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Contrasting Hydrological Regimes in A Semi-Arid Area

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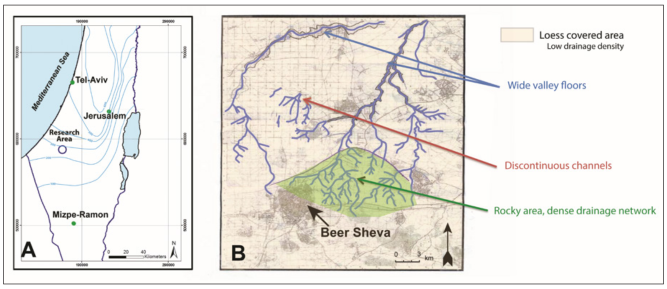
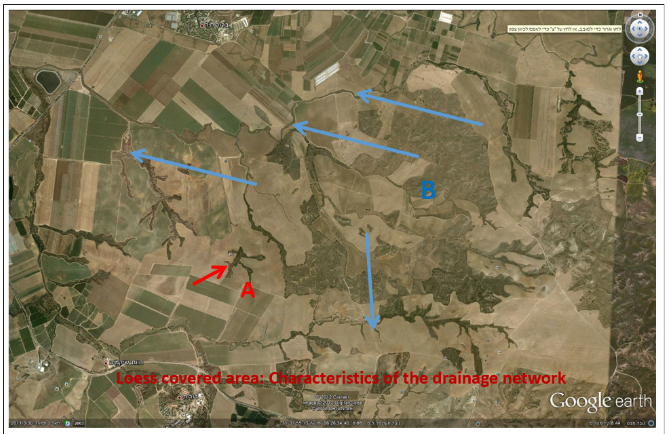
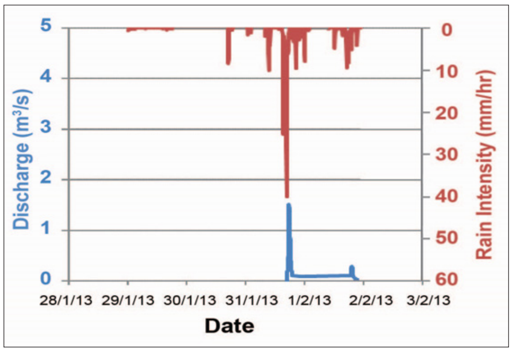
Introduction
Spatial relationships, or connectivity, represent a basic concern in our understanding of geomorphic processes, and their effects on the structure and functioning of ecosystems. High values of connectivity are indicative of an efficient system for the transfer of water and sediments through the drainage system; while a low hydrological connectivity would encourage infiltration losses, sediment deposition and spatial variability in the redistribution of water resources. The present talk will focus on the complex relationships between average annual rainfall and runoff generation in two adjoining watersheds in a semi-arid area.





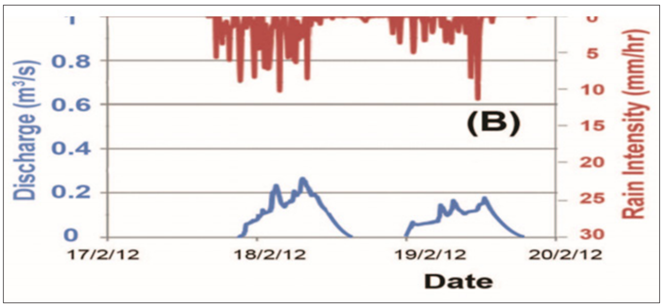
Loess covered area: Characteristics of the drainage network

Hydrological characteristics of the Loess covered area
- Very high frequency of flash floods in ephemeral streams (4-8 flow events every year).
- Very low peak discharges, even at extreme rain events.
- Runoff generation at very low rain intensities, below 5 mm/hr-1, far below the final infiltration rates reported in the literature for the loess covered areas: 10-15 mm/hr-1



Extreme rain event in the Haggedi basin (11 km2)

1. Runoff coefficient at peak flow: 0.005 %.
2. Second flow at very low rain intensity.
3. Very steep rising and falling limbs, usually indicative of saturated areas, at the vicinity of the monitoring station.



Total rain amount: 59.4 mm
This storm was preceded by a storm of 36 mm a week ago
Runoff coefficient at peak discharge: 0.0032%

1. In this event we would have expected a significant contribution from the adjoining hillslope. This did not happen.
2. Runoff generation at very low rain intensities (≤ 5mm/hr). Far below the values of final infiltration rates reported for loess soils (10-15 mm/hr.)
3. Very low runoff coefficients at peak rain intensity.

