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An expression for the water sediment moving layer in unsteady flows

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During floods the effects of sediment transport in river beds cannot be neglected, either by a morphological or an hydrodynamical point of view. Sediment transport is here studied through the "moving layer", i.e. the water-sediment layer which moves in the lower part of a flow. Moving layer variations along rivers lead to depositions and erosions and are typically unsteady, but are often tackled with expressions developed for steady (equilibrium) conditions, as a consequence of the still limited knowledge of the sediment transport in strong time-dependent conditions and of the scarcity of experimental measures. In this paper we develop an expression for the moving layer in unsteady condition, and calibrate it with experimental data. During laboratory tests, we have in fact reproduced a rapidly changing unsteady flow by the erosion of a steep slope, built with non-cohesive granular sediments. Along the slopes, for fixed discharges, moving layer depths have shown to increase from upstream to downstream, showing a clear tendency toward equilibrium conditions. Knowing the equilibrium achievement has anyway presented many difficulties, being influenced by choice of the equilibrium expression and moreover by the estimation of the parameters involved (for example friction angle..). Even though water-sediment flows ranged from hyper-concentrated to ordinary bed load transport, we have experimentally quantified and used for the calibration only data (sediment concentrations, bed and free surface slopes, moving layer depths, etc...) relevant to hyper-concentrated mono-dimensional flows, occurred for slope gradients in the range 3% - 20%. Consequently, our model can be applied both on open channels and on embankments/dams providing that the flows can be modelled as mono-dimensional, and that slopes and applied shear stress levels fall within the considered ranges.