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A stumbling or wandering giant? The role of large floods in driving episodic versus progressive channel migration of a large tropical river.

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There is long standing debate as to whether rates of bank erosion and channel migration are episodic or progressive in nature. Although many internal mechanisms may determine the observed pattern of erosion, episodic (stumbling) behaviour may imply a response to an external forcing event or events (i.e. floods), whereas progressive (wandering) behaviour may indicate that channel migration rates are less affected by extrinsic stimuli. Recently, the role of large events (defined herein as events with a return period of 1 in 90 years or greater) in promoting geomorphic change has come under increasing attention. If river systems display episodic bank erosion behaviour, such large events should result in distinct periods of migration, whereas systems dominated by progressive channel migration should not be greatly affected by large floods, although the magnitude of erosion may still scale with flood magnitude.

We use a combination of satellite imagery and aerial photography covering the period 1959 to 2013 to evaluate how channel migration on the Lower Mekong River has responded to a series of five large flood events. At the local (< 8 km) scale, bank erosion is a highly episodic process, occurring discontinuously through both time and space. However, at the larger reach scale (>40 km), we find that during epochs that contain no large flood events, the Lower Mekong typically displays progressive, wandering behaviour, characterised by steady bank erosion (μ = -1.5 ma-1, σ = 0.7 ma-1). This pattern of migration is, however, interrupted by large flood events which typically induce periods of limited deposition in the form of bar or floodplain construction which induces a planform change (μ = +0.03 ma-1, σ = 0.4 ma 1). These time averaged rates of deposition are, however, so low that they are only detectable over relatively long time periods. The reach scale behaviour appears to display an oscillating temporal trend between periods of erosion and deposition, with a 15 to 20 year periodicity. This periodicity matches that of the Pacific Decadal Oscillation (PDO), and it is found that channel migration rates observed on the Mekong show a statistically significant (p = 0.05) positive correlation (R = 0.69) to PDO phase. The reach scale behaviour observed here implies that under normal conditions, the Mekong may be sediment deficient, and that only under the largest floods is the sediment load of the system brought to parity with transport capacity.