Soil mapping for farm development and infrastructure

Department of Agriculture and Fisheries

Capel Farms, Western Australia

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Key outcomes

- Soil mapping is useful for determining soil variability across a farm, allowing different soil type areas to be treated as separate production zones.
- Soil mapping helps to inform decisions about drainage options on farm.
- NDVI imagery should be used on crops that have a low weed burden as excessive weeds can cause an incorrect estimation of crop biomass.
- A difference in crop vigour can be determined using NDVI imagery, however detailed assessment of the imagery and field sampling is required soon after capture to provide early information for crop management decisions.

Grower: Capel Farms *(pictured is David Blakers, co-owner)*

Location: Capel, Western Australia

What they grow: broccolini, English spinach, kale and chard

Soils: sandy surface with silty clay soil at depth

Topography: flat

Average annual rainfall: 860 mm

Precision technologies implemented: EM38 soil mapping, drone crop sensing imagery

Background

Precision agriculture techniques on Capel Farms had not previously been used. David Blakers, from Capel Farms was interested in using precision agriculture techniques to investigate soil properties on a new area of land being developed for vegetable production.

The new development area of land was sand mined about 20 years previously and had been rehabilitated after mining to allow farming to recommence. Grazing was the predominant land use after rehabilitation.

> *"The EM imagery was really useful for whole farm planning for future cropping."*
> *– David Blakers*

The surface soil in the area is mainly sand, however the mining operations had left some silty clay layers from deep in the soil profile on the soil surface. These silty clay areas did not mix well into the surrounding sandy soil and set very hard when dry. Identification and removal of the clay areas was required prior to vegetable production on the new farm.

In existing vegetable cropping areas, assessing variability in soils and crop growth was of interest, to see if improvements in the existing cropping area could be made.

Activities

Electromagnetic (EM38), elevation and radiometric soil mapping data was collected to identify and understand variability in soil characteristics across both the new development area and current cropping area. The soil mapping activity was carried out at 14 m swaths. After processing this data the resulting maps were used to locate sample points within each zone (based on both ECa and radiometric data). Soil samples were collected at each of these sample points to a depth of 60 cm and analysed for soil texture, electrical conductivity, soil pH and nutrients.

Drone imagery was also captured across two commercial broccolini crops. This imagery included crop sensing for NDVI, a measure of crop biomass/ vigour.

Figure 1. EM38 Soil mapping (left and inset) and drone taking off for plant counts and crop sensing (right).

New development soil mapping

Ground-truthing of the soil maps indicated the EM38 data had accurately identifyed the location of clay areas, providing a guide for their removal. The dark blue colour on the maps indicates a substantial amount of clay in that location, with the lighter colour areas indicating less clay was present.

During removal operations, it was found that although the location of the clay areas was accurately identified, the depth of the clay layer was not accurately determined.

The clay layers were stratified through the soil profile to varying depths, which may have caused a false indication of the quantity of clay present in an area. However, the depth of clay to be removed was not considered to be a major concern as it was the spread of the clay across the entire paddock that was important to locate.

Elevation and depression data was also used to determine the potential flow of surface water (Figure 4), which assisted with decisions for the installation of drainage lines in the new development areas.

Figure 2. Left: Soil type areas identified from EM38 soil mapping. Dark blue areas indicate higher EC and contained clay, red areas were lower EC and were predominantly sand.
Right: Soil cores showing soil cores from ground-truthing.

Figure 3. Clay removed from future vegetable crop area after location using EM38 soil analysis.

Figure 4. Accumulated water flows (left) and breach flow paths (right) modelled from elevation data in the new development area. Accumulated flow is the direction the water could potentially flow if the soil profile is at field capacity. The accumulated flow is modelled based on the elevation and depression data captured during the EM38 mapping.

Soil mapping of cropped areas

The EM38, elevation and radiometric mapping layers were also used to understand soil type differences in the cropped areas and formed the basis for modelling drainage across the farm. This data was used to map the location of a new drain across cropping areas that are occasionally excessively wet for vegetable production, providing better drainage of existing centre pivots.

"The ability to harvest plants earlier is a significant finding with potential cost savings as less inputs such as water, fertiliser and pest control may be required."
– David Blakers.

Drone imagery

Of the two broccolini crops where drone imagery was taken, only one had usable data. In one field the high weed burden confounded the crop vigour data as the image analysis for NDVI does not distinguish between weeds and crop. The second broccolini crop, which had a very low weed burden, provided imagery where it was possible to use NDVI to distinguish between areas of high and low crop vigour. In this case:

- The crop yield between the high and low areas was similar although there was a difference in the time to harvest.
- The high area had a greater percentage (over 60%) of the crop ready for harvest in the first 6 days of the harvest period compared with just 25 per cent for the low crop vigour area.
- The low area had the majority (over 70%) of the crop ready for harvest from days 8 to 13 of the harvest period, with only 35 per cent of the harvest in the high crop vigour areas remaining at 8–13 days.

