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Geoelectrical cartography of soils

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Spatial information on soils is usually obtained using the following mapping approach : firstly, localized visual observations are made on sampled soil profiles to recognize soil types and their characteristics and secondly, qualitative relationships between soil types and environmental factors (geology, topography . . .) are used to interpolate local soil information. This approach fails when the soil cover is highly heterogeneous or when soil spatial distribution weakly depends on environmental factors. Geophysical methods allow a quasi-continuous survey (high density of measurements) and thus have the potential to highlight soil variability. In addition to the improvement of soil cartography, these methods are expected to contribute to a better characterization of polluted sites and to reduce the risks of diffuse contamination of ground water by pollutants in connection with the agricultural practices.
Measurement of electrical resistivity with a towed device, ARP (Automatic Resistivity Profiling) is performed at three depths following electrode spacing. However geoelectrical survey provides an integrative measurement of soil properties but not a direct estimation of its geometrical characteristics (depth, thickness of soil horizons). Consequently, geophysical interpretation is required to obtain the most likely 3D spatial structure of soil.
Firstly, forward modelling by the moment method was used to provide knowledge about the resolution of the technique when measuring the response of a resistive anomaly of various dimensions and thickness. This allowed the optimum experimental measurement conditions to be defined. Secondly, experimental data resulting from survey on several sites were used to obtain, after data interpolation, three maps of apparent resistivity corresponding to the three electrode arrays. Apparent resistivity contrasts corresponds well to those of the soil cover. Calcisols with high resistivity can be easily distinguished from more conductive luvisols. Different apparent resistivities within luvisols are found to be related to different clay or stones content. Finally, inversion of experimental data is realized so as to work with interpreted resistivities. Inverse modelling is carried out by a classical least square scheme including Levenberg-Marquardt stabilisation. Bayesian inversion is also considered in a probabilistic approach. Data inversion is constrained by soil profile observations to lead to the best 3D representation of the soil cover.
As a perspective we will try to define geophysical taxons that could correspond to the pedological map for a specific geological context. Another approach will be to interpolate a vertical profile of resistivity with the three measurements and assign each of these profiles to a soil taxon.