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Resistivity mapping with Geophilus electricus

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Geophysical methods allow rapid and cost-efficient acquisition of soil related data. Many successful surveys with gamma radiometric and electrical conductivity sensors were published. After summarizing practical experiences with existing conductivity sensors (EM38, VERIS3100, ARP and OhmMapper), the GEOPHILUS ELECTRICUS was designed. The novel system measures geo-referenced (DGPS) soil electrical properties (electrical resistivity and phase angle). Using an array of galvanic coupled electrodes, the sensor design and its technical specification allow measuring the electrical parameters at five depth levels up to 1.5 m. This gives the possibility to image lateral differentiation as well as vertical stratification within the surface and subsurface. Rolling electrodes can be combined with any electrical device which is capable to measure continuously. The recent system consists of an equatorial dipole-dipole array combined with an electrical instrument developed by T. Radic (Radic Research, Germany). The complex resistivity values (amplitude and phase) are measured simultaneously for four frequencies within a frequency range between 1 mHz and 1 kHz. GEOPHILUS was developed to study further possibilities for soil mapping, especially to clarify the following topics:
- variation of signal frequency and its influence on resistivity measurements
- optimization of data quality using several frequencies simultaneously
- data inversion to image resistivity distribution instead of apparent values
- resistivity as a complex value – additional measurements of phase angle
- complementary information from phase data
The rolling electrode system will be moved by an off-road vehicle; the velocity depends on soil surface properties and required resolution and ranges between 5 and 15 km/h. The maximum daily mapping performance is about 100 ha. The GEOPHILUS system was tested under very contrasting conditions and for different purposes. Now, we have practical measurement experiments along a virtual transect of more than 1000 km length corresponding to an area of about 1300 ha. The overall consistency of the individual maps as well the obvious stratification (also confirmed by independent data) indicates a good performance of the GEOPHILUS system based on the good quality of the measured data. Therefore, the GEOPHILUS maps can be used to identify structural boundaries. In combination with soil sampling data, these EC measurements can be an effective instrument to create 3D maps of basic soil parameters.