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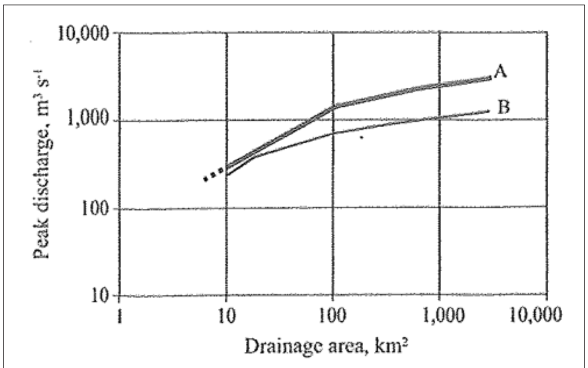
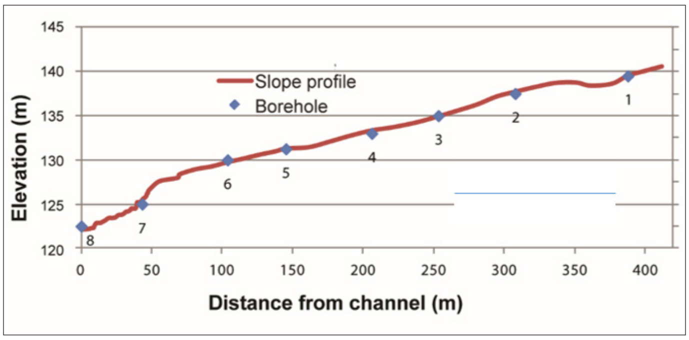


A —— Late Holocene envelope curve of paleofloods in the Negev

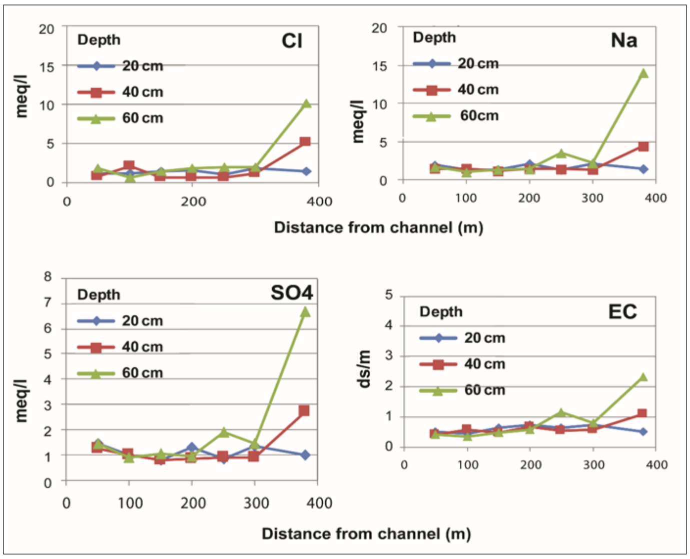
B —— Envelope curve of measured floods in the Negev (Meirovich et al., 1998)

Figure 7. Envelope curves for Late Holocene paleofloods (A) (after Greenbaum et al., 2001) and measured floods (B) (after Meirovich et al., 1998) in the Negev.

