Bed and suspended flux distribution along migrating dunes

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Dunes form the main source of hydraulic roughness of the river bed due to the flow separation and associated energy dissipation. Engelund and Hansen [1967] showed that hydraulic roughness due to dunes can be twice larger compared to grain roughness. During floods in several rivers, initially dunes are observed to grow rapidly as flow strength increases, undergoing an unstable transition regime after which they are washed out what is termed as upper stage plane beds [see Simons and Richardson, 1966]. This morphological evolution of dunes to upper stage plane beds is associated with a significant change in hydraulic roughness and water levels [Nelson et al., 2011].

Dunes are generated by divergences and convergences of sediment transport. To be able to predict dune dimensions and thus water levels accurately, knowledge on sediment transport processes is crucial. The present study focuses on sediment transport fluxes along dunes. The main goal is to determine suspended sediment gradients in the dune growth, decay and equilibrium regimes (Figure 1). This will provide us insights in the contribution of suspended sediment to dune morphology and evolution. To this end, we have conducted flume experiments in the hydraulics laboratory of the Leichtweiss institute (LWI) of the technical University of Braunschweig. For the measurements of sediment fluxes along dunes, we have employed the Acoustic Concentration and Velocity Profiler ACVP developed by [Hurther et al., 2011]. ACVP is capable of measuring co-located, high resolution, vertical profiles of the multi-component flow velocity, suspended sediment concentration and corresponding bed interface position thus providing direct sediment flux measurements along the bed profiles.

The preliminary results of these measurements show that bed and suspended sediment fluxes are both important for the migration of dunes. Although bed load is more dominant under equilibrium conditions, suspended load becomes important when dunes are developing towards their equilibrium forms.

Future work

As we have simultaneous, co-located measurements of both flow velocity and sediment concentration, we are able to investigate the magnitude of the turbulent sediment fluxes compared to the mean sediment fluxes. While using two instruments for the measurements of flow velocity and sediment concentration, which is normally the case, the turbulent sediment fluxes are neglected. These fluxes could be important in highly turbulent flow regions e.g. the flow separation region of a dune.

References

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Figure 1. Flattened sand bed before the start of the experiments (left), developed dune field at the end of the experiments (right).