Comparison of Spatial Soil Moisture Sensing Technologies

CRDC Summer Research Project
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Abstract:

Soil moisture assessment is a critical input to improve irrigation scheduling, water use efficiency, and sustainability in broadacre agriculture. However, there can be significant variability in soil moisture across fields and existing sensors typically only measure a single point. Multiple soil moisture sensing technologies have been demonstrated that enable spatial sensing, for example, the Geonics EM38 Mk2 which uses electromagnetic induction and the Skaha Labs P-band Polarimeter which uses P-band polarimetric radar. Both devices represent advanced tools for non-invasive soil moisture assessment, and have different sensing mechanisms and deployment methods, i.e. the EM38 is towed over a field while the polarimetric radar can be drone mounted.

This research, supported by a CRDC Summer Research Scholarship, aims to evaluate and compare the performance of these sensors. The project focuses on how effectively each device detects and maps soil moisture under real-world conditions, particularly in the high-clay Vertosol soils of cotton-growing areas in the Darling Downs region and identifying the practical benefits and limitations of each sensor. The study involves field deployment, data collection, and comparative analysis of spatial resolution, depth sensitivity, accuracy, ease of use, and responsiveness to variable moisture levels. Findings from this research will support more informed decisions about soil moisture monitoring tools in Australian cotton systems.

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1.0 Introduction

Soil variability is a significant factor that can influence the performance of a crop; this is seen particularly for intensive cropping systems including much of the cotton grown in Australia. Understanding the subsoil characteristics which may include moisture content, texture and salinity, allows for farmers to perform a more targeted management system. Through work and experiences at the Centre for Agricultural Engineering at University of Southern Queensland, a key tool used for assessing soil variability is the Geonics EM38-MK2. This device is an electromagnetic ground conductivity meter being a relatively niche and expensive tool. The EM38-Mk2 is relatively lightweight, non-invasive instrument that is employed particularly in research for agricultural, archaeological and environmental fields.

While the technology has proven to be a major tool for research projects, the technology dates back to 1980 for the original EM38 and update in 2008 for the EM38Mk2. In recent years, advancements in non-invasive, remote sensing technology has allowed for new possibilities in assessing soil moisture with greater efficiency and effectiveness. One such innovation includes the Skaha Labs P-band Polarimeter, developed and trialled within the last decade. Unlike the EM38 device which detects variation in soil characteristics as a whole, the polarimeter device can distinguish the volumetric water content (VWC) through detection of microwave frequencies emitted by the soil. Early trials have indicated it has potential for rapid and large scale mapping, it does however remain largely untested in Australian cotton growing conditions.

This summer research project funded by CRDC aims to evaluate and compared the effectiveness of the Geonics EM38-Mk2 and the Skaha Labs P-band Polarimeter devices. It particularly focuses on the ability to detect and map soil moisture content in clay rich soils of the Darling Downs region. By analysing the performance, benefits and limitations of each sensor device, the study intends to provide practical insights for improving irrigation scheduling, water use efficiency and soil management strategies within the Australian cotton industry. Whilst the depth of this research comparison is limited by the time available, the expected outcomes and future recommendations from this research will ultimately assist growers, researchers and agronomists in field mapping and more well-rounded management decisions. In doing so, the project contributes to the broader industry objectives by harnessing emerging sensing technologies to support resilient, sustainable and profitability cotton production systems.

2.0 Literature Review

2.1 Soil Moisture and Crop Performance

Soil moisture is defined as the amount of water stored in the active layer of the soil which is generally considered to be the to 1 to 2m (Robock, 2012). This is a dominant abiotic constraint that influences crop water uptake, stomatal conductance and ultimately photosynthesis. These impact on the biomass accumulation and the crop yield with the magnitude of yield loss greatly dependant on the timing of water deficiency and the soils root zone water holding capacity. This soil moisture is a crucial aspect in soil health and has a strong relationship with the overall crop performance (Xing et al., 2025). In broad acre cropping agricultural systems, the moisture content within a field is most often increased by precipitation events but can also be supplemented through irrigation. With water considered to be one of the scarcest resources for crop production, plenty of research has been conducted to evaluate the effect of this soil moisture content on a variety of crop yields. This has ultimately led to the development of irrigation management plant to supplement crops such as cotton with water during crucial times in the plant's development. With evidence determining that reduced soil moisture content results in a lower crop yield, technological advancements are required to optimise irrigation systems and improve management decision in dryland situations. This has led to the development of a variety of remote sensing equipment, sensors and software for agricultural production optimisation.

The technology can range from point sensors in a field to mobile units, with a range of invasive and non-invasive equipment currently available. The application and accuracy of sensing equipment can vary across many aspects of plants, soil types and field scale. The efficacy of the equipment in soil moisture sensing for promoting greater crop performance is related to precision in mapping or plotting water content in the plant root zone. The top 5cm can respond rapidly to weather conditions and evaporation, however the root zone of the crop, which is generally between 0 and 60cm, can provide predictive capabilities for final yield. While there are a variety of technologies which are useful in research applications there appears to be a lack of knowledge surrounding soil moisture data driven crop modelling and effectiveness of new technologies in Australian agricultural conditions.

