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Landform-water-vegetation feedbacks regulate ecosystem stability and restoration potential in semiarid landscapes

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Plant production and vegetation dynamics in drylands are shaped by landform patterns, and largely depends on favorable surface redistribution of runoff and sediments. Similarly, the organization of vegetation in these systems controls runoff generation and erosion, and strongly influences the spatial redistribution of water and soil resources. Landform-water-vegetation feedbacks may have, therefore, a key role determining the stability and restoration potential of arid and semiarid ecosystems. We present a synthesis of field, remotely-sensed and modelling studies on landform-soil-vegetation patterns in semiarid rangelands of Australia and reclaimed coal-mining slopes of Mediterranean-dry Spain. Our results indicate that the organization and stability of vegetation patterns strongly depends on feedbacks with coevolving landforms. Exploration of banded woodlands in central Australia reveals that disturbances (e.g. grazing, wildfires) can impact landform-water-vegetation feedbacks, altering the way water is spatially redistributed and used by vegetation, which results in non-linear reductions of ecosystem function. Successful experiences on the restoration of these systems suggest that the spatial management of runoff and sediments is decisive to rehabilitate vegetation patchiness and landscape function. The study of vegetation-water-landform feedbacks in Mediterranean-dry reclaimed mining slopes of Spain offers additional indications on the restoration of drylands, particularly on the effects of rill and gully erosion on the stability of restored vegetation. The development of rill and gully networks provides very efficient drainage networks for the routing of runoff and sediments that drastically reduce the availability of water and soil resources for plant production, ultimately causing degradation of vegetation and restoration failure.

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