Geophysical Research Abstracts
Vol. 18, EGU2016-74, 2016
EGU General Assembly 2016

Stressed deserts: A new vegetation/sediment-transport model for dryland environments

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In many drylands, vegetation is patchy and dynamic through time and space, with complex ecohydrological feedbacks and plant-plant interactions leading to the emergence of characteristic vegetation patterning. There is increasing evidence that information from the patterns themselves can be used as indicators of a dryland system's proximity to collapse. However, current models simulating the evolution of these vegetation patterns do not account for their effects on wind flow and on the entrainment, transport and redistribution of wind-blown material. Significant uncertainty therefore remains about how these vulnerable landscapes will react to increasing climate forcing and land-use pressure over the 21st century and beyond.

We present the coupled Vegetation and Sediment TrAnsport model (ViSTA), a new, multi-scale cellular automaton model designed to simulate transport in vegetated dryland contexts. The model is parameterised using empirical data collected during a field campaign in Namibia that sought to investigate the impact of desert vegetation on wind speed and turbulence at the surface. A new turbulence-based model for aeolian transport is also used to drive the movement of sediment within ViSTA. We show that this coupled approach allows for realistic simulations of dynamics at both the bedform and landscape scale.

It is especially important to understand the geomorphological responses of vegetated semi-arid landscapes to a variety of simulated stresses, since these regions are often heavily used for pastoralism, agriculture and habitation. In characterising possible transition scenarios between patterned and desert states, the ViSTA model therefore represents a powerful tool that has direct relevance to land management policies in highly vulnerable environments.