

AUTOMATED SOIL SALINITY MAPPING

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Introduction

Sask Water is involved in a program of salinity mapping as part of irrigation development investigations, and where problems arise with operation of existing water and sewer projects. We have used the EM38 electromagnetic conductivity meter developed by Geonics Limited of Mississauga, Ontario for a number of years to manually take readings on a predetermined grid or at random locations to assist in our investigations.

The EM38 can be linked to a data logger. This allows large land areas to be thoroughly investigated in a short period of time. This detailed field mapping can then be combined with the results of limited field soil sampling and laboratory salinity analysis to produce computer generated contour maps of salinity levels in the top 0.75 and 1.5 meters of soil.

This information is then combined with other factors to determine irrigation suitability or the extent and severity of a salinity problem.

Methods

An EM38 is an electrical conductivity meter designed to measure soil conductivity without requiring soil contact, that is, without the use of soil probes. The unit is comprised of a transmitter and a receiver separated by an inter-coil spacing of one meter. When energized, the transmitter produces an electromagnetic field that induces current flow in the soil. The magnitude of the current flow is proportional to the bulk electrical conductivity of the soil through which the current passes. This current produces a secondary electromagnetic field which is sensed by the receiver and converted to an output voltage. This voltage is linearly related to the bulk electrical conductivity.

The EM38 can operate in either a vertical (v) or horizontal (h) position. Vertical EM readings give an indication of salinity levels to a depth of 1.5 metres in the soil profile. Horizontal readings indicate salinity in the upper 0.75 metre of the profile. EM38 readings in literature are shown as **v/h**.

Saline soils often develop an inverted salinity profile. In such a soil the conductivity of the surface layer exceeds that of the layers below it. In these cases the horizontal values exceed the vertical values.

Data Collection

A plexiglass box, containing the EM38, is attached to a length of lexan which is mounted on a sled constructed of PVC tubing. These materials were chosen because of their non-conductive nature. The EM38 is connected to a Polycorder digital data recorder. A microswitch attached to a metering wheel signals the polycorder of incoming EM38 data. The sled is pulled through a field behind a 4x4 all terrain vehicle along pre-determined grid lines at a speed of about 5 km/h.

The spacing of the grid lines is dependent on the size of the field being mapped and the desired detail of the map being produced.

Upon completion of the EM38 work, files are copied from the polycorder to a personal computer.

Soil Sample Collection

During the EM38 mapping operation, sites are flagged within the grid area which cover the range of EM38 values encountered. At each flagged site, soils are sampled to a depth of 120 centimetres, at 30 centimetre increments. These soils are analyzed for saturated paste E.C. and then related back to the EM38 readings for correlation purposes.

During the soil sampling procedure, the soil profile/horizons, texture, moisture, etc. are noted.

Sodicity is also a very important factor but is not used in this soil salinity mapping process.

Map Production

Saturated paste EC values are regressed with the EM38 readings. The correlation coefficient is determined, a linear curve is plotted and a curve equation is recorded. Based upon these equations, salinity ranges are calculated for both the vertical and horizontal EM38 readings.

The data collected from the EM38 survey is stored in a file in a three column (x, y, z) format; x and y being the directional coordinates and z being the EM38 reading. The file in which this information is contained is imported into a software package with contouring capabilities. The particular software used by Sask Water is the Geosoft Mapping and Processing System. With this package, two dimensional contour maps are produced which provide the final soil salinity map.

Irrigation Suitability Classification System

Salinity Rating (mS/cm)

Depth (m)	None	Slight	Moderate	Severe
0.0 - 0.6	<2	2 - 4	4 - 8	>8
0.6 - 1.2	<4	4 - 8	8 - 16	>16
1.2 - 3.0	<8	8 - 16	>16	>16

Conclusions

Soil salinity on irrigated and rainfed lands in Western Canada is a major concern to the sustainability of agriculture.

The automated EM38 electromagnetic conductivity meter provides a rapid and accurate assessment of field soil salinity. The process of salinity mapping has evolved into an electronic system which can now map a quarter section of land in approximately four hours subject to terrain and detail required.

The Global Positioning System (GPS) is an advanced radionavigation system being deployed by the United States military and by civilian applications world wide. In southern Alberta, the GPS system has been successfully tested in conjunction with the EM38 meter. Sask Water is currently looking at the feasibility of employing this technology.

Automated soil salinity mapping has assisted Sask Water in the classification of land for irrigation suitability, mapping and monitoring saline areas, and advising clients on crop selection based on salinity tolerance.

References

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