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Session HS 8.3.14: Soil water repellency in a changing climate

Water repellency in an Alpine forest soil and its impact on hydraulic characteristics under simulated climate change

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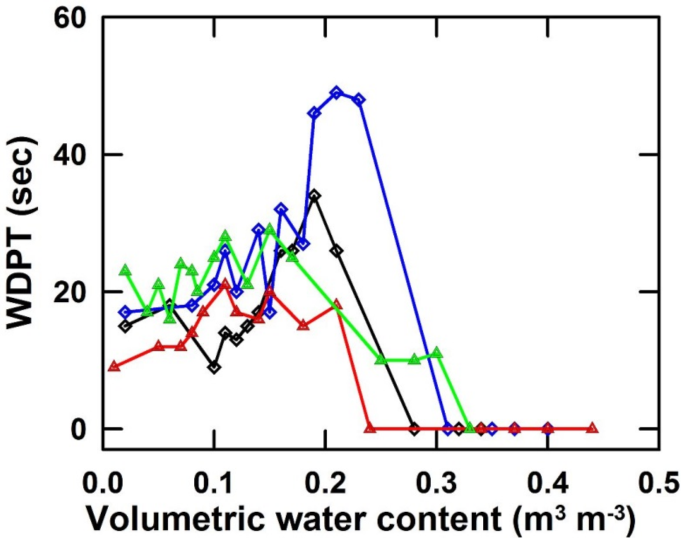
Occurence and types of soil water repellency (SWR)

- **Potential** SWR depends on rather static physical and chemical soil properties (texture, organic matter, pH)
- **Actual** SWR is a function of the soil water content and occurs below site-specific critical values only
- Climatic conditions (occurence of times with low soil water contents) control the degree of actual SWR
- Climate change is expected to result in prolonged drought periods and strong rainfall in central Europe



Determination of critical water contents (Landl, 2013): Pallic soil, Hawke‘s Bay, New Zealand

Inhibited sample saturation (Asadian, 2014): Podsolic Cambisol, Rosalian Mountains, Austria

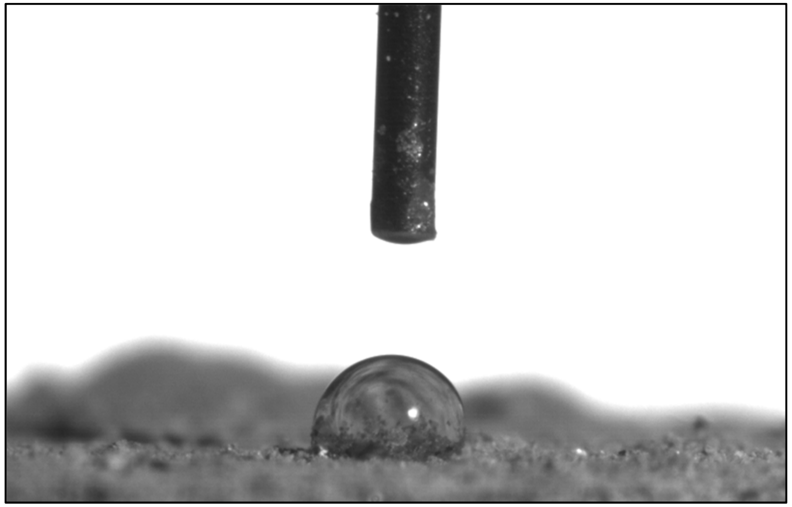
Hypotheses and study objectives

Hypotheses

- Occurence and degree of SWR are controlled by climatic conditions and increase with prolonged drought periods
- SWR can be quantified by the soil/water contact angle (CA, potential repellency) and by combined infiltration experiments with water and ethanol (actual repellency)

