ALBERTA

Global Positioning Systems and Electromagnetic Induction – High Tech Tools for Salinity Mapping

By Colin McKenzie

Soil salinity is a major cause of reduced crop production in many soils of the northern Great Plains. Traditional methods for mapping salinity were based on a few soil samples per quarter section. Limited samples make it difficult to accurately describe the extent and variability of soil salinity and the rate of salinization.

New measuring techniques combined with global positioning systems (GPS) are improving the accuracy of soil salinity mapping.

The electromagnetic induction meter (EM38), a relatively new method for rapid measurement of salinity, has greatly improved our ability to measure soil salinity. The EM38 records conductivity readings proportionate to the amount of salts in the soil solution. And, because it does not require direct soil contact, a large number of salinity measurements can be obtained at much lower costs than by conventional sampling methods.

The EM38 salinity measurements can be made by either an operator carrying the unit on the shoulder or with the unit mounted on a non-magnetic sled pulled by a vehicle operating at speeds of 6 to 12 miles per hour. This allows about 18 to 36 acres to be surveyed per day when mapping on 33 by 130 ft. grid.

Though an improvement over conventional salinity mapping methods, use of the EM38 had some constraints: (1) establishing the grid takes considerable time, (2) movement of the EM unit along predetermined straight grid lines can be difficult in rugged topography, and (3) it is difficult to conduct more frequent measurements in local areas where salinity is suspected of changing rapidly, such as long irrigation canals. Teaming up the EM38 with GPS has removed these constraints and further improved the ability of the EM38 to document soil salinity.

Alberta Experiences

A few years ago we began testing a differential system GPS and an EM38 meter to map salinity in southern

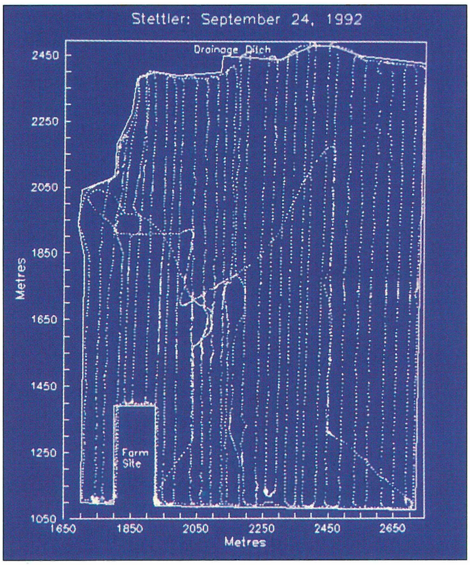

Figure 1. An EM-GPS soil salinity survey of a 120 acre field generates 6,000 data points in three hours.

Alberta. An all terrain vehicle was used to pull a non-magnetic toboggan housing the EM38 and the GPS receiver.

Results from a 120 acre field near Stettler, Alberta, are shown in **Figure 1**. The 6,000 data points were generated in three hours, confirming the high productivity of the GPS-based EM system. The random trajectories zigzagging the parallel runs were made intentionally at the end of the survey to obtain cross-over measurements for verifying the internal accuracy of the system. The salinity measurements obtained at the 51 cross-over points, located within about 40 inches of each other, and duplication of the survey on a subsequent day showed that the GPS-based EM system was repeatable and accurate.

Combining GPS and EM38 technology permits the user to easily map irregular shaped areas where rough topography, trees and buildings restrict the line of sight to ground targets. Under normal operating conditions this system can easily survey up to several hundred acres per day, which is about a five-fold increase compared to use of conventional grid EM survey methods.

