Digital Soil Mapping with Limited Data

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Editors

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With a foreword by Robert J. Ahrens

Springer

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Foreword

Significant technological advances have been few and far between in the past approximately one hundred years of soil survey activities. Perhaps one of the most innovative techniques in the history of soil survey was the introduction of aerial photographs as base maps for field mapping, which replaced the conventional base map laboriously prepared by planetable and alidade. Such a relatively simple idea by today's standards revolutionized soil surveys by vastly increasing the accuracy and efficiently. Yet, even this innovative approach did not gain universal acceptance immediately and was hampered by a lack of aerial coverage of the world, funds to cover the costs, and in some cases a reluctance by some soil mappers and cartographers to change.

Digital Soil Mapping (DSM), which is already being used and tested by groups of dedicated and innovative pedologists, is perhaps the next great advancement in delivering soil survey information. However, like many new technologies, it too has yet to gain universal acceptance and is hampered by ignorance on the part of some pedologists and other scientists.

DSM is a spatial soil information system created by numerical models that account for the spatial and temporal variations of soil properties based on soil information and related environmental variables (Lagacheric and McBratney, 2007). Pedologists working with DSM technology are in the process of addressing questions and concerns. Some of these questions include production and processing of covariates (soil forming factors derived from remote sensing and existing soil maps), the collection of soil data, the development of soil predictions based on numerical models, and the representation of digital soil maps.

Covariates include the traditional soil forming factors of parent material, topography, vegetation, and climate. Some of the more sophisticated remote sensing techniques help glean information on the mineralogy and specific properties of the surface layers or horizons. The ever expanding application of remote sensing and associated decrease in costs open the doors for advantageous development of stronger soil covariates and improvement to the predictive utility of DSM.

Traditional soil survey has always struggled with the collection of data. The amount of soil data and information required to justify the mapping product, how to interpolate data to similar areas, and how to incorporate older data are all challenges that need further discussion. Older data often were collected with antiquated

or imprecise terms and must be cross-referenced to current standards, but the biggest obstacle in using older data is the lack of georeferencing. Traditional soil surveys have tried to write standards for data collection, but the practicality of applying the standards is difficult and not completely satisfactory. The amount of data is dependent on the complexity of the area and the experience of the mapper among other things. DSM also needs some guides or standards that will be difficult to cultivate to meet everyone's expectations and requirements. Some of the most ardent discussions in pedology center around standards, including different soil classification systems, and seemingly fail to concentrate and evaluate the end-product, which is the soil information provided to the user. DSM is a technological advancement that has the potential to be misunderstood and thus viewed with skepticism.

Numerical models are the functions that predict soil properties or soil classes. Most of these models have been calibrated with soil samplings and have been tested over small areas. The limitation of soil sampling dense enough to capture the spatial variability presently somewhat limit the use of numerical models to for large areas.

The world's overpopulation of the human race and associated pressures on resources, necessitate the immediate need for valuable soil information to make informed decisions about the soil resource, or, at the very least, make people aware of the problems and potential problems. We do not have the time or resources to canvass the earth and gather all the soil data and information needed to make soil surveys by our traditional methods. We need to look at the data that we do have and employ new methods and new technologies to deliver information on the soil resource. At the same time we should not be enamored solely on technology without an appreciation and understanding of soil-landscape relationships, which provide the predictive tools and foundations of soil survey.

DSM has the potential to deliver the needed information and in fact may provide better and more accurate information. However, the technology of DSM must overcome the skepticism associated with any new technology in the traditional world of soil survey where new technologies have been few and far between.

The purpose of this book is to present the latest technologies, challenges, and ideas related to DSM. Papers in this book were presented at the second Global Workshop on Digital Soil Mapping for Regions and Countries with Sparse Soil Spatial Data Infrastructures, which was held in Rio de Janeiro in July 2006. The EMBRAPA CNPS (Brazilian National Soil Research Centre) hosted the meeting, and the organizing committee was co-chaired by Dr. Lou Mendonça-Santos of EMBRAPA Solos and Prof. Alex McBratney of The University of Sydney, Australia. Chapters range from overviews of the DSM technology in general to specific applications in areas without much soil information or areas where specific parameters are investigated. Case studies in different parts of the world provide the opportunity to evaluate the information and test its utility. I invite you all to engage in this new technology, keep an open mind, continue the lively discussions that have always made pedology exciting and enjoyable, and in the process strive to save our most valuable resource, the soil.

USDA-NRCS Robert J. Ahrens

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Preface

This book reports on the second of a series of global workshops on digital soil mapping held in Rio de Janeiro in July 2006 which coincided with the FIFA World Cup – so it was an exciting time to be in Brazil. The meeting was hosted by EMBRAPA Solos (Brazilian National Soil Research Centre) and the organizing committee was co-chaired by Dr. M.L. Mendonça-Santos of EMBRAPA Solos and Prof. Alex McBratney of the University of Sydney. The meeting was organised with the financial support of EMBRAPA, FAPERJ (Carlos Chagas Filho Foundation for Research Support of Rio de Janeiro State), CNPq (The National Council for Scientific and Technological Development) and CPRM (Brazilian Geological Service). There were some 100 participants from 20 countries.

The theme of the workshop was Digital Soil Mapping for Regions and Countries with Sparse Soil Spatial Data Infrastructures.

There has been considerable expansion in the use of digital soil mapping technologies and development of methodologies that improve digital soil mapping at all scales and levels of resolutions. These developments have occurred in all parts of the world in the past few years also in countries where it was previously absent. Much in the same way money and time are always short, there is almost always a shortage of data in soil research and its applications. That may lead to unsupported statements, sloppy statistics, misrepresentations and ultimately bad resource management. In digital soil mapping, maximum use is made of sparse data and this books contains several examples how that can be done.

From the Rio de Janeiro workshop we have selected 34 papers that focused on digital soil mapping methodologies and applications for areas where data are limited. The papers have been loosely grouped into the following sections (i) introductory papers, (ii) dealing with limited spatial data infrastructures, (iii) methodology development, and (iv) examples of digital soil mapping in various parts of the globe (including USA, Brazil, UK, France, Czech Republic, Honduras, Kenya, Australia). The last chapter summarises priorities for digital soil mapping. We feel this book is a logical development of the ideas presented in "Digital soil mapping – an introductory perspective", edited by Lagacherie et al., (2007) in the Developments in Soil Science Series.

Wageningen — A.E. Hartemink
Sydney — A.B. McBratney
Rio de Janeiro — M.L. Mendonça-Santos

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