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A NUMERICAL MODEL FOR THE EFFICIENT SIMULATION OF MULTIPLE LANDSLIDE-TSUNAMI SCENARIOS

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INTRODUCTION

Submarine landslides can pose serious tsunami hazard to coastal communities, occurring frequently near the coast itself. The properties of the tsunami and the consequent inundation depend on many factors, such as the geometry, the rheology and the kinematic of the landslide and the local bathymetry. However, when evaluating the risk related to landslide tsunamis, it is very difficult to accurately predict all of the above mentioned parameters. It is therefore useful to carry out many simulations of tsunami generation and propagation, with reference to different landslide scenarios, in order to deal with such uncertainties (see for example the probabilistic approach by Grilli et al. 2009). Accurate computations of landslide tsunami generation, propagation, and inundation, however, is computationally expensive, thus limiting the possible maximum number of scenarios. To partially overcome this difficulty, in the present research, a numerical model is proposed that can efficiently compute a large number of tsunami simulations triggered by different landslides. The main goal is to provide a numerical tool that can be used in a Monte Carlo approach framework. Following the study by Ward (2001), we propose a methodology taking advantage of the linear superposition of elementary tsunami solutions.

THE NUMERICAL MODEL

The proposed method uses as wave solver the elliptic version of the mild-slope equation (MSE) with a source term representing the seafloor motion (see for example Cecioni & Bellotti, 2010). The area where the landslide can occur is split into small rectangles, as shown in Figure 1 for the test case described in the following. In each of these, a pseudo Green's function is calculated, representing the tsunami triggered by a bottom uplift of unitary magnitude over each small area. Once the actual source term is specified in terms of bottom motion for a generic landslide scenario, the tsunami solution can be quickly built by linearly superposing the effects of the elementary Green's function multiplied by the actual magnitude of the source term in each rectangle. As many preliminary computations must be carried out in order to calculate all the pseudo Green's functions, the definition of the size of the small rectangles is a crucial step in order to make the computational times acceptable.

TEST CASE

Our proposed modeling methodology was tested by reproducing the experimental study by Enet & Grilli (2007), which considers tsunamis generated by a rigid landslide in a three-dimensional tank. First, the experiments were reproduced using the MSE. Due to the fact that the employed model is linear and depth-integrated, the agreement between the numerical and

the experimental results was found to be much better in the far-field than in the near-field. Then, a parametric analysis was carried out by varying the size of the unit source rectangles. As expected, it was found that, when using relatively large rectangles, the accuracy of the solution deteriorates with respect to the benchmark.

Guidance for the selection of the rectangle size with respect to the landslide dimensions will be provided based on results obtained. The superposition method will be further tested by simulating the physical model experiments by Di Risio et al. (2009), which simulate the propagation of tsunamis generated by landslides occurring at the coast of a conical island. The method will then be applied to a real world case.

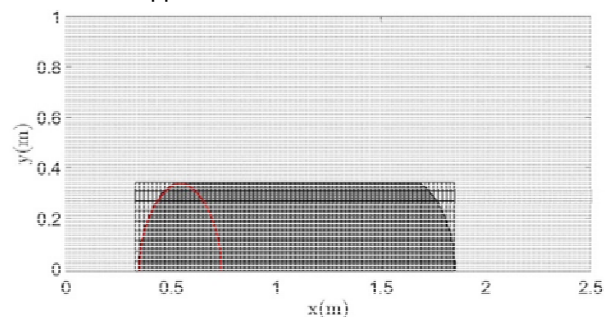


Figure 1 - Enet & Grilli (2007) test. Gray dots: computational grid. Red line: position of the landslide at the beginning of the test. Small black rectangles: unit source areas.

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