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Methods Summary

Mapping Soil Spatial Variability with Apparent Soil Electrical Conductivity (EC_a) Directed Soil Sampling

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In this summary, we provide a brief overview of the chapter entitled "Field-Scale Soil Electrical Conductivity", recently published in the *Methods of Soil Analysis* (vol. 1) series.

Abbreviations: EC_a, apparent soil electrical conductivity.

Core Ideas

- **Protocols and guidelines are presented for measuring and mapping the spatial variability of soil properties using apparent soil electrical conductivity (EC_a).**
- **The protocols focus on EC_a–directed soil sampling.**
- **Mobile EC_a equipment, protocols, guidelines, special considerations, data reliability, and strengths and limitations of EC_a–directed soil sampling are presented.**

Soil has a profound impact on environmental and agricultural processes, such as plant–water–soil interactions, water flow, and solute transport, which influence crop yield and degradation of soil quality. However, soil is highly variable, particularly for properties such as salinity, water content, and various chemical constituents (e.g., major cations and anions, trace elements, etc.), often over short spatial scales. Measurements of the apparent soil electrical conductivity (EC_a) are a proven and robust means of characterizing the spatial distribution of a variety of soil properties, including salinity, water content, texture, organic matter, bulk density, and cation exchange capacity [e.g., Corwin and Lesch (2003)]. However, the interpretation of EC_a is not straightforward: measurement errors, complex interactions among the soil properties influencing the sensor measurements, and other factors could lead to misleading information about soil spatial variability. Therefore, when using spatial measurements of EC_a, protocols and guidelines should be followed to maximize the quality and reliability of the sensor measurements.

Methods for measuring the spatial variability of soil properties (e.g., salinity, texture, water content, bulk density, and organic matter) at field scale and larger spatial extents (i.e., > 1–10 km^2) are presented in the chapter entitled "Field-Scale Apparent Soil Electrical Conductivity", recently published in the *Methods of Soil Analysis* (vol. 1) series (Corwin and Scudiero, 2016). Corwin and Scudiero (2016) provide an overview of characterizing soil spatial variability using EC_a–directed soil sampling across multiple scales with a primary focus on field scale. Conceptually, EC_a–directed soil sampling uses geo-referenced measurements of EC_a as a surrogate of soil spatial variability to direct soil sampling and is based on the notion that when EC_a correlates with a soil property, then spatial EC_a information can be used to identify sites that reflect the range and spatial variability of the property.

The information in Corwin and Scudiero (2016) provides undergraduate and graduate students, university faculty and staff, post-graduate researchers, soil scientists, agricultural engineers, resource specialists, agronomists, crop scientists, private industry professionals in agriculture and conservation, and agricultural consultants with the step-by-step instructions for mapping soil spatial variability from geo-referenced EC_a information. There are 10 basic steps that comprise the protocols for conducting an EC_a–directed sampling survey to characterize soil spatial variability: (i) recording of metadata, site description, GPS control and boundary points, (ii) EC_a survey design, (iii) geo-referenced EC_a data collection,

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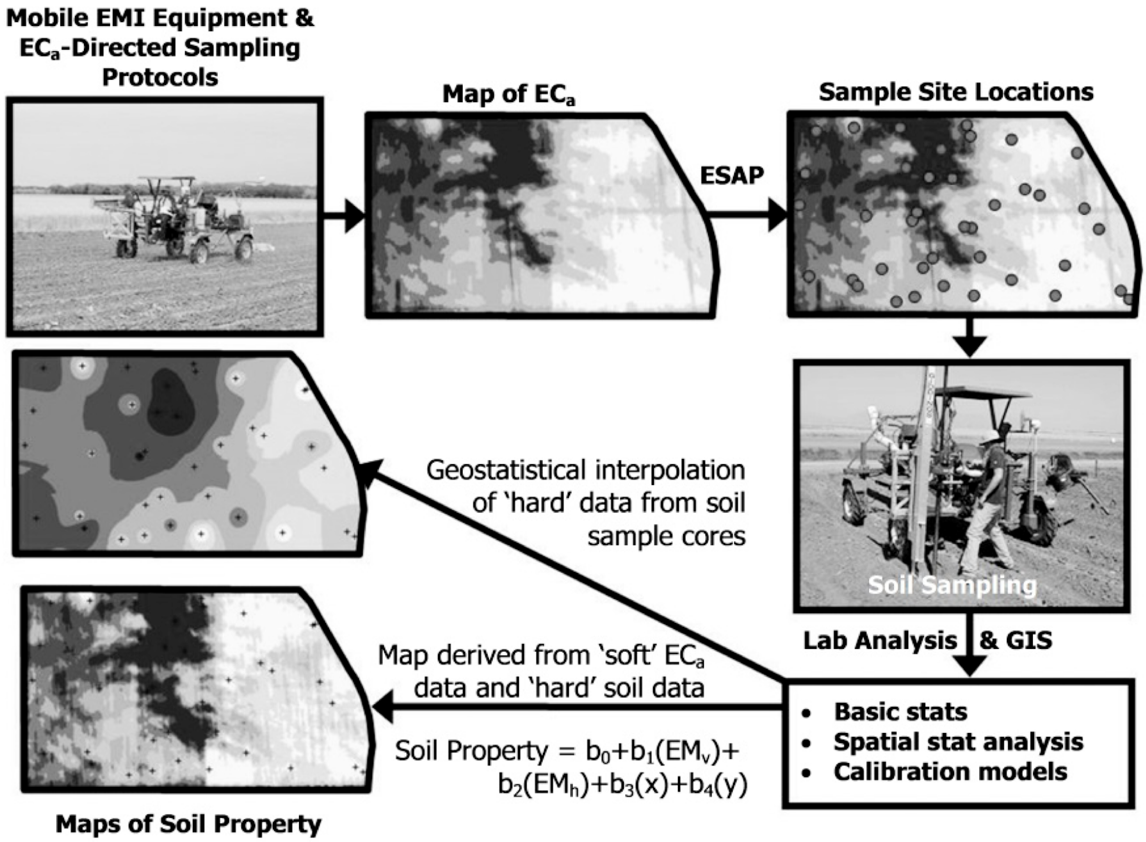

Fig. 1. Schematic of the integrated system for field-scale mapping of soil spatial variability using apparent soil electrical conductivity (EC_a) directed sampling protocols, mobile electromagnetic induction (EMI) equipment, ESAP software, and geographic information system (GIS). Modified from Corwin (2015). EM_v refers to EMI measurement in the vertical coil configuration and EM_h refers to EMI measurement in the horizontal coil configuration.

(iv) soil sample design based on geo-referenced EC_a data, (v) soil sample collection, (vi) physical and chemical analysis of pertinent soil properties, (vii) development of a stochastic and/or deterministic calibration of EC_a to a target property (e.g., soil salinity), (viii) spatial statistical analysis, (ix) geographic information system database development, and (x) graphic display of spatial data. Each step is discussed in detail. Figure 1 shows the flow of information for the integrated system of mobile equipment, protocols, and software that produces maps characterizing soil spatial variability using EC_a–directed soil sampling.

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