Sand Dunes in Steady Flow at Low Froude Numbers: Dune Height Evolution and Flow Resistance

The development of sand dunes in an erodible bed exposed to flowing water is considered using a numerical flow model. The bed is initially given a small perturbation, which is followed in the time domain. Examples are given where a sinusoidal perturbation reaches the fully developed steady equilibrium shape. The flow modeling is based on a k-ω turbulence closure. The sediment transport is assumed to be bed-load only, with an avalanche-like movement on the steep dune front. The model is also found capable of predicting the growth in wavelength if the initially prescribed wavelength is sufficiently short. Results of the dune development are presented for different initial wavelengths. It is demonstrated that an equilibrium shape is developed for a range of wavelength-depth ratios as long as this ratio is sufficiently small.