Geophysical Research Abstracts
Vol. 13, EGU2011-8101, 2011
EGU General Assembly 2011

Modelling Tsunami Hydro- Morphodynamics For Real World Applications

David Kelly (1), Nicholas Dodd (2), and Michiel Knaapen (3)

(1) University of Nottingham, Nottingham and HR Wallingford, Wallingford, United Kingdom (david.m.kelly@nottingham.ac.uk), (2) University of Nottingham, Nottingham, United Kingdom (nicholas.dodd@nottingham.ac.uk), (3) HR Wallingford, Wallingford, United Kingdom (m.knaapen@hrwalllingford.co.uk)

Tsumamis are waves that are set in motion as a consequence of profound and sudden changes in the whole water column typically being generated by landslides or seismic activity. Tsunami waves are often responsible for extensive loss of life and property damage. Tsunamis can be responsible for vast amounts of sediment transport with the onshore transport of sediment during the run–up and remobilisation and erosion of sediment in the run–down. The grain size of sediment transported during tsunami inundation can range from silt to large boulders. Due to their extremely long wave length earthquake generated tsunamis behave like shallow water, or long waves. Consequently, tsunamis are typically modelled within the framework of the shallow water theory as a trade off of accuracy against computational cost. As tsunami run–up is characterised by high Froude number flow the hydro– and morphodynamic evolution occurs at the same timescale requiring fully coupled hydro– morphodynamics. Models that are also capable of modelling the morphological response to tsunami are, however, rare. It is with this in mind that we consider a tsunami model in which the hydro– morphodynamics are fully coupled within the constraints imposed by the governing equations and sediment transport formula. The purpose of this investigation is to estimate the net sediment movement and bathymetric change during a real tsunami event.

A new 2DH hydro– morphodynamic model, HYSWASH–2D, has been developed based on the simultaneous solution of the non–linear shallow water equations and sediment conservation (Exner) equation. The equations are solved numerically using a novel finite–volume scheme. The scheme has been constructed such that it can work on irregular quadrilateral meshes and can deal with the wetting and drying of complex domains. This model is capable of predicting sediment transport rates and morphodynamic evolution due to long waves that involve wetting and drying fronts. The model was written primarily for generic swash zone modelling; however, it is particularly well suited to modelling the high Froude number flow typical of tsunami run–up. An important feature of HYSWASH–2D is that the numerical approach allows for different sediment transport formulae to be slotted in at will. This is novel as changing the sediment transport formula in other available solvers, in which the hydro– and morphodynamics are fully coupled, is a somewhat involved procedure.

A number of numerical experiments to simulate tsumanis on fixed and mobile beds have been conducted. Comparisons between fixed and mobile bed experiments indicate that incorporating bed mobility into the model reduces the extent of the maximum run–up. The limiting of run–up by mobile sediment is significant and varies according to the type of sediment under consideration. Clearly this has a profound impact on predictions of tsunami run–up in cases where sediment is expected to be mobilised. Examples of selected numerical experiments will be presented and the associated results will be analysed and discussed