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Experimental implementation of parallel riverbed erosion to study vegetation uprooting by flow

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In nature, flow erosion leading to the uprooting of vegetation is often a delayed process that gradually reduces anchoring by root exposure and correspondingly increases drag on the exposed biomass. The process determining scouring or deposition of the riverbed, and consequently plant root exposure is complex and scale dependent. At the local scale, it is hydrodynamically driven and depends on obstacle porosity, as well as sediment vs obstacle size ratio. At a larger scale it results from morphodynamic conditions, which mostly depend on riverbed topography and stream bedload transport capacity. In the latter case, ablation of sediment gradually reduces local bed elevation around the obstacle at a scale larger than the obstacle size, and uprooting eventually occurs when flow drag exceeds the residual anchoring. Ideally, one would study the timescales of vegetation uprooting by flow by inducing parallel bed erosion. This condition is not trivial to obtain experimentally because bed elevation adjustments occur in relation to longitudinal changes in sediment apportion as described by Exner's equation.
In this work, we study the physical conditions leading to parallel bed erosion by reducing Exner equation closed for bedload transport to a nonlinear partial differential equation, and showing that this is a particular "boundary value" problem. Eventually, we use the data of Edmaier (2014) from a small scale mobile-bed flume setup to verify the proposed theoretical framework, and to show how such a simple experiment can provide useful insights into the timescales of the uprooting process (Edmaier et al., 2011).

REFERENCES

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