DIGIFARM PROJECT: Soil water mapping

Background

Water drives agricultural production in northern NSW and knowledge of stored soil moisture is essential to crop planning and decision making. Unfortunately, soil is highly variable across a paddock and therefore levels of stored moisture also vary. To fully realise the potential of variable rate agriculture measurement of variation in soil moisture is required. The possibilities for measuring soil water spatially are limited. Soil sampling is labour intensive and use of multiple capacitance probes (c probes) is expensive. Modelling of soil water accumulation during a fallow is also possible, use of Electromagnetic Induction (EMI) is another possibility.

How does it work?

Electromagnetic induction measures the apparent electrical conductivity (ECa) of the soil profile. The instrument contains a transmitter and a receiver induction coil at opposite ends of the instrument. Supplying current to the transmitter coil causes it to generate a magnetic field. This primary magnetic field interacts with the soil and secondary 'eddy' currents are generated within the soil. The receiver coil detects the secondary currents and coverts this into a reading.

There are many physical and chemical soil attributes that are known to influence ECa including: percent of clay and texture, salinity, moisture content, CEC, mineralogy, porosity, organic matter, soil depth and temperature. However, clay, moisture and salinity have the largest influence.

If clay content and salinity remain constant changes in EMI readings over time will reflect changes in soil moisture content.

In this project a paddock was surveyed using EMI and the resulting map used to split the paddock into three moisture zones (low, medium and high). Soil coring revealed that these three zones represented differing soil depth. Soil characterisation sites were established on each of the three zones to obtain water holding capacity. This involves wetting up the soil to find out the water content when it is full (upper limit), growing a crop in the soil and measuring the water content when the crop has drawn as much water as possible from the soil (lower limit). From this two measurements soil water capacity can be obtained.

An EMI survey was taken during a fallow and then towards the end of the fallow when there was confidence the profile was full or near full. A crop of well fertilised long season wheat was planted in 2020 with the hope that a survey at harvest would record an "empty" paddock. Unfortunately, a wet harvest has meant that this lower limit has not yet been obtained. At planting a number of soil cores in each zone were also taken and used to estimate starting moisture.

Pros/cons

Using this method there is the potential to map soil water during fallow and also during the crop. This would allow the use of variable rate application of inputs according to soil type and moisture. In Figure 2 below it can be seen that starting moisture by soil sampling at the start of the 2020 crop generally matches up with the zone obtained by EMI (low, medium, high). There are however some instances

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where it does not and may be a result of the EMI survey not being intense enough ie the runs were too far apart (36 metres). Closer runs would incur additional cost.

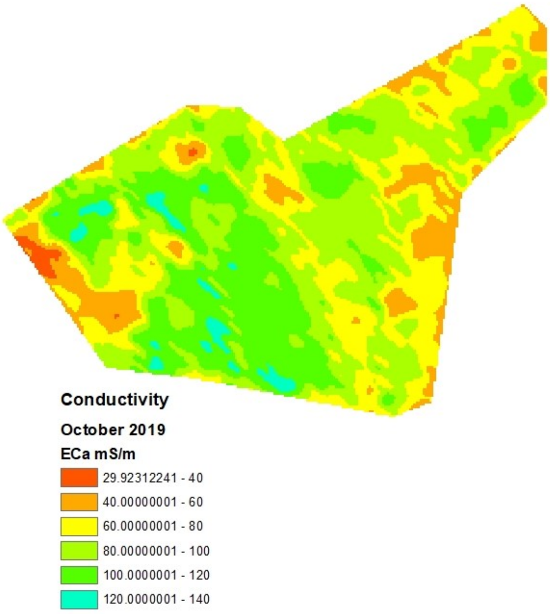

Figure 1. EMI survey of a fallow paddock showing variations in conductivity.

Farmer/advisor experience using the technology

Growers are already using EMI surveys to determine differences in soil type across paddocks. Using the soil characterisation data in addition technique would allow these maps to be approximately calibrated with soil moisture which will allow not only variable rate fertilizer application, but fertilization adjusted to starting soil moisture. The collaborator on this project is hopeful that eventually they will be able use this information to selectively apply fertiliser and fungicide and some cases growth regulators.

What's next?

Once a lower limit has been established it will be possible to put together a full picture of the water holding content of the paddock and use EMI surveys to gain a spatial estimate of the available soil water at any time. In the future it may be possible to link this with models designed to simulate paddock water use from a range of data sources such as satellite imagery, local weather stations and c probes.

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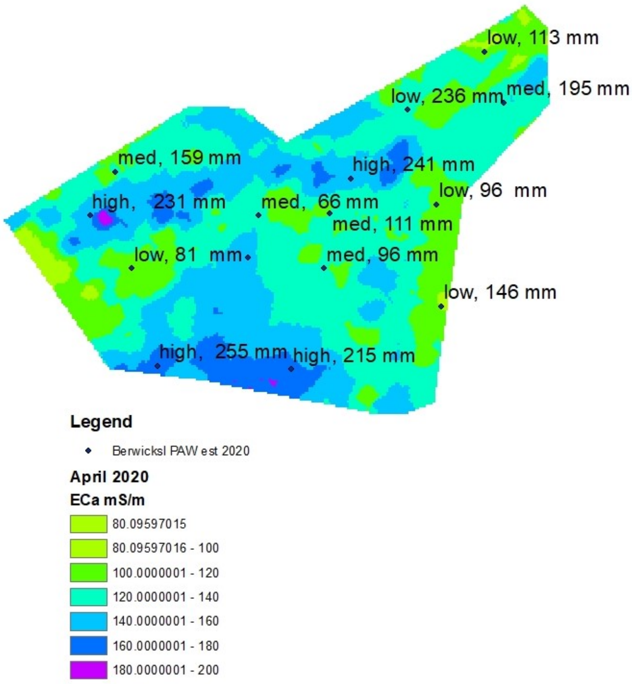

Figure 2. EMI survey of the same paddock six months later with increased conductivity and soil moisture. Points show starting moisture from soil sampling at the same time as the EMI survey.

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