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Rainfall-runoff-infiltration relationships on groundwater recharge in terraced landscape, Southern Judea Mountain

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Rainfall-runoff-infiltration relations is one of the basic factors to determine the hydrological regime at the watershed scale. It controls deep infiltration into the unsaturated zone and ultimately determines groundwater recharge. Characterization of rainfall-runoff-infiltration relations is considered a complex process due to the dynamic variation in rainfall pattern, as well as the complex dynamics of water infiltration through various man-made landscape, geomorphic setups and the heterogeneous characteristics of the unsaturated zone. Herein, a comprehensive monitoring setup was used to enable simultaneous tracking of the surface and subsurface hydrological processes in a semi-arid terraced landscape.

The research area is a part of the recharging zone of the southern part of the Yarqon - Taninim aquifer, characterized by two typical geomorphological features that play major roles in deep percolation: (1) rocky hills, composed of mainly massive rock exposures, and (2) terraces in first order stream, with deep soil accumulation.

The field experimental site is located at water shade (10.7 hectare) on the southern part of Judea Mountain. The upper 10 m of the unsaturated zone of each site was instrumented with a vadose zone monitoring systems (VMS) which provide high-resolution measurements of variation sediment water content, and frequent sampling of the sediment pore-water for chemical and isotopic composition. Temporal variations in sediment water content along with tracers breakthrough curves across the unsaturated zone of both sites were used to estimate infiltration velocities. The chemical and isotopic composition of the vadose zone pore water were used to estimate the water infiltration conditions and identification hydrochemcial processes taking place during rain water percolation. In addition to the subsurface measurement setup, a meteorological station that was established at the site provided continuous meteorological data and flume at the terrace outlet provided runoff discharge.

One year of continuous monitoring of variations in the profiles of water content, as well as chemical and isotopic analysis of water samples obtained from the unsaturated zone, revealed direct link from surface to deep sections of the unsaturated zone under the rocky hill slope. Quick rise in measured water content after rain events lasted for long period and showed significant wetting of the rocky profile. On the other hand, in the deep soil under the terraces insignificant infiltration was monitored as no changes in water content were measured in the deep soil. The direct link between the rain water and the deep water was approved through the similar stable isotope composition of δO18 in the sediment pore-water and the rain water.

These results showed that under low precipitation conditions, a total of 194 mm that year, no run-off was measured at the outlet of a terraced first order stream. However, high moisture content values at the rocky hillslopes indicate a major role in deep infiltration and groundwater recharge compared to the deep soil terraces, where most infiltrating rain water and local runoff evaporates and probably does not contribute significantly to groundwater recharge.