Living landscapes: Muddy and vegetated floodplain effects on fluvial pattern in an incised river (Kleinhans et al. 2018) [1]

Cohesive floodplain sediment and vegetation are both thought to cause meandering river patterns. Our aims are to compare the isolated and combined effects of mud and vegetation on river planform and morphodynamics in the setting of intermediate-sized valley rivers. We use a numerical model for century-scale simulation of flow, sediment transport and morphology coupled with riparian vegetation settlement, growth and mortality as functions of species traits on which flow resistance depends. Mud fluxes were predicted by excess shear stress relations in combination with the active layer formulation. We found that valley-flooding water levels increase with vegetation density, causing a higher braiding intensity rather than meandering tendency.

The shear stress during floods carves channels through the muddy floodplain surface. Higher mud concentration, on the other hand, increases floodplain aggradation, reduces the overbank flow frequency and ultimately causes formation of a single-thread channel. Vegetation causes mud to deposit closer to the river channel as a levee, showing that mud sedimentation and vegetation settling mutually enhance floodplain formation. However, mud and vegetation counteract in two ways. First, vegetation enhances floodplain accretion, which ultimately increases plant desiccation for high mud concentrations. Second, vegetation increases the tendency of periodic chute cutoffs in valleys. The chute cutoffs locally reset the landscape and create new windows of opportunity for the vegetation. Surprisingly, in systems with a high mud concentration this causes hysteretic loops of vegetation cover and delayed mud deposition. Ramifications for the interpretation of Palaeozoic fluvial facies are that even rootless vegetation, capturing cohesive mud closer to the river channel to form thicker floodplain on the point bar, can enhance the tendency to meander and, under high mud supply, form stable channels. However, meandering is more unlikely in narrower valley rivers with higher vegetation density.

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Links
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