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Advances in modelling the coevolving soils, landforms and vegetation in semiarid regions: a multidisciplinary approach.

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Semiarid landscapes exhibit highly nonlinear interactions between coevolving physical and biological processes. Coevolution in these systems leads to the emergence of remarkable soil, landform and vegetation patterns. Growing concern over ecosystem resilience to climate and land use perturbations that could result in irreversible degradation imposes a pressing need for research, aiming at elucidating the processes, feedbacks, and dynamics leading to these coevolving patterns. This is particularly important since degradation in drylands has been frequently linked to feedback effects between soils, biota and erosion processes.

In many dryland regions, feedbacks are responsible for the emergence of areas with low infiltration in unvegetated soil patches (due to surface crusting) and high infiltration rates in the vegetated soil patches (due to improved soil aggregation and macroporosity). This variable infiltration field gives rise to runoff–runon redistribution which determines areas of soil erosion and deposition. We have combined a coupled landform-soil-vegetation model with remote sensing and field data to capture these feedbacks and improve our knowledge of these coevolving biotic-abiotic processes. We discuss and present results showing that the dynamics of the individual processes and their response to climatic and anthropic disturbances cannot be fully understood or predicted if nonlinear feedbacks and coevolution are not considered. Implications for management and restoration efforts are illustrated using data and observations from agricultural sites in central Australia and reclaimed mining sites in Spain.