Geophysical Research Abstracts
Vol. 12, EGU2010-15561, 2010
EGU General Assembly 2010

Shrubs as landscape modulators in semiarid shrubland – long-term studies in Park Shaked LTER, Israel

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Small shrubs (*Atractylis serratuloides and Noaea mucronata*) in semiarid shrublands of the northern Negev of Israel (at 150 to 200 mm of rainfall per year) form shrub patches in the soil crust matrix by multiple changes in their immediate environment. The changes include structural modification by creation of a soil mound and water flow redistribution, which produce enriched soil moisture patches. These changes have far-reaching effects on water regime, soil erosion and biological productivity and diversity in watersheds.
Landscape modulation by the shrub patches results from: 1) interactions of the growing shrubs with flows of water, sediment and organic matter by wind and runoff, 2) accumulation of material deposited under the shrub canopy, 3) changes in the topography and structure of the surface and substrate near and under the shrubs, 4) successional replacement of shrub species, and 5) colonization by a herbaceous understory. The patch formation processes are linked, resulting in positive feedback relationships between the growing shrub, the properties of the mound underneath, the interception of resource flows, and the density of the herbaceous understory vegetation.
Since the shrub patches intercept resource flows, and form patterns of patches on the slopes, they have larger-scale effects on the functioning of the ecosystem by controlling the retention and leakage of resources in the watershed. At the slope scale this gives rise to positive and negative feedbacks. Accumulation of material causes mound expansion, increasing deposition (positive feedback 1), while increased resource retention enhances shrub and herbaceous growth, also causing more accumulation and retention (positive feedback 2). On the other hand, when mounds increase, soil crust cover that generates runoff decreases, halting the process of shrub patch expansion (negative feedback).
We present a conceptual model of a growing shrub patch with its direct and large-scale effects on the functioning of the watershed, based on empirical field evidence. In the model we relate shrub patch formation to land-use and climate change by including the impacts of livestock grazing, clear-cutting, and periodic and prolonged drought.