EGU22-8520
https://doi.org/10.5194/egusphere-egu22-8520
EGU General Assembly 2022

Effects of coastal roughness on long wave runup

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Studies of the influence of coast roughness on run-up height have numerous applications to tsunami problem. It happens when tsunami propagates over the urban area and houses and coastal structures represent roughness elements, which help to dissipate wave energy and reduce maximum tsunami inundation and at the same time can break due to tsunami loading. In this paper we focus on this topic from both points of view and study experimentally and numerically reduction of wave run-up height due to the bed roughness and corresponding wave loading on roughness elements.

Experiments have been performed in a 307 m long, 7 m deep and 5 m wide Large Wave Flume in Hannover, Germany. The experimental setup contained a 251 m long section of the constant depth, which was kept at the depth of h = 3.5 m during all tests, and a 1:6 slope section. A total of 16 wave gauges were mounted along the flume to reconstruct the incident wave field and to study its nonlinear deformation. During the tests, two video cameras and a capacitance probe were used to measure wave run-up on a sloping beach. Two cameras were set up to film the surf zone. One video record was used to calibrate the run-up data measured by the capacitance probe. An additional video record was used to determine the shape of the water surface, which was illuminated by a laser sheet along the direction of wave propagation.

Logs with rectangular 10×10 cm cross-section were used as roughness elements and the force acting on logs was recorded. Two logs were equipped with force transducers; one located at the unperturbed shoreline 272 m and the one located at 276 m mark. Four roughness configurations were considered, with logs every 1 m, 2 m, and 4 m which was compared to the smooth, zero log baseline condition. Waves of different height, period and shape have been used as input signals.

Experimentally shown, that run-up height has a strong non-linear dependence on the amplitude of incident wave and the number of roughness elements. Force acting on the roughness elements is related to the amplitude of the incident wave during the run-up phase and is defined by the flowing down near-slope layer when the bulk of the fluid recedes. At higher wave amplitudes, the average force (total momentum) imposed by roughness elements on the fluid is directed up the slope

Described experiments have been used to validate two numerical models (nondispersive shallow water model and dispersive model based on modified Peregrine equations) and to evaluate the potential of these models to simulate wave attenuation due to sea bed roughness. To model the bottom friction, we used both Manning's and Chezy's roughness laws. The results of this work are also discussed.