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Nonlinear deformation and run-up of elongated solitary waves: numerical simulations and analytical predictions

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The nonlinear deformation and run-up of elongated solitary waves of positive polarity in the conjoined water basin, which consists of the constant depth section and a plane beach is studied numerically and analytically in the framework of the nonlinear shallow water theory. Analytically, wave propagation along the constant depth section and its run-up on a beach are considered independently without taking into account wave reflection from the toe of the bottom slope. The propagation along the bottom of constant depth is described by Riemann wave, while the wave run-up on a plane beach is calculated using rigorous analytical solutions of the nonlinear shallow water theory following the Carrier-Greenspan approach. Numerically, we use the finite volume method with the second order UNO_2 reconstruction in space and the third order Runge-Kutta scheme with locally adaptive time steps. During wave propagation along the constant depth section, solitary wave becomes asymmetric with a steep wave front. Shown, that the maximum run-up height depends on the face front steepness of the incoming wave approaching the toe of the bottom slope. The corresponding formula for maximum run-up height which takes into account the solitary wave front steepness is suggested.