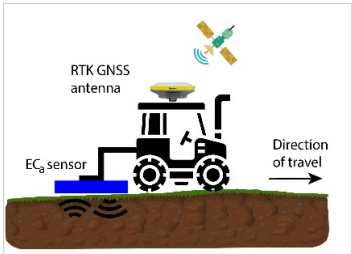

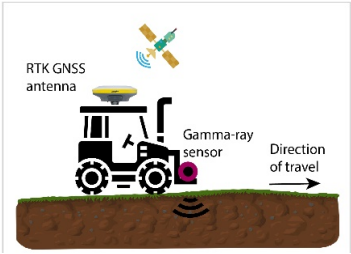

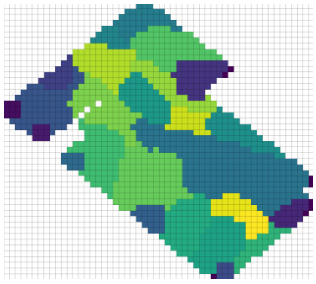

OPTIMIZATION OF GEOSPATIAL DATA MODELLING FOR CROP PRODUCTION BY INTEGRATING PROXIMAL SOIL SENSING AND REMOTE SENSING DATA

Oral Defence by PhD Candidate Md Saifuzzaman

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Abstract

Maps of soil variability identified by traditional methods are often inaccurate at the local scale, precluding cost-effective precision agriculture (PA). Remote sensing (RS) and proximal soil sensing (PSS) technologies offer an advanced array of methods which can combine surface and subsurface soil parameters to infer spatial patterns of soil heterogeneity and then develop thematic maps for site-specific management. In the present research, high-density PSS and RS-based soil characterization was explored and optimization techniques for digital soil mapping in PA were evaluated. PSS-based topography, apparent soil electrical conductivity (EC_a), and RS-based indices were subjected to multivariate statistical analysis, followed by an evaluation of the Neighborhood Search Analyst (NSA) and other data clustering algorithms' capacity to delineate spatially contiguous zones in agricultural fields and optimize soil sampling locations to inform the selection of best management practices. In creating homogeneous zones, a maximum of 70% field variance (R^2 = 0.70) was achieved. The NSA's capacity was tested using data from various sites across Ontario, Canada, and optimum targeted soil sampling locations were determined. Measured EC_a, topographic parameters and six lab-quantified soil properties (pH, buffer pH, SOM, P, K and CEC) were used in evaluating the method's predictive capacity and to compare different fields' propagated soil measurement error by drawing on the results of the North American Proficiency Testing program. Lastly, a random forest (RF) regression model delineated the complex hierarchical relationships existing among the sensor variables and evaluated prediction efficiencies for multiple soil nutrients. The coefficient of determination (R^2) showed the greatest accuracy was achieved for pH, K, and Zn prediction ($R^2 \geq 0.80$). This research indicated that an accurate assessment of soil variability, determined using sensor-fused data and optimization techniques, could assist in constructing precise soil property prediction models and in developing reliable thematic maps for site-specific crop management.

About the Candidate

Md Saifuzzaman is a Ph.D. candidate in the Department of Bioresource Engineering under the supervision of Dr. Viacheslav Adamchuk. He studied Geography and Environment (B.Sc. and M.Sc.) at Jahangirnagar University, Bangladesh. Prior to joining the Precision Agriculture and Sensor System research team at McGill, he received his second graduate degree in Environmental Studies from Queen's University, Canada. His doctoral research emphasized the optimization of geospatial data from proximal soil sensing and remote sensing technologies that could help produce digital soil maps for farm-scale crop production.