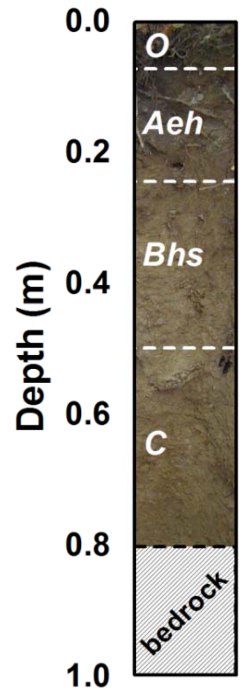
Objectives

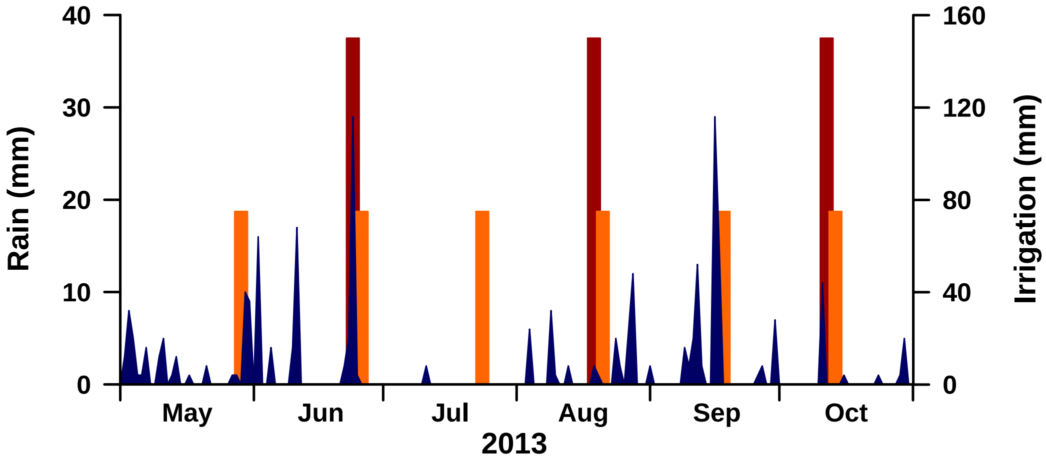
- Quantification of potential and actual SWR under different rainfall treatments
- Impact assessment of SWR on hydraulic soil properties



Experimental site and measurements

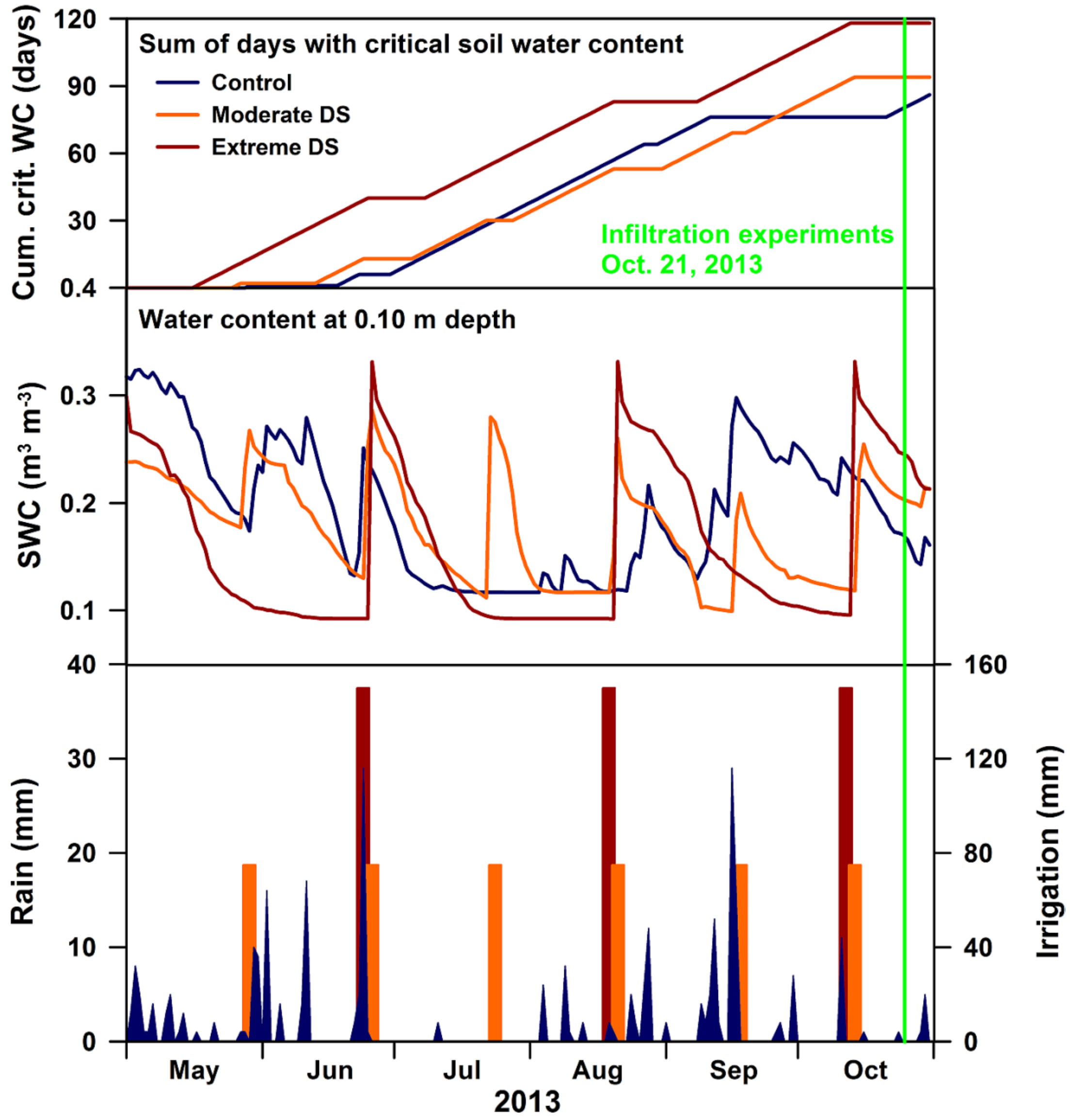
- Field trial at the BOKU forest demonstration centre in the Rosalian Mountains, Lower Austria
- Podsolic Cambisol over granitic bedrock, beech forest with some spruces, mean P =796 mm
- 3 different climate change treatments: **Control**, **moderate** and **extreme** rainfall redistribution
- Experiments end of October 2013:
  - Small-scale determination of CA (modified sessile drop method), TOC and OM composition (FT-IR) in two depths
  - Determination of (intrinsic) soil hydraulic properties (evaporation method)
  - Combined infiltration experiments with water and ethanol (tension infiltrometer)





