Soil mapping in vegetables using EM38

What is EM38 soil mapping?

EM38 refers to electromagnetic soil mapping. EM38 surveys involve a vehicle towed sensor that is used in the field to measure electrical conductivity (EC) in the soil at designated depths. Electrical conductivity is primarily influenced by soil texture, in particular clay content, soil salinity and moisture levels.

EM38 data is used to generate a spatial layer that provides information about soil variability within a field (Figure 1). Identifying different soil zones in a field is one step in developing management options to address crop performance issues.

Electrical conductivity (EC): is a measure of a soils ability to transmit an electrical current.

Salinity: The amount of salt, usually sodium, in soil.

Texture: A description of the size of soil particles (i.e. sand, silt and clay).

Moisture: This is related to soil texture differences, where soils high in clay have a greater water holding capacity.

Why EM38 mapping?

EM38 soil maps can assist with agronomic management decisions. Mapping different soil zones allows for targeted sampling and input applications to understand and manage variability, respectively.

EM38 mapping can be used to:

- develop management strategies for poorer performing zones in the field, e.g. variable rate applications of fertilisers, soil amendments or irrigation
- assist in infrastructure planning i.e. field or irrigation layout
- assist with drainage mapping.

How is an EM38 soil map generated?

A service provider tows an EM38 sensor behind a vehicle across a field either under fallow or low crop residue levels (Figure 2). The data is processed to generate a spatial map depicting changes in EC. Different colours generally indicate differences in soil EC (colours may vary depending on the service provider processing the data). Maps can be obtained as a range of file types e.g. raw data, pdf, KMZ, shape files. KMZ files are necessary to locate sampling points to ground truth EC differences. Also request the raw data so that this can be utilised in the future to compare with other data layers or to upload into spatial data software. Specify upfront the file types you wish to receive.

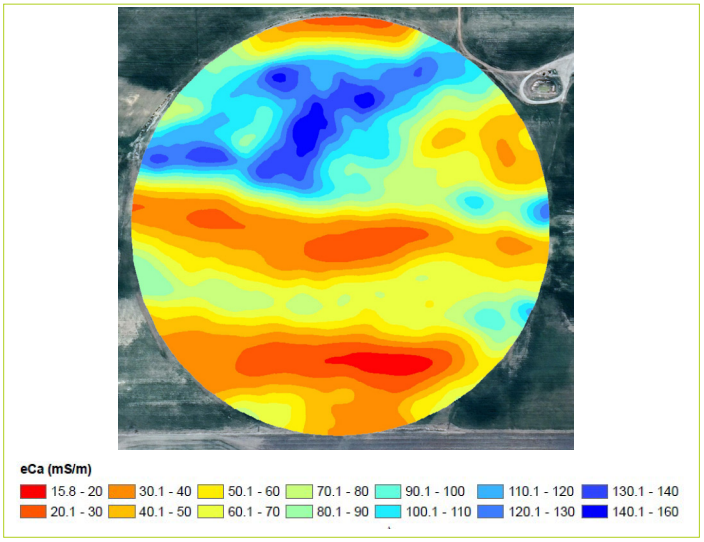

Figure 1. *An EM38 map of a carrot pivot in SA showing different zones related to EC. Blue zones indicate higher EC and red zones indicate lower EC. This pivot is an example of a dune-swale landscape and shows a characteristic of high soil salinity.*

Figure 2. *An EM38 Sensor towed behind a quad bike to assess soil variability in a fallow field. Source: DAF QLD (2014)*

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Interpretation of maps and ground truthing

Targeted and replicated soil testing within each zone is considered critical to ground truth and calibrate the EM38 data to understand what the variation in EC means, e.g. whether the variability is an indicator of high salt levels in the soil or a difference in soil texture, or both? (Figure 3) and to relate EC values to soil properties at each site. This sampling provides the necessary information to develop management strategies to address soil constraints. Prescription maps for variable inputs can also be generated based on ground truthing data.

Interpreting a spatial EM38 map involves looking at the different colour zones to identify areas with the greatest degree of variability. Historical knowledge of the area is often useful in interpreting the cause of variability.

