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Ecogeomorphology of semiarid rangelands: understanding and quantifying rates and feedbacks to prevent landscape degradation.

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In semiarid systems, hydrologic, geomorphic and ecological processes are tightly coupled through strong feedback mechanisms occurring across fine to coarse scales. These feedbacks have implications for equilibrium and resilience of the landscape and are particularly relevant for understanding the potential degradation effects of climate and anthropogenic pressures. The vegetation of these regions is sparse and often associated to the development and maintenance of spatially variable infiltration rates, with lower infiltration in the bare areas. These variable infiltration rates have been observed in many field studies and are responsible for the emergence of a runoff–runon system, and for the associated redistribution of water and sediments.

We will present a modelling framework developed to understand the role of surface water connectivity in degradation processes in semiarid landscapes with patchy vegetation. Surface water connectivity in these systems is highly dynamic and emerges from non-linear feedbacks between vegetation patterns and the coevolving landforms. The model captures these feedbacks through the coupled nature of the processes included in the landform-vegetation modules. As increased surface runoff connectivity has been linked to degradation, we focus on evolving hydrologic connectivity patterns resulting from feedback effects and co-evolving structures.

First, we will discuss some general results on the coevolution of semiarid rangelands, and the effects of varying abiotic and biotic conditions. Next we will present results in which we investigate changes in functional hydrologic connectivity, and the existence of tipping points as observed in several sites in Australia. These results are based on data from our recent studies along a precipitation gradient in the Mulga bioregion of Australia. The analysis from satellite images reveals a major role of surface connectivity on the spatial organization of patchy vegetation, suggesting that transitions on the distribution of vegetation leading to degradation are related to sharp variations on the landscape surface connectivity. Finally we will discuss results analysing the potential effect of soils depths on the coevolution of system structures and connectivity. The relevance and implications of these results for the successful reclamation of water-limited environments in which vegetation stability largely depends on the redistribution of the scarce water resources will be discussed.