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Boulder transport by tsunamis: A laboratory experiment on incipient motion

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Coastal boulders transported inland by high-energy events, such as tsunamis or storms, have been found along several coastal areas worldwide. The importance of these deposits relies on their implications on coastal hazard assessment, since they contribute to the identification of past events and to the study of their magnitude and characteristics. However, the identification of the event responsible of the dislocation of the boulder (tsunami or storm) is not trivial given the complexities of the tsunami and storm phenomena, the coastal environment, the initial boulder conditions, the uncertainties of the problem, etc. The hydrodynamics methods usually adopted are 1) the use of simple hydrodynamics formulae to estimate the minimum flow velocity and height required to move a boulder, and 2) numerical simulations that model the boulder transport together with the specific tsunami (or storm) event. The main shortcomings of the first method are the simplifications adopted, while the second approach implies the simulation of the transport event, which might not be practical because of the amount of uncertainties involved.
To contribute to this study field, a laboratory experiment on the flow conditions for boulder transport was carried out at the Hydraulic Engineering Laboratory (LIDR) of the University of Bologna, Italy, in a 11 m long and 0.5 m wide flume. The main objective of this experiment is to provide experimental data for the conditions of the incipient motion for boulders, i.e. to relate the threshold flow velocity and depth for transport with the characteristics of the boulders, i.e. weight and geometry.
The experimental channel is divided in three parts: on one end of the channel, a water tank is closed by a gate, followed by a central flat bed and a 1:10 slope, where the boulder is located. A bore, generated by quickly opening the gate (simulating a dam-break), flows in the channel, climbs up the slope and hits the boulder. The impact of the flow on the boulder is recorded with a high frequency camera, while the flow velocity is measured with a Doppler ultrasound velocimeter (DOP) and the flow depth with a resistive level sensor. A series of laboratory tests has been carried out with boulders of different weight and dimension, and varying the water level in the tank in order to test different flow conditions (velocities and heights).
The preliminary outcomes of these tests are commented, especially in light of their contribution to the discussion on the validity and limits of the hydrodynamics formulations of boulder incipient motion.