

Proximal Soil Sensing

Edited by R.A. Viscarra Rossel, A.B. McBratney, and B. Minasny. Springer, New York. 2010. 468 pp. Hardcover, \$179.00. ISBN 978-90-481-8858-1.

Challenges associated with water resources and land use issues have driven developments in soil science to better characterize phenomena at both fine and coarse spatial scales. To gain a better understanding of soil processes, a multidisciplinary approach needs to be applied to view the diversity and variability of soil chemistry, biology, and physical properties. Combined with advances in computer models and advances in digital mapping, the approaches that are presented in the book *Proximal Soil Sensing* address not only statistical validations, but also the economics associated with collecting and analyzing experimental data. The tools described in this book offer the researcher methods for reducing the costs associated with data collection and interpretation by strategic sampling and mathematical treatments of data.

The term *proximal soil sensing* in this context can be defined as a subdiscipline of soil science that includes the study of soil phenomena across spatial scales. Proximal soil science studies are relevant to precision agriculture, erosion, land use, and many other environmental concerns.

Proximal Soil Sensing is a collection of topics and case studies from a Digital Soil Sensing Workshop held in Sidney Australia in 2008. The book has 7 parts, with a total of 36 chapters. Each chapter briefly introduces a topic and provides a specific case study. There are about 120 contributors mentioned in this book. Two of the contributors are from Asia, 28 from Australia/New Zealand, 61 from Europe, and 20 from North America.

Part I introduces soil mapping and “On the Go” Sensors. “On the Go” refers to fast, mobile, inexpensive data collection techniques, primarily mobile electromagnetic sensors mounted to vehicles. Other topics include ultraviolet/visible and infrared spectroscopy (UV/VIS and IR) finger printing and spatial interpretations using various Kriging techniques.

Part II contains a number of papers on sensing techniques using electromagnetic sensors, electrochemical sensors, Latin Cube Sampling, and digital imagery. Part II also highlights the pioneers of proximal soil sensing, scientists such as Rothamsted, Haines, and Keen. This early work dates back to the 1920s, and some of the sensing systems they used were quite innovative for their time. The book points out that almost no papers were published on proximal soil sensing from the 1930s until precision agriculture emerged in the mid 1980s.

Part III focuses on UV/VIS and IR spectral sampling. The techniques described here address soil carbon, nutrient content, and one chapter on urban contaminants. Several chapters discuss data analyses of Fourier transform infrared spectroscopy, showing good statistical correlations between predictions and independently measured values.

The focus of Part IV is soil sensing by electromagnetic induction (EMI) and electrical resistivity. In this section, one study demonstrates that bulk apparent electrical conductivity (ECa) could possibly be used to calibrate electromagnetic induction and penetrating ECa data. Other studies published in Part IV use multivariate linear regression of perpendicular EMI ECa data to predict clay content in both the horizontal and vertical.

Also described are electromagnetic sensor (EM38) methods used to detect spatial patterns of subsoil compaction and soil moisture in the root zone with good success, while other studies show that EMI methods can't predict areas of crop vigor with the same degree of confidence.

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Vadose Zone J. 10:1–2
doi:10.2136/vzj2011.0105br
Received 8 Aug. 2011.

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Part V focuses on gamma and radar radiometric sensors. Ground penetrating radar, vector network analyzer technology, and radio frequency wave form modeling techniques have improved substantially during the past decade. These noninvasive techniques are now able to characterize vertical profiles of soil. With a strong correlation between radio isotopes and clay content and mineralogy, gamma ray emission can fingerprint not only the mineralogy, but also soil texture, nutrients, and heavy metal pollution. One case study used gamma sensing to detect naturally abundant Cd and correlated the Cd abundance to crop yield with a high coefficient of determination (R^2). Other studies suggest that gamma sensing in combination with other electromagnetic techniques may overcome limitations from one method alone.

Part VI is titled “Multisensor Systems and Other Sensors.” In this part, several sensing methods are used in combination to make assumptions about cropping systems. One study uses time domain

reflectometry data in combination with EMI mapping, and VIS-NIR to predict available water capacity.

Part VII contains two case studies. In the first case study, inverse meta-modeling of yield data is used to estimate soil available water holding capacities. The second case study uses EMI to map the vertical ECa. These data help reveal the paleotopography. During the last glacial period, loess filled in the valleys of the study area, flattening the landscape. The loess and the underlying paleosol clays have different ECa characteristics. Mapping the paleotopography can be used to reveal erosion patterns.

The book concludes with a brief look at the progress that has been made in proximal soil sensing and suggests future work for several of the techniques described in the previous chapters. Also mentioned is the development of the Global Soil Spectral Library.