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Medium to long-term cellular modelling of braided river dynamics

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There is relatively little literature that documents the medium (10-100 years) to long-term (>100 years) evolution of braided rivers, either for specific field examples or based on the results of laboratory experiments or numerical simulations. Few numerical models exist that are suitable for simulating medium to long-term braided river evolution. Some previous exploratory models are too simplistic to provide much insight into mechanisms of longer-term braided river evolution, whereas complex physically-based models, although more realistic and potentially more accurate, have excessive computational requirements. Thus far, these complex models have only simulated hydraulic processes, and so the incorporation of sediment dynamics represents another level of extreme complexity. Consequently, they are of limited use with regards to the simulation of long-term braided river behaviour. This situation has not been addressed to date, possibly because of the emphasis on small-scale process-form interactions in the majority of geomorphological research into braided rivers. However, it seems plausible to suggest that braided rivers must exhibit some imprint of long-term influences, rather than purely short-term, small-scale influences, such as those associated with the bar-pool unit.

A new cellular model of braided river dynamics has been developed and evaluated. The model simulates flow, sediment transport, morphological change and the effects of braidplain vegetation. The results of this cellular model are extremely encouraging in that they suggest that this model may be capable of generating more realistic predictions of flow characteristics, channel morphology and river evolution than previous exploratory models. Consequently, the cellular model developed here may provide a

useful tool for simulating and understanding medium to long-term braided river behaviour.

Results from medium to long-term (>100 years) simulations illustrate that the model may provide a means of examining mechanisms of braidplain evolution over extended time periods. Modelled long-term morphological change, in response to aggradation and degradation, was seen to produce channel characteristics that were similar to those reported in the literature, suggesting the model may also be a useful tool for interpreting evidence of aggradation and degradation in natural channels. Simulated distributions of vegetation throughout the braidplain provide a useful indicator of surface age and channel stability. Young vegetation distributions, as observed in simulations characterised by increased sediment supply, were indicative of relatively recent/active surfaces created by channel instability, lateral reworking, surface burial and/or vegetation removal, as a result of aggradation. Older vegetation distributions, as seen in simulations that showed evidence of degradation, were indicative of older, more stable terrace surfaces that had been abandoned and left to age without reworking as a result of channel incision. When examined in greater detail, the cellular model results also highlight the complexity of the relationship between surface age distributions and the time period since the occurrence of substantial morphological change. Cellular models offer the potential to have an important role as an exploratory tool for investigating the medium to long-term and large-scale channel evolution, not just for braided rivers but for fluvial systems in general.