Detailed and rapidly made salinity

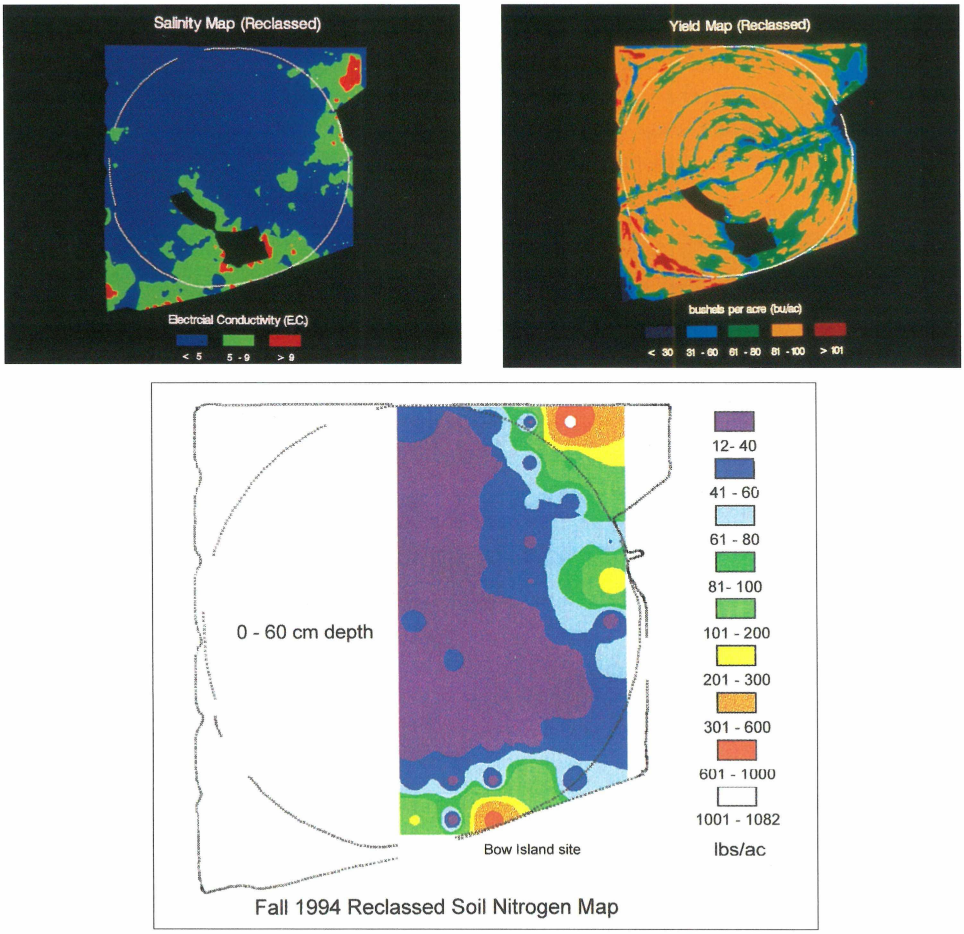

Figure 2. Salinity map derived from a GPS-based EM system, soil nitrogen map based on soil sampling and a yield map made from a yield monitor of an irrigated soft wheat field.

maps will help define the yield limitations necessary for site-specific management. **Figure 2** compares a salinity map made using a GPS-based EM system, a soil nitrogen (N) map based on intensive soil sampling, and a yield map made from a yield monitor for an irrigated soft wheat field near Bow Island, Alberta. Note areas of high electrical conductivity (i.e. salinity) correspond to areas of high N and low wheat yields.

A fertilizer recommendation based on a composite soil sample is influenced by these saline areas with high N. This causes an under-estimation of the fertilizer requirement for most of the field while unnecessary fertilizer is applied to the saline portions of the field. Salinity is easier to identify and map than is soil N.

A detailed salinity map will permit crop selection to be used as part of precision farming. For example, when growing a saline-sensitive crop like corn or beans, saline portions of the field can be planted to a more salinity-tolerant crop like barley.

Summary

Geographic information systems (GIS) allow data from yield, salinity, topography, fertility or other maps to be combined and analyzed to generate more accurate variable rate input maps. Salinity maps are one more tool in a farmer's arsenal to better utilize and manage the information needed for precision agriculture. BC

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Computer Enhancement... *continued from page 33*

ferences that were there all along, but were difficult to discern at first. The enhancement process has not created any new information, merely exaggerated what was there.

The red-orange foliage in the lower portion of the scene results from soil having very high available magnesium (Mg), high cation exchange capacity (CEC) and plants with potassium (K) deficiency. This area is a former (Pleistocene) lakebed, dominated by montmorillonitic clays. The upper green portion is an alluvial fan whose watershed is largely rhyolite, giving the soil a lower CEC and a much better K/Mg ratio. The peak of the fan is at the upper left. One can see the gradation from lighter to darker green associated with decreasing rock and gravel, increasing silt content and associated variation in soil water-holding capacity. The irregular white patch in the middle-right portion results from very weak vine growth, so that we are seeing much more bare soil than in other parts of the vineyard. This section has shallow soil underlain by a calcium-cemented hardpan.

If one were not familiar with this vineyard, it could easily require many backhoe pits and samples to "investigate" the soil in enough detail to make a geostatistical map. Using the computer-enhanced photo as a guide, it would be much simpler (and less expensive) to sample in key locations, then use the photo as the map. BC

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