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# Evaluating the impact of a wide range of vegetation densities on river channel pattern

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Braided rivers are very dynamic systems which have complex controls over their planform and flow dynamics. Vegetation is one variable which influences channel geometry and pattern, through its effect on local flow hydraulics and the process continuum of sediment erosion-transport-deposition. Furthermore, where in the braided floodplain stable vegetation develops depends on the temporal sequencing of the river discharge i.e. floods. Understanding the effect of vegetation in these highly dynamic systems has multiple consequences for human activity and floodplain management. This paper focusses on the specific role of vegetation density in controlling braided river form and processes. Previous research in this field has been contradictory; with Gran and Paola (2001) finding that increasing vegetation density decreased the number of active channels. In contrast, Coulthard (2005] observed that as vegetation become denser there was an increase in the number of channels. This was hypothesized to be caused by flow separation around vegetation and the development of bars immediately downstream of the plant.

This paper reports the results from a set of experiments in a 4m by 1m flume, where discharge, slope and sediment size were kept constant. Artificial grass was used to represent vegetation with a density ranging from 50 plants/m2 to 400 plants/m2. Digital photographs, using a GoPro camera with a fish eye lens, were taken from ∼1m above the flume at an interval of 30 seconds during the 3 hour experiment.

The experiments showed that as the vegetation density increased from 50 to 150 plants/m2, the number of channel bars developing doubled from 12 to 24. At vegetation densities greater than 150 plants/m2 there was a decline in the number of bars created to a minimum of 8 bars for a density of 400 plants/m2. We attribute these patterns to the effect that the vegetation has on flow hydraulics, sediment transport processes and the spatial patterns of erosion and deposition. We develop a simple conceptual model to explain the observations along the wide range of vegetation densities investigated. At low plant densities, each plant acted independently and caused flow separation and convergence around each plant, similar to in the Coulthard (2005] experiment. At medium densities, individual plants start to interact together with narrow channels developing longitudinally between vegetative bars. Finally at very high densities, there was both lateral and longitudinal interaction between plants meaning that flow was diverted around them forming wandering, meandering channels. In summary, the relationship between vegetation density and channel braiding is more complex than previous thought, taking a parabolic shape, with maximum braiding occurring at medium vegetation densities.