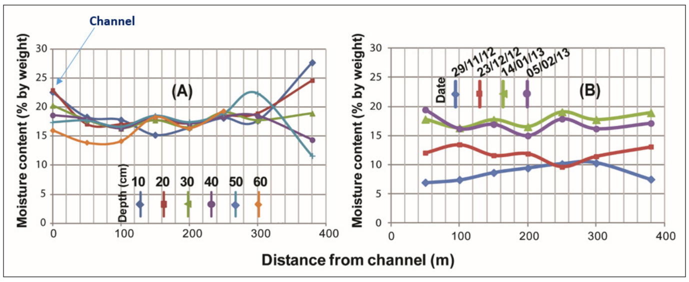
Annual flow frequency: 0-3



Haggedi toposequence: Location of boreholes



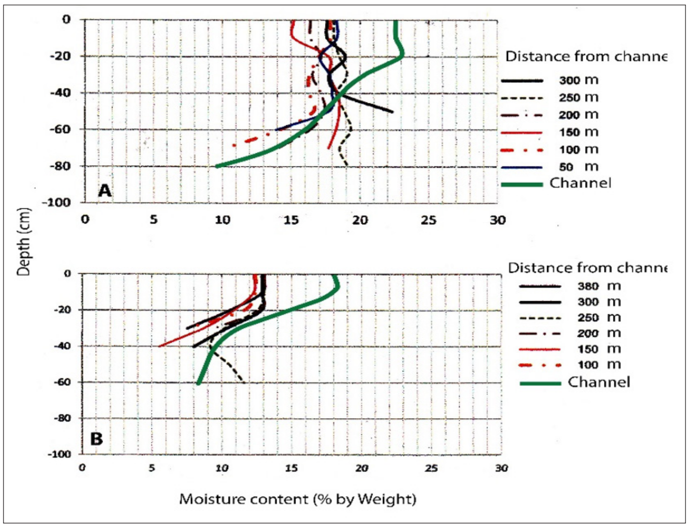
Haggedi toposequence: Chemical data



Spatial variability of soil moisture content along the Haggedi toposequence

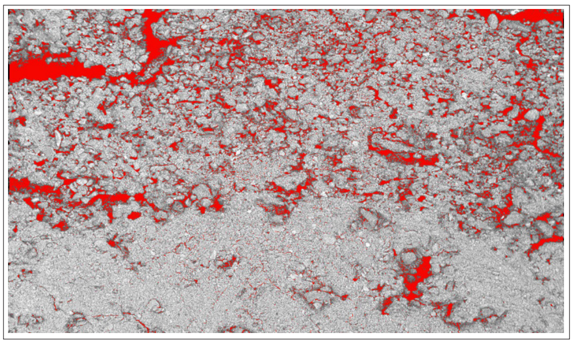
Clay content along the Haggedi topsequence (%)

Borehole number	1	2	3	4	5	6	7	8 (Channel)
Depth (cm)								
0-20	34	35	27	27	27	37	35	45
20-40	38	35	32	27	34	27	35	43
40-60	45	40	32	33	34	33	36	43
60-80	47	41	37	36	36	35	34	39



Upper figure: Following a rainstorm of 46 mm
Lower figure: End of the rainy season: (215 mm)

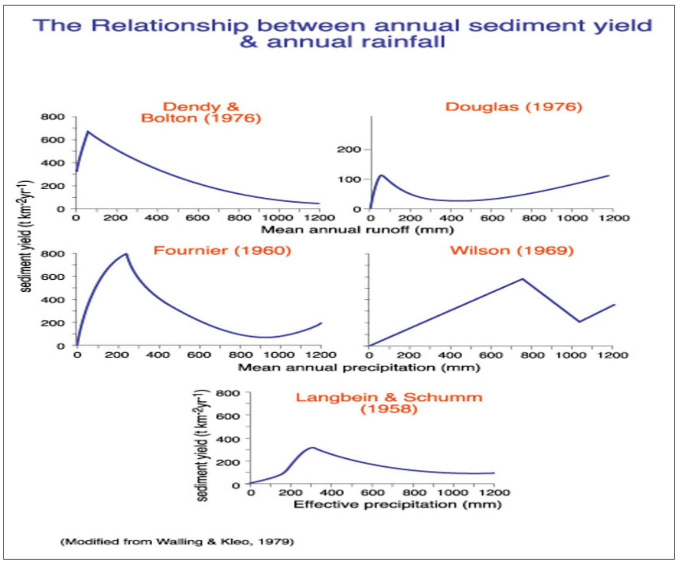
- **Mineralogical composition of the clay fraction**
- (conducted by Dr Amir Sandler, Geological Institute of Israel)
- Sample 1: Top of alluvial channel (0-10 cm).
- Smectite-illite: predominant.
- Kaolinite: secondary
- Illite, Palygorskite, chlorite: minor to traces.