2.2 Geonics EM38 Mk2

Geonics Limited have developed a range of electromagnetic induction (EMI) instruments starting with the EM15 produced in 1962. The updated EM38 came out in 1980 before the current updated EM38-MK2 version which was released in 2008 (Lyseng, 2011). This device is a non-invasive ground conductivity meter that provides electrical conductivity (ECa) measurements at varying depths. Typically, the technology records soil properties down to a depth of around 1.5m in the vertical dipole mode recording both quad phase (conductivity proxy) and in-phase (magnetic susceptibility proxy) simultaneously. The non-invasive nature of the instrument has allowed for widespread research and commercial adoption of the technology for field mapping surveys. The ECa value represents a wide range of soil characteristics of which include:

- Salinity
- Volumetric Water Content
- Clay Content
- Clay Minerology
- Organic Matter and,
- Bulk Density

While there are many factors that can cause variations in electrical conductivity readings, the most important are related to soil texture and soil moisture. This ultimately means that the EM38Mk2 device is effective at mapping agricultural fields and delineating patterns soil properties relative to crop management. While the Geonics device has been well established in mapping soil variability, there is only an indirect relationship between ECa and volumetric water content that is dependant on each site. This is due to salinity and high clay soils dominating ECa signals, masking the moisture variation. There can be multiple trials and soil coring of a single location to calibrate the device and ultimately derive the soil moisture content. This can eventually become an intensive and highly laborious process using a relatively expensive and complex device. The future of soil mapping technology particularly in soil moisture aims reduce the input of variable soil characteristics while still maintaining a non-invasive, time efficient approach.

2.3 Skaha Labs P-band Polarimeter

Skaha Labs is an engineering firm based in Canada who have completed work on soil moisture sensing technology through the usage of polarimeter devices. Their P-Band polarimeter device operates in the frequency range of 380 to 420 MHz and is designed to detect variations in volumetric water content (VWC) (Skaha Labs, 2025). It can do so by measuring the polarisation properties from microwaves emitted from the soil surface. Unlike conventional soil moisture probes which provide point based readings, the polarimeter allows for spatially distributed mapping of VWC across an entire paddock. The device is claimed to have a theoretical sensing depth of 50cm and is a no invasive sensing technology. This enables researchers to capture real time changes in soil water distribution that is influence by irrigation and rainfall events.

There is many reports conducted on the equipment and its effectiveness however there is limited information on its efficacy in Australia and more specifically the clay soils in the Darling Downs region. The key principle underpinning the device is its sensitivity to dielectric properties of soils which has been linked to moisture content. By measuring the brightness temperature at different polarisation states, the instrument can derive water content maps across fields. Research has suggested that the P-band frequencies are particularly advantageous for penetrating through vegetation and residue cover to produce more accurate moisture data. This makes the Skaha Labs technology potential useful for research and growers where ground cover or tillage may otherwise complicate measurement accuracy.

Overall, the polarimeter device represents a novel approach to soil moisture sensing at field scale, despite not being commercial seen in Australian cropping systems. Through its limited testing in Australian conditions, it has the potential to detect dynamic moisture variability offering valuable insights to soil management, crop establishment and short term water availability data. This project aims to test the technology alongside other pronounced soil moisture sensing equipment to evaluate the effectiveness across Australian agricultural systems.

2.4 Impact of Soil Type

Both the electromagnetic induction and microwave polarimetry devices are employable in mapping field variability. While prior research and experience shows that the EM38Mk2 device is affected by soil types, the Skaha Labs polarimeter has not been tested in Australian agricultural conditions. Particularly in the case of the Geonics EMI device, variations in clay content, mineralogy and salinity have strong influences on the recorded electrical conductivity values. This variation in soil type can overshadow the soil moisture content and is therefore less valuable for farm management decisions.

The P-Band polarimeter aims to only evaluate the soil moisture content providing the researcher or farmer with a direct volumetric water content value as a percentage. This is achieved by recording the unpolarised brightness temperature and calibrate against the polarised brightness to factor out any variation caused by humans. While it is only designed to measure soil moisture, it is said to be able to determine soil variation through differing water holding capacity. In particular a clay soil on the Darling Downs region at saturation point can hold 50 % volumetric water content compared to around 40% for sandy soils (Verburg et al., 2020). This is valuable information as moisture is one of the major factors in a plant’s growth. These devices whilst different in nature have the ability to produce maps that can illustrate through maps the variability of soil and moisture within a field to make more knowledgeable management decisions.

3.0 Methodology

3.1 Site Selection/Overview

The study was conducted on at a farm of just under 450 Hectares located near Bowenville, Queensland, within the Darling Downs regions as per the figure below. This area is widely recognised as one of Australia's most productive regions, characterised by the fertile cracking clay soils known as Vertosols. It generally receives over 600mm of rainfall in a semi-arid subtropical climate, with the region typically producing cotton, sorghum, wheat and barley. This particular site was made available for research purposes by the farmer, with the entire operation under dryland conditions. The location was also well known to have high variability in soil characteristics, with the three fields outlined in figure 1 below. These fields were known to include sandier red soils and parts with high salinity, also with different cropping management plans. More specifically John's piece was left as fallow ground with minimal tillage practices and stubble retention after being sorghum in the previous summer. Billy's field was also fallow and had characteristic cracking clay soil that had been worked using a chisel plough in the month prior to testing. The 85 acre paddock was a unique shaped field that contained approximately 20 contours and had a crop of Sunblade wheat planted in mid-June. These variable conditions provided a suitable environment for preliminary testing of spatial soil moisture sensing technologies where conditions are representation of typical commercial farming practices within the region.

Figure 1: *Testing location provided at 393 Morgans Road, Bowenville, QLD on 16th of August using imagery from Data Farming (2025).*

3.2 Sensor Deployment

As referenced previously, the project was aimed at evaluating the effectiveness of remote sensing technologies for soil moisture sensing. This included subjecting the Geonics EM38Mk2 device and Skaha Labs P-Band Polarimeter to on farm testing. The polarimeter testing was conducted using a custom designed mount on the back of a Polaris Ace 500 as supplied by the farm. This entire setup is picture in the below figure with the processing equipment placed in the back of the Polaris while the polarimeter device hangs approximately 1.5m back at a height of a 1m when on flat ground. The device is also mounted at an approximate 45 degree angle towards the ground. This setup was designed to minimise the interference from the side by side vehicle and be above the wheat crop of the 85 acre paddock.

