# Understanding geomorphic response to floods: the role of scale and gradients

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**Abstract.** Morphodynamic response of channels and floodplains to flooding reflects interactions of erosive and resisting forces with sediment transport capacity and supply at multiple scales. Monotonic relationships between reach-scale channel response to floods with independent variables such as flood stream power and channel confinement can be confounded by longitudinal variations (i.e., gradients) in these variables. In these cases, channel response depends on both local and upstream drivers. Using high resolution pre- and post-flood digital elevation models, we calculate reach-scale (0.5 to 1 km) and segment scale (10 km) longitudinal variations in channel widening and sediment balance as a response to the 2013 Colorado Front Range flood. We relate these responses to longitudinal variations of unit stream power and channel confinement. These streams transition from steep and relatively confined in the canyons of the foothills to less steep and unconfined on the high plains.
The channel widening response is more closely linked with reach scale gradients in unit stream power: abrupt widening typically occurred within reaches where a large drop in unit stream power occurred relative to upstream. Sediment balance exhibited a net degradational trend within the foothills that transitioned to a net aggradational trend within the transition to the plains and was less sensitive to reach-scale fluctuations in unit stream power and confinement. These findings indicate that unit stream power gradients mediate channel response at reach to segment scales. Predictive modeling of stream response to floods and fluvial hazards assessments that only consider absolute values of reach-scale stream power may under-estimate fluvial hazards in some settings by ignoring unit stream power gradients.