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Investigating the impact of vegetation on alluvial fans using laboratory experiments

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Riparian vegetation can significantly influence the geomorphology of fluvial systems, affecting channel geometry and flow dynamics. However, there is still limited understanding of the role vegetation plays in the development of alluvial fans, despite the large number of vegetated fans located in temperate and humid climates. An understanding of the feedback loops between water flow, sediment dynamics and vegetation is key to understanding the geomorphological response of alluvial fans. But it is difficult to investigate these relationships in the natural world due to the complexity of the geomorphic and biological processes and timescales involved, whereas the controlled conditions afforded by laboratory experiments provide the ideal opportunity to explore these relationships.

To examine the effects of vegetation on channel form, flow dynamics and morphology during fan evolution, a series of experiments were conducted using the Total Environment Simulator (operated by the University of Hull). The experiments followed a 'similarity of processes' approach and so were not scaled to a specific field prototype. Live vegetation (Medicago Sativa) was used to simulate the influence of vegetation on the fan development. A range of experiments were conducted on 2x2m fan plots, the same initial conditions and constant water discharge and sediment feed rates were used, but the vegetation density and amount of geomorphic time (when the sediment and water were running and there was active fan development) between seeding / vegetation growth varied between runs.

The fan morphology was recorded at regular intervals using a laser scanner (at 1mm resolution) and high resolution video recording and overhead photography were used to gain near-continuous data quantifying fan topography, flow patterns, channel migration and avulsion frequency. Image analysis also monitored the spatial extent of vegetation establishment. The use of these techniques allowed collection of high resolution spatial and temporal data on fan development with minimal disruption to the experiments.

Results indicate that vegetation has a major influence on fan morphology and flow conditions; creating steeper and shorter fans, whilst also reducing the number of active channels and lowering the lateral migration rate. Vegetation also impacted avulsion behaviour by reducing the frequency of avulsion events, but increasing the magnitude of the events that occurred.