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Relationship among soil surface properties, hydrology and nitrogen cycling along a climatological gradient in drylands

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Primary production and nutrient cycling in dryland systems are limited by water supply. There are two groups of primary producers, high biomass production plants and low biomass producing organisms found in biological soil crusts (BSC's), which control energy flow, nutrient cycling and hydrology. Biological or biogenic soil crusts are common in the world's drylands, from dry sub-humid to hyper-arid systems. The crusts are formed by communities of microphytes, mainly cyanobacteria, green algae, mosses, and lichens. The extracellular polysaccharide materials produced by the crust organisms attach soil particles, creating a solid horizontal layer of crust. Biological soil crusts modify soil quality by (1) aggregating soil particles, thereby reducing wind and water erosion; (2) reducing water infiltration, causing overland water run-off; and (3) N fixation and C sequestration.

Dryland landscapes are two phase mosaic composed of BSC and high production patches. Development or loss of BSC may trigger changes in the spatial distribution of the patch types and therefore transitions between functional and degraded ecosystem states.

We present a conceptual model depicting the function of each patch type and the link between them. Taking into account the contrast between low and high vegetation cover of dryland systems and their role in controlling soil nitrogen and water flows. The model describes the functioning of dryland systems with low biomass producing crust organisms cover, low rainfall, low top soil water and production, which cause low infiltration rate, low N uptake, nitrate accumulation, high evaporation and runoff. This leads to leaching of nitrates, oxygen depletion with high anaerobic conditions, high denitrification rates and N loss, resulting in low plant cover and soil organic matter i.e., degraded soil. It also depicts the functioning of the high production plants under low rainfall regimes resulting in low rates of N and energy flows. The model shows that when the two patches are combined into a source-sink system there is a synergetic effect increasing productivity and diversity, and N cycling and hydrology. The strength of the synergism depends on the climatological gradient.

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