# ASSESSING TSUNAMI HAZARD AND MITIGATION MEASURES

By

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A thesis submitted to University of Moratuwa
for the Degree in Master of Science

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# Abstract

The Indian Ocean Tsunami in 2004 caused widespread damage in the coastal regions of Sri Lanka. The extent of inundation and the associated damage varied significantly with the local near shore wave height, topography and the resistance offered to the overland flow. This study is concerned on a methodology to calculate and record the wave heights around Sri Lanka by a tsunami generated in Indu- Andaman region or Sunda trench and the mitigation measures which could be implement within the coastal region. As Sri Lanka is exposed to tsunamis, as indicated by the Indian Ocean Tsunami in 2004 and subsequent alerts in 2005 and 2007, it will be important to assess the risk of tsunamis for Sri Lanka in terms of tsunami arrival time, nearshore wave height, extent of inundation, period of risk etc. Online Software named ComMIT developed by the Indian Ocean Tsunami Warning System was used to calculate the tsunami wave heights along the coastal belt of Sri Lanka and it was selected after consideration of input parameters and the given output of some available tsunami software. Taking into consideration of the tsunami generation, deep water propagation and shallow water transformation, it is expected by this study to simulate various scenarios to arrive at an outcome which can be finally used to develop a database containing information to be effectively utilized by a tsunami early warning system. As part of the research, large scale physical modelling was developed to simulate tsunamis and testing was done by generating waves in the 2D flume of the Lanka Hydraulic Institute. Physical tests were carried out to assess the effectiveness of breakwaters and coastal vegetation as a tsunami impact mitigation measure and results on the effect of wave steepness and the porosity of the vegetation in reducing the tsunami wave heights were presented.

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*A. V. A. U. Karunathilaka*

# Declaration

This thesis is a report of research carried out in the Department of Civil Engineering, University of Moratuwa, between January 2008 and April 2010. Except where references are made to other work, the contents of this thesis are original and have been carried out by the undersigned. The work has not been submitted in part or whole to any other university. This thesis contains 118 pages.

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# List of Abbreviations

| Abbreviation | Description |
|---|---|
| BMRC | Bureau of Meteorology Research Centre |
| $C_d$ | Coefficient of Dissipation |
| $C_r$ | Coefficient of Reflection |
| $C_t$ | Coefficient of Transmission |
| CFL condition | Courant–Friedrichs–Lewy condition |
| ComMIT | Community Model Interface for Tsunami |
| D | Average fault displacement |
| DEM | Digital Elevation Models |
| GTDB | Global Tsunami Database |
| ICMMG | Institute of Computational Mathematics and Mathematical Geophysics |
| ITDB | Integrated Tsunami Database |
| ITIC | International Tsunami Information Centre |
| ITSU | International Co-ordination Group for the Tsunami Warning System in the Pacific |
| IUGG | International Union of Geodesy and Geophysics |
| L | Rupture Length |
| LHI | Lanka Hydraulic Institute |
| $M_L$ | Local magnitude/ Richter scale |
| $M_o$ | Seismic moment |
| $M_s$ | Surface wave magnitude |
| $M_w$ | Moment magnitude |
| MOST | Method of Splitting Tsunami |
| MMS | Moment magnitude scale |

| | |
|---|---|
| $m_b$ | Body-wave magnitude |
| NOAA | National Oceanic and Atmospheric Administration |
| NTL | Novosibirsk Tsunami Laboratory |
| *P* wave | Primary wave |
| PMEL | Pacific Marine Environmental Laboratory |
| S wave | Secondary wave |
| TREMORS | Tsunami Risk Evaluation through seismic Moment in a Real time System |
| USAID | United States Agency for International Development |
| W | Rupture width |
| 2D | Two Dimensional |
| μ | rigidity /shear modulus |