The EM38Mk2 require greater calibration prior to testing with both the horizontal and vertical dipole meticulous calibrated upon testing of each individual field. The device was dragged behind the same Polaris vehicle (without the polarimeter attached) on a wooden sled. This was approximately 3 metres offset from the back of the vehicle to minimise any potential interference caused by metal objects. The instrument was connected to an Archer 2 datalogger via Bluetooth which was held onboard the vehicle. While there remains potential future improvements to the sensor deployment methodology, this chosen procedures were effective in application for mapping electrical conductivity and polarised light reflectance.

Figure 2: *Skaha Labs P-Band Polarimeter attached to Polaris Ace 500 for field testing.*

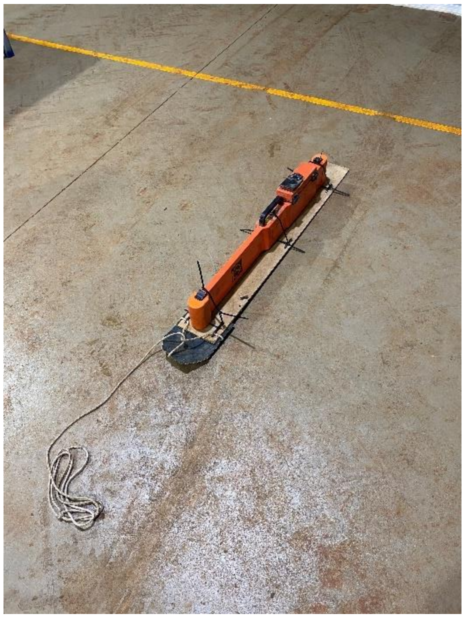

Figure 3: *Geonics EM38Mk2 device on wooden sled dragged behind same Polaris Ace 500 vehicle in testing.*

3.3 Data Collection

The data collection aspect of the project took place under dry weather conditions to ensure minimal interference from recent rainfall events. The fields as identified in the prior section were completed by doing the Skaha Labs polarimeter first for all fields and then changing to the Geonics EM38Mk2. The polarimeter was kept at a relatively constant speed of 22 km/h using the cruise control on the vehicle, starting with a boundary line around the entire paddock. The transects were conducted by travelling along the tramlines produced by the self-propelled sprayer at around 27.5m apart. The Skaha Labs device has a GPS module that plots each point where data has been collected on the user interface as observed in figure 4. Whilst not very intuitive, it provides a general understand of what areas on the field have been covered.

The EM38Mk2 data collection was conducted in a similar way by starting with a boundary line around the field under assessment. This was conducted generally at a speed of 11 km/h ensuring constant monitoring of the instrument so that it doesn't flip from the vertical orientation to horizontal. The reduction in speed meant it took longer to complete so every second tramline was used as the transect lines. This would equation to about 55 metes between each line, with it recommended to avoid sharp turns due to pulling of a sled. The ECa values were recorded in (ms/m) with data points taken every second. While the tramlines may have influenced water content due to compaction it was useful for ensuring efficient mapping of a field without access to real time refined GPS mapping technology.

Figure 4: Billy field test plot of raw data points with Skaha Labs P-Band Polarimeter.

3.4 Data Analysis

The data processing was conducted over multiple days with the aim to produce maps that can be used and interpreted in a comparative aspect. The polarimeter device raw data was sent directly from the system to Skaha Labs cloud server for processing in Canada before being sent back as maps and an excel file. The three figures below show the maps produced as the raw data is getting processed to determine the final Volumetric Water Content (VWC) as a percentage. The first aspect completed by Skaha labs is to grid the raw data points together to develop a map of the unpolarised brightness temperature. The next processing step involves mapping the polarised component which can be interpretated as human made radio interference. This polarised data can then be used to filter any errors or discrepancies in the unpolarised data for greater accuracy. The filtered unpolarised brightness temperature can be utilised to approximate soil moisture content can be determined. With reference to figure 7, the formula is Skaha's own land-surface model and is defined as (values specific to John's Piece test):

$$VWC\ (\%) = -0.5(TB(K) - 220.8K)$$

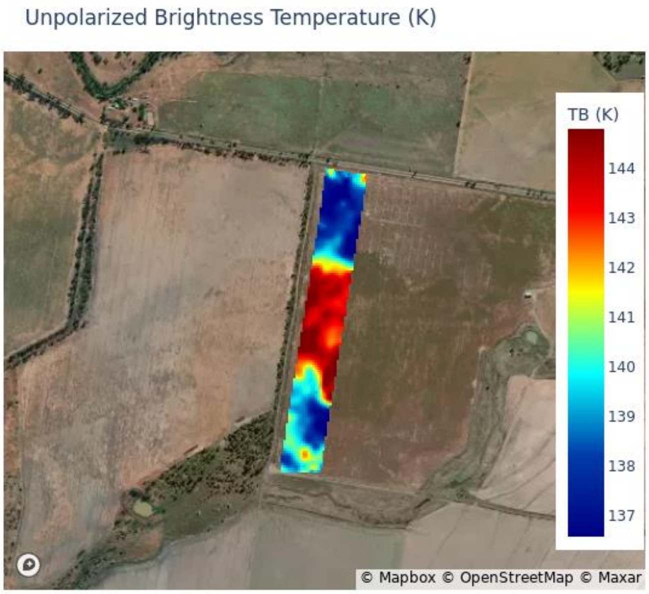

Figure 5: *Gridded unpolarised brightness temperature for John's Piece using polarimeter.*

