Using estimates of stream power to predict channel erosion during an extreme flood event

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Abstract

Stream power has the potential to be a unifying theme in many aspects of channel and catchment behavior. Early work by Costa and O'Connor on gemorphologically-effective floods highlighted the key role of stream power and flood duration on catchment response. This study avails of high-resolution DEMs and hydraulic modelling to illustrate the longitudinal distribution of stream power and erosion following an extreme flood event in January 2011 in the Lockyer Valley, Australia. There was a clear spatial delineation between fluvial entrainment erosion in the upper catchment and wet flow bank mass failures in the lower, with ~50% of the eroded material sourced within the upper 25km of channel. The correlation between stream power and erosion improved significantly when erosion was differentiated by process and standardized to channel area. A regression model consisting of specific stream power, bank height and hydraulic radius explains 45% of the variability in fluvial entrainment. Stream power hydrographs reflected high rates of total power approaching estimates for bedrock incision in the upper reaches; a rapid rate of rise in total power over a short duration mid-valley and long duration, low power for the lower reaches. This sequence of stream power and flood duration was similar to the model proposed by Costa and O'Connor for individual floods. This study illustrated that such a sequence can occur within a single flood event based on longitudinal patterns in slope and channel dimensions.

Keywords

Lockyer Valley, Flood, channel adjustment, bank erosion, slumping, geomorphic effectiveness.

Index Terms:

1825 Geomorphology: Fluvial (1625); 1856 River channels (0483, 0744); 1816 Estimation and forecasting (4315)