually derived from field measurements based on selected parameters which determine the level of vulnerability. The disaster research has been characterized by inductive field studies at the site of a reported disaster and through personal interviews (Stallings, 2007).

The establishment of early warning and evacuation process are the key elements to reduce vulnerability and risk (UNESCO IOC, 2009; Taubenbock et al., 2009) to improve the disaster preparedness and elements at risk by providing information to the people. Human or Community vulnerability can be determined by a person or a group and their situation that influence their capacity to anticipate resist and recover from the impact of a natural hazard (Wisner, 2005). On identifying the present situation in warning and evacuation system a better community based planning can be affordable.

The present study introduces a new concept of Vulnerability Analysis for disasters with a specific focus on Tsunamis. This new approach for a particular type of disaster also forces one to fully understand all the components of disaster mitigation plans and processes.

1.3 NEED FOR THE PRESENT STUDY

From the lessons learned from 2004 Tsunami event that made emphasize on the need to study and stress the importance of Tsunami vulnerability. On December 26, 2004, an earthquake of magnitude 9.0 on Richter scale occurred off the west coast of Sumatra in Indonesian
Archipelago at 06:29 AM IST (00:59 AM GMT). The epicentre of the earthquake was located under seawater at 3.4N 95.7E. The earthquake occurred along the plate boundary marked by the subduction zone between the Indian plate and the Burmese micro plate (Navalgund, 2005). The earthquake was the biggest in four decades and it generated huge Tsunami waves. The Tsunami waves travelled a distance of more than 2000 km in the Indian Ocean. It had a catastrophic impact on the lives of the people and coastal ecosystem in Indonesia, Sri Lanka, Thailand, India and Somalia in the Indian Ocean. The Tsunami claimed more than 300 thousand human lives in these countries. These events emphasized the need to assess Tsunami vulnerability associated with various Tsunamigenic zones in the Indian Ocean basin. According to official estimates (Ministry of Home Affairs, India), the death toll in India was about 16,389 due to the December 2004 Tsunami. The Nagapattinam area in the state of Tamilnadu has undergone catastrophic impacts, with around 6,065 casualties (Collectorate, Nagapattinam).

From the above descriptions, it is very clear that Tsunami waves threatened all communities along the coast, and it became imperative to assess the vulnerability as well as the safety measures to protect the society against the Tsunami disaster.

1.4 PROBLEM IDENTIFICATION

• The resettlement planning could not be implemented since the life of coastal community relies only upon the coastal areas.

• The coastal areas are highly vulnerable to Tsunami, an improved Tsunami Warning Evacuation Process (TWEP) is required.

• Since the needs and expectation of the community were not fulfilled by the existing measures, certain strategies are to be determined and implemented.
1.5 BENEFITS OF STUDY

The current study helps in several aspects as follows;

• The result certainly gives benefits to the government and society.

• It can be a key element to preparedness.

• It could be used as consideration in Tsunami mitigation.

• The proposed model is also applicable to the future research to various natural hazards.

1.6 SCOPE OF RESEARCH

The building and community vulnerability factors have been identified and analyzed using relevant statistical tools viz. ANOVA, t-test, chi square test, discriminant analysis and logistic regression to identify the critical factors. The obtained results from the analysis are used to explain the relative importance of measurements and to generate a canonical variable score for each case. Based on the analysis results the pitfalls are strengthened to enhance a better mitigation plan.

1.7 RESEARCH QUESTIONS

Is it possible to evaluate the upgradation made in the building vulnerability condition and TWEP and whether it is upto expectation of the community in the basic research question which yields the following sub questions. The answers finally comprise the body of this research.

• What are the ways to reduce risk in human and buildings during Tsunami?

• Is it possible to attain community’s present living environment and building vulnerability?

• What statistical model can be proposed for identifying vulnerability assessment?
• What is the reliability of the information obtained through interviews? What is the corresponding influence to the final statistical model?

• What are all the parameters interconnecting the community vulnerability?

• Is it possible to identify the weaknesses in the existing Tsunami warning and evacuation process in India?

• Is it possible to investigate the evacuation process in India and scrutinize the lapse?

• Is it possible to acquire opinion from the community subjecting the present warning and evacuation system?

• What is the view of the community regarding their experience, awareness, beliefs, expectations after the 2004 Tsunami?

• Whether enough services and facilities have been provided for the community after the 2004 Tsunami?

• What are all the organisations or departments involved in Tsunami warning and evacuation activities and what further improved proposals can be given to them?

• Does the information obtained from the community relying with that of officials?

• Is it possible to create a separate model for various respondents and highly vulnerable areas?

1.8 RESEARCH OBJECTIVES

The main objectives of this research are

• To acquire a basic understanding of Tsunamis and existing practices of TWEP.

• To develop a building vulnerability model and implement the model to the current situation.
• To analyze the community vulnerability using logistic regression model and to identify the pitfalls in existing TWEP.

• To enhance a better community based TWEP.

1.9 ORGANISATION OF THE THESIS

Chapter 1: Introduction

The chapter describes the general instructions and justification of the current research including background, need, scope and limitations, identified problems, research questions and research objectives of the study.

Chapter 2: Literature Review

This chapter presents a wide range of study related to disaster management such as important definitions of Tsunamis and related issues. Community based disaster management, vulnerability concepts, vulnerability assessment methods, vulnerability indicators, building vulnerability, importance of TWEP are adequately discussed.

Chapter 3: Description of Study Area

This chapter illustrates the reason for choosing this study area including overview, population, community exposure to the impact, geographic and geomorphologic descriptions.

Chapter 4: Methodology and Theoretical Framework

The research component includes the qualitative and quantitative aspects of the complete research, identification of factors, data collection techniques, data analysis and interpretation using a suitable statistical model to evaluate the research validity.
Chapter 5: Building Vulnerability Analysis

This chapter depicts the building vulnerability assessment using a Discriminant Analysis approach based on a combination of different factors that affect the building resistance.

Chapter 6: Community Vulnerability Data Assessment

This chapter offers a detailed explanation of the assessment of community vulnerability of TWEP and the socio economic and demographic profile of the sample like gender, education, occupation, hamlet, living environment and other study parameters. It also includes t’ test, ANOVA, cross tabulation and Chi Square test enduring all variables to prove whether they are statistically significant.

Chapter 7: Statistical Model for Community Vulnerability

In this chapter a statistical model is proposed to determine the community vulnerability. The statistical tool used here is Logistic Regression.

Chapter 8: Results and Discussions

This chapter presents the findings, discussion and suggestions of the study.

Chapter 9: Conclusions

This chapter summarizes the research out comes with overall conclusions, research contributions, limitations and recommended future work.