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A simple model of the effect of bottom sediment transport on wave set-up

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Wave-averaged mean field equations are commonly used to describe wave set-up and wave-induced mean currents in the near-shore zone. Here we combine these with a simple empirical sediment flux law depending only on the wave-induced mean current. The resulting model allows the bottom to evolve slowly in time, and is used to examine how sediment transport affects wave set-up in the surf zone. We show that the mean bottom depth in the surf zone evolves according to a simple wave equation, whose solution predicts that the mean bottom depth increases and the shoreline recedes. Further, we show that if the introduced sediment flux law also allows for a dependence on the beach slope then the simple wave equation is replaced by a nonlinear diffusion equation which allows a steady-state solution, the equilibrium beach profile.