

Beyond Traditional Methods: Integrated Ground Penetrating Radar and Electromagnetic Induction Can Estimate Pore-Water Electrical Conductivity in Podzolic Soil.

Abstract

Pore-water electrical conductivity (EC_w) is the most accurate index for soil salinity in agriculture, as it directly reflects the salinity level experienced by plant roots. However, its practical use is limited due to its dependence on soil water content (SWC) and labour-intensive, costly, and time-consuming process of pore-water extraction and analysis, especially for large-scale field applications. Near-surface geophysical techniques like ground-penetrating radar (GPR) and electromagnetic induction (EMI) provide non-destructive, time-efficient and cost-effective methods with larger sampling volumes compared to traditional sampling to estimate soil properties and state variables. As a novel perspective, this study aimed to develop a non-destructive approach for estimating EC_w in boreal podzolic soils by integrating GPR and EMI techniques while applying both stochastic and deterministic approaches at the field scale. EMI and GPR surveys were conducted before and after controlled irrigation events, and soil samples were collected for laboratory analysis as ground truthing. GPR was used to estimate SWC, EMI measured apparent electrical conductivity, and EC_w and soil porosity were derived from soil sampling data for further analysis. The stochastic approach utilized multiple linear regression (MLR) models, while the deterministic approach involved modifying and evaluating Archie's equation. The developed MLR models demonstrated high accuracy ($R^2 = 0.75$ between measured and predicted EC_w). Both approaches provided reliable EC_w predictions, with low root mean square error (RMSE) values—less than 1.67 mS/m for the stochastic model and 2.65 mS/m for the deterministic model. However, modifications were necessary for the parameters in Archie's equation, as they deviated from laboratory-estimated parameters. At the study site, the stochastic approach outperformed the deterministic approach. Future research should focus on refining these models to enhance their applicability across different soil textures and SWC conditions, aiming to further improve the accuracy and reliability of soil salinity assessments in diverse agricultural landscapes.

Presenting Author



Sashini Pathirana

Memorial University of Newfoundland

Authors



Lakshman Galagedara

- G** Memorial University of Newfoundland
- L** Sébastien Lambot
Université catholique de Louvain
- K** Manokarajah Krishnapillai
Memorial University of Newfoundland
- S** Christina Smeaton
Memorial University of Newfoundland
- C** Mumtaz Akhtar Cheema
Memorial University of Newfoundland
-

Abstract Citation

Pathirana, S., Galagedara, L., Lambot, S., Krishnapillai, M., Smeaton, C., & Cheema, M. A. (2025) Beyond Traditional Methods: Integrated Ground Penetrating Radar and Electromagnetic Induction Can Estimate Pore-Water Electrical Conductivity in Podzolic Soil. [Abstract]. CANVAS 2025, Salt Lake City, UT. <https://scisoc.confex.com/scisoc/2025am/meetingapp.cgi/Paper/164931>

View Related
