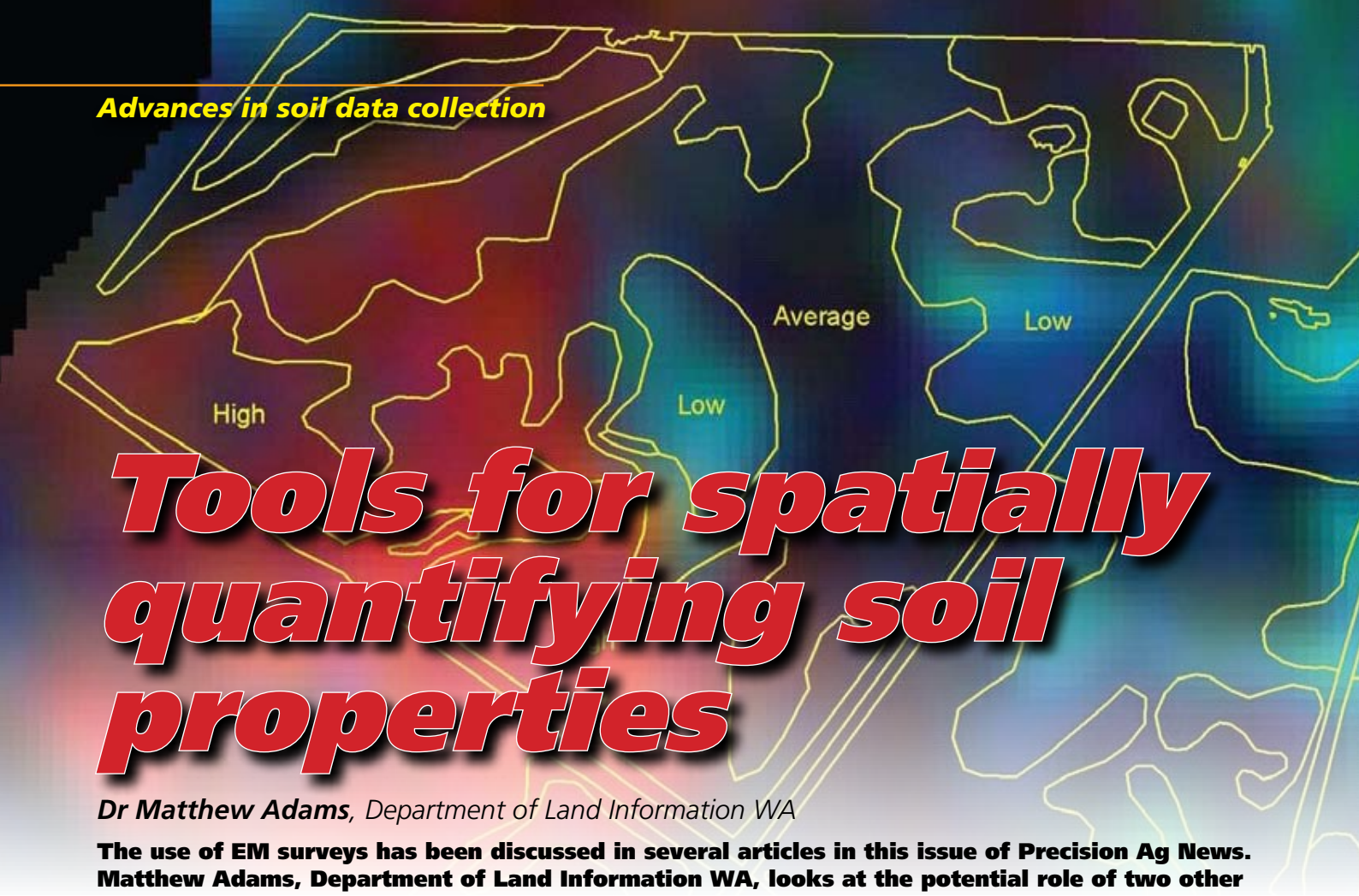


Tools for spatially quantifying soil properties

***Dr Matthew Adams**, Department of Land Information WA*

The use of EM surveys has been discussed in several articles in this issue of Precision Ag News. Matthew Adams, Department of Land Information WA, looks at the potential role of two other systems for gathering soils data.

