STREAK INSTABILITY INDUCED BY BEDLOAD DIFFUSION

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An alluvial river forms its bed with the sediment it transports, either in the bulk of the flow (suspended load) or in a thin layer near the bed surface (bedload). The channel bounds the flow, which in turns deforms it by erosion and sedimentation. This coupling between flow and bedload transport spontaneously selects the shape and size of the river.

Gravity pulls the moving grains towards the center of the channel, thus eroding the banks continually [1]. However, laboratory observations show that, due to the roughness of the bed, the trajectory of a moving grain fluctuates in the transverse direction [2]. The bedload layer is therefore a collection of random walkers which diffuse towards the less active areas of the bed. In a river at equilibrium, bedload diffusion counteracts gravity to maintain the banks.

If an initially flat bed of sediment is perturbed with longitudinal streaks, the flow-induced shear stress is weaker where the flow is shallower. Therefore, we expect bedload diffusion to induce a flux of sediment towards the crests of the perturbation. This positive feedback induces an instability which can generate new channels. We suggest that this mechanism could explain the transition from single-thread rivers to braided ones.

References

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