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Dominant geomorphic controls on channel capacity and flood risk in a hydrologically variable fluvial system

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Traditionally, particular emphasis has been placed on the hydrological characteristics of rivers to understand the role of channel morphology in flood risk. However, in regions of high hydrological variability, the relationship between channel characteristics and flood conveyance is often highly complex. Consequently in these settings, the applicability of stream discharge or steady-state form-process relationships, may be of less use to understanding flood conveyance. In the subtropical region of southeast Queensland, Australia, rivers are characterized by highly variable flows and entrenched channel morphologies. The latter are such dramatic features, they are termed 'macrochannels'. Following the extreme flood of 2011 in the Lockyer Creek in this region, longitudinal variations in the macrochannel form were found to be a significant factor in flood conveyance. Nine reaches were identified on a basis of flood inundation extent, with significant non-linear changes in channel capacity and discharge, alternating between flood expansion and contraction zones with associated increases and decreases in flood risk.
Detailed geomorphic and chronostratigraphic analyses presented here indicate that macrochannel capacity is being strongly influenced by the antecedent bedrock topography, resistant valley-fill and abrupt downstream changes in sediment delivery. A large proportion of the valley fill represents a major Late Pleistocene aggradation phase of fine-grained alluvium that overlies older Pleistocene basal sediments. Subsequent channel incision at 10 ka reoccupied a pre-existing bedrock valley and resistant Pleistocene alluvium imposed substantial controls on the capacity for lateral adjustment. Abrupt changes in sediment supply associated with the location of tributaries provide further evidence for geomorphic controls on macrochannel form and capacity. Identification of the dominant geomorphic factors influencing the overall macrochannel form highlights the relative importance of considering such factors in flood risk assessment. Such considerations are of particular relevance in regions of high hydrological variability where discharge does not provide adequate explanatory power and abrupt longitudinal changes in channel dimensions can significantly influence flood conveyance.