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Experimental study of soil water storage capacity on rocky slopes in the Negev Highlands, Israel

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Deserts and semi-deserts cover more than one-third of the global land surface. That means that in total about 49 million km2 are affected by aridity. Arid regions are characterized by sparse and patchy vegetation, forming so called “fertility islands”. The mosaic of vegetated and non-vegetated patches is dynamically interdependent and has shown to be an adaptation of the ecosystem to limited water availability and soil resources. To understand spatial heterogeneity of vegetation in (semi-)arid regions and vegetation response to climate change, studies on small scale runoff patterns, infiltration and their role in ecohydrology are required. Dryland vegetation is expected to respond sensitively to climate change and the projected variability of rainfall events. While rainfall as a water source is an obvious factor for vegetation water supply, the ability of patchy soil coverage to store water has not been studied in detail for dryland hydrological systems.
The aim of the study is to investigate the relationship between climate change and plant available water on patchy soils in the Negev desert / Israel. Understanding rainfall-soil interaction will improve our understanding of the impact of climate change on vegetation in arid environments. Ten micro-catchments in different landscape units near Sede Boqer were examined. Topographic variables were extracted from high resolution ($\sim$0.02m) digital elevation models for each micro-catchment. Soil volume was estimated by laser scanning before and after soil excavation. Bulk density was estimated by weighing the excavated soil. To study the formation of runoff and redistribution of precipitation at the different catchment surface units, sprinkling experiments were conducted. Rainfall of 18mm/h was applied on 20 plots with an area of 1m2 each. The experiments lasted 25 to 40 minutes, until equilibrium runoff rates were achieved. Furthermore, rainfall records for the period of 1976-2008 of the vegetation periods (November – February) were analyzed. Based on experiments, analysis of rainfall records, soil properties and infiltration rates, it was possible to estimate the recurrence interval of events generating sufficient runoff to wet soil patches to a degree that is suitable for plant growth.
The preliminary results indicate that a minimum effective rainfall amount of 2.5 mm in the soil patch contribution area is required to saturate soil patches with water. Such low rainfall events are relatively frequent in this region of the Negev, indicating that there is potential to frequently fill soil pore volume. The storage capacity of the soil is particularly relevant for plant water supply during periods without rain. Our results therefore show that the impact of climate change in drylands can only be predicted by taking the soil water storage capacity into account. The study also illustrates how rainfall simulation experiments and the analysis of meteorological records can be combined as a tool for the assessment of environmental change.