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Spatial heterogeneity of soil and substrate characteristics and its microscale hydrological effects

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Small-scale runoff patterns and infiltration are highly relevant for catchment hydrology in (semi-)arid regions. The extent and pattern of rock and soil surfaces are particularly important for runoff connectivity and thus vegetation growth and sediment dynamics. So far, most studies focused on the relationship between rainfall, runoff and sediment yield, on the plot and catchment scale. Less attention, however, has been paid to microscale processes where small differences in surface properties cause a high variability in runoff generation and connectivity.

The aim of this study is to understand the role of microscale surface properties and their spatial constellation on infiltration and runoff patterns. We mapped six microcatchments in the study area near Sede Boqer, Israel. Mapping included the generation of high resolution DEMs using a laser scanner, soil thickness and vegetation patterns. In addition, soil properties (porosity, texture, nutrients, organic matter content) were analysed. These field data were used to model patterns of runoff generation and the redistribution of runoff water onto soil patches. The patterns of plant available water were then compared with the density of shrub plant cover in the different catchments.

First results suggest a negative correlation between soil volume and vegetation density. Areas with low soil thickness are characterized by high plant density, plant diversity and nutrient availability in clefts and cracks. Microcatchments at upper and lower slope sections are controlled by dry conditions, characterised by a low vegetation heights and a low density of shrub plant cover. These patterns seem to be strongly dependent on water, sediment and nutrient fluxes from rocky to vegetated patches. We suggest that these dynamics are related to the spatial variance of rock soil-cover ratio which controls water concentration and allocation. Finally nutrient contents were compared between different microcatchments. The results indicate that there is a good agreement between the content of nutrients/organic matter and a high rock soil-cover ratio.

These preliminary results confirm the significant influence of infiltration and runoff patterns on microscale ecohydrology of arid environments. Runoff and water availability on patchy rock and soil surfaces strongly depend on rainfall characteristics. Further research will aim at identifying simple parameters for describing rainfall-surface interactions to model runoff and ecohydrology of dryland slopes and catchments.