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NUMERICAL MODEL FOR THE KRAKATOA HYDROVOLCANIC EXPLOSION AND TSUNAMI

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ABSTRACT

Krakatoa exploded August 27, 1883 obliterating 5 square miles of land and leaving a crater 3.5 miles across and 200-300 meters deep. Thirty three feet high tsunami waves hit Anjer and Merak demolishing the towns and killing over 10,000 people. In Merak the wave rose to 135 feet above sea level and moved 100 ton coral blocks up on the shore.

Tsunami waves swept over 300 coastal towns and villages killing 40,000 people. The sea withdrew at Bombay, India and killed one person in Sri Lanka.

The tsunami was produced by a hydrovolcanic explosion and the associated shock wave and pyroclastic flows.

A hydrovolcanic explosion is generated by the interaction of hot magma with ground water. It is called Surtseyan after the 1963 explosive eruption off Iceland. The water flashes to steam and expands explosively. Liquid water becoming water gas at constant volume generates a pressure of 30,000 atmospheres.

The Krakatoa hydrovolcanic explosion was modeled using the full Navier-Stokes AMR Eulerian compressible hydrodynamic code called SAGE which includes the high pressure physics of explosions.

The water in the hydrovolcanic explosion was described as liquid water heated by the magma to 1100 degree Kelvin or 19 kcal/mole. The high temperature water is an explosive with the hot liquid water going to a water gas. The BKW steady state detonation state has a peak pressure of 89 kilobars, a propagation velocity of 5900 meters/second and the water is compressed to 1.33 grams/cc.

The observed Krakatoa tsunami had a period of less than 5 minutes and wavelength of less than 7 kilometers and thus rapidly decayed. The far field tsunami wave was negligible. The air shock generated by the hydrovolcanic explosion propagated around the world and coupled to the ocean resulting in the explosion being recorded on tide gauges around the world.

PERSISTENT HIGH WATER LEVELS AROUND ANDAMAN & NICOBAR ISLANDS FOLLOWING THE 26 DECEMBER 2004 TSUNAMI

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ABSTRACT

During the tsunami of 26th December 2004 in the Indian Ocean, media reports suggested that high water levels persisted around the Andaman & Nicobar Islands for several days. These persistent high water levels can be explained by invoking the existence of trapped and partially leaky modes on the shelves surrounding these islands. It has been known in the studies of tides in the global oceans, that there are two distinct types of oscillations, separated in their frequencies by the period of the pendulum day. One species are the gravity waves, and the others are the rotational waves, associated with earth's rotation. Both these species can be found in tidal records around islands as well as near coastlines. Essentially these are either trapped or partly leaky modes, partly trapped on the continental shelves. These two types of modes are usually found in the tsunami records on tide gauges. The tide gauge records as well as visual descriptions of the water levels during and after the occurrence of a tsunami clearly show the presence of these oscillations.

POTENTIAL OVERLOOKED ANALOGUES TO THE INDIAN OCEAN TSUNAMI IN THE WESTERN AND SOUTHWESTERN PACIFIC

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ABSTRACT

In a more detailed examination of subducting margins of the Western and Southwestern Pacific, segments are found that are similar to the segment along the Indian Ocean that ruptured on 26 December 2004. Similarities are found in terms of hypocenter distributions and historical seismicity. The largest reported moment magnitudes in the Western and Southwestern Pacific since 1900 were an 8.5, an 8.4, and an 8.3. Should any substantially larger earthquakes occur along these segments or elsewhere in the Western or Southwestern Pacific, Civil Defense agencies in the Hawaiian Islands should be aware of any possible inadequacies in existing evacuation procedures for western and southern shores.

EFFECTS OF THE DECEMBER 2004 TSUNAMI AND DISASTER MANAGEMENT IN SOUTHERN THAILAND

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ABSTRACT

A quake-triggered tsunami lashed the Andaman coast of southern Thailand on December 26, 2004 at around 9.30 am local time. It was the first to strike the shorelines of southern Thailand in living memory. Coastal provinces along the Andaman coast suffered a total of 5,395 deaths – more than half of whom were foreign tourists, with another 2,822 reported missing. Of the 6 affected coastal provinces, Phang Nga was the worst-hit province with some 4,224 lives lost and 7,003 ha of land area devastated. Takua Pa District, which was a prime tourist area with numerous beach resorts, was the most severely affected area in Phang Nga Province.

Through the use of the aerial photographs and Ikonos images, it was found that 4,738 ha of Takua Pa District's coastal area were affected by the tsunami. The tsunami run-up heights of 7-8, 5-7 and 10-12 metres, were observed at, respectively, Ban Namkhem, Pakarang Cape and Ban Bangnieng in Takua Pa District. The tsunami caused heavy damage to houses, tourist resorts, fishing boats and gear, culture ponds and crops, and consequently affected the livelihood of large numbers of the coastal communities. The destructive wave impacted not only soil and water resources, but also damaged healthy coral reefs, sea grass beds and beach forests. The surviving victims faced psychosocial stresses resulting from the loss of their loved ones, being rendered homeless and fears of another tsunami. The tsunami effects on human settlements, livelihoods, coastal resources, natural environment together with the psychosocial well being of the coastal communities have contributed to the degradation of the coastal ecosystems.

Following the 2004 event, it has become apparent that the country's disaster management strategies need to be strengthened through the implementation of mitigation and preparedness options to enhance the community's resilience to natural events such as tsunami. The improved strategies are discussed in this paper.

WHAT IS THE PROBABILITY FUNCTION FOR LARGE TSUNAMI WAVES?

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ABSTRACT

Most coastal locations have few if any records of tsunami wave heights obtained over various time periods. Still one sees reference to the 100-year and 500-year tsunamis. In fact, in the USA, FEMA requires that at all coastal regions, those wave heights due to tsunamis and hurricanes be specified. The same is required for stream flooding at any location where stream flooding is possible. How are the 100 and 500-year tsunami wave and stream flooding heights predicted and how defensible are they? This paper discusses these questions.

TSUNAMI ON 26 DECEMBER 2004: SPATIAL DISTRIBUTION OF TSUNAMI HEIGHT AND THE EXTENT OF INUNDATION IN SRI LANKA

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ABSTRACT

This paper examines the impact of the massive tsunami of 26 December 2004 on Sri Lanka by tracing the tsunami height, the extent of inundation and the level of damage along the affected coastal belt. The results of an extensive field survey that was carried out in the east, south and west coasts to record the evidence of water levels left behind by the tsunami clearly indicate non-uniform spatial distribution of inundation along the affected coastline of the country. The tsunami inundation had been significantly greater for most parts of the east and the south-east coastal areas than the south, south-west and the west coasts of Sri Lanka. The results also indicate the possible influence of the coastal geomorphology on the extent of inundation. On the other hand, the measurements suggest maximum tsunami heights of 3 m – 7 m along the east coast, 3 m – 11 m on the south coast, and 1.5 m – 6 m on the west coast.