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Semi-arid ecohydrology: field-based observations of interactions between vegetation, hydrology and biogeochemistry

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In order to further understanding of semi-arid vegetation transitions the interactions and feedbacks that occur between vegetation, hydrology and nutrient cycling operating over vegetation transitions need to be elucidated. This study employed a field-based monitoring approach, using a space for time analogue, to determine how landscape structure and function change over a grass-shrub transition, placing emphasis on the redistribution, retention and loss of water, sediment and nutrients that occur during convective rainfall events. Monitoring was carried out over a grass-shrub transition zone within the Sevilleta Long Term Ecological Research site, at the northern margin of the Chihuahuan Desert in the south-western United States. The monitoring approach enabled examination of both temporal variations in the hydrologic response (within an event and through the monsoon season) and spatial variations of resource fluxes at the sub-plot scale. Nested sampling was used to monitor spatial and temporal variations in soil moisture over the grass-shrub transition, and spatial variations in soil texture, nutrient concentrations and organic matter content. Geostatistical techniques were then applied to determine how the distribution of resources varies over the grass-shrub transition.

Results from the monitoring campaign reveal how changes in ecosystem structure affect hydrological processes, and furthermore, how hydrological processes impact upon ecosystem structure. High concentrations of plant-limiting nutrients and sediment were monitored in runoff over grassland, while concentrations tended to decrease as grass cover decreased and shrub cover increased. The magnitude of the hydrologi-

cal response increases with a decline in grass cover and increase in shrub cover. Over grassland, runoff redistributes high concentrations of nutrients and sediment locally. As grass cover declines and shrub cover increases, flow lines become well-connected which results in runoff redistributing nutrients and sediment over greater distances leading to an overall increase in the loss of water, nutrients and sediment from the shrub-covered plots. Throughout the monsoon season, an initial flushing of ammonium during runoff events was observed, followed by the retention of ammonium entering the system through rainfall. Nitrate concentrations in runoff rarely exceeded that entering the plots via atmospheric deposition and rainfall. Finally, observations reveal how feedbacks between ecosystem structure and hydrological response determine the magnitude and extent of resource redistribution which drive further changes to ecosystem structure. The improved understanding of interactions between vegetation and hydrology has been used to conceptualise an ecohydrological modelling approach which is an important tool for carrying out further investigations into semi-arid vegetation transitions.