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Transitions induced by human activities in Australian rangelands: the role biogeomorphology feedbacks

Patricia Saco (1), Mariano Moreno de la Heras (2), Samira Azadi (1), Garry Willgoose (1), and Juan Quijano (1)

(1) School of Engineering, The University of Newcastle, Callaghan, New South Wales, Australia (patricia.saco@newcastle.edu.au), (2) Institute of Environmental Assessment and Water Research (IDAEA), Spanish Research Council (CSIC), Barcelona, Spain

Understanding biogeomorphology feedbacks between biota, hydrology and landform evolution is particularly important in drylands, as these systems are vulnerable to desertification processes. This risk is aggravated by the recent intensification of anthropogenic activities and climate change that are imposing an unprecedented pressure in these areas. It is now widely recognized that patchy vegetation cover in drylands emerges from complex non-linear interactions between biotic, hydrologic, geomorphologic and soil processes. When vegetation patches are altered by external disturbances leading to loss of plant cover, the hydrologic connectivity of the landscape is increased producing higher runoff and triggering erosion. Previous work has linked changes in the vegetation patch size distribution to degradation, deriving indicators of proximity to transitions from healthy functional to degraded states. However, previous indicators have not considered the anisotropic distribution of the patches (either natural or caused by human disturbance) that can affect runoff generation, erosion and associated biogeomorphologic feedbacks. Here we present results from the combined analysis of remote sensing data and model simulations to investigate changes induced by human activities in the biogeomorphologic response of Australian rangelands across a precipitation gradient. Model simulations are designed to investigate the effects of climate change and human activities on surface vegetation cover and landform changes at the hillslope scale, and used to derive metrics of landscape functionality (productivity and rainfall use efficiency). Observations and simulation results suggest that changes in feedbacks between biota and erosion are responsible for the appearance of threshold behaviour in landscape functionality from healthy to degraded states. In addition, we analyse model simulations to understand the role of vegetation pattern structure and organization in the transitions from healthy to degraded states, in order to improve the identification of early indicators. Understanding these dynamics is of key importance to design strategies and management practices aligned to the concept of “building with nature” to prevent degradation.