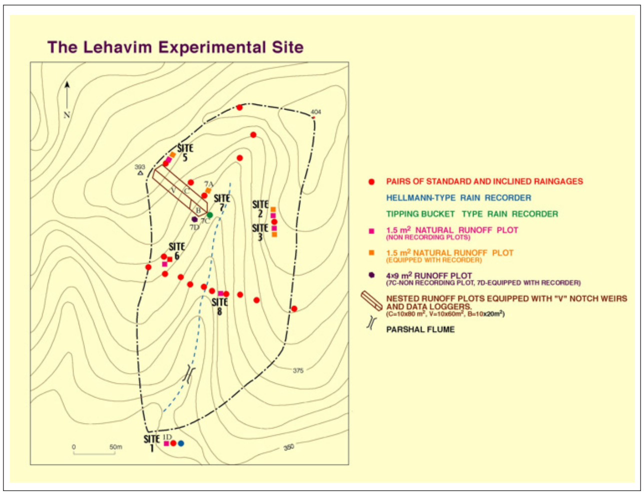


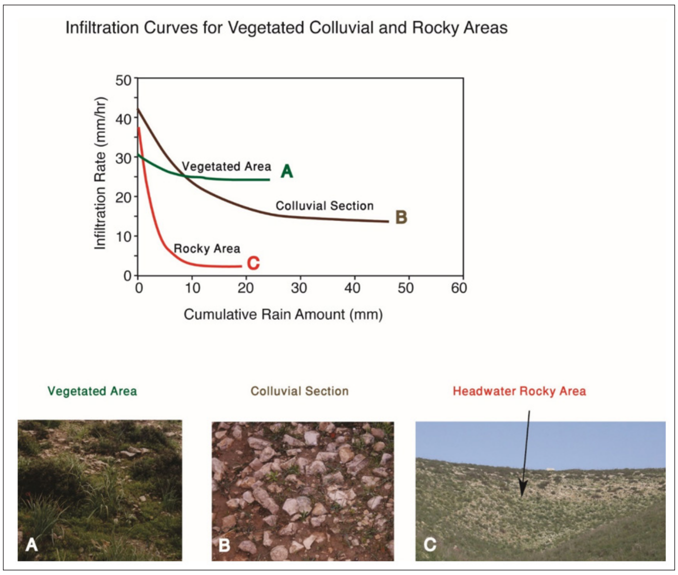
Stratigraphy of the upper part of the alluvium
Upper coarse layer: Porosity 16.7 %
Lower fine-grained layer: Porosity 5.4%

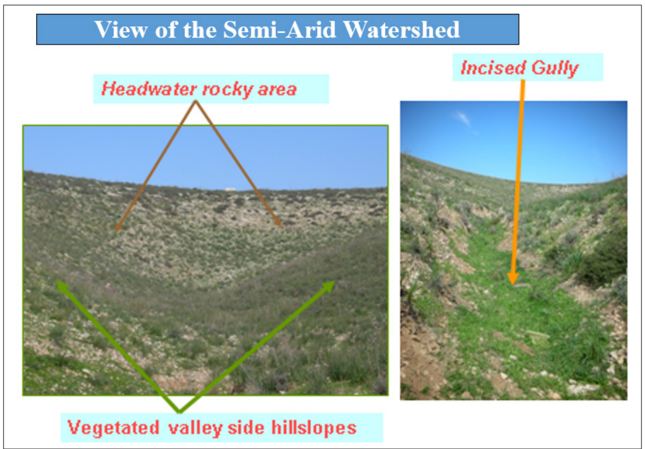
Conclusions

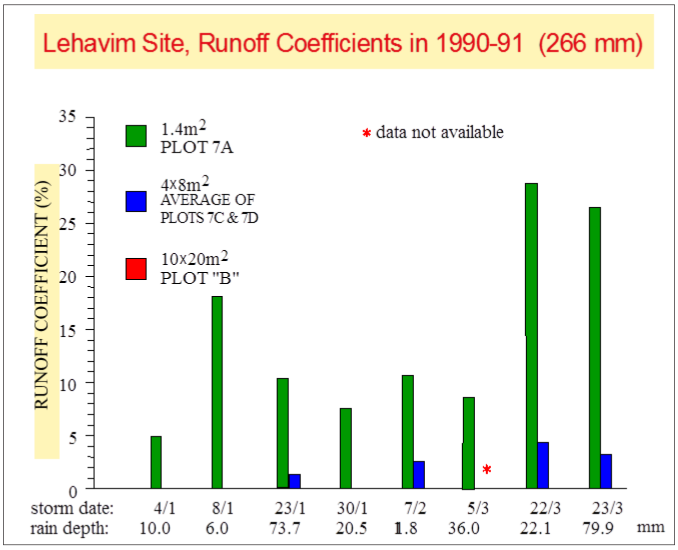
- The process of clay dispersion easily explains the very high frequency of storm rain events in the study area. In case clay dispersion is achieved at the end of the first rain event, the chances for runoff generation are much greater at the following rain events.
- The limitation of this process to the alluvial channel also explains the very low peak flows, even in extreme rain events, as well as the steep rising and falling limbs of the hydrographs.
- Data presented conform with the concept of "Partial area runoff generation" observed in humid areas. However, the similarity ends here. Whereas in humid areas this pattern is associated with saturated areas; in the present study this pattern is associated with the structure and composition of the Alluvial fill.
- Finally, more attention should be devoted to the clay dispersion process of runoff generation in dryland areas, where Smectite is the most dominant clay.

