UNIVERSITI PUTRA MALAYSIA

SPATIAL APPARENT ELECTRICAL CONDUCTIVITY OF PADDY SOIL
AS INDICATOR OF SELECTED SOIL PHYSICAL PROPERTIES

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ITMA 2011 15
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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science

September 2011
Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of of Master of Science

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September 2011

Chairman: Professor Ir. Mohd Amin Mohd Soom, PhD, P. Eng.

Institute: Advanced Technology

Efficient and accurate methods of measuring within-field variations of soil physical properties are important in precision farming. Soil sensors that can collect data across the field will provide several advantages over traditional measurement methods that involve soil sample collection and laboratory analysis. The study on sensor-based measurement such as Veris 3100 and soil physical properties (soil particle distribution, dry bulk density, porosity, soil water retention, saturated hydraulic conductivity, soil organic matter and soil compaction (CI)) has been done. The main reason for the study is to determine whether the on-the-go sensor-based soil apparent electrical conductivity (EC_a) can be used as an indicator of soil physical properties.

The EC_a sensor was pulled across 380 ha paddy fields in Sawah Sempadan, Tanjung Karang, Selangor, Malaysia. The sensor provides values of deep (EC_a d) and shallow EC_a (EC_a s). The soil samples were taken from two depths, topsoil (0 to 15 cm) and subsoil layer (16 to 30 cm).
The readings of cone index values were taken by using cone penetrometer at the same point as the soil sampling locations.

Most properties were found to have significant correlation with EC$_a$, in Zone 3. The soil physical properties were found to have more significant correlation in topsoil compared to subsoil layer. At topsoil layer, estimated Ks, sand, clay and porosity were significantly correlated with EC$_a$ while only estimated Ks, sand and clay had significant correlation with EC$_a$. At subsoil layer, sand, silt and clay had significant correlation with both EC$_a$ and EC$_a$. Results show that the models for the topsoil can use shallow EC$_a$ as an indicator (constant) and deep EC$_a$ for subsoil layer.

The analysis for soil CI was run by correlating the CI at 4 depths of soil with EC$_a$ and found EC$_a$ can be used as an indicator to determine the most compacted layer in the paddy field which had negative correlation with CI at depth 2 (13-26 cm) and had significance with EC$_a$ in mid range EC$_a$ (zone 2). The study show only moisture content at saturation (0 kPa) had significant positive correlation with EC$_a$. So that, EC$_a$ can be used as an indicator to determine soil moisture content when the field is in saturation stage.

The Paddy Soil Physical Properties Calculator (PSPPC) was developed to ease users in estimating soil physical properties based on EC$_a$ values. JavaScript language was used to develop the GUI and the results using the calculator in web base feature. Textural class, sand percentage, silt percentage, clay percentage, bulk density, soil organic matter and saturated hydraulic conductivity can be calculated. This application can help users to estimate values of soil physical properties based on easily derived values of EC$_a$. This calculator is only recommended for the Sawah Sempadan area because the program was developed based on data taken in that area.
Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Master Sains

SPATIAL KONDUKTIVITI ELEKTRIK BERKELIHATAN SEBAGAI PENUNJUK BAGI CIRI FIZIKAL TANAH SAWAH YANG TERPILIH

By

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Kaedah yang cekap dan tepat untuk mengukur sifat fizik tanah di lapangan adalah penting dalam pertanian persis. Penderia tanah yang boleh mengumpul data di lapangan akan memberikan beberapa kelebihan berbanding dengan kaedah pengukuran secara tradisional yang melibatkan pengambilan sampel tanah dan analisis di makmal. Kajian telah dijalankan dalam penggunaan penderia tanah seperti Veris 3100 dan sifat fizik tanah seperti jumlah relatif pasir, kelodak, lempung, ketumpatan pukal, bahan organik, kelembapan, keupayaan pegangan air, konduktiviti hidraulik tepu, dan kemampatan tanah (CI). Tujuan utama kajian ini adalah untuk menentukan sama ada penderia konduktiviti elektrik tanah pukal ($EC_a$) boleh digunakan sebagai petunjuk untuk sifat fizik tanah.

Penderia $EC_a$ dibawa merentasi tanah sawah seluas 380 ha di Sawah Sempadan, Tanjong Karang, Selangor, Malaysia. Penderia memberi nilai $EC_a$ dalam ($EC_a$) dan $EC_a$ cetek ($EC_d$). Terdapat dua kedalaman sampel tanah yang diambil iaitu lapisan atas (dari 0 ke 15
cm) dan lapisan bawah (16 ke 30 cm). Pembacaan indeks kon diambil dengan menggunakan
alat penetrometer pada lokasi yang sama dengan pensampelan tanah.

