Digital Soil Morphometrics

Progress in Soil Science

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Foreword

Digital Soil Morphometrics: needed now because just seeing is not enough anymore!

The visionary discovery by our pioneers in the late nineteenth century that soils were more than dirt obscuring rocks has been the remarkable start of the development of soil science as a separate and vital discipline. As the importance of soils contributing to ecosystem services and sustainable development goals becomes increasingly evident at this point in time, soil scientists should not only cherish their existing knowledge and expertise but should also be alert as to new developments that can increase the significance of their input into interdisciplinary programs aimed at sustainable development.

Seeing, feeling, smelling, and tasting represented basic activities in the early phases of soil science and they still are highly relevant. The “seeing” deserves special attention, because our pioneers noticed elements that had apparently been overlooked by earlier observers as they were restricted in their views by their particular paradigms and hang-ups. I recall lectures at Wageningen University where a vertisol expert mentioned many early profile descriptions of vertisols where slickensides were not noticed. Once they were recognized, they became operational morphological features, quite significant to illustrate swelling processes and soil behavior and for soil classification. The lesson is to always keep an open eye when “seeing” morphological features in soil: Allow yourself to be surprised.

Be that as it may, there still is a high variability among observations by different observers. Standardization of description schemes has helped, and an excellent, early, example are the Munsell color charts of 1938. This book on Digital Soil Morphometrics represents a major step forward in “seeing” in at least two ways. First, several innovative techniques are discussed that allow in situ characterization of soil morphological features which is comparable, in principle, to use of the Munsell charts. These techniques provide quantitative, reproducible data that are crucial for modern applications. Second, data will be part of a digital environment allowing statistical and spatial variability analyses and modern forms of visualization.

The analogy with soil survey is striking. In essence, empirical survey procedures of the past have been strengthened by geostatistical spatial analyses and by the introduction of innovative field techniques and digital landscape modeling. In a comparable manner, Digital Soil Morphometrics closes an obvious gap in the pedological toolkit because so far profile descriptions were just that: descriptions. Of course, quantitative analyses have been a successful part of micromorphological analyses over the years, but preparation of thin sections is costly and time-consuming, and even though micromorphology has made major contributions to soil genesis studies, it has never become a standard tool in soil survey interpretations. Direct measurement of morphological features in soil profiles presents therefore an approach with a much higher operational potential when facing modern soil survey interpretations.

Finally, this is an age where scientists have to continually earn their “societal license to research” and their particular “niche,” facing a critical population and policy arena. Soil science has major contributions to make to research on food, water and energy security, climate change, and biodiversity loss. What could be a “niche” for Digital Soil Morphometrics? Chemical soil analyses of mixed samples indicate what is there on average. Soil morphology explains why chemical reactions are different when the compounds occur as, e.g., small or large concretions or as cutans. Physical flow models still implicitly assume that soils are isotropic and homogeneous. Soil morphology defines heterogeneous pore systems that are also important for root functioning, etc.

Digital Soil Morphometrics will earn its place in the pedological toolkit when it demonstrates that moving away from approaches based on “averages” or “simplifications” provides new enlightening insights into the incredibly complicated but highly fascinating ways of the living soil.

Johan Bouma
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Preface

After years of diminishing investment and intellectual efforts, pedology is thriving again. The reasons hereto are several fold, but increased interest and appreciation in soils as well as a range of new instruments and techniques brightened soil research across the globe. Although soils can be studied without digging a pit or taking a soil core, the soil profile is at the heart of many soil studies. Rightfully so, much of our understanding has come from careful and precise measurement and observations along a soil profile wall. However, the observational and interpretative techniques have not changed much in the past decades despite the technical revolution that is taken place in many soil science subdisciplines. We have proposed the use of *digital soil morphometrics* to expand and compliment the pedologists's fieldkit to observe soil profiles. Digital soil morphometrics is defined as the application of instruments and techniques for measuring, mapping, and quantifying soil profile properties and deriving depth functions of soil properties. The pedon is at the heart of digital soil morphometrics.

In 2014, the *International Union of Soil Sciences* (IUSS) recognized the need for a Working Group on Digital Soil Morphometrics. The *IUSS Inaugural Global Workshop on Digital Soil Morphometrics* was held in June 2015 in Madison, USA, and consisted of three days of presentations and discussions, preceded by a one-day fieldtrip. There were 70 participants from over 15 countries. This book contains selected papers from the *IUSS Inaugural Global Workshop on Digital Soil Morphometrics*. The conference presentations (and this book) were structured along four research topics: (i) soil profile properties, (ii) soil profile imaging, (iii) soil depth functions, and (iv) use and applications of digital soil morphometrics. We have selected 26 papers that focus on novel and exciting aspects of soil morphometrics and included a few review papers and summary chapter.

We are greatly indebted to all conference participants and authors that helped shape the conference and made excellent contributions to discussions and papers in this book. We acknowledge the financial support from the University of Wisconsin—Madison, College of Agriculture and Life Science (CALS), and the Department of Soil Science. Special thanks to Bill Bland, Birl Lowery, and Carol Duffy, and to

Leah leighty of CALS Conference Services for their kind assistance. It is our hope that the ideas and results in this book will help to shape critical thinking about how we look at soil profiles for we need to move forward and deepen our understanding.

Alfred E. Hartemink
Budiman Minasny

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