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Microtopography affecting critical transitions in drylands.

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Human and natural disturbances in drylands can suddenly induce a transition to a degraded ecosystem state that is difficult to reverse. Water availability for plants is essential for the resilience and stability of these water limited ecosystems. On hillslopes, the redistribution of surface water flow can be altered by microtopographic structures of mounds that develop under isolated plant patches, thereby affecting the vegetation. For low mounds, the flow velocity of surface water can reduce near the vegetation patches, thereby increasing run-on towards the vegetation. However, if mound height increases, it is expected that surface water circumvents the vegetation patch. Little is known yet about the influence of human pressures such as livestock grazing on these microtopographic structures.

To investigate the effect of grazing on the microtopographic structures on hillslopes with patchy vegetation, a simple model has been developed and a field pilot study has been done. According to the model, grazing can alter the system in two ways. First, under low grazing pressure, trampling can increase the bare soil erodibility which amplifies the development of microtopographic structures. Second, under high grazing pressure, increased bare soil erodibility and reduced vegetation cover are operating simultaneously. Here, reduced protection of the soil by plants causes a relative decrease in the microtopographic structures compared to the low grazing pressure. Microtopographic field data were collected in SE Spain. The target species Stipa tennacissima is an unpalatable plant species, so only the effect of trampling was tested. These data suggest that mound development under the unpalatable plant only occurs at the highly grazed sites. This implies that the microtopography can significantly change due to trampling by grazers.

Current research suggests that grazing changes the microtopography of hillslopes in drylands. However, further research is needed to understand how this affects the timing and outcome of a sudden critical transition to a degraded ecosystem state. Based on current results, we hypothesize that including microtopography in the framework of critical transitions in drylands would decrease the amount of pressure that is required to cause a critical shift to a degraded ecosystem state. This is due to a reduction in run-on towards the vegetation patches. So far, we only measured the response of the microtopography to grazing. However, we will continue to study the dynamic interaction between grazing, microtopograpy, vegetation growth, and hydrology. This might be essential to detect early warning signals and to understand the mechanisms responsible for sudden critical transitions in drylands.