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Validation of a paleo river system derived by ground based electromagnetic induction measurements with satellite based RapidEye images

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Morphological remnants of an inactive river system that has been filled by younger sediments can provide datable proxies about past climatic conditions. However, sediment composition of their infillings is a challenge for agriculture, in particular for precision agriculture. Differential crop development and yield reduction are often a consequence of lateral and vertical textural inhomogeneities. Several studies have shown that buried river systems can be traced by the use of remote sensing. However, the appearance of crop marks strongly depends on environmental conditions, and therefore, the reliance of remotely acquired data can become time and cost expensive. Soil physical properties which are related to textural differences can be mapped fast and cost-effective by the use of near surface geophysics. Especially electromagnetic induction (EMI), which measures soil apparent conductivity (ECa), has become a tool of choice to characterize large areas in high resolution. The introduction of multiple coil EMI systems as well as the quantification of respective measurements enables a reliable multilayer inversion.

The aim of this study was to map a postglacial river system on agricultural fields and to mark out buried remains such as trenches and bomb craters of World War II. In summer 2012 ten fields (17 ha) were mapped with the CMD MiniExplorer, a multiple coil EMI system especially appropriate for near surface applications, after the harvest of winter wheat and sugar beet. At elevated sandy sites meander like patterns with higher conductivity were mapped. ECa measurements were verified by textural data taken from directed soil samples and vertical ECa logs. Sediment thickness was evaluated on soil cores and electrical resistivity tomography (ERT) transects. Furthermore, ERT quantified ECa measurements were correlated with satellite as well as destructive derived leaf area index (LAI) measurements. In 3 of 71 LAI maps derived by multispectral RapidEye imagery crop marks were clearly visible following a dry season in spring 2011. These patterns are in coincidence with higher conductivity patterns caused by a higher amount of silt and clay. Good correlations were found for LAI measurements taken during a growing season with underlying sediments especially in the early stages of plant development. Finally, ECa measurements of two heterogeneous fields were used for a 3D layer inversion which will be further implemented into landscape models. This study shows that multiple EMI measurements can be successfully used to recover buried river systems, highlight possible sample locations and support farmers to manage their fields more precisely.