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Numerical modeling of tsunami in Indian Ocean

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INTRODUCTION

The most fatal, destructive, tragic and significant disaster caused by the Tsunamis in recent memory, was the one occurred in peaceful morning on the 26th day of December 2004. This was with a magnitude of a 9.3 earthquake in the Northwest coast of the Indonesian island of Sumatra. The earthquake resulted from complex slip on the fault where the oceanic portion of the Indian Plate slides under Sumatra, part of the Eurasian Plate. The earthquake deformed the ocean floor, pushing the overlying water up into a tsunami wave. The Asian Tsunami of December 2004 left an unprecedented trail of destruction in my motherland Sri Lanka and around much of the Indian Ocean. When they arrived with little or no warning, the mega-waves were ruthless and indiscriminate. The tsunami wave devastated nearby areas where the wave may have been as high as 25 meters (80 feet) tall and killed nearly 300,000 people from nations in the region and tourists from around the world. In overall terms, its level of destruction is higher than in Lisbon earthquake (1755 AD) which is regarded as the deadliest earthquake in modern history which took well over 100,000 lives in Lisbon city.

Tsunamis are long shallow waves generated by impulsive geophysical events of the seafloor and of the coastline, such as earthquakes and submarine or aerial landslides. Volcanic eruptions and asteroid impacts are less common but more spectacular triggers of tsunamis. The determination of the terminal effects of tsunamis as they strike shorelines and coastal structures is one of the quintessential problems in earthquake engineering. Tsunamis are notorious for exporting “death and destruction at distant coastlines,” as tsunamis sometimes travel across the world’s oceans without dissipating sufficient energy to render them harmless.

There are three key earthquake parameters that can be determined quickly from seismic waveform data for the evaluation of an earthquake’s tsunamigenic potential. They are:

1) Location - whether the earthquake is located under or very near the sea,

2) Depth - whether the earthquake is located close enough to the earth’s surface to have caused a significant displacement of that surface, and

3) Magnitude - the size of the earthquake.

NUMERICAL SIMULATION

The 2004 tsunami tragedy highlighted the need to develop technical capabilities on tsunami modelling in the field of tsunami hazard assessment. My master dissertation research is aimed to make a numerical model of the region close to Sri Lanka to simulate the past tsunamis created by the earthquakes and to use it for the early warnings to preserve the nation in future disasters.

Based on earthquake data and information about the topography of the sea floor provided, the model calculates the elevation of the sea surface at a series of grid points on a map of the area over a period of time. It is very evident that prevent of occurrence of natural disasters is impossible, but their results, such as loss of life & property can be reduced by proper planning. So, we need to have a good understanding of its nature of phenomenon & complex behavior due to physical, social and cultural factors.The current research will include:

- Study in detail the geophysics to identify the earthquake occurring phenomena and to find out relationships between strain energy accumulations and earthquake repeatability.

- Study and identify the different characteristics of fault rupture mechanisms, its behavior, and geological aspects affect rupture propagation and to introduce some pre identifying techniques for rupture propagation.

- Conduct some experimental and numerical simulation work to identify the complex behavior of seismic wave propagation through the earth structure. Also verify and validate the available data through a much sensitive and accurate numerical simulation process.

- Study about the ocean hazards, wave transformations, Tsunami generation mechanisms and earthquakes as tsunami sources.

- Conduct numerical simulation procedure to demonstrate the tsunami wave propagation in both deep and shallow water and then,

- Identify the possible Tsunamigenic scenarios around the Sri Lanka.

- Modeling of those scenarios and figure out the possible risk involved to Sri Lanka.

- Create inundation maps for all possible scenarios for a certain magnitude range of the earthquake.

- Find out a relationship between the run-up and the magnitude of the earthquake.(Where, as we know that:

Ms = Log (A) + 4.0 ;

Abrahamson & Silva method.

Where; Ms = Moment Magnitude of the earthquake. A = Area of the fault rupture in km2.

Accurate seismic data is generally available only after an event is over. With the future development of seismic technology, a more accurate and rapid estimation of seismic data might be provided. It then might be possible to use such simulations to predict tsunami behaviour immediately after an earthquake is detected.