



Modelling hydraulic and stratigraphic responses to rainfall variability in threshold landscapes

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Sediment routing systems offer a unique opportunity to study the metaphorical conveyor of sediment as it is eroded, transferred and deposited downstream. Measurable sedimentological and geomorphic elements can help unlock changes in sediment supply and paleohydraulics; key indicators of changing environmental boundary conditions. Catchment-fan systems may represent the simplest and least complex source to sink system we can study, especially in arid climates such as Death Valley in the United States, where coupling between rainfall and alluvial fan sedimentology can be pronounced. Using detailed fan mapping and field measurements of grain size and a newly developed iteration of a 1D numerical catchment-fan model, we have explored the sensitivity of catchment-fan systems to rapid climate change. Using an effective rainfall threshold in a 1D catchment-fan model we show that observed changes in grain size may be the product of a sequence of sudden changes in storm magnitude frequency rather than a simple increase in mean rainfall. From this finding, we have conducted paleohydraulic analyses on further catchment-fan systems to assess whether the presence of conspicuous and extensive coarse-grained deposits in Death Valley may be the product of rapid shifts in storm activity. This work illustrates how short, arid-climate catchment-fan systems are capable of transmitting signals of rapid climate change, in particular of storm magnitude-frequency, into the stratigraphic record. We highlight how threshold landscapes may be preferentially sensitive to a given portion of the input distribution of events and their sequencing, ultimately controlling how climate signals are preserved in the stratigraphic archive.