Estimating soil textural variability using electromagnetic induction

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Introduction

Soils on the east coast of southern Africa are often extremely variable over short distances, which need to be accounted for in randomisation of treatments for field trials. Clay content is the soil parameter affecting most other soil properties. The conventional grid method used for obtaining soil clay data to design treatment randomisation is expensive, labour intensive and time consuming.

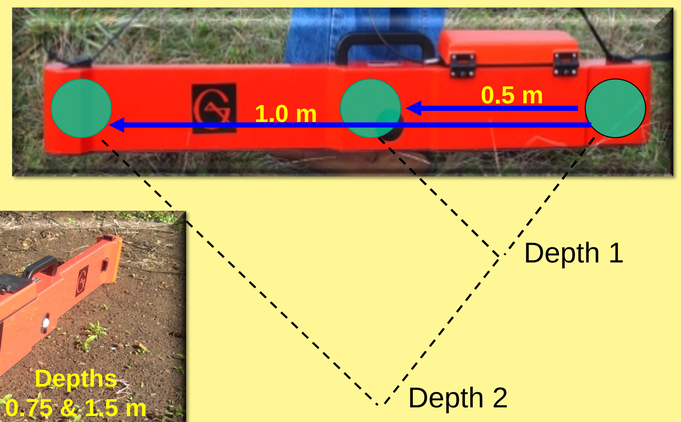
Objective

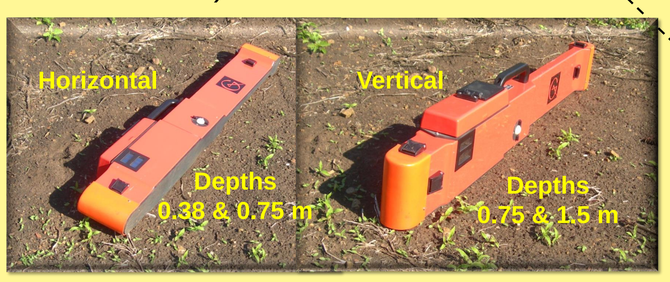
To evaluate electromagnetic inductance as a tool to assess whether it may serve as an effective means to rapidly determine in-field soil-variability, thereby accelerating the process of trial site selection. Calibration of the EM38 to estimate clay is not an objective.

Materials

The EM38-MK2® instrument manufactured by Geonics Limited, Ontario, Canada, was used in this study. It has one transmitter and two receiver coils spaced 0.5 m and 1.0 m apart.

In the horizontal position values are obtained for approximate depths 0.38 and 0.75 m and in the vertical position for depths 0.75 and 1.50 m (See Picture below).



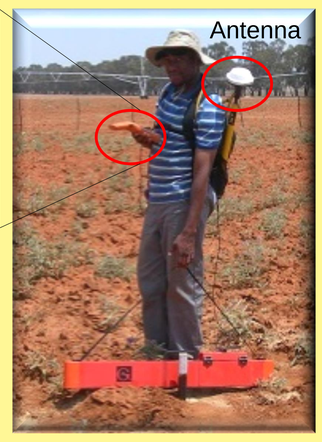


The instrument is carried near the soil surface (See Picture below) and measurements are logged either at fixed grid positions or fixed time intervals. Fixed grid positions was used for this project.

An Archer hand held data logger equipped with a Hemisphere GPS XF101 receiver (Picture right) was connected to the EM38 via blue tooth and used to record both soil and GPS data.



Data logger & GPS unit



Drift of the instrument electronics was minimised by recalibration every time the orientation of the instrument was changed (approximately every 20 minutes).

Methods

Work was conducted at Glenside in the KZN midlands. The site had a 5 to 7% slope in a North-Westerly direction. The lower part of the field had a bleached sandy topsoil with a soft plinthic B horizon on weathered sandstone (Westleigh, Haplic Plinthosols). The top part of the field was higher in clay and had a red colour (Swartland, Cutanic Luvisols).

Zone	Sandy			Clayey		
Depth*	1	2	3	1	2	3
Mean (%)	15.3	18.8	14.8	38.7	55.6	66.8

*1 = 0.15-0.30 m 2 = 0.55-0.70 m 3 = 1.15-1.30 m





A grid was superimposed on the site and readings taken in the vertical and horizontal dipole orientations at each grid position. The grid spacing was 4 x 10 m with 11 positions spaced 10 m apart diagonal to the contour and 9 positions spaced 4 m apart along the contour (thus 0.32 ha with 99 measuring positions). The data were statistically analysed using a paired two sample t-test (GENSTAT for Windows 14th edition).

Results

In Figures 1 and 2 the peaks represent the portion of the field with a higher clay content and the dip between peaks the sandier parts of the field. The EM38 measured apparent electrical conductivity (ECa) followed the clay content pattern of the topsoil (0.15-0.30 m) remarkably well (Figure 1). Figure 2 show the same data for the deepest soil layer (1.15-1.30 m). Although more variable, the ECa values were still able to reflect the variability of the clay content.

