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Feedbacks between vegetation pattern and resource loss enhance degradation potential in drylands

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Conceptual frameworks of dryland degradation commonly include ecohydrological feedbacks between landscape spatial organization and resource loss, so that decreasing cover and size of vegetation patches result in higher water and soil losses, which lead to further vegetation loss. However, the impacts of these feedbacks on dryland dynamics in response to external stress have barely been tested. Using a spatially-explicit model, we mimicked feedbacks between vegetation pattern and landscape resource loss by establishing a negative dependence of plant establishment on bare-soil hydrological connectivity. We assessed the impact of various feedback strengths on the response of dryland ecosystems to changing human and climatic pressure. The connectivity-mediated feedbacks decrease the amount of pressure required to cause a critical shift to a degraded state and increase the pressure release needed to achieve the ecosystem recovery. The impact of these feedbacks is markedly non-linear, which is explained by the non-linear increase in bare-soil hydrological connectivity with decreasing vegetation cover. Modelling studies on dryland vegetation dynamics not accounting for the connectivity-mediated feedbacks studied here may underestimate the degradation potential of drylands in response to external stress. Our results also suggest that changes in vegetation pattern and associated hydrological connectivity may be more informative early-warning indicators of dryland degradation than changes in vegetation cover.