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Experimental observation and prediction of the shape of surface waves generated by landslides

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Wave shape is recognized to be a critically important parameter in shallow water as water waves change shape as they shoal and break which influences wave orbital velocities, bed shear stresses and wave impact forces. For very large waves generated by the impact of landslides or avalanches into water, the impacts can be immense due to run-up that can be greater than 100 m above shorelines. In this study, laboratory experiments are conducted to generate waves from the impact of slides into a large wave flume. In these experiments the water depths, source volumes, and slide materials are varied, resulting in waves with a range of different amplitudes and shapes. Observations are made using a system of digital cameras and capacitance wave probes, and the wave shape is quantified by calculating the asymmetry about the vertical axis at each wave probe. The experimental results indicate that waves with positive or near-zero asymmetry in the near-field have a small influence on the maximum wave amplitude as the waves propagate along the flume. However, waves with negative asymmetry in the near-field change rapidly in shape and amplitude due to breaking until a stable state with symmetrical shape is reached. A method of quantifying the wave shape is developed and validated using the observations. This is achieved by modifying the solitary wave equation by introducing horizontal scale coefficients to account for the asymmetry. This new method could be used in combination with predictions of the maximum wave amplitude to predict more accurate boundary conditions for numerical models, which could then be applied to simulate wave propagation, improve tsunami hazard evaluation and reduce risk to human life and infrastructure in mountainous coastal regions.