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Physical and Biological Effects in the Ecogeomorphic Coevolution of Semiarid Hillslopes.

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Nonlinear interactions between physical and biological structures affect the coevolution of soils, landforms and vegetation in drylands, and lead to the emergence of distinct landform-vegetation patterns. These patterns are intimately linked to the spatial redistribution of resources and, therefore, to the productivity and carrying capacity of the land. Moreover, disturbances altering vegetation and landform patterns can trigger feedback effects between biota and erosion processes and, in extreme cases, lead to severe degradation. These aspects highlight the importance of the analysis and modelling of coevolving semiarid landform-soil-vegetation systems.

Here we use a modelling framework to investigate the impact of physical (relief, erodibility, and soil diffusion) and biological (protective effect of vegetation on soil) factors affecting and modulating the processes and feedbacks that lead to the appearance of banded and striped landform-vegetation patterns. Results show that, though banded patterns tend to appear on gentle slopes (due to low fluvial erosion effects), they can also appear in higher slopes (due to high diffusion or high protective vegetation cover effects). Higher slopes tend to develop flow concentration, rills and vegetation stripes. We also show that in some areas, small variations in slope and/or abiotic (soil erodibility or diffusivity) and biotic (plant species with varying protective effects on erodibility) factors can give rise to changes from banded to striped patterns. We summarize the previous results in a phase diagram that identifies similarity regions, i.e. regions with varying physical characteristics that display similar landscape patterns. We use this diagram to investigate the effect of disturbances on the landscape due to both climate variability (extreme rainfall events) and human impacts (grazing or wood harvesting), which can lead to severe degradation on both banded and striped systems.