

Modeling self organizing shrub mound formation and their stability on semi-arid slopes

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Introduction

- Shrubs become enriched
 - Crusted areas are depleted
- self promoting process



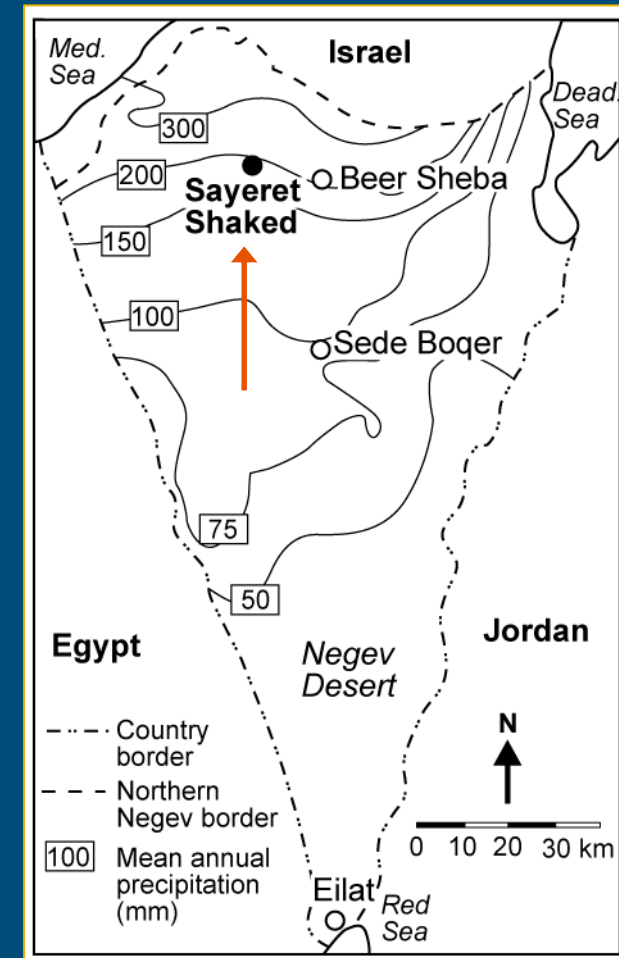
Introduction

- Shrubs often grow on mounds
- Dust and OM deposition
- Water erosion
- Splash erosion and sedimentation
- Root growth and bioturbation

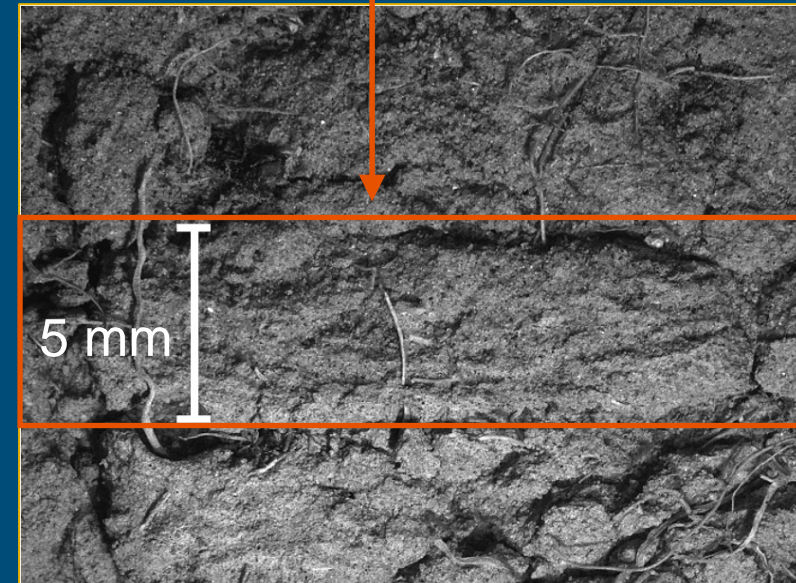
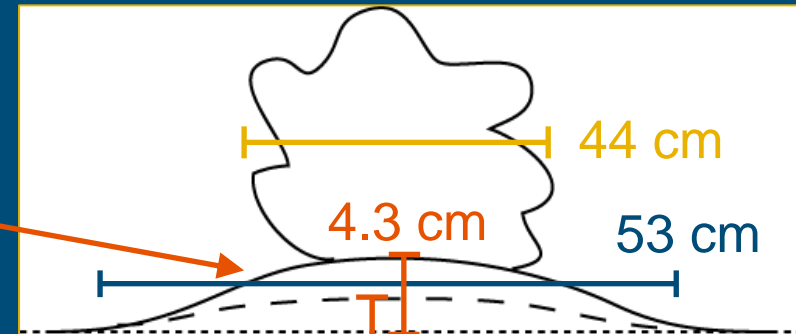


