Special Issue Foreword

Remote Sensing of Soils for Environmental Assessment and Management

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The next generation of imaging systems integrated with complex analytical methods will revolutionize the way we inventory and manage soil resources across a wide range of scientific disciplines and application domains. This special issue highlights those systems and methods for the direct benefit of environmental professionals and students who employ imaging and geospatial information for improved understanding, management, and monitoring of soil resources.

We solicited articles for this special issue of *Photogrammetric Engineering & Remote Sensing* (*PE&RS*) on the following topics:

- Imaging and geospatial information for characterizing dynamic soil properties
- Airborne topographic lidar for mapping terrain derivatives and landscape conditions
- Multi- and hyper-spectral image processing and analysis for soil survey
- Radar remote sensing of soils
- Remote and proximal sensing of soil properties for digital soil mapping
- Unmanned Aerial Systems (UAS) for soil characterization and monitoring
- Geospatial data fusion for soil inventory, mapping, and resource management
- Web-enabled soil assessment and monitoring

We received a number of manuscripts which were subjected to the standard peer-review process for papers submitted to *PE&RS*. From that set, we selected six papers for publication in this special issue. The special issue Highlight Article complements these six papers by providing an overview of other forms of remotely and proximally sensed data and related geospatial information for soil investigations.

In the first paper, "Toward Linking Aboveground Vegetation Properties and Soil Microbial Communities Using Remote Sensing," Hamada *et al.* provide an extensive literature review on the importance of advancing our understanding of the spatial distribution of soil microorganisms which contribute significantly to the functioning of terrestrial ecosystems. They posit that remote sensing and attendant imaging technologies, when integrated with soil microbial research findings, can enhance our ability to map the spatial distribution of these communities at landscape scale. They advocate for a new research paradigm to integrate biophysical remote sensing with soil microbial community biogeography through standardization of taxonomy, improve strategies to scale and correlate observed surface properties with characteristics of subsurface microbial communities, and promote interdisciplinary collaborations.

In the second paper, "Mapping the Subaqueous Soils of Lake Champlain's Missisquoi Bay using Ground-Penetrating Radar, Digital Soil Mapping and Field Measurements," Libohova *et al.* convey the importance of mapping soils in subaqueous environments to improve understanding of depositional environments in fresh water systems. They focus on characterizing chemical and physical properties using ground penetrating radar and laboratory analyses and relating those properties to selected subaqueous depositional landscapes and aquatic vegetation types using digital soil mapping techniques. Several landscape units were defined based on interpretation of radar data in conjunction with subaqueous soil properties, geomorphic setting, and differences in water depth. The authors argue that such data from active sensors when combined with terrain analysis and limited field sampling can be used to map subaqueous soils in other freshwater lakes and ponds in temperate latitudes.

In the third paper, "Geostatistical Methods for Predicting Soil Moisture Continuously in a Subalpine Basin," Williams and Anderson explore the use of spatial statistical methods to map the spatial distribution of soil moisture conditions in a mountainous landscape. They apply regression modeling and interpolation methods to optimally combine remotely sensed imagery and lidar data for predicting the spatial distribution of a soil property key to understanding alpine ecosystems. Their approach is well-suited to characterizing soil properties and advancing our understanding of local variations of soil moisture conditions under short-range terrain differences as controlled by slope position. This paper is an excellent example of how regression modeling with remotely sensed predictor variables is being used to estimate soil properties in diverse landscapes.

In the fourth paper, "Mapping Impervious Surfaces Using Object-oriented Classification in a Semiarid Urban Region," Sugg *et al.* address the challenge of mapping impervious surfaces in urban areas where traditional methods tend to yield unreliable results. Employing remotely sensed imagery of high spatial resolution, they successfully mapped impervious surfaces using advanced image classification techniques without relying on spectral indicators common to mapping such surfaces. By attaining high classification accuracy, they demonstrate a more efficient methodology comparable to manual interpretation of high resolution imagery for monitoring impervious surfaces associated with urban growth in arid and semi-arid environments. This mapping approach holds promise for hydrologic modeling and watershed management at variable spatial scales.

In the fifth paper, "Semi-Automated Disaggregation of Conventional Soil Maps Using Knowledge Driven Data Mining and Random Forests in the Sonoran Desert, USA," Nauman *et al.* demonstrate the importance of integrating legacy soil surveys, appropriately processed, with several environmental covariates derived from remotely sensed data and digital elevation models. Their methodology employs disaggregation of soil survey data to provide a finer scale field data set for use by environmental professionals to implement resource conservation strategies in diverse landscapes. Given the high level of agreement with independent field validation sites, the disaggregated maps not only provide useful soil property information at finer resolution than the original soil survey data but also generate estimates of prediction uncertainty useful for resource management purposes.

Our sixth paper in this issue is an Applications Paper, "Monitoring Agricultural Soil Sealing in Peri-Urban Areas Using Remote Sensing," in which Su *et al.* effectively integrate remote sensing, geographic information systems, and digital soil data to characterize the dynamics of agricultural soil loss, defined as sealing of the soil surface due to rapid construction of urban infrastructure, or urbanization. Using traditional manual interpretation of aerial photographs, they were able to monitor the expansion of built-up land and estimate the rate of soil sealing over a twelve-year period. Using well-established spatial analysis methods, vulnerability of agricultural soils to urban development was mapped in relation to urban infrastructure proximity, population growth, and economic development. Their results reinforce the need for smart growth modeling in suburban areas supported by spatial data derived from aerial imagery.

We thank those authors who contributed papers to this special issue and express our sincere appreciation to all reviewers who conducted their reviews with due diligence in a timely manner and with a high degree of professionalism. We are grateful for the opportunity afforded to us by the *PE&RS* Editor-in-Chief to convey to our fellow geospatial professionals the critical importance of imaging and geospatial data for characterizing, mapping, and monitoring our most valuable natural resource.

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