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Using hydrological connectivity to develop understanding of water, soil and carbon losses across drylands undergoing vegetation change

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Connectivity has emerged as a key concept for understanding the hydrological response to vegetation change in drylands, providing an explanatory link between abiotic and biotic, structure and function. Reduced vegetation cover following woody encroachment, generally promotes longer, more connected overland flow pathways, which has the potential to result in an accentuated rainfall-runoff response and fluxes of both soil erosion and carbon.

Changing hydrological connectivity was investigated as an emergent property of changing ecosystem structure over two contrasting semi-arid grass to woody vegetation transitions in New Mexico, USA. Vegetation structure was quantified to evaluate if it can be used to explain observed variations in water, sediment and carbon fluxes. Hydrological connectivity was quantified using a flow length metric (mean flowpath length), combining topographic and vegetation cover data.

Results at the large plot scale (300 m2) demonstrated that the two woody-dominated sites had significantly longer mean flowpath lengths (4.3 m), than the grass-dominated sites (2.4 m). Mean flowpath lengths illustrated a significant positive relationship with the functional response. The woody-dominated sites lost more water, soil and carbon than their grassland counterparts. Woody sites eroded more, with mean event-based sediment yields of 1203 g, compared to 295 g from grasslands. In addition, the woody sites lost more organic carbon, with mean event yields of 39 g compared to 5 g from grassland sites (Puttock et al, 2013).
Hydrological connectivity will be discussed as a meaningful measure of the interaction between structure and function and how this manifests under the extreme rainfall events that occur in drylands. Further work is required to assess how flow length varies across spatial scales and evolves across temporal scales. However, it is argued that flow path length metrics provide a valuable tool by which to classify hydrological connectivity at the catchment scale and to quantify the relationship between structure, function and resultant fluvial fluxes in dryland landscapes undergoing vegetation change.

Reference

Puttock, A., Macleod, C. J.A., Bol, R., Sessford, P., Dungait, J. and Brazier, R. E. (2013), Changes in ecosystem structure, function and hydrological connectivity control water, soil and carbon losses in semi-arid grass to woody vegetation transitions. Earth Surf. Process. Landforms, 38: 1602–1611. doi: 10.1002/esp.3455