Aim of the study

- Shed light on shrub mounds
 - Process of mound formation
 - Circumstances under which mounds form
 - How stable mounds are
- Studying shrub mounds in the field and with thin sections in Sayeret Shaked
- Model simulations for single events and 100 years events based on Sayeret Shaked



Results field studies



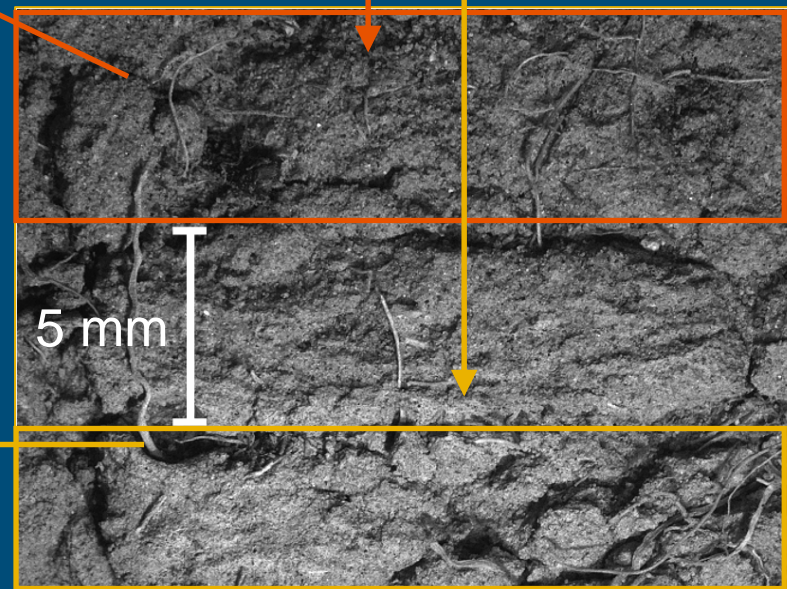
Results field studies



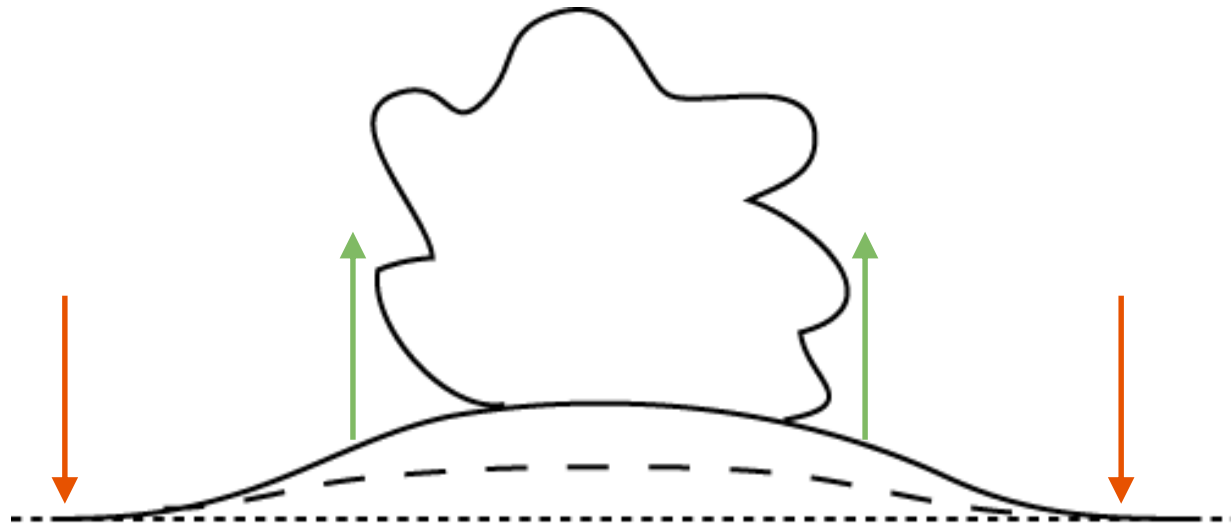
2.03 cm



2.85 cm



Discussion field study



- Sedimentation ± 2.03 cm, erosion ± 2.85 cm
- Mounds are formed by erosion and sedimentation