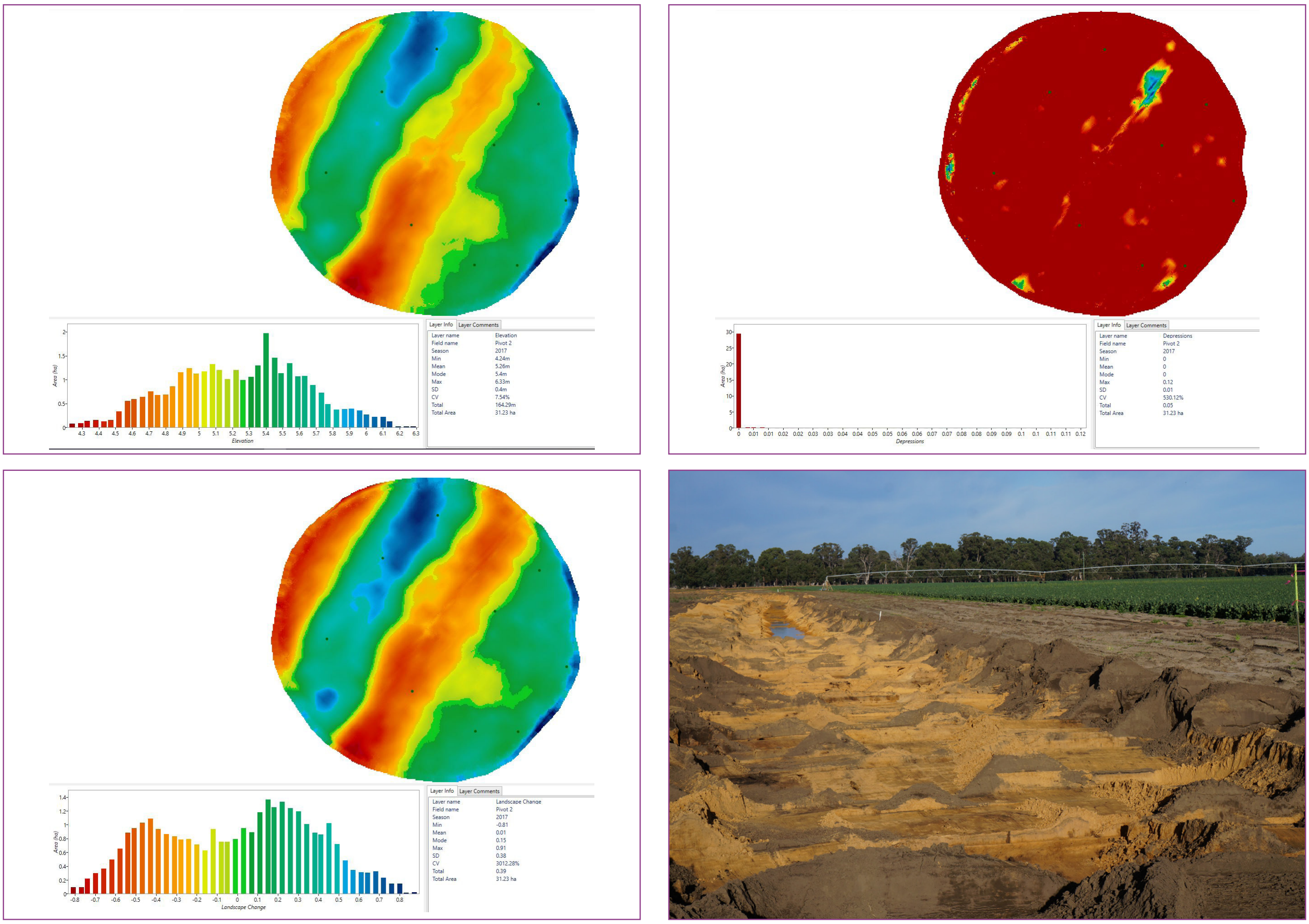

Figure 5. Using elevation data captured with EM38 soil mapping (top left) combined with depression data (top right) and landscape change (the differences between elevation and depression layers) (bottom left) has allowed Capel Farms to identify locations to install farm drains (bottom right).

Figure 6. Hand harvest maturity data from high and low biomass areas (left) and the harvest sample area in the high biomass zone identified using NDVI imagery.

Cost benefit analysis

EM38 soil mapping costs were $40/ha. Soil sampling and analysis was additional and included soil texture, electrical conductivity, soil pH and exchangeable cations. This mapping proved extremely valuable for both clay removal on new development areas and understanding soil type differences in existing vegetable production areas.

Drone crop sensing imagery was captured over two existing centre pivots. The costs for this imagery were $500 for drone imagery capture, $300 for associated data processing, and $550 for travel. Travel costs would vary with location, and data capture and processing costs are dependent on the area of crop to be mapped.

Challenges and considerations with crop sensing using drones

While crop sensing imagery can provide an indication of how crop health and vigour varies it is not without some challenges. These include:

- Differentiation of weeds from crops to provide an accurate estimation of crop biomass. It is important when using NDVI imagery to consider the weed burden in the crop and if this is likely to cause false results for biomass determination.
- Timing of crop sensing operations is critical. Too late in the crop and crop biomass may be too high so that NDVI 'saturates' and the variability is not evident in the bulk of the biomass. Similarly, too early in a crop and the plants may be too small to properly sense or complete different image analyses.

PA service providers: Precision Agronomics; Stratus Imaging

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Costs presented in this document were accurate as of October 2019. These will change over time and between data processing service providers.

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