Geoelectrical Monitoring of Soil Moisture in Hugelcultures

Natalie Müller[1], Johannes Hoppenbrock[1,2], Falko Feldmann[2], Matthias Bücker[1]

[1] Technische Universität Braunschweig | Institut für Geophysik und extraterrestrische Physik | Braunschweig, Germany
[2] Julius Kühn-Institut | Institut für Pflanzenschutz in Gartenbau und urbanem Grün | Braunschweig, Germany

Contact: natalie.mueller@tu-braunschweig.de

Gefördert durch: Bundesministerium für Ernährung und Landwirtschaft aufgrund eines Beschlusses des Deutschen Bundestages

Motivation

Hugelcultures are a promising technique for gardeners to attain profitable harvests with minimal watering

Hypothesis: The core of hugelcultures serves as a moisture reservoir

Objective: Comparison of soil moisture monitoring methods to prove water retaining capability of hugelcultures located in Braunschweig

Methods:

- **ERT** (Electrical resistivity tomography) monitoring with GEOTOM as measuring device
- **TDR** (Time domain reflectometry) measurements of volumetric water content with TEROS 11 sensors
- Climate data form a nearby climate station located in Braunschweig

Structure of a hugelculture

Hugelculture is a gardening practice that involves creating raised beds using decaying wood and organic matter

Fig 1: Image of a hugelculture in Braunschweig

- Soil and compost
- Grass sole
- Smaller branches
- Leaves and shredded material
- **Inner core**
- Branches
- Excavated soil
- Decaying wood

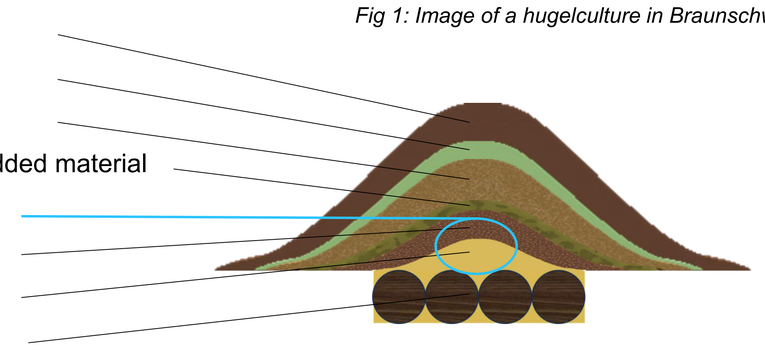


Fig 2: Schematic illustration of the internal structure of a hugelculture

Temporal variation of TDR water content data

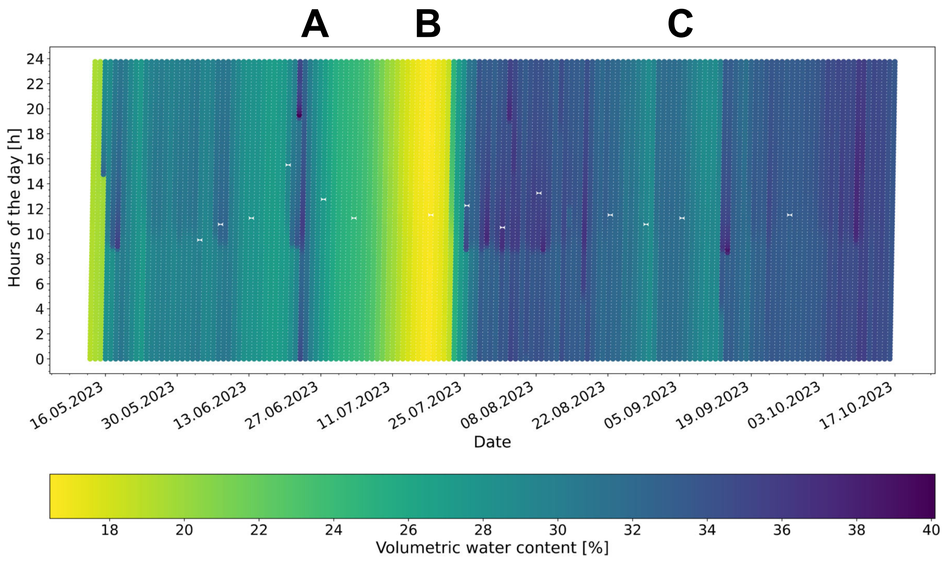


Fig 3: Volumetric water content color-coded over the hours of the day (vertical axis) and the days of the experiment (horizontal axis). The events A, B and C are discussed in more detail