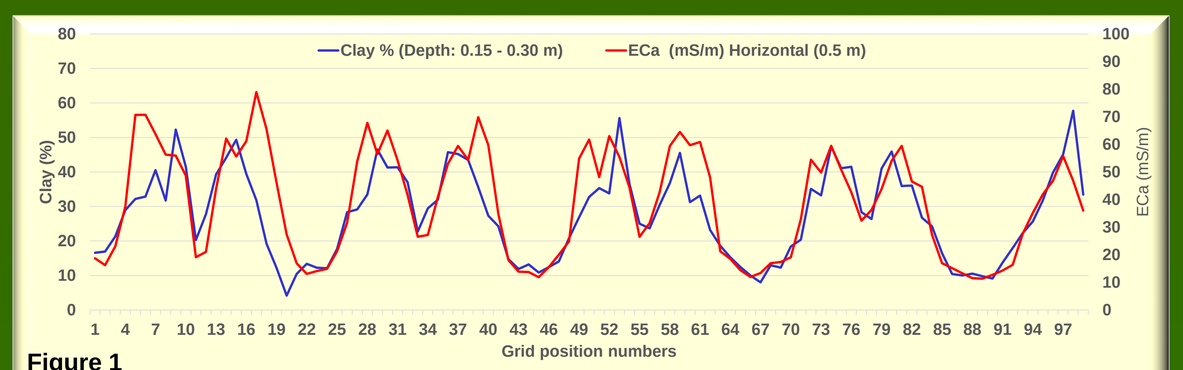


Figure 1

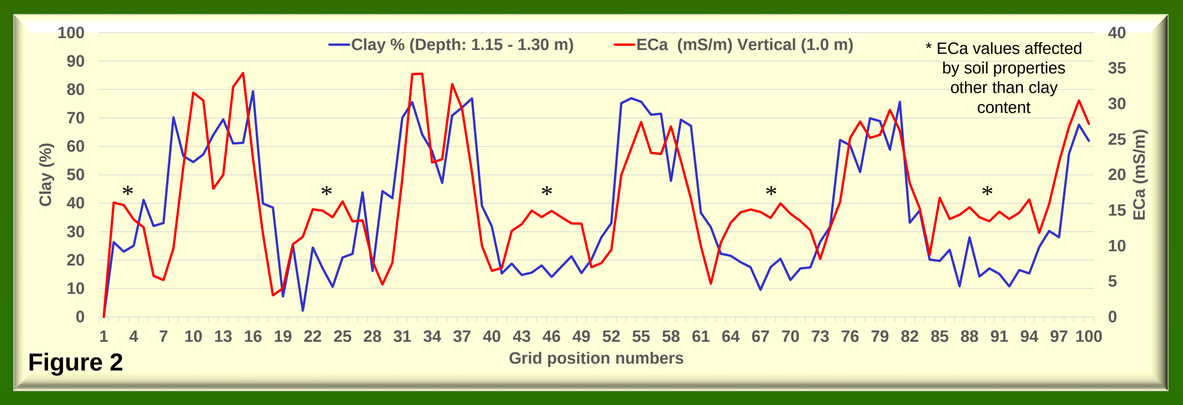


Figure 2

The survey was conducted twice on dates separated by 2.5 months and the same ECa survey patterns were obtained for both top and subsoil layers. The data used in Figures 1 and 2 are presented in a regression plot for the topsoil (Figure 3) and subsoil (Figure 4) along with the data collected from the paired survey 2.5 months later. Coefficient of Determination (r^2) for both survey dates were very similar at 0.72 and 0.73 for the topsoil and 0.45 and 0.44 for the subsoil.

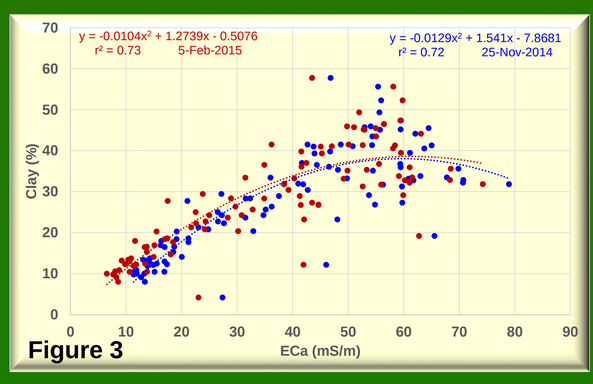


Figure 3

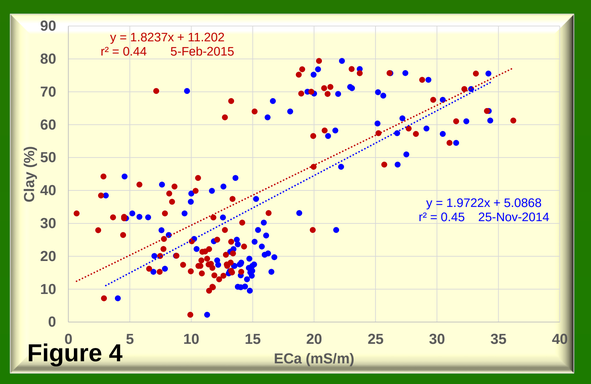


Figure 4

Summary

- The ECa values obtained with the EM38 instrument were able to reflect on the variability of the clay content in both the topsoil and subsoil layers.
- Although clay content in the topsoil layer was lower than that contained in the subsoil, ECa values for the topsoil were almost double that obtained for the subsoil.
- Not all responses obtained with the EM38 instrument can be attributed to the variability in clay content. See Figure 2 – the smaller peaks obtained between the larger peaks were probably the result of a more conductive soil property such as a higher concentration of iron at depth in the sandier part of the field.
- The repeatability of results obtained 2.5 months apart were good.

Conclusion

Electromagnetic induction technique is an alternative method that can be used to quickly assess the variability of both topsoil and subsoil layers. Although results are given for only one survey site, similar results were obtained for three other distinctly different sites.