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PREDICTABLE EQUILIBRIUM MULTICHANNEL NETWORK CHARACTERIZES THE INDUS RIVER, PAKISTAN

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The Indus River in Pakistan between Chasma and Taunsa is a 304 river km reach characterised by islands dividing multiple channels. Previously, the behaviour of such channel networks has been considered unpredictable. Crosato & Mosselman (2009) argue that physics-based predictors of channel splitting developed for braided-river bars apply poorly to island-divided rivers and recommend the application of regime theory (Bettess & White, 1983) to predict the number (n) of channels in rivers such as the Indus. The Indus is characterized by two to 11 channels at each cross section with, on average, about four channels being active during the dry season and five during the monsoon. Thus the expansion of the network during the monsoon is slight and is due to reoccupation of channels that are dry during low flows. The network evolves on an annual basis primarily due to bendway progression, whilst avulsions to form major new channels are relatively rare (one or two in the reach per year) and are matched by a similar number of closures. Thus the network structure, if not its shape, is relatively stable year to year. The standard deviation of channel numbers comparing sections throughout the reach is practically identical at c. two channels and there is no significant variation between years. Theory indicates that stable networks have three to four channels, thus the stability in the number of active channels through the annual monsoon and between years accords with the presence of a near-equilibrium reach-scale channel network that demonstrates local disequilibrium when $3 > n > 4$, being perturbed by the annual monsoon. Application of the Bettess & White regime theory demonstrates that the river channel network does not respond to monsoon floods (which typically peak at 13,200 m3s-1), but rather it maintains a network that is in near-equilibrium with the 20-year mean annual flow (3090 m3s-1) for a narrow range of channel slopes (2.8 - 2.9 10-4) and a narrow range of total sediment load (120 – 180 mg l-1). Given the stability in n and B (channel width), it can be inferred that channel depths (d) also are relatively stable during the monsoon. Thus despite any minor adjustments in B:d during the annual hydrological cycle, the time-scale for adjustment of the physical network is much longer than the time-scale of the monsoon hydrograph, with the annual excess water being stored and transported across neighbouring floodplains, rather than being conveyed in enlarged channels or in new avulsed channels. The analysis explains the lack of significant channel adjustment following the largest recorded flood in 40 years: 27,100 m3s-1 in 2010.