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Numerical modelling of alluvial landscape evolution

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This presentation introduces a new computational model designed to investigate the effects of climate variability and land-use change on alluvial landscape evolution. The model is based on the cellular automaton concept, whereby the continued iteration of a series of local process-‘rules’ governs the behaviour of the entire system. The model is a modified version of the Caesar landscape evolution model, which applies a suite of physically-based rules to simulate the entrainment, transport and deposition of sediments. The Caesar model has been altered to improve the representation of hydraulic and geomorphic processes in an alluvial environment. In-channel and overbank flow, sediment entrainment and deposition, suspended load and bed load transport, lateral erosion and bank failure have all been represented as local cellular automaton rules. Although these rules are relatively simple and straightforward, their combined and repeatedly iterated effect is such that complex, non-linear geomorphological response can be simulated within the model. Examples of such larger scale, emergent responses include channel incision and aggradation, terrace formation, channel migration and river meandering, formation of meander cutoffs, and transitions between braided and single-thread channel patterns. In the current study, the model is applied to simulate the Holocene evolution of the Upper River Severn (Wales, UK). A range of climate and land-use scenarios are simulated, and their impacts on sediment delivery and geomorphological evolution are evaluated.