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Hydropedology of a mildly-arid loess covered area, southern Israel

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Extensive loess covered areas characterize the mildly arid areas of western Israel, where average annual rainfall is 280 mm. Hydrological data available point to a peculiar hydrological behavior of the ephemeral streams. The frequency of channel flow is very high. Four to eight flows are recorded annually. However, even in extreme rain events peak discharges are extremely low representing 0.002-0.005% of the rain amount received by the basin at peak flow. In addition, hydrographs are usually characterized by very steep rising and falling limbs, representative of saturated or nearly saturated areas, extending over a limited part of the watershed. Following this observation we advanced the hypothesis that storm channel runoff originated in the channel itself, with negligible contribution from the adjoining hillslopes. The study was based on two complementary approaches. The hydrological approach was based on the detailed analysis of rainfall-runoff relationships in a small watershed (11 km2). The second approach was based on the toposequence concept. According to this concept soil's properties are closely related to the position of a soil along a slope. Constituents and water lost by the upper part of the slope accumulate in its lower part, which is richer in clay and better leached. Several boreholes were dug along a hillslope 400 m long. Soil samples were collected for chemical and particle size analysis. In addition, samples for soil moisture data were taken following each major rain event. Chemical data obtained show no significant observable difference in the downslope direction. Similar results were also obtained for the particle size distribution and soil moisture content. However, particle size distribution in the active channel reveals very high clay content down to 60 cm. Data obtained lead to two main conclusions. 1. Data presented perfectly fit the concept of "Partial Area Contribution", in its narrow sense, as it presents an extreme case of hydrological discontinuity at the hillslope-channel interface. The high water absorption of the clayey alluvium limits infiltration depth resulting in a very high frequency of channel flow, even at low intensity rain events. The limited wet channel area is responsible for the low peak discharges, and for the steep shapes of most hydrographs. 2. The lack of pedological trends in the downslope direction is an additional indication of the limited connectivity between the hillslopes and the adjoining channel. The limited connectivity is attributed to the prevalence of low rain intensities in the study area. 90-95% of the rains are below 10 mm/hr., whereas final infiltration rates of the loamy-clayey soils are 10-15 mm/hr. higher rain intensities do exist, but there duration is extremely short, drastically limiting flow distances and overland flow contribution to the channel. The present study is also relevant to our understanding of pedological processes in dry-land areas. The high frequency of the intermittent low intensity rainstorms limits runoff generation and flow distances, and casts doubt on the general application of the toposequence approach.