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A Simple robust scheme for landslide tsunami run-up

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We present a novel scheme for landslide tsunami run-up that can also be generalized for other types of Tsunami waves. The run-up stage is, from the coastal hazard point of view, the most relevant part of the Tsunami propagation. A need for a computationally cheap and easy-to-use scheme for the run-up that can be integrated with the propagation scheme is widely felt.

Apart from computationally expensive numerical wave tank models, it is usually difficult to integrate the run-up stage to the fully discretized generation and propagation schemes. For the generation and propagation parts, as an alternative, we use the method of images embedded in an integral equation formalism to satisfy the kinematic condition on the irregular sea bottom and kinematic and dynamic conditions on the free surface. In doing so, we reduce the final propagation problem to a set of ordinary differential equations in which the right-hand sides are constructed by the use of integral operators that we apply on the virtual sources and sinks. We do not make a shallow water approximation as the triggering force (the landslide) has a spatially very localized nature, our scheme is fully three dimensional. The use of the integral equation enables us to propagate the dispersive waves until the point where we connect the algorithm to our new run-up scheme with minimal difficulty.

For the run-up part, we use Carrier-Greenspan transformations of the non-linear shallow water equations. This is a common practice in the run-up community. Although this hodograph transformation linearizes the system to be solved in auxiliary variables, the initial value problem for the incident wave becomes cumbersome that necessitates performing singular integrals. This being the case, researchers working in this field were invariably forced to perform the derivatives that serve the propagation numerically. We show that a Green's function approach greatly simplifies the problem and the singular integrals are completely removed, the derivatives can be calculated analytically and the algorithm can be run on machines with modest cpu resources. The tests show that the run-up scheme can succesfully be integrated with the propagation scheme. Additional tests with well-known incident gaussian and N-waves give satisfactory results.