Climate data over duration of experiment

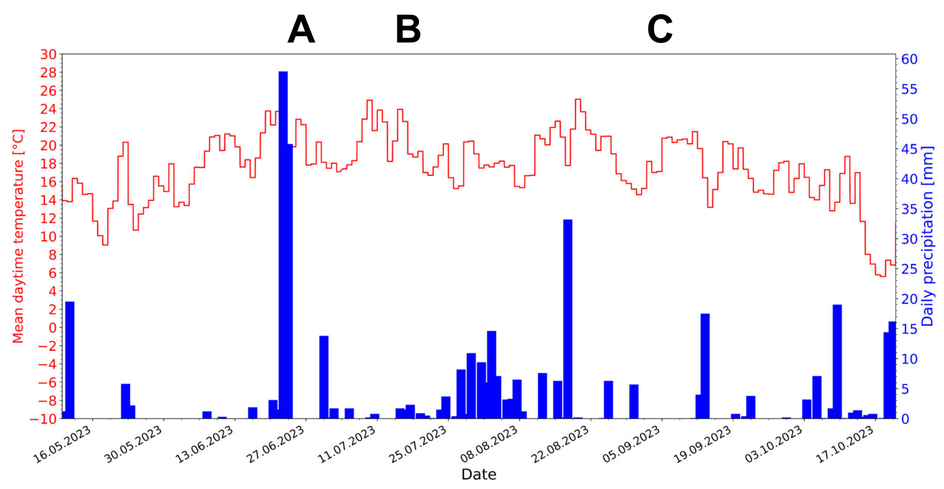


Fig 4: Average daytime temperature and sum of daily precipitation over the duration of the experiment

Results of the methods

- Event A: Heavy rainfall at end of June evident in climate and water-content data
- Event B: Dry period mid July evident in climate and water-content data
- Event C: Representation of an average day
- At June end (A) hugelculture shows significantly lower resistivity values compared to mid-July (B)

↳ Resistivity models correlate well with climate and water content data

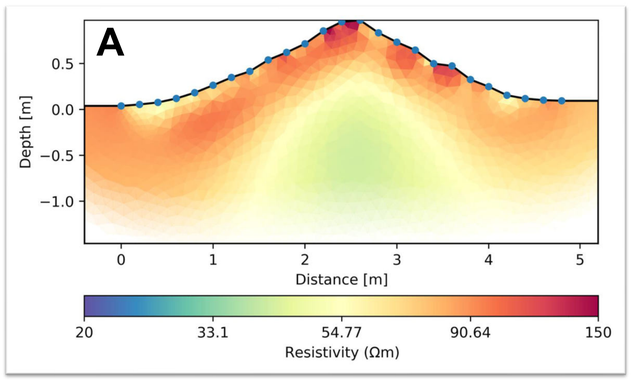
Through all ERT models:

- Surface layer exhibits lower resistivity values resulting from irrigation
- Sub-surface layer exhibits higher resistivity values than interior of the hugelculture

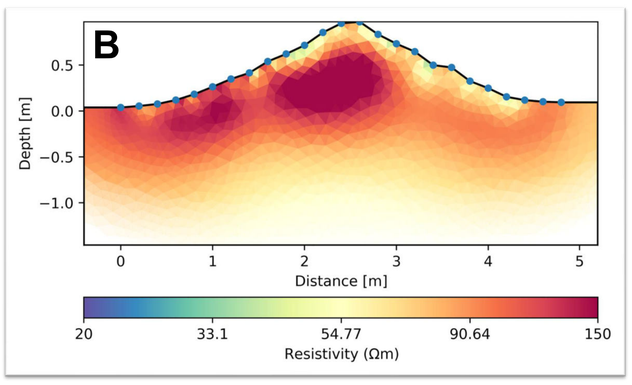
⟶ **The inner core seems to retain moisture**

Temporal variation of resistivity

27.06.2023



18.07.2023



05.09.2023

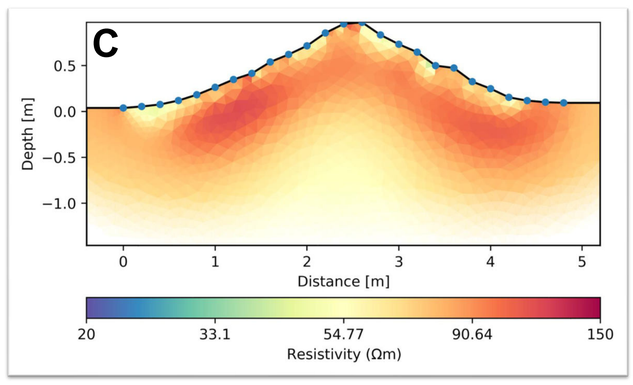


Fig 5: Inversion results for the same profile in June, July and September, inverted with pyGiMLi [1]

Conclusion and Outlook

ERT and TDR monitoring match with the climate data

- Seasonal fluctuations can be observed
- The inner core of the hugelculture retains water and may act as a moisture reservoir

Future steps:

- Comparison of the results for different hugelcultures
- Time-lapse inversions for improved detection of the water regime in the hugelculture

Acknowledgement and References

Many thanks to the CliMax Project for supporting my project and supplying the TDR sensors.

References:

[1] Rücker, Carsten; Günther, Thomas; Wagner, Florian M.(2017): pyGIMLi: An open-source library for modelling andinversion in geophysics. In: Computers & Geosciences109, S. 106–123. DOI: 10.1016/j.cageo.2017.07.011.