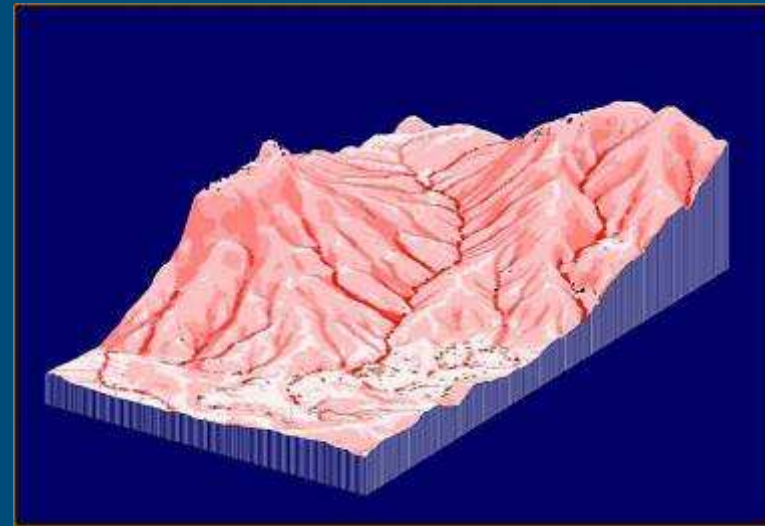
Material & methods model simulations

- Single precipitation events → effect shrub size and cover on water and soil redistribution and surface circumstances for mound formation
- 100 years precipitation events at 3 precipitation scenarios (100, 200 & 400 mm / year) → reconstruct mounds and climate range for mound formation
- Using test slope of 20x20 m based on study site
- Surface only covered by shrub and crust
- Using landscape evolution model LAPSUS-DE



LAPSUS-DE

- LandscApe ProcesS modeling at mUlti dimensions and scaleS in Deserts
- Spatially explicit
- Water redistribution
- Erosion and sedimentation
- Dust deposition
- Daily precipitation events
- Borland C++



Based on:

