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EMERGENCY PLANNING IN NORTHERN ALGERIA BASED ON REMOTE SENSING DATA IN RESPECT TO TSUNAMI HAZARD PREPAREDNESS

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ABSTRACT

LANDSAT ETM and Digital Elevation Model (DEM) data from the coastal areas of Algeria were investigated in order to detect traces of earlier tsunami events. Digital image processing methods used to produce morphometric maps - such as hillshade, slope, minimum and maximum curvature maps based on the SRTM DEM data - contribute to the detection of morphologic traces that might be related to catastrophic tsunami events. These maps combined with LANDSAT ETM and seismotectonic data in a GIS environment allow the delineation of areas with potential tsunami risk. The evaluations of LANDSAT ETM imageries merged with digitally processed and enhanced SRTM data clearly show areas that must have been flooded in earlier times. In some cases morphological traces of flood waves as curvilinear scarps open to the seaside or traces of abrasion are clearly visible.

MODELING THE ASIAN TSUNAMI EVOLUTION AND PROPAGATION WITH A NEW GENERATION MECHANISM AND A NON-LINEAR DISPERSIVE WAVE MODEL

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ABSTRACT

A common approach in modeling the generation and propagation of tsunami is based on the assumption of a kinematic vertical displacement of ocean water that is analogous to the ocean bottom displacement during a submarine earthquake and the use of a non-dispersive long-wave model to simulate its physical transformation as it radiates outward from the source region. In this study, a new generation mechanism and the use of a highly-dispersive wave model to simulate tsunami inception, propagation and transformation are proposed. The new generation model assumes that transient ground motion during the earthquake can accelerate horizontal currents with opposing directions near the fault line whose successive convergence and divergence generate a series of potentially destructive oceanic waves. The new dynamic model incorporates the effects of earthquake moment magnitude, ocean compressibility through the buoyancy frequency, the effects of focal and water depths, and the orientation of ruptured fault line in the tsunami magnitude and directivity.

For tsunami wave simulation, the nonlinear momentum-based wave model includes important wave propagation and transformation mechanisms such as refraction, diffraction, shoaling, partial reflection and transmission, back-scattering, frequency dispersion, and resonant wave-wave interaction. Using this model and a coarse-resolution bathymetry, the new mechanism is tested for the Indian Ocean tsunami of December 26, 2004. A new flooding and drying algorithm that consider waves coming from every direction is also proposed for simulation of inundation of low-lying coastal regions.

It is shown in the present study that with the proposed generation model, the observed features of the Asian tsunami such as the initial drying of areas east of the source region and the initial flooding of western coasts are correctly simulated. The formation of a series of tsunami waves with periods and lengths comparable to observations are also well simulated with the new generation model. Furthermore, the shoaling behavior of the tsunami waves during flooding of dry land was also simulated by the new run-up algorithm. Finally, the new generation and propagation models can explain the combined and independent effects of various factors in tsunami generation and transformation taking into consideration the properties of the ocean and the geologic disturbance.

TWO-DIMENSIONAL SIMULATIONS OF EXPLOSIVE ERUPTIONS OF KICK-EM JENNY AND OTHER SUBMARINE VOLCANOS

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ABSTRACT

Kick-em Jenny, in the Eastern Caribbean, is a submerged volcanic cone that has erupted a dozen or more times since its discovery in 1939. The most likely hazard posed by this volcano is to shipping in the immediate vicinity (through volcanic missiles or loss-of-buoyancy), but it is of interest to estimate upper limits on tsunamis that might be produced by a catastrophic explosive eruption. To this end, we have performed two-dimensional simulations of such an event in a geometry resembling that of Kick-em Jenny with our SAGE adaptive mesh Eulerian multifluid compressible hydrocode. We use realistic equations of state for air, water, and basalt, and follow the event from the initial explosive eruption, through the generation of a transient water cavity and the propagation of waves away from the site. We find that even for extremely catastrophic *explosive* eruptions, tsunamis from Kick-em Jenny are unlikely to pose significant danger to nearby islands. For comparison, we have also performed simulations of explosive eruptions at the much larger shield volcano Vailulu'u in the Samoan chain, where the greater energy available can produce a more impressive wave. In general, however, we conclude that explosive eruptions do not couple well to water waves. The waves that are produced from such events are turbulent and highly dissipative, and don't propagate well. This is consistent with what we have found previously in simulations of asteroid-impact generated tsunamis. Non-explosive events, however, such as landslides or gas hydrate releases, do couple well to waves, and our simulations of tsunamis generated by sub-aerial and sub-aqueous landslides demonstrate this.

WAVE DISPERSION STUDY IN THE INDIAN OCEAN TSUNAMI OF DECEMBER 26, 2004

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ABSTRACT

A numerical study which takes into account wave dispersion effects has been carried out in the Indian Ocean to reproduce the initial stage of wave propagation of the tsunami event occurred on December 26, 2004. Three different numerical models have been used: the nonlinear shallow water (nondispersive), the nonlinear Boussinesq and the full Navier-Stokes aided by the volume of fluid method to track the free surface. Numerical model results are compared against each other. General features of the wave propagation agreed very well in all numerical studies. However some important differences are observed in the wave patterns, i.e., the development in time of the wave front is shown to be strongly connected to the dispersion effects. Discussions and conclusions are made about the spatial and temporal distribution of the free surface reaffirming that the dispersion mechanism is important for tsunami hazard mitigation.