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Delineation of soil drainage class by electromagnetically measurements of soil magnetic susceptibility

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Soil has the most important role in agriculture. For instance, it prevents run off and also through its capacity for storing water, it acts as a water reservoir and provide water resources for plant roots. Water retention characteristics, nutrient holding capacities and solute transport of soil can affect its productivity. So, the plant growth is directly associated with the type of soil drainage. The prediction of soil drainage classes is one of the major steps in developing crop modelling. Among different physical and chemical soil health indicators, soil magnetic susceptibility (MS) is a promising factor for soil surveying because it is strongly affected by soil drainage class. The extremely reducing conditions, present in hydric soils, significantly enhance dissolution of soil ferrimagnetic minerals such as magnetite and maghemite. Since the MS of soils is mainly controlled by magnetite and maghemite concentrations, therefore MS values are typically very low in hydric, i.e. poorly drained or gleyed, soils.

The common method for measuring soil MS is utilizing handheld or laboratory MS meters (e.g. Bartington MS2 sensors). Such MS meters are required soil specimen to be available to directly measure MS of that specimen. So, their application is limited to surface soils, soil exposures and sampled soils. Other types of instruments for quickly measuring soil properties are electromagnetic induction (EMI) instruments. Although the EMI instruments were primarily invented to measure electrical conductivity (EC) of the topsoil for assessment of soil salinity, they can also be utilized to measure absolute value of the volume MS of the topsoil. These volume MS values can be further processed and inverted to reveal MS variations of soil layers.

In this study, 1-D inversion of volume MS data, measured by Geonics EM38 instrument in both vertical and horizontal magnetic dipole configurations, was done to calculate MS of selected soil profiles in order to delineate soil drainage classes. Besides, laboratory measurements of volume and mass-specific MS of soil core samples, collected in the same soil profiles, were done using Bartington MS2B and MS2C sensors. Results show a strong and positive relationship between MS values measured in the laboratory and volume MS recovered from inversion technique. Furthermore, the results reveal that MS in a well drained profile is higher than that of a poorly drained profile. Since EMI measurements of soil MS are done quickly in the field, then using surface MS measurements facilitates hydric soil delineation in a faster and more precise way.