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Ecosystem Stability Thresholds along a Precipitation Gradient in Australia

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Drylands are particularly sensitive to climatic or anthropogenic pressures, frequently showing critical degradation thresholds which make rehabilitation efforts considerably difficult. The spatial structure of vegetation is closely linked to the hydrologic connectivity of these systems and determines the spatial distribution of sources and sinks of overland flow. Vegetation patterns, that coevolve with geomorphic processes (sediment erosion and deposition) have therefore important implications for the resilience of these ecosystems, and are especially relevant for the detection of landscape degradation processes. In fact, disturbances can disrupt the spatial integrity of the vegetation pattern, triggering erosion and producing a substantial loss of water by increasing landscape hydrological connectivity and, consequently, affecting ecosystem function (e.g. decreasing the rainfall-use efficiency of the landscape).

Here we present some preliminary results exploring the impact of degradation processes, induced by grazing pressure, along a precipitation gradient in the Mulga Lands bioregion (New South Wales) and sites of the Northern Territory in Australia. Our assessment is based on the analysis of vegetation patterns derived from high resolution remote sensing images (IKONOS and QuickBird), precipitation records, and MODIS vegetation indices. The analysis of the NDVI MODIS data show the presence of a critical degradation threshold, associated to loss of vegetation cover. Below this threshold, landscapes with high vegetation cover display high rainfall use efficiency, and we call these landscapes “functional landscapes” (resources are retained and used by vegetation). Above this threshold, we found that vegetation has low rainfall use efficiency and we have “dysfunctional landscapes”. We compare the different behaviors and stability thresholds for several sites along the precipitation gradient (250mm to 450mm annual average rainfall) and discuss implications for ecosystem resilience.