E. Buis & A. Veldkamp (in press)

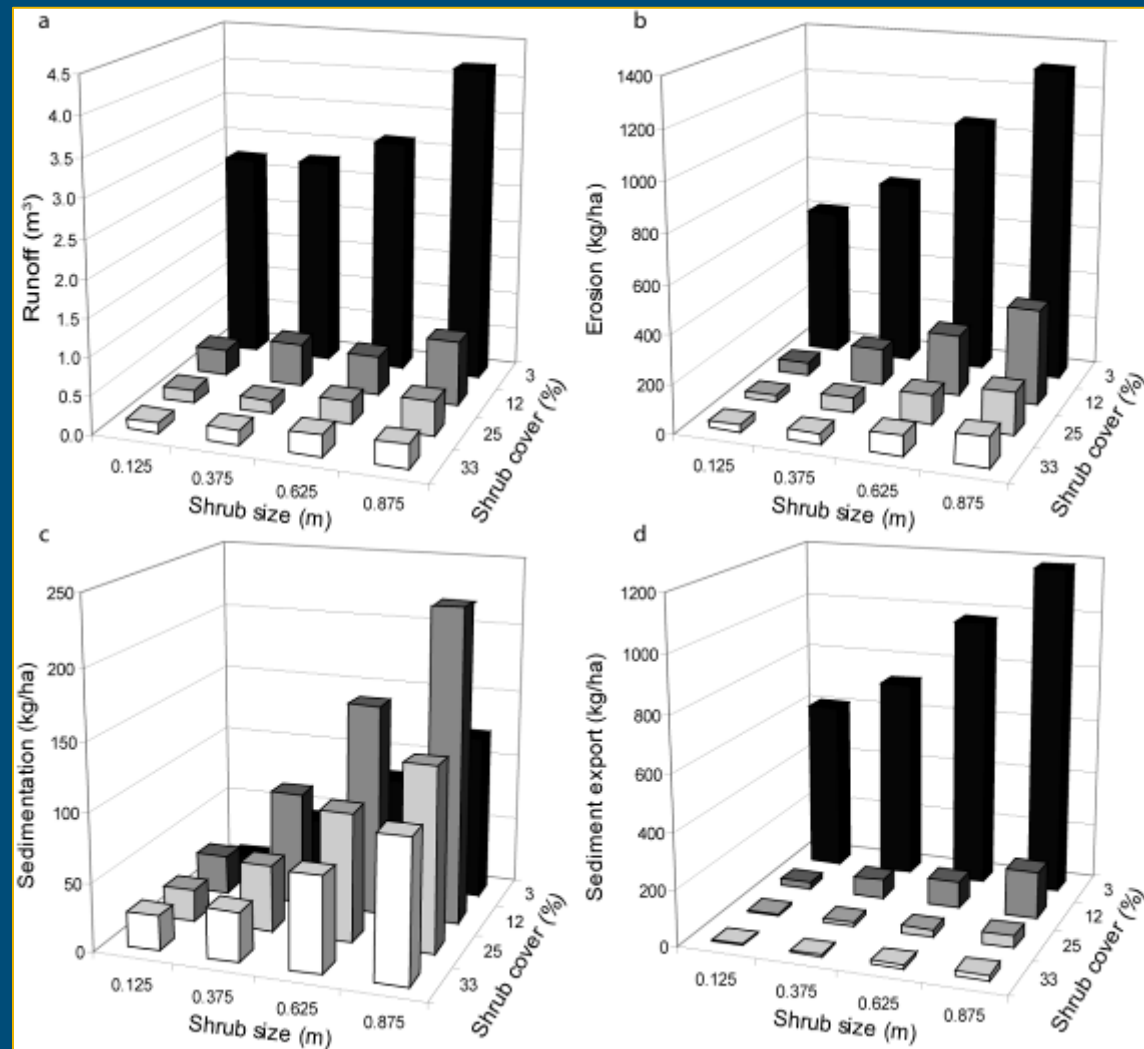
JM Schoorl, MPW Sonneveld & A Veldkamp (2000), Earth Surface Processes & Landforms 25: 1025-1034



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Results single event simulation

