Geophysical Research Abstracts
Vol. 16, EGU2014-3493, 2014
EGU General Assembly 2014

How will increases in rainfall intensity affect semiarid ecosystems?

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Model studies suggest that semiarid ecosystems with patterned vegetation can respond in a non-linear way to climate change. This means that gradual changes can result in a sudden and significant loss of biological productivity, also referred to as desertification. Previous model studies focused on the response of patterned semiarid ecosystems to changes in mean annual rainfall. However, climate projections show that, as a result of global warming, the intensity of rain events may change as well. We studied the effect of changes in rainfall intensity on the functioning of patterned semiarid ecosystems with a spatially explicit model that captures rainwater partitioning and runoff-runon processes with simple event based process descriptions. Analytical and numerical analyses of the model revealed that rainfall intensity is a key parameter in explaining patterning of vegetation in semiarid ecosystems as low mean rainfall intensities do not allow for vegetation patterning to occur. Surprisingly, we found that, for a constant annual rainfall rate, both an increase and a decrease in mean rainfall intensity can trigger desertification. An increase negatively affects productivity as a greater fraction of the rainwater is lost as runoff. This can result in a shift to a bare desert state only if the mean rainfall intensity exceeds the infiltration capacity of bare soil. On the other hand, a decrease in mean rainfall intensity leads to an increased fraction of rainwater infiltrating in bare soils, remaining unavailable to plants. Our findings suggest that considering rainfall intensity as a variable may help in assessing the proximity to regime shifts in patterned semiarid ecosystems and that monitoring losses of resource through runoff and bare soil infiltration could be used to determine ecosystem resilience.