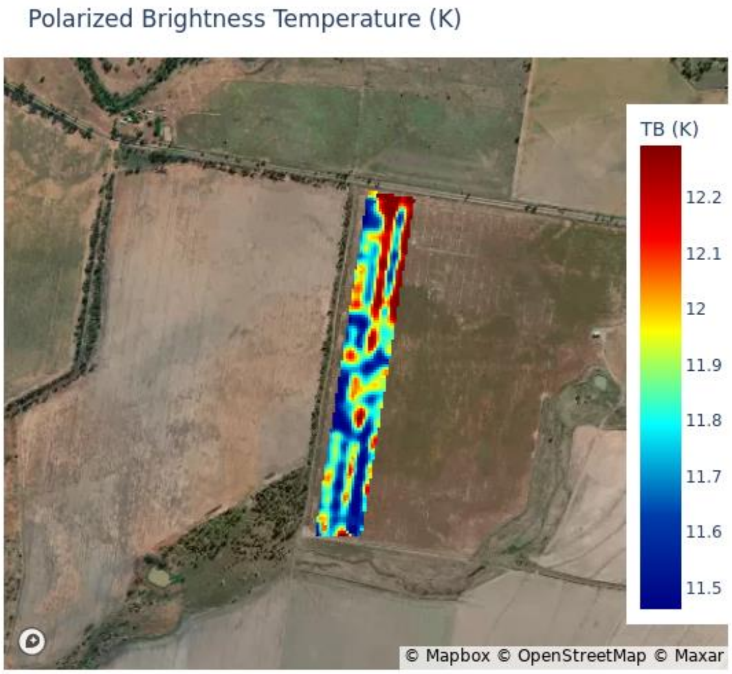

Figure 6: *Skaha Labs gridded polarised brightness temperature for John's Piece.*

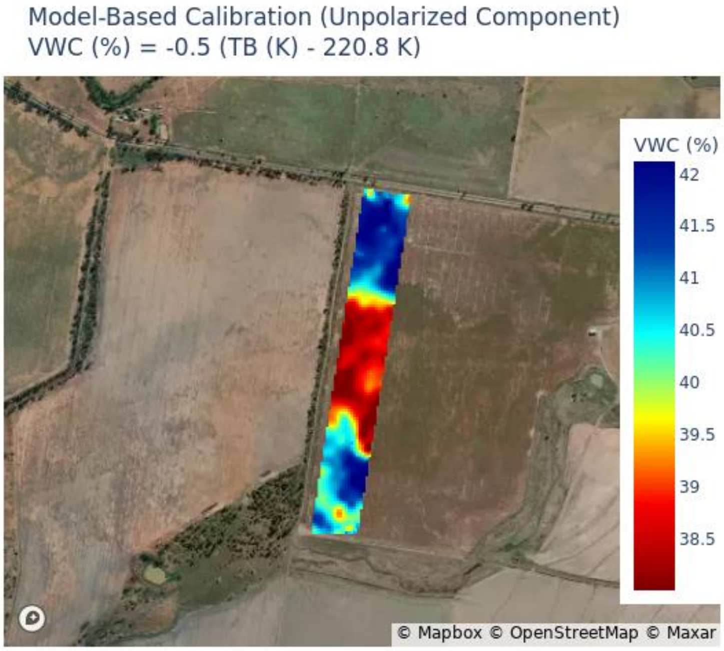

Figure 7: *Model based calibration of Volumetric Water Content (VWC) using unpolarised data and the following formula.*

The processing of data for the Geonics EM38Mk2 was manually conducted with the assistance of QGIS software. The archer presented a data file that contained the GPS positioning, alongside the ECa for the 0.5m and 1.0m coils. QGIS software would plot the GPS points at which data was found as per figure 8 and require IDW interpolation to occur. This would use the recorded data points to extrapolate the values for the areas in between and ultimately develop a map. Whilst it only reveals the electrical conductivity values for the field, it could be used to assess the soil variability found on each technology and make further conclusions about the suitability for integration into precision farming management strategies.

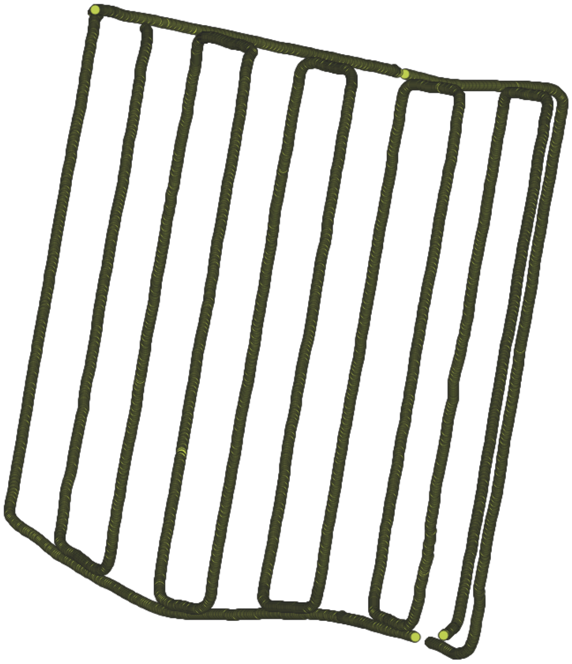

Figure 8: *QGIS plot of GPS points which data was collected using the Geonics EM38Mk2.*

4.0 Results

4.1 85 Acre Paddock

The results came in the form of tabulated data but are presented visually in volumetric water content and electrical conductivity maps. Figures 9 and 10 below illustrates the results from the 85 acre paddock which contained a relatively uniform and highly prosperous Sunblade week crop. The electrical conductivity map produced found significantly less conductivity in the top right part of the field at the highest elevation point of around 10 to 70 mS/m. From visual assessment and conversations with the farmer, this low conductivity part of the field had a red soil which gradually changed to traditional black clay in the lower parts of the field. The results showed a rise in conductivity to up to around 200 mS/m in the more visibly fertile soil. This ultimately shows that the Geonics EM38Mk2 has effectively mapped variability in soil characteristics however it appears to focus particularly on soil texture variation and less on moisture content. The map produced from the polarimeter in figure 10 reveals the approximate water content of 85 acres paddock as a percentage. The results appear to be rather patchy with a general lower water content value of around 30.5% in the top right and bottom left of the field. There also remains some patches in the field that are blue and have approximately 32% VWC with potential for lower crop density in these patches. The VWC is important information for the farmer with study suggesting that the crop lower limit for plant available water content is around 30% In vertosol soils

(Verburg et al., 2017). This would ultimately suggest that the wheat crop is close to wilting point and requires rain or irrigation in the near future to reduce yield loss.

