Tsunami Induced Sediment Cloud: An Experimental Study

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ABSTRACT

Researches about tsunamis showed that a huge mass of water movement caused not only life and property losses on coastal areas, but also caused severe damages on ocean ecosystem due to huge mass of sand movements and tsunami backwash flow. In this study, it is aimed to understand the horizontal changes in suspended sediment concentration in water, originated from the tsunami run up and backwash flow with an experimental setup. This study has showed that the tsunami induced sediment transport has two layer sediment clouds as it is observed and the empirical equations have verified this fact.

KEY WORDS: Tsunami; Sediment Cloud; Suspended Sediment Concentration, Sediment Transport, OPCON.

INTRODUCTION

The most particular characteristics of tsunamis which are also categorized as long waves, are due to their strong water mass movement on the terrestrial part of the coastal line. During the propagation of the tsunami in deep water, due to their considerably low wave heights and very long wave periods in open water conditions, they have no severe effect. However as they reach to the coastal region and start the runup process, life and property losses are recorded. Tsunamis also terminate their movement in wave character in a particular depth and start their movement as a mass. Runup process of the water mass is directly affected by the topographical characteristics of the coastal area. As the water mass reaches to a certain level, backwash flow starts.

Researches about tsunamis showed that a huge mass of water movement caused not only life and property losses on coastal areas, but also caused severe damages on ocean ecosystem due to huge mass of sand movements and tsunami backwash flow. Suspended matters in water can accumulate on reefs and marine flora causing adverse effects on water quality due to the oxygen deficiency. Furthermore, recent investigations on ocean floor have focused on analyzing, sediment depositions in layers, which can be the geological records of ancient tsunamis, to determine the magnitude of past tsunami. However, it is more important to understand the amount of offshore sediment transport just after a recent tsunami for ecological risk modeling. In this context, it is more convenient to model a tsunami experimentally and develop a numerical approach, since it is hard to get a real time data from a tsunami.

The most important fact that why tsunamis are so devastating, not only because they caused life and property losses on coastal areas, but also caused severe damages on ocean ecosystem due to huge mass of sand movements and tsunami backwash flow. Since it is very hard to evaluate the damage caused by tsunamis on field, the satellite views are widely used for the damage assessment. One of the studies carried out by Ramachandran et al. (2005) have showed that, turbulent water including dense silt was observed over the reefs at the day of tsunami and after. The silt covered area was measured as 400.71 ha in Nancowry and 552.44 ha in Trinikat with the help of satellite views. It was also recorded that the affected area by silt and turbulent water was covered with the muddy bottom 10 days after tsunami. Ramachandran et al. (2005) also reported that the huge amount of silt accumulated over the reefs for a long period has posed the death of reefs and sea grass. On the other hand, it was also focused that the tons of coastal material grapped from the coast and washed out towards offshore has damaged the nesting places of the sea turtles on the coast.

The other studies about tsunamis are focussed on the tsunami run-up for different slopes and different coastal materials Ambraseys, (1962); Gedik, et al. (2005); Koroglu, & Kabdasli, (2011); Nieuwkoop, (2007). The unique experimental study in the literature reporting the tsunami induced sediment transport was conducted by Sugawara et al., (2008). The study aimed to explain the hydraulic capacity of an tsunami and the sediment amount at the bottom. The coastal slope was 1/10 with an impermeable surface. It was recorded that the total sediment amount was related with the tsunami height. It was also stressed that the sediment transport was supported by the backwash of the tsunami and accumulating on a relatively low slopes. The overall accumulated sediment was measured as 0.5 kg/m² after the water with 0.005 m³ volume has passed over the sloped sediment bottom.

As it was recorded in Indian Ocean Tsunami in 2004, following dense wave run-up and backwash flow, consireably high amount of sediment was trapped on water column and transported to the sea (Department of Ocean Development, 2005). Satellite views from Chennai and Nellore coastas showed that tsunamis has bringing solid wastes, soil and coastal...