3D Numerical Study of Tsunami Loading and Inundation in a Model Urban Area

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Abstract : We develop a new set of diagnostic tools to analyze inundation into a model district using three-dimensional CFD simulations, with a view to generating a database against which to test simpler models. A three-dimensional model of Oregon city with different-sized groups of building next to the coastline is used to run calculations of the movement of a long period wave on the shore. The initial and boundary conditions of the off-shore water are set using a nonlinear inverse method based on Eulerian spatial information matching experimental Eulerian time series measurements of water height. The water movement is followed in time, and this enables the pressure distribution on every surface of each building to be followed in a temporal manner. The three-dimensional numerical data set is validated against published experimental work. In the first instance, we use the dataset as a basis to understand the success of reduced models - including 2D shallow water model and reduced 1D models - to predict water heights, flow velocity and forces. This is because models based on the shallow water equations are known to underestimate drag forces after the initial surge of water. The second component is to identify critical flow features, such as hydraulic jumps and choked states, which are flow regions where dissipation occurs and drag forces are large. Finally, we describe how future tsunami inundation models should be modified to account for the complex effects of buildings through drag and blocking.Financial support from UCL and HR Wallingford is greatly appreciated. The authors would like to thank Professor Daniel Cox and Dr. Hyoungsu Park for providing the data on the Seaside Oregon experiment.

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