EQUILIBRIUM, QUASI-EQUILIBRIUM, AND TRANSIENT RIVER LONGITUDINAL PROFILES

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There has long been a debate on the relative importance of particle abrasion and grain size selective transport regarding downstream fining and river profile concavity. Here we analytically solve the problem and show that in the equilibrium or graded state profile concavity and downstream fining in an alluvial river are mild, whereas in the transient state grain size selective transport can lead to large spatial gradients in grain size and slope. Figure 1 illustrates how predicted data on equilibrium profile concavity and downstream fining nicely fall within the envelope of measured data for natural streams collected by Morris and Williams (1999). The predicted data do not cover those field data that are governed by large concavity and downstream fining values, as (1) part of the field data is governed by transient conditions and associated stronger concavity and downstream fining, and (2) the predicted data do not include the effect of tributaries. We show how the gravel-sand transition generally is a characteristic of a transient or ungraded river profile and results from a progradational gravel wedge. The migration speed of the wedge front is very small and, under conditions of base level rise, subsidence or delta progradation, potentially zero or negative. The large time scale of front migration generally allows us to assume a state of quasi-equilibrium in the gravel-bed and the sand-bed reach and apply the formulations of a graded river to both reaches.

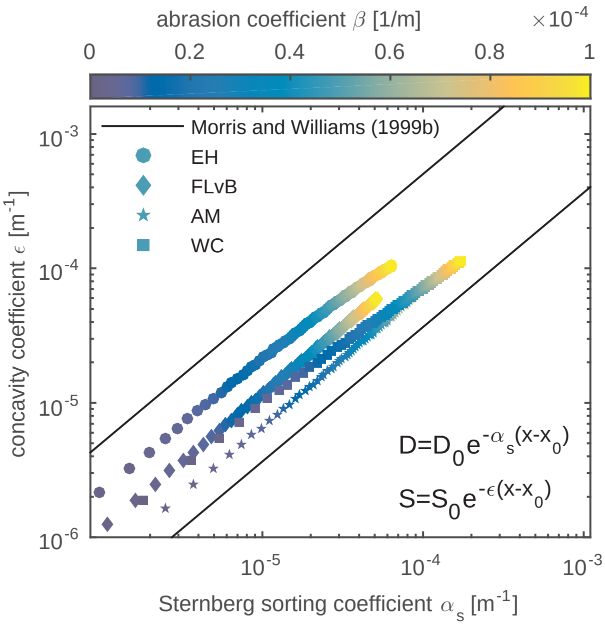

Figure 1: Predicted equilibrium values of the downstream fining coefficient α_s versus the profile concavity coefficient ϵ, for a varying abrasion coefficient, for a base case. The black lines indicate the envelope of field data for natural streams collected by [1]. We applied four sediment transport relations: [2] (EH), [3] (FLvB), [4] (AM), and [5] (WC).

References

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