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Exploring ecohydrological feedbacks and non-linear behavior in dryland ecosystems

Mariano Moreno de las Heras

Institute of Environmental Assessment and Water Research (IDAEA), Spanish Research Council (CSIC), Barcelona, Spain (mariano.moreno@idaea.csic.es)

How ecosystems undergo environmental change represents one of the main frontiers in environmental sciences. The effects of climate change and the massive anthropogenic alteration of natural habitats are considered the main threads to ecosystem stability, particularly for drylands. Monitoring the integrity of the fundamental properties that regulate ecosystem function is, therefore, critical to maintain the stability of water-limited landscapes. Here, this presentation explores the incidence of ecohydrological feedbacks and non-linear behavior on ecosystem stability across a variety of remote-sensing and field studies developed in Mediterranean-dry ecosystems, semi-arid Australian landscapes and desert ecosystems of SW USA. Overall, this synthesis indicates that human disturbance in drylands can induce non-linear alterations on the ecosystems' functions (e.g., water budgeting, primary production) and structure. In banded semi-arid Mulga landscapes of Australia, where the development and maintenance of vegetation patterns is tightly coupled with the spatial redistribution of surface runoff, altering the way water is spatially redistributed and used by vegetation causes the emergence of sharp, landscape degradation thresholds. These ecosystem changes, under particular circumstances, can be largely irreversible. For example, in desert landscapes of SW USA, where the combined effects of grazing and climate variations accompanied by soil erosion have resulted in the encroachment of desert shrubs over semi-arid grasslands, landform-water-vegetation feedbacks strongly limit grass re-establishment in shrub-dominated areas. Further implications for ecosystem resilience and management are discussed.