→ Shrub cover has strongest effect



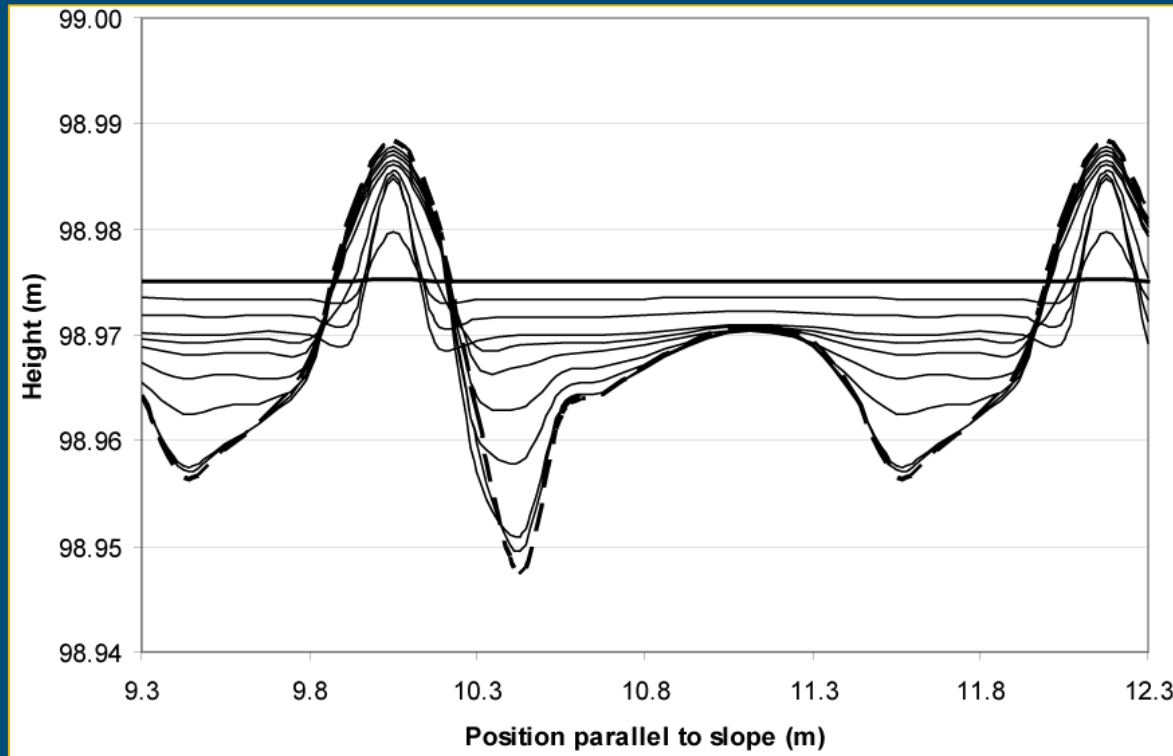
Discussion single event simulation

- Shrub mound formation occurs only if both erosion and sedimentation are active
- Individual shrubs receive most resources on slopes with low shrub cover and large shrub size
- Mound formation is strongest on these highly erosive slopes



Results 100 years simulation – normal scenario

200 mm
per year



- Shrub mounds are formed: sedimentation 1.32 cm, erosion 2.77 cm



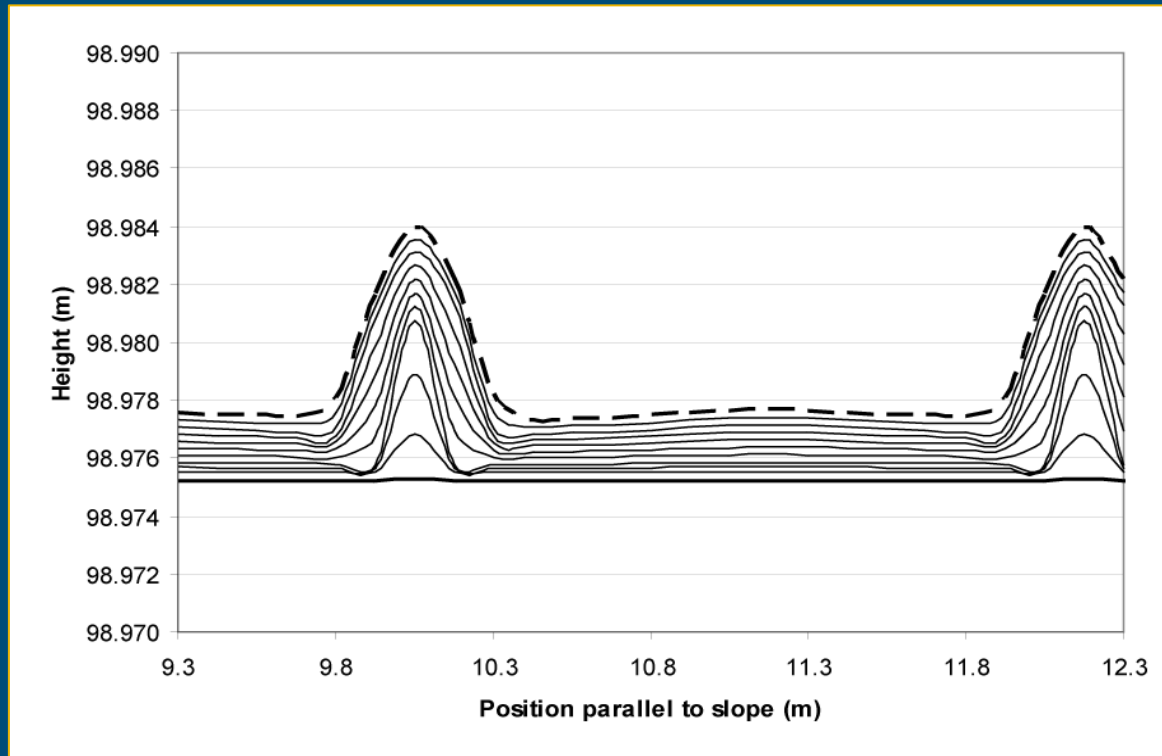
Discussion 100 years simulation

- At the current annual precipitation shrub mounds are formed, though simulation not totally correct
 - Erosion is well simulated
 - Sedimentation too low:
 - 1) no splash erosion in model,
 - 2) additional dust collection surface not modeled,
 - 3) bioturbation and increased porosity not modeled