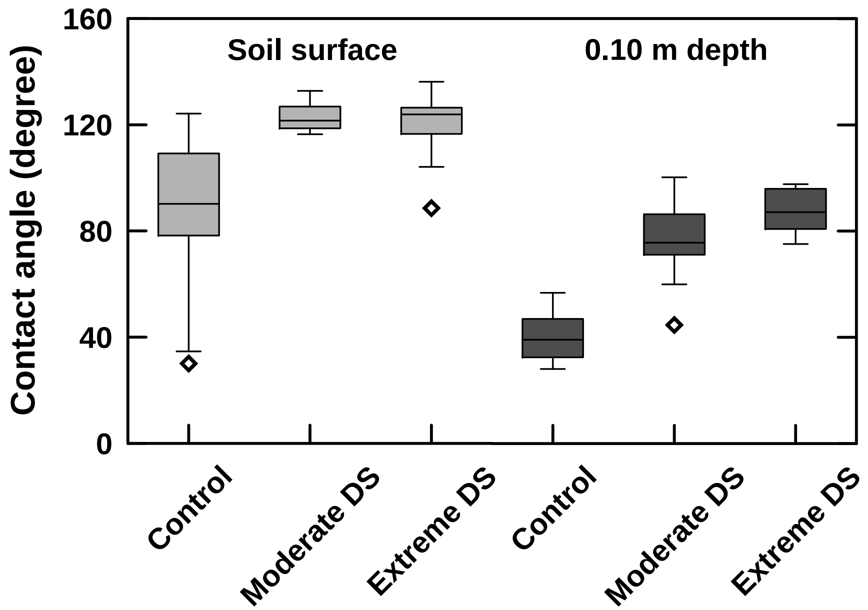
Occurence of critical soil water contents

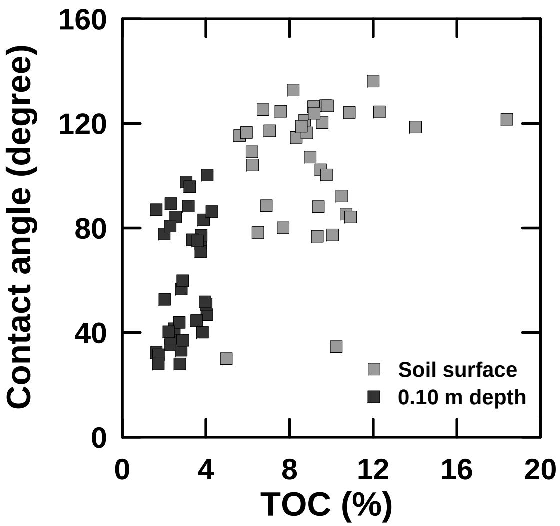
- $\theta_{crit} = 0.18\ m^3\ m^{-3}$ (Dekker et al., 2001)
- Sum on Oct. 21
  - Control: 76 days
  - Moderate DS: 94 days
  - Extreme DS: 118 days