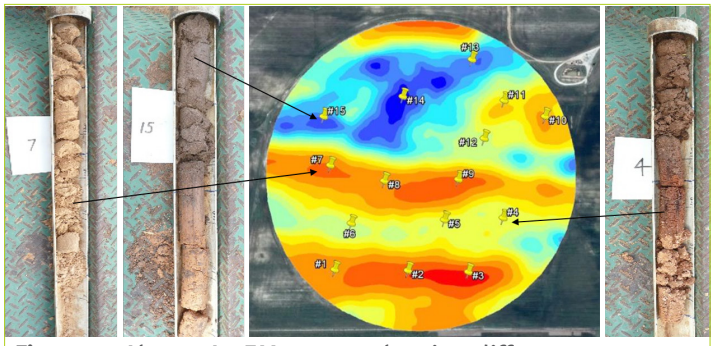
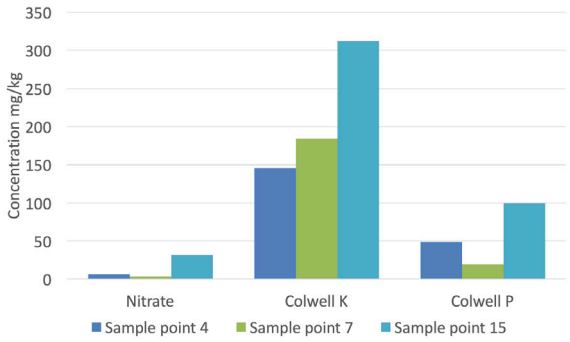


Figure 3. *Above: An EM38 map showing different zones related to EC. Images of soil cores from individual sample points highlight differences in soil texture.*
Below: Nutrient analysis results from points 4, 7 and 15 showing differences in salinity and soil NPK.
Source: Mel Fraser, PIRSA (2018).



Sample Point	7	4	15
Chloride (mg/kg)	3	32	907
Exchangeable Sodium %	1.3	3.85	20.31
Electrical Conductivity (dS/m)	0.14	0.61	1.6

Other types of soil sensors

Several different sensors are commercially available to test different soil characteristics, including gamma radiation and electrochemical sensors.

- **Gamma radiation** (High frequency electromagnetic radiation) is a measure of soil texture and mineralogy. Most appropriate for high sand soils.
- **Veris®** for EC and pH mapping.
- **Electrochemical sensors** are used for in-field testing of pH and nutrients.

Steps for EM38 mapping

STEP 1 Check field conditions	• Field should be fallow or with light crop residues • A full and even moisture profile produces best results
STEP 2 Install computer software	• Install Google Earth for opening KMZ file
STEP 3 Schedule EM38 mapping	• Schedule an EM38 survey • Some providers will have a day rate so multiple fields may be able to be surveyed for a fixed rate • Information on EM38 service providers is available by contacting DAF QLD staff or visiting www.spaa.com.au • Specify up front the file types you want to receive the data as, e.g pdf, kmz, raw data
STEP 4 Identify production zones	• Download files emailed by service provider in Google Earth • Identify different soil zones based on variability of the colour in the EM38 map legend
STEP 5 Ground truthing	• Identify areas of field that require follow up information (e.g. replicated soil sampling in low, medium and high EC zones; grid sample the field)
STEP 6 Amend soil variability	• Develop management strategies based on the soil analyses to address constraints within the field (e.g. variable rate applications of lime to low pH zones; variable rate irrigation for fields that have differing soil texture zones)
STEP 7 Evaluate field variability	• Evaluate any changes based on soil variability management (e.g. improvements in crop yield or uniformity)

Ground truthing is a practice that involves targeted sampling of soil, yield or plant tissue from GPS referenced points in the field, based on spatial data such as that from EM38 or crop sensing imagery.

KMZ files are a file that uses GPS coordinates to accurately identify areas of the field with different soil zones. To open a KMZ file, install Google Earth™.

Shape files can be uploaded into a range of software packages to further analyse spatial EM38 data, e.g. to add sampling points.

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