Delineation of soil structure and the plough horizon through electrical imaging: laboratory investigations

Golab, Antonia (Research Group Geophysics, Department of Geodesy and Geoinformation, TU-Wien, Wien, AUT);
Gallistl, Jakob (Research Group Geophysics, Department of Geodesy and Geoinformation, TU-Wien, Wien, AUT);
Strauss, Peter (Institute of Land and Water Management, Petzenkirchen, AUT);
Flores-Orozco, Adrian (Research Group Geophysics, Department of Geodesy and Geoinformation, TU-Wien, Wien, AUT)

Tillage has major influence on the soils structure in the top layer of a field and therefore on the surface-groundwater interactions. The resulting soil structure, thus, depends on the method and depth used for tillage. Moreover, repeated tillage results in the creation of a plough pan, a dense layer characterized by low hydraulic permittivity, with the structure of the uppermost layer changing after every field treatment. Adequate field management, for instance to design of artificial irrigation systems require detailed information about the geometry of the plough pan (i.e., depth and micro-topography), as well as the structure of the top soil layer. Some studies have proposed the application of geophysical electrical methods to gain information of the soil electrical properties in an imaging framework and use this information to delineate the plough pan and soil structures. To achieve this, this study investigates the feasibility of electrical resistivity tomography (ERT) to map water paths and the plough pan. To reduce the uncertainties associated to field acquisition, measurements were conducted in the laboratory using an undisturbed soil core with dimensions of 100.1 x 49.5 x 28.8 cm. Different electrode configurations were tested deploying electrodes placed on top and the bottom of the soil core, and with various separations between the electrodes. Data analysis was carefully performed for each dataset to identify and remove outliers (systematic error) and quantify random error and improve the reliability of the resulting inversion results. Imaging results show structures near the surface which could be related to water flow paths. Moreover, a clear contact in the electrical properties may be interpreted as the plough pan. Results presented here demonstrate the potential of the ERT method to assess soil structures with high resolution as required for an improved field management.