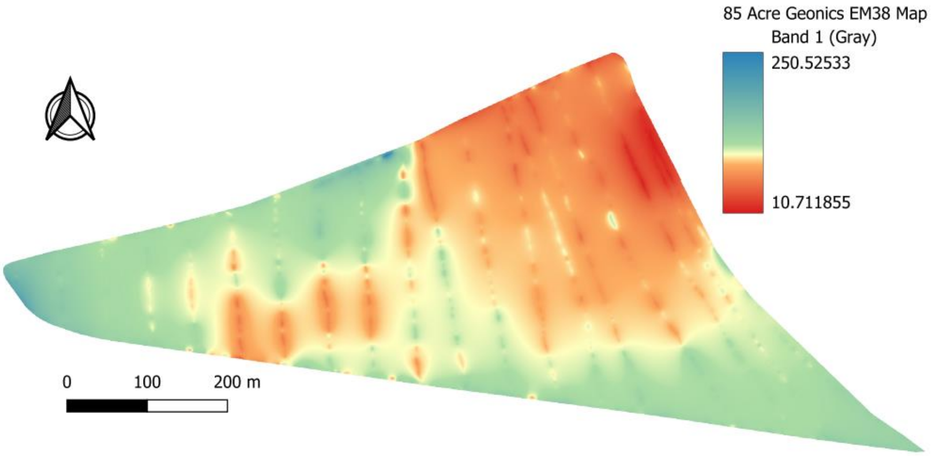

Figure 9: *Electrical conductivity (ECa) map of 85 Acre paddock with approximately 7 week old Sunblade wheat planted using Geonics EM38Mk2 device.*

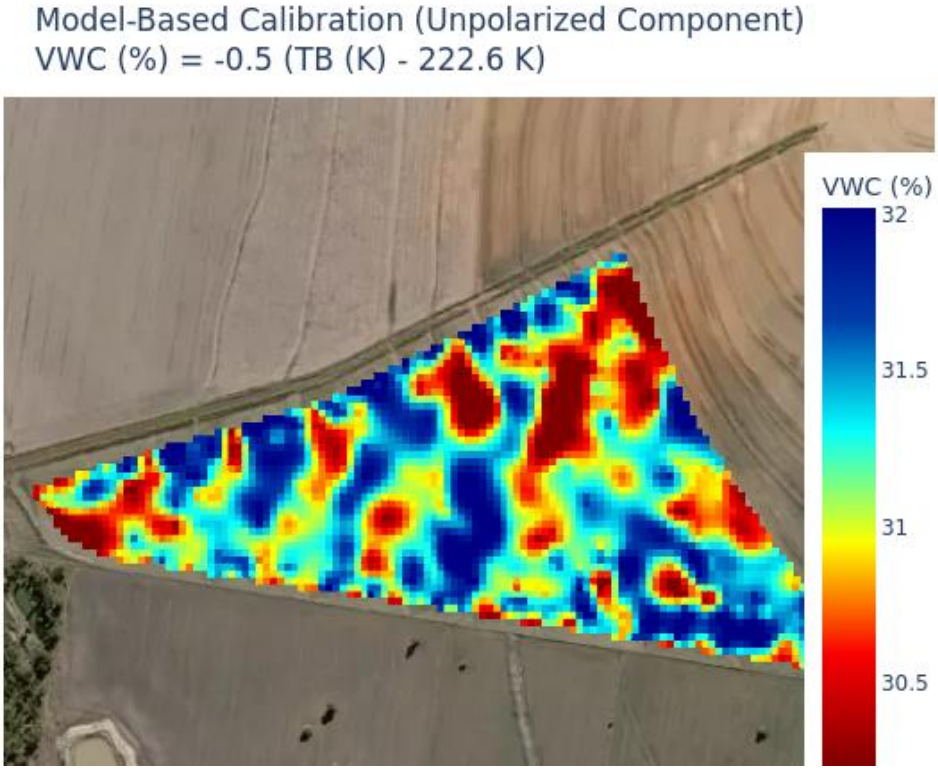

Figure 10: *VWC of 85 Acre paddock with approximately 9 week old Sunblade wheat planted from Skaha Labs.*

4.2 John's Piece

The results for a partial map of John's piece illustrated the conductivity and water content of a field with no crop established and only minimal tillage practices employed. The absence of crop cover provided an opportunity to evaluate soil variability without the influence of active vegetation and minimal ground disturbance. The electrical conductivity maps produced in figure 11 below from the EM38Mk2 indicated a general range of 50 to 220 mS/m across the entire field. It was however clearly visible in the map that there is a lower conductivity in the centre portion of the field, with both ends significantly higher. Through interactions with the farmer and physical soil analysis there was sandier red soil observed in the centre of the field and darker clay on the edges. The lower electrical conductivity has been found to be linked with soil of less clay content but without further investigation cannot isolate the variability of soil moisture.

The Skaha Labs polarimeter has produced a VWC map that appears to complement the electrical conductivity. There is a clear difference in figure 12 where the centre section of the field has reasonably lower water content of around 38%. This is major drop in comparison to the edges with up to 42% VWC. Given that there was no crop present, the variation is not likely to be associated with plant water uptake and refers more to the water holding capacity of different soils. This would suggest that the red soil in the centre part of the field does not have capacity to store as much water as per the cracking clays. This particular comparison reveals similar maps despite each sensor focussing on different aspects. The EM38Mk2 identified variable soil characteristics in texture compared to the polarimeter map which emphasised soil moisture distribution. Together they highlight the spatial zones within John's piece that would respond different to rainfall or irrigation events, proving valuable for future cropping in this paddock.

