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Why rivers anabranch: a case of inbank-overbank connectivity?

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Anabranching is the prevailing river pattern in large alluvial rivers: the world's 5 largest rivers anabranch for >90 % of their alluvial tracts. Yet, a comprehensive explanation for anabranching remains elusive. In Magela Creek, northern Australia, anabranching reaches optimise bedload transport rate per unit stream power, relative to single-channel reaches. In this paper we examine water and sediment flux connectivity between channels and floodplains using hydraulic geometry data allied with field-measured and modelled bedload transport data for discharges up to 14-times greater than bankfull. Our key findings are: 1) Unlike conventional hydraulic geometry, which implies that discharge is the dominant independent variable governing channel form, vegetation-reinforced anabranches dictate the dynamics of flow and sediment transport, rather than reflecting the frequent flows that pass through them. 2) For equilibrium anabranching rivers, such as Magela Creek, channel-forming discharge may greatly exceed bankfull. Therefore, hydraulic connectivity linking inbank to overbank flows must be included in any quantitative description relating channel morphology to sediment transport and flow properties. In Magela Creek, the hydraulic connectivity linking multiple anabranches to the islands and floodplains that separate them is integral to sediment transport efficiency and therefore the capacity to maintain sediment flux balance. 3) Multiple independent channels that self-regulate gradient, channel geometry and boundary resistance possess enhanced capacity for fluvial adjustment. This capacity is especially useful in low-gradient settings close to base level, a common feature of many anabranching rivers, and may explain the diversity of anabranching forms recognised so far, particularly among the world's great rivers.