APPLICATION OF GEOPHYSICAL METHODS FOR THE EVALUATION OF SOIL PHYSICAL PROPERTIES

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ABSTRACT

Quest for reliable detail information of the subsurface layers for human sustenance and advancement particularly with the emerging growth in population necessitated the conception of this research study. Soil assessment primarily is centered on confirmation of its depth and spatial attributes variability and prediction of such characterization over a real extent that may inform its proper utilizations. Such information are usually documented in reports that may include maps, logs and other statistical representations. Most traditional soil investigations approaches are commonly executed via discrete (point) source data representing laboratory scale and then interpolated. There are other associated constraints to the conventional methods such as time, cost, and concealing nature of the subsurface that introduce shortcomings to the outcomes of that type of investigations. However, alternative approach that can circumvent such shortcomings while integrity of results is not compromised was attempted in this study using geophysical methods with emphasis on ground penetrating radar (GPR). The goal of the study is the evaluation of soil basic physical properties from geophysical data that may depict field scale assessment which bypass interpolation that characterized points methods.

To achieve the aim of the study, various mechanisms were design which include modeling of the subsurface and simulation of the response of the selected principal method of the soil evaluation (GPR). This was sequel to series and rigorous review of previous records documented in literature on the topic with a view to have the grasp of the underlying background of the subject. Integration of similar geophysical survey method (electromagnetic conductivity) and remote sensing

method (hyperspectral imaging) for correlation of results was also included in the field test design. And soil sample test was also incorporated in the research study plan to serve as guide during interpretation of field data. After the modeling and armed with detailed information on the direction of the study, field data measurements were commenced on pre-established profiles at the test sites. Test sites were selected at random within the southern province of Poland particularly on farmlands with a view that in-situ nature of the soil horizons is still preserved. Several profiles of GPR field measurements were made being the major test method at both single-offset and multi-offset modes using

proEX GPR system equipment manufactured by Mala Inc. Sweden. Field measurements using the other integrated methods were also carried out at some selected profiles of the GPR readings and soil samples at strategically located points within the profiles were also taken. Acquired data were processed using series of methods spanning from simple filtering through advance signal complex analysis, statistical analysis, inversion (EM conductivity) and neural network evaluation. Subsequently, interpretation of the processed data were made and physical quantity calculated which were used as input in empirical equations for the evaluation of the soil physical properties. Correlation of the results of the different approaches utilized in the study shows the possibilities of quantitative evaluation of soil attributes such as bulk density, porosity and volumetric moisture content, from geophysical data. Results of soil compaction test shows that soil densification causes changes in the reflection coefficient of the GPR signal as depicted in its amplitude variations which may serve as distinguishing feature on GPR section. Soil matric potentials may also be identified on the GPR scans from the analysis of the frequency components that may distinguish low from high matric potential zones.

Conclusively, results analyses from the study have shown that GPR can be used quantitatively to estimate soil porosity, bulk density, water contents in a fast, less expensive, and non-destructive manner such as may not be accomplished in the traditional methods. The study had also depicted possibility of prevention of outliers that characterized point-based soil assessment results via scanning of entire test site by the GPR technique. The swiftness of its operation can be used to monitor

temporal changes to soil which is expensive and time consuming via the other traditional soil assessment method.