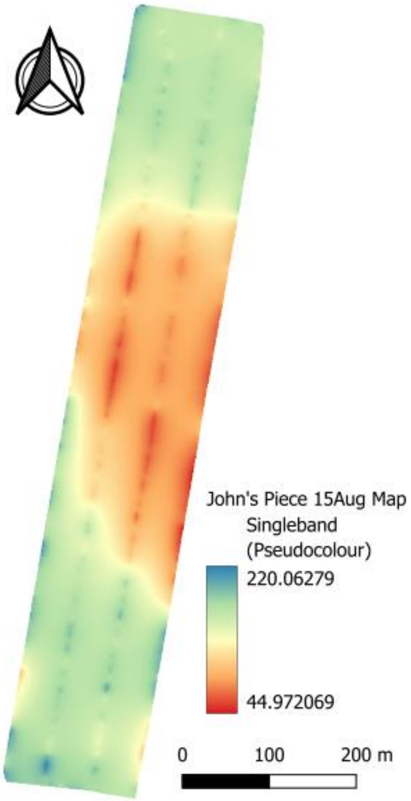

Figure 11: *Electrical Conductivity (ECa) map for John's piece with no crop and minimal tillage practice using Geonics EM38Mk2.*

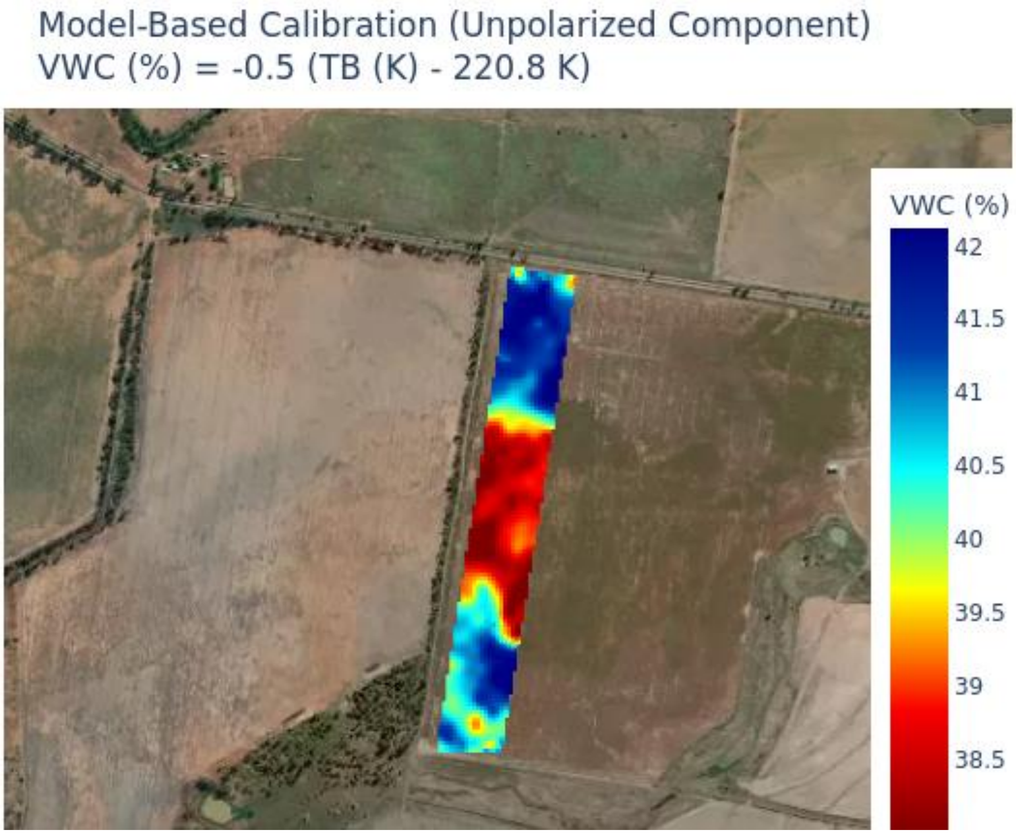

Figure 12: *VWC of John's piece with no crop and minimal tillage practice using polarimeter device.*

4.3 Billy's Field

The results for Billy's field, which as mentioned had no crop at the time of testing and was recently worked with a chisel plough are shown in figures 13 and 14 below. The recent tillage operation was conducted to reduce compaction particularly on the tramlines but was tested to provide a unique environment to assess how soil disturbance influences the sensor reading. The electrical conductivity (ECa) map generated with the Geonics EM38Mk2 indicated less variation than prior tests of between 145 to 242 mS/m. This values in comparison to other trials would suggest that there the field is predominantly the cracking clay vertosol soils. The map also suggests there Is heavier clay soils in the southwestern part of the field and with less clay content generally observed in the northeastern side of the field. This is expected to be the result of soil texture however it could also have been affected by the soil disturbance which reduced bulk density, lowering soil moisture content and reducing conductivity readings. To determine the exact cause a comparison to the polarimeter can be conducted which only accounts for variability in moisture content.

The Skaha Labs polarimeter device revealed some patchy variability as per figure 14. While it appears to be rather variable the actual VWC only ranges from 41.0% to 41.8%, with the map produced exacerbate the differences. Overall, this means that there is only a 0.8% difference in water content with a slight tendency for lower values in the northwestern side where higher conductivity was observed. While this similar patchiness was observed in 85 acres field where wheat was being grown, this instance may suggest slight variability as a result of the recent soil disturbance. The uneven working of the soil can create uneven infiltration and changes to soil structure that influences the microwave signals recorded from the polarimeter. This test has shown that there is more irregular water distribution in Billy's field and 85 acres when compared to John's piece which emphasises the external effects of tillage and crop establishment on soil water dynamics. Overall, the results were able to provide insight into the effect of management decisions and efficacy of conductivity and moisture mapping tools. The EM38Mk2 was particularly effective in identifying the broader soil texture related variability whereas the polarimeter captured the soil moisture content at that specific time of testing.

