Resistivity mapping with *Geophilus electricus* – information about lateral and vertical soil heterogeneity

E. Lueck (University of Potsdam, Germany)  
J. Ruehlmann (Institute of Vegetable and Ornamental Crops, Germany)

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**Electrical conductivity (EC, ECa)**

- Images spatial soil heterogeneity  
- Contains information about stratification

- Can be measured with:
  1. Direct current method with galvanic coupling (DC-method)  
  2. Electromagnetic method  
  3. Capacitive coupled electrodes

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**What is new?**

- Five/six channels ➔ five/six depth levels  
- Modular system allows to change the geometry between the electrodes and therefore the depth of investigation  
- Investigation of frequency dependency  
- Additional information about phase shift

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**Geophilus electricus**

= a soil mapping system with rolling electrodes

5 channels  
6 channels

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**Geocoding**

- Trimble-dGPS (accuracy < 50 cm)  
- GPS EZ-Guide 500 System  
- Parallel drive assistant  
- GPS receiver

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**Geophilus electricus**

- SIP-instrument  
  T. Radic, Berlin

- Maximum power: 50 W  
- Maximum voltage: ± 400 V  
- Maximum current: ± 125 mA  
- Frequency range: 1 mHz - 1 kHz  
- 4 frequencies simultaneously
Highly exact digital elevation model: Optic-electronical tachymeter (accuracy < 1 cm)

GPS EZ-Guide 500 System
Parallel drive assistant

Test sites
- Agricultural land (precision farming)
- long term experiments (spatial heterogeneity, compaction, fertilization)
- peat regions
- saline areas (nature conservation)
- post-mining landscape
- archaeology (ditches, settlements, park structures)

- more than 1500ha (~ 800 km)
- conductivities between 0.2 and 100 mS/m

Conductivity mapping on farm scale Trebbin (Brandenburg)

Comparison with Veris-data

ECa maps have a better spatial resolution than existing soil maps because the higher density of data values.

Soil map (redrawn after German Land Classification)
**Conductivity-depth-models - Köllitsch**

Profile I: Contact between loam and sand

Profile II: Sandy region

**Experimental test site in Großbeeren near Potsdam**
- Transect of 200 m length and 3 m width
- Sandy soil (78.75 % sand, 18 % silt, 3.25 % clay)
- Man-made structures at several locations
  - Loam (autumn 2004) 45-64 m
    (52.73 % sand, 38.77 % silt, 8.43 % clay)
  - Peat (spring 2005) 125-135 m
  - Bricks and basaltic powder (autumn 2008)

**Geophilus measurements**

**Why different frequencies?**

Frequency dependency of EC due to:
- Induced polarization ($f < 100$ Hz)
- Resistance between electrodes and soil ($f > 100$ Hz)
- Electromagnetic effects

- Spectra depend on soil properties
- Frequency affects the signal to noise ratio
- Different frequency effects for amplitude and phase

**Spectra**

Loamy soil

Sandy soil

**Signal quality**

Depends on measured voltage depends on spacing between electrodes

<table>
<thead>
<tr>
<th>Dipole spacing [m]</th>
<th>0.5</th>
<th>1.0</th>
<th>1.5</th>
<th>2.0</th>
<th>2.5</th>
<th>3.0</th>
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<td>1.0</td>
<td>0.5</td>
<td>0.3</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Ohrsleben (Sachsen-Anhalt), clay content up to 50% high conductive soil
Phase data

- Induced polarisation
  - RC-coupling between electrodes and soil
- Correlation between phase and EC

Time stability of conductivity pattern

Time stability of phase pattern

Additional information from phase data

- Pore structure → compaction
- Electromagnetic effects → metallic pipes

Electronic:
- sinus wave generator
- top-message instrument – Delphin
- WLAN – computer controlling
Thank you for your attention!