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Experimental study of flow width dynamics on alluvial fans

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Alluvial fans represent small-scale coupled transport/depositional systems that provide the opportunity to undertake detailed studies of non-equilibrium landform behaviour. Previous interpretation of fans in the field has tended to emphasize the importance of external controls on their evolution (e.g. climate and tectonics). However, recent theoretical models have shown that internal process-driven feedbacks may be equally important. This presentation explains results from a series of laboratory experiments designed to quantify the role of internal process-form interactions as controls on alluvial fan evolution. The experimental approach follows the "similarity of processes" concept and so is not scaled to a real world prototype. The experiments were conducted in the University of Exeter Sediment Research Facility using a 3x3x1 metre fixed bed experimental table with a controlled sediment and water supply fed to the fan apex. The experiments presented maintained a constant ratio of sediment feed to water discharge but the discharge rates were varied.

The evolution of the fan was recorded using close-range digital photogrammetry with four Canon Eos 10D digital cameras set-up overhead to gain near-continuous data quantifying fan topography, flow patterns, channel migration and avulsion on the fan surface over the course of the experimental runs. The rich data allow exploration of the controls on channel width dynamics and in particular the relationship between aggradation rate and flow configuration. Qualitative and quantitative patterns are explored and compared with published experimental data. It was demonstrated that a declining aggradation rate, driven by increasing fan area and an upper limit on sediment accommodation space, promoted temporal changes in flow configuration over the course of experiments. This transition takes the form of a change from sheetflow dominated conditions at the start of experiments to channelised flow as fan aggradation ceases. It was also found that as aggradation rate increases, changes in flow configuration from a channelised to sheetflow state may lead to a decline in avulsion frequency (where the aggradation rate is simply too high for channels to be maintained). The high spatial and temporal resolution of flow width data that was achieved provided a wealth of data, and has been used to parameterise and improve a numerical model of alluvial fan evolution (Nicholas and Quine, 2009).