Geophysical Research Abstracts
Vol. 20, EGU2018-10760, 2018
EGU General Assembly 2018

Modelling coevolving multi-process connectivity to undertand degradation trends along a semiarid transect in Australia

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Vegetation patterns in semiarid regions are known to be linked to healthy soil and landscape functions. Previous research suggests that preserving the integrity of vegetation patterns is of key importance to maintain soil and ecosystem services, and that substantial disturbances to the natural patchy spatial organization of plant cover can lead to severe degradation. A decrease in vegetation can lead to an increase in runoff and associated erosion, and therefore trigger water, soil and organic matter losses leading to a degraded landscape that is difficult to restore.

We study these interactions and the possible existence of threshold behaviour in the semiarid Mulga land bioregion in Australia. We combine remote sensing observations and results from an ecohydrology model to investigate changes in ecosystem function and the possible existence of threshold behaviour in degraded landscapes. More than 30 sites selected along a precipitation gradient from approximately 250 to 500 mm annual rainfall were investigated. The analysis of vegetation patterns is derived from high resolution remote sensing images (IKONOS, QuickBird, Pleiades) and MODIS NDVI, which combined with local precipitation data is used to compute rainfall use efficiency to assess the ecosystem function. A critical tipping point associated to loss of vegetation cover was found in the sites with lower annual precipitation. We found that this tipping point behaviour decreases for sites with higher rainfall. We use the model to investigate the relation between structural and functional connectivity and the emergence of threshold behaviour for selected plots along this precipitation gradient. Both observations and modelling results suggest that sites with higher rainfall are more resilient to changes in vegetation cover and surface connectivity. The implications for ecosystem resilience and land restoration and rehabilitation are discussed.