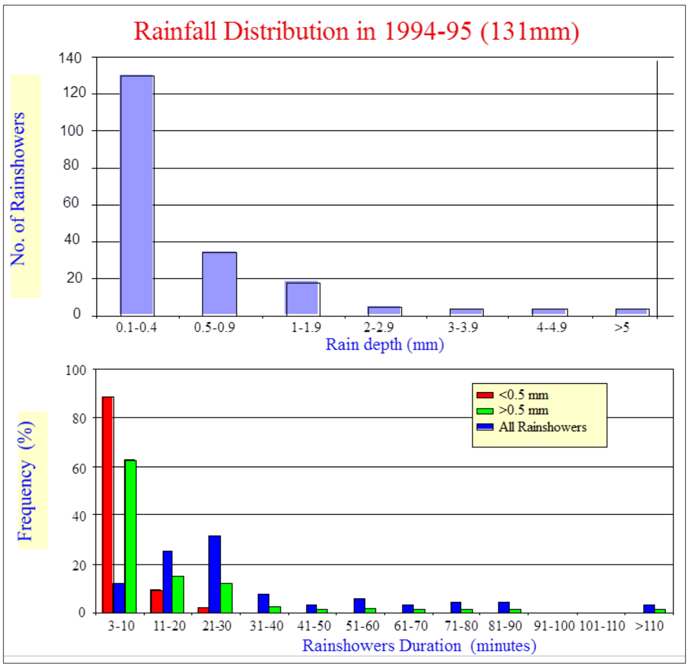


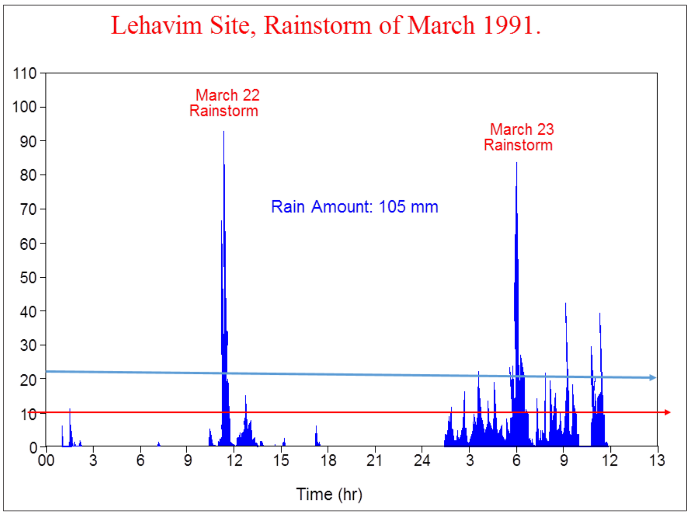


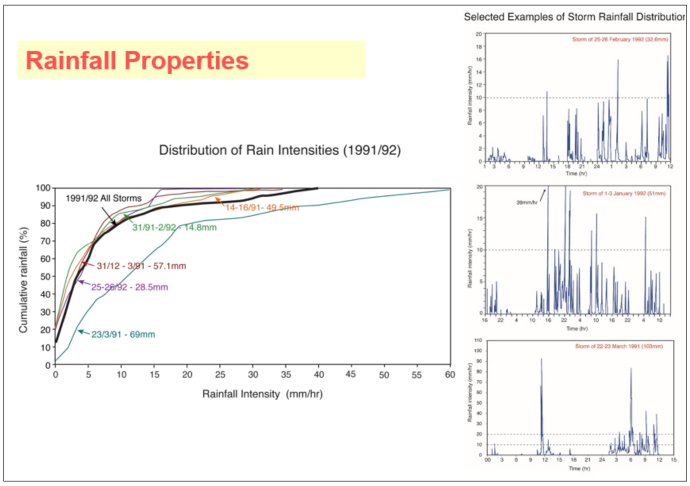












The Main Reason for the Process Described above is the Very Short Duration of Effective Individual Rain-showers. This Duration is Much Shorter than the Concentration Time Required for a Continuous Flow along Long Hillslopes.

Conclusions

Hydrological, Sedimentological and Pedological Data presented show a Positive Relationship Between Slope Length and Deposition Processes, Regardless of Slope Angle. The Longer the Hillslope the Longer and Thicker the Colluvial Mantle. Deposition at the Slope base increases infiltration, promotes the chances for flow discontinuity, further enhancing deposition processes.