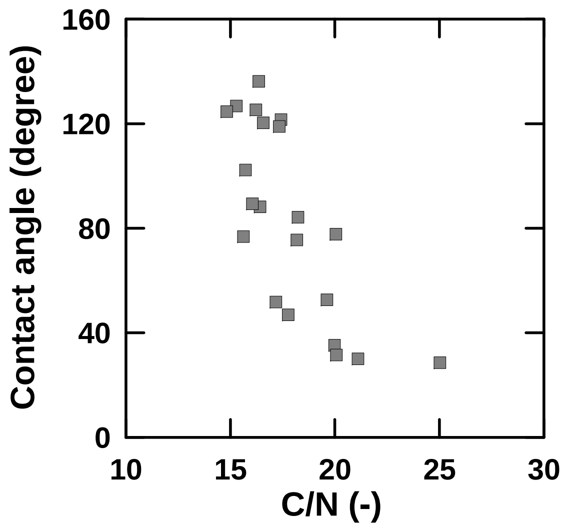


Potential repellency and its controlling factors

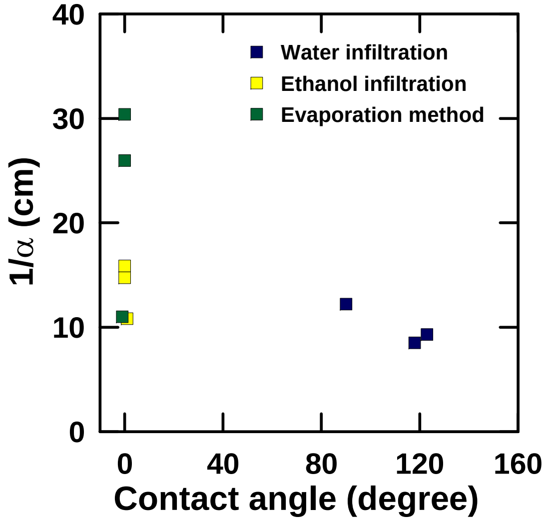
- Weak correlation with TOC
- Good correlation with C/N (Lamparter et al., 2014)
- Short-term effects of treatment establishment
- Increased repellency in 0.10 m depth

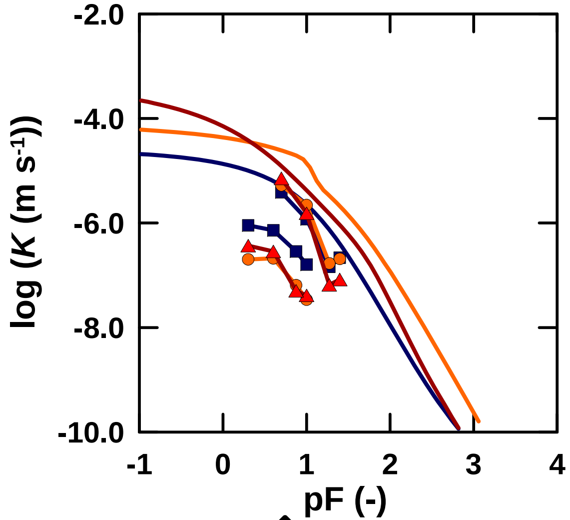






Actual repellency and impact on soil hydraulic properties

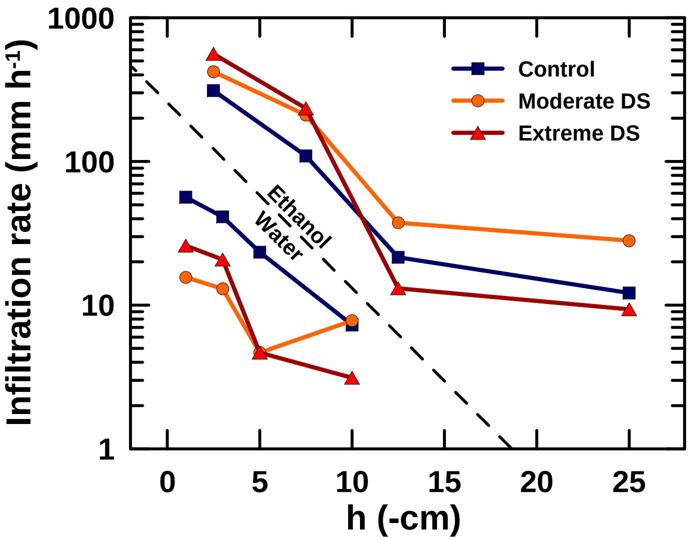




Wooding (1968)

Mean reduction in K(h):

- Control: 85.6 %
- Moderate DS: 97.4 %
- Extreme DS: 96.9 %



Conclusion

- The experimental design and irrigation schedule resulted in slightly prolonged periods with critical (low) soil water contents followed by strong rainfall events.
- We found a considerable degree of potential and actual SWR as a result of natural soil properties and opposed rainfall redistribution treatments.
- Potential SWR was characterized by critical (> 90°) CA. CA were inversely correlated with the C/N ratio and showed treatment-induced reductions, especially in the subsurface.
- The degree of actual repellency resulted in strongly reduced near-saturated hydraulic conductivities compared to intrinsic hydraulic properties. The air-entry point (inverse of van Genuchten α) was reduced due to SWR as reflected by the CA.

Perspective

- Development of a conceptual soil hydraulic property model that accounts for SWR
- Quantification of temporal SWR variations as affected by the rainfall treatments

Thank you for your attention !

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