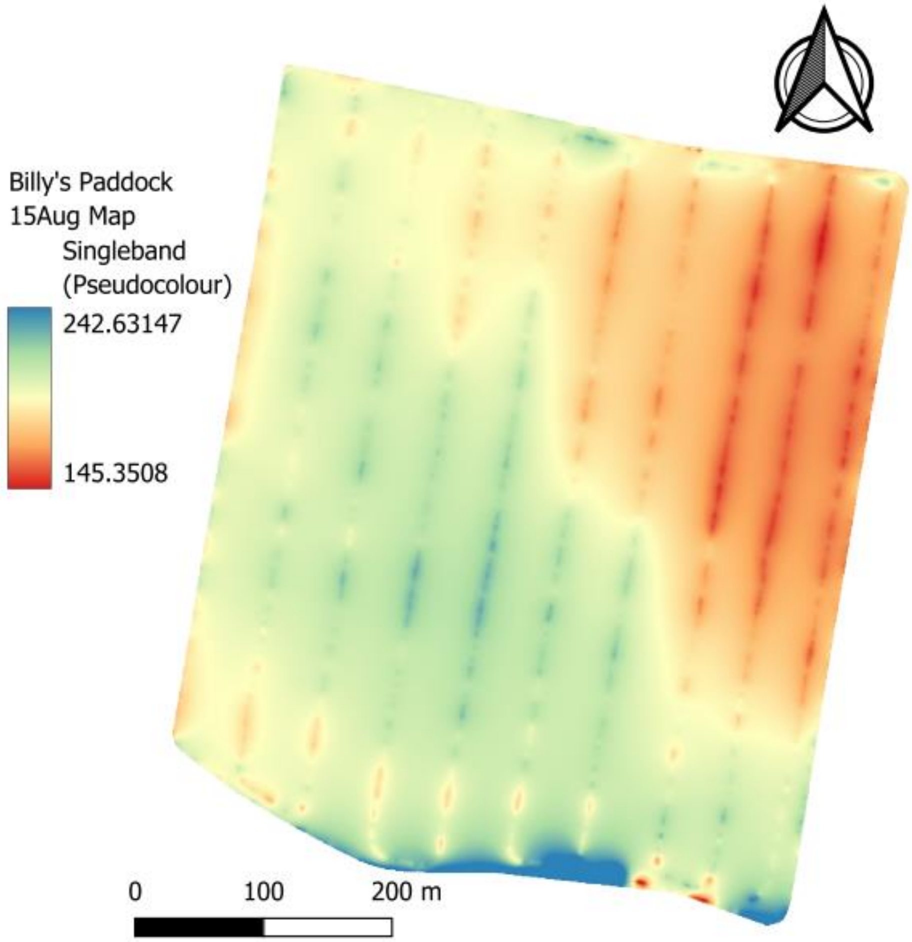

Figure 13: *Electrical Conductivity (ECa) map for Billy's field with no crop and recently ploughed using Geonics EM38Mk2.*

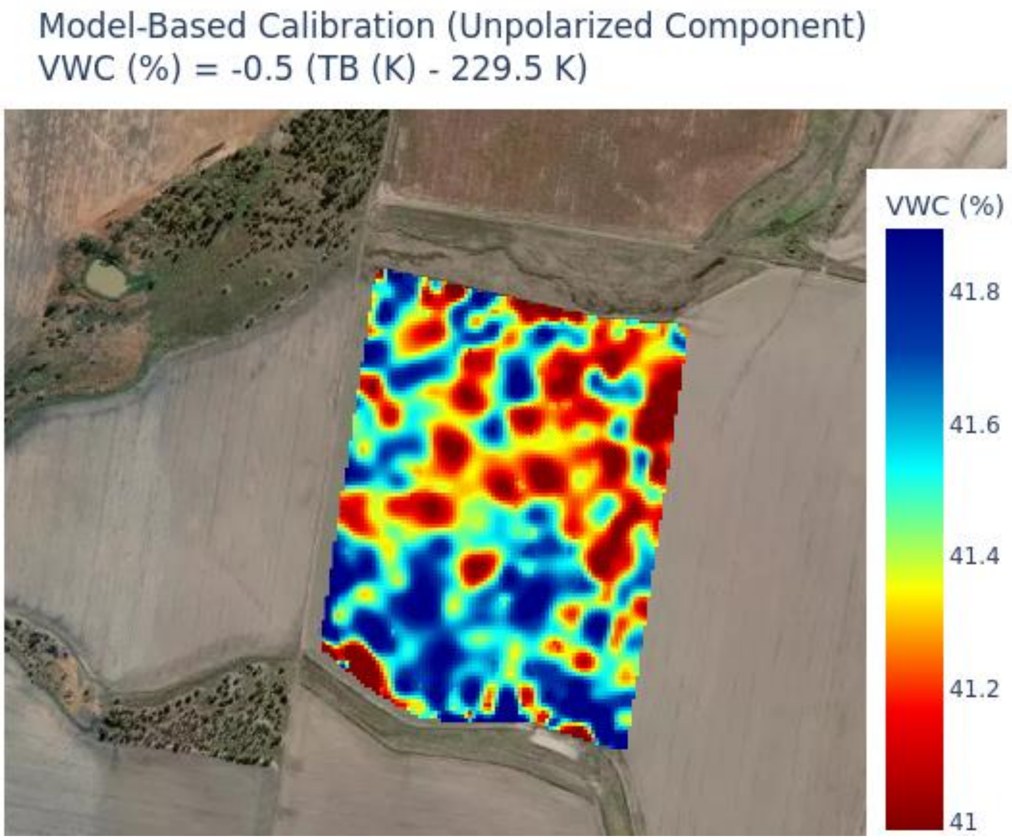

Figure 14: *VWC of Billy's Field with no crop and recently worked with chisel plough using polarimeter device.*