Lebih banyak ciri ditemui mempunyai perkaitan dengan EC$_a$ dalam zone 3. Sifat fizik tanah
yang ditemui mempunyai hubungan lebih signifikan bagi tanah lapisan atas berbanding tanah
lapisan bawah. Di lapisan atas, Ks anggaran, pasir, lempung dan porosity mempunyai
perkaitan dengan EC$_{a_d}$ manakala Ks anggaran, pasir dan lempung mempunyai perkaitan
dengan EC$_{a_s}$. Bagi tanah lapisan bawah, pasir, lumpur dan lempung, mempunyai perkaitan
terhadap kedua-dua EC$_{a_d}$ dan EC$_{a_s}$. Keputusan kajian menunjukkan model bagi tanah lapisan
atas boleh menggunakan EC$_{a_s}$ sebagai penunjuk (pemalar) dan EC$_{a_d}$ untuk lapisan tanah
bawah.

Analisis untuk kemampatan tanah dijalankan dengan mencari perkaitan CI pada 4
kedalaman dengan EC$_a$. Keputusan analisis menunjukkan EC$_{a_d}$ dan EC$_{a_s}$ mempunyai
perkaitan negatif dengan CI pada kedalaman 2 (13-26 cm) di mana kemampatan tanah
tertinggi terjadi dan nilai CI mempunyai perkaitan dengan EC$_{a_d}$ dalam zon pertengahan (zon
2). Kajian menunjukkan hanya lembapan pada peringkat tepu mempunyai kaitan dengan
EC$_a$. Oleh itu EC$_a$ boleh dijadikan sebagai penunjuk dalam menentukan lembapan tanah
semasa sawah dalam keadaan tepu.

Pengira Sifat-sifat Fizikal Tanah Sawah (PSPPC) telah dibangunkan untuk memudahkan
pengguna dalam mengangarkan nilai sifat fizikal tanah berdasarkan nilai EC$_a$. Bahasa
JavaScript telah digunakan untuk membangunkan program antara muka dan pengira yang
berasaskan web. Jumlah kandungan relatif pasir, kelodak, lempung, kelas tekstur tanah,
ketumpatan pukal, bahan organik dan konduktiviti hidraulik tepu boleh dikira. Ini dapat
membantu pengguna menganggar nilai ciri fizik tanah berdasarkan nilai EC$_a$ yang mudah
diperolehi. Pengira ini hanya dicadangkan untuk kegunaan kawasan Sawah Sempadan kerana ia dibangunkan berdasarkan data yang diperoleh dari kawasan tersebut.
ACKNOWLEDGEMENTS

Firstly, I would like to say Alhamdulillah, for giving me the strength and health to complete this study.

I would like to express my sincere gratitude to my supervisor, Prof. Ir. Dr. Mohd. Amin Mohd. Soom, for his untiring guidance, advice, support and encouragement throughout my study. I am very grateful to the members of my supervisory committee, Associate Professor Dr. Anuar Abdul Rahim and Dr. Hasfalina Che Man for their valuable suggestions to complete the study. Special appreciation to Dr. Aimrun Wayayok for his time and afford to guide me throughout my study.

I am thankful to Science Officer at ITMA, Mr. Ezrin Mohd Husin for his assistance. Not forgetting to all laboratory staff of the Soil Physic Laboratory at Faculty of Agriculture, and Soil Laboratory, Faculty of Engineering for their valuable assistance in analysing soil properties. Special thanks to Mr. Aziz and Mr. Soaid for their support and assistance.

I would like to express my special thanks to all of my friends and colleagues, Siti Khadijah Abu, Ubaidillah Deraman, Nik Norasma Che Ya, Rashidi and the others who are not mentioned here, for their assistance and support.

Lastly, I would like to extend my heartfelt thanks to my parents, husband (Mohamad Hairie), brothers and sisters for their love, understanding and encouragement to complete this study.
I certify that an Examination Committee has met on 28 September 2011 to conduct the final examination of Mastura Mohamed on her Master Degree thesis entitled "Spatial Apparent Electrical Conductivity Of Paddy Soil As An Indicator Of Selected Soil Physical Properties" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the (Degree of Master of Science). Members of the Examination Committee were as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master. The members of the Supervisory Committee were as follows:

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Date:
DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institutions.

__________________________

MASTURA MOHAMED

Date: 28 September 2011
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