



Contrasting effects of transience and substrate erodibility on downstream variations in bedrock channel geometry and erosional capacity

John Jansen (1), Alexandru Codilean (2), Paul Bishop (1), and Trevor Hoey (1)

(1) University of Glasgow, Geographical & Earth Sciences, Glasgow, United Kingdom, (2) GFZ-German Research Centre for Geosciences, Earth Surface Geochemistry, Potsdam, Germany.

Channel geometry directly influences the erosional capacity of rivers incising bedrock and so is key to how fluvial erosion drives landscape evolution; however, widely divergent relationships among river incision rate, channel width, and channel slope, have been observed in different settings. Based on a large empirical dataset of channel width and slope ($n \sim 6000$) we identify regression-based scaling relationships in four mixed bedrock-alluvial rivers in western Scotland that are subject to spatial variations in fluvial incision rate and substrate erodibility.

We find that stream power per unit area (reach-averaged) increases by up to a factor of 10 downstream of actively retreating bedrock knickpoints, and that channel narrowing is the dominant mechanism for raising erosional capacity under transient conditions. By contrast when it comes to substrate erodibility we find that bedrock channel width is far less sensitive than channel slope. Resistant outcrops (quartzites) steepen bedrock channels by a factor of 1.5 to 6.0 and, in terms of stream power per unit area, channels increase their erosional capacity by a factor of 2.7 to 3.5. Yet only 4 to 13 % of this increase is due to channel narrowing. Channel width scales with discharge as $W = 3.32 Q^{0.33}$, irrespective of lithology.

Our results are consistent with the view that $W-Q$ scaling is similar in all single-thread rivers subject to transport-limited conditions, but for increasingly sediment supply-limited settings such as western Scotland, erosional thresholds at the channel boundary exert a strong control on bedrock channel width.