5.0 Discussion

5.1 Interpretation of Key Differences in Performance

The EM38Mk2 and the Skaha Labs P-Band Polarimeter each revealed distinct strengths in mapping spatial variability across the three trial paddocks. The Geonics device consistently identified zones of variable soil texture with results showing that conductivity is most strongly related to clay content. This was evident in the 85 Acre paddock and John's piece where the red sandy soils were mapped as having lower conductivity compared to the cracking clays. In contrast to this, the polarimeter was more responsive to differences in soil moisture, highlighting areas of lower water content in both cropped and fallow fields. The discrepancies between the two datasets place emphasis on how texture and moisture often interact however they do not always align. An example of this is in Billy's field where the conductivity values suggested heavier clay in the southwestern corner, but the polarimeter revealed only a minimal variation in VWC. As referred to in the results, part of the reason for these potential inconsistencies was from the management method being tillage or no tillage and whether the field had a crop using moisture. These ultimately affected how much moisture remained in the soil without changing the soil texture related results that was picked up with the electrical conductivity map. Ultimately the preliminary comparative testing of these devices demonstrated that the EM38Mk2 provides a more stable indication of soil structural variability, whereas the polarimeter device is more sensitive to short term changes in water distribution and more valuable for real time management decisions.

5.2 Assessing tool accuracy and potential limitations

This project completed testing which found that both tools demonstrated the ability to capture spatial variability, however, there remains limitations in accuracy that requires further investigation. The project was relatively short and had time limitations that affected the ability to assess the accuracy of each tool. It is recommended that the Geonics and Skaha Labs devices be subjected to repeated testing over a period of a year to gain a series of data and determine the influence of seasonal factors and crop management decisions on results. Furthermore, it would be beneficial to include a comparison of the technology to other high precision sensors that are proven in this particular area. This could include completing a comparison of results to a TDR soil moisture probe that is buried at a specific location. There is also high value in completing soil cores to complete analysis in a laboratory revealing the exact soil moisture content, salinity and soil texture. This can be used to validate and even calibrate the data that is taken from the EM38Mk2 and the polarimeter.

Despite the limited timeframe the project found that the EM38Mk2 has limited capacity to distinguish soil moisture directly as a result of the conductivity values being influence by multiple factors including salinity and texture. This ultimately makes interpreting moisture difficult without supporting ground truthing such as soil cores and/or high precision point sensors. Conversely, the polarimeter showed high sensitivity to surface conditions with the results appearing to be exaggerated when supplied back from Skaha Labs. For example, the Billy's field test showed patches of extreme red and blue, suggesting strong variability however the VWC actually only varied by 0.8%. This is a potential issue with the mapping process but not necessarily affecting the overall results. Furthermore, the crop canopy and tillage operations have appeared to alter the microwave reflectance, introducing additional noise into the moisture readings. More rigorous testing would be required to determine what effect these management and cropping aspects have on data accuracy, revealing the suitability of the polarimeter for yearlong usage. Overall, the project found calibration and ground truthing would be valuable to ensure reliable application whilst limiting their standalone use for decision making.

5.3 Reviewing tool ability to assist researchers and growers

Despite the limitations and requirement for future research to valid data accuracy, both tools hold strong potential in assisting researchers and growers in understanding field variability. For researchers in particular the EM38Mk2 provides reliable insights into longer term spatial zones defined by key soil characteristics. This is critical for designing management zones or assessing experimental treatments. The polarimeter, is more valuable for monitoring short term soil water levels and informing irrigation decisions. For growers these tools could be used together to provide complementary information with a conductivity map for baseline understanding of soil variability and moisture mapping from the polarimeter to provide real time insights into crop water availability. When individually or collectively integrated, the technology can be used to refine site specific management, improve irrigation scheduling and crop selection strategies. Ultimately the project through limited testing has demonstrated great potential for the Geonics and Skaha Labs tools to be utilised in both research outcomes and practical on farm decision making.

6.0 Future Recommendations

The outcomes of this study have highlighted many different directions for future research and practical application of these tools. The first major recommendation would be to test the technology alongside ground truth measurements such as soil cores or high precision point sensors. Without this information the data may be misaligned or inaccurate in mapping soil moisture content. Another aspect for future research would include testing under different seasonal conditions and crop stages, with this project limited by time it was unable to do so. More specifically for the polarimeter aspects like the canopy cover and recent soil disturbance has been found to disturb results as per the preliminary findings. Further to this there is potential for integration of technology particularly the Skaha Labs P-Band polarimeter into real time variable rate equipment. Skaha Labs have already worked in producing maps for variable rate irrigation however moisture is also an important factor affecting aspects like fertilisation and planting rates. A large project could use the data from the device to alter the planting quantity reducing number of seeds in areas of lower soil moisture content. Overall, this initial project comparing soil moisture sensing equipment has found to be beneficial however there remains many branching research projects that could allow for improved precision agriculture systems on a more commercial scale.

7.0 Conclusion

This study successfully compared the performance of the Geonics EM38Mk2 and the Skaha Labs P-Band Polarimeter across three contrasting paddocks. The aim of this project was to evaluate their capacity to detect soil and moisture variability. The results showed that the EM38Mk2 reliably identified broader soil texture differences, while the polarimeter was more responsive to short term water distribution. Although each tool displayed certain limitations particularly in separating texture and moisture or the exaggerating of moisture variability in maps, there is great potential strengths for both. They have been identified as being of value to researchers and growers in mapping inherent soil variability (EM38Mk2) and dynamic monitoring of water content (Polarimeter). The project found through additional research and ground truthing with other spatial sensing technologies would validate data accuracy. It did however through initial research suggest the tools provide practical insights in water variability both for scientific research and on farm decision making.

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