Results 100 years simulation – dry scenario

100 mm
per year

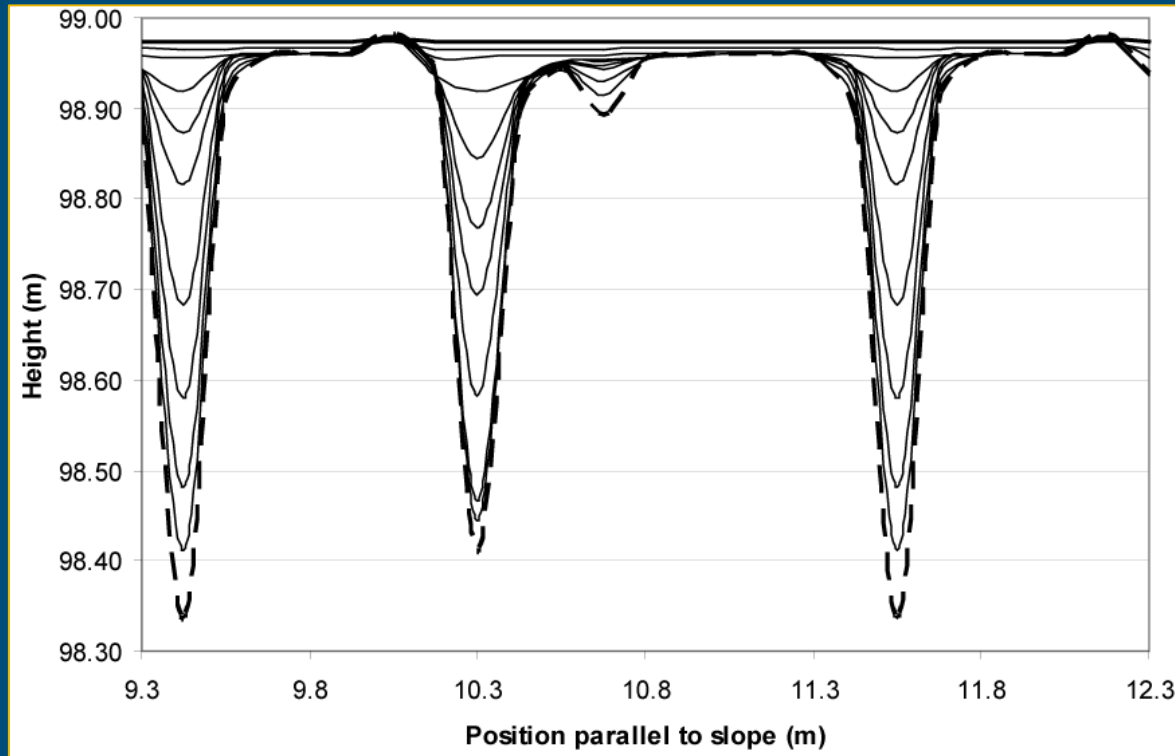


- Shrub mounds are barely formed: sedimentation max. 0.9 cm, almost no erosion



Results 100 years simulation – wet scenario

400 mm
per year



- Deep gullies are formed: almost no sedimentation, erosion very severe (max. 64 cm)



Discussion 100 years simulation

- At dryer climate no shrubs are formed, as barely erosion takes place and no sediments are available
→ Slopes are very stable: no shrub – crust landscape
- At wetter climate erosion is too strong for mound formation
→ Slopes are unstable. BUT in natural situation vegetation cover is complete: no shrub – crust landscape



Conclusions

- In the study site shrub mounds are formed by combined process of erosion and sedimentation
- Mound formation strongest on slopes with low shrub cover and large shrub size
- Shrubs do best in a degrading environment and form a highly resistant shrub – crust landscape
- In both dryer and wetter climate no mound formation will occur → mound formation is limited to a small precipitation range