Gamma-radiometrics

Gamma-radiometrics is the measurement of natural gamma ray emissions of radioactivity, primarily from the top 30cm of soil or rock. This can provide information about the parent material of the soil and be related to soil types across the region or paddock.

The primary elements measured are radioactive isotopes of Potassium (K), Thorium (Th) and Uranium (U). Differences in soil types are identified by different levels and distribution of these isotopes in landscape.

Gamma rays are emitted as high-energy, short-wavelength electromagnetic radiation, as quanta of energy or photons. It is part of the natural radioactive decay process in which alpha particles, beta particles and gamma rays are emitted. Unlike alpha and beta particles, gamma rays are detectable to remote sensors due to the absorption of gamma radiation through hundreds of meters of air.

Issues

Users need to be aware that the isotopes in top 10 to 15cm are more influential on the reading than the level of isotopes between 15 and 30cm below the surface. This may be an issue in distinguishing a duplex soil from a deep sand.

Uses in agriculture

Gamma-radiometrics have been applied as an efficient land resource assessment tool for soil type or soil landscape mapping in Australia. Airborne surveys have provided information for land resource assessment at scales of 1:50 000 and 1:100 000. The information derived from this information may be as simple as a visual assessment of soil type boundaries and may provide a very valuable input for the spatial modelling of soils.

If acquired at sufficient line/traverse spacing the potential exists to acquire short-range variation over paddocks and farms that are indicative of soil forming processes and soil parent material – a key component for those wishing to manage within paddock variation. For a 40 to 50 hectare paddock line spacing of 100m is sufficient for within paddock estimates.

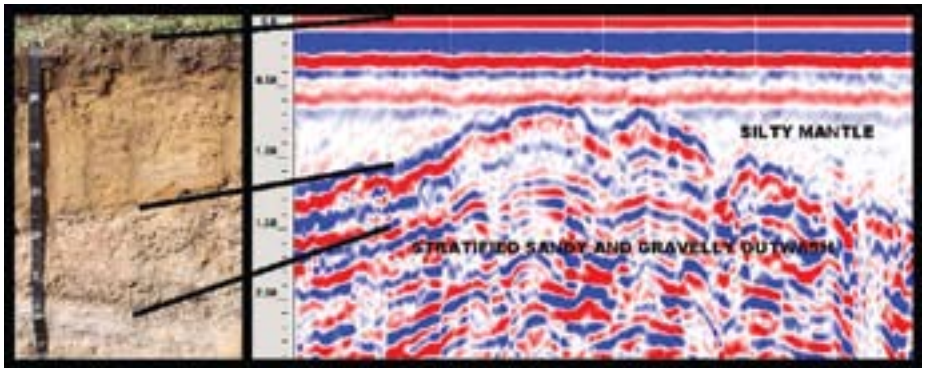
Useful relationships have been found between gamma-radiometrics with or without additional layers (elevation, EM, biomass etc), and geomorphology, soil properties (particularly plant available potassium), particle size distribution in topsoil, unsaturated hydraulic conductivity, bulk density, organic carbon, Colwell phosphorus, and pH. All of these studies, are specific to the areas in which the relationships were observed and can not necessarily be extrapolated Australia-wide.

In addition to gamma-radiometrics, magnetics and digital elevation data are usually acquired at the same time. Magnetic data has been found useful in hydrological applications. In Western Australia, it is a particularly useful dataset for locating faults and fractures in the bedrock, which affect how water moves through the landscape.

Availability

Currently, airborne gamma-radiometrics data is available for quite large areas of Australia. This is often obtained by government

Figure 1 Example of results from ground penetrating radar (source: http://nesoil.com/gpr/)



agencies for the purpose of geological exploration. There is complete coverage for Victoria. These surveys range in line spacing from about 250m to 400m. While these surveys are good at a regional scale, the usefulness of data at a paddock scale is limited.

Two commercial sources are:

- Fugro (http://www.fugroairborne.com.au/) - aerial and ground based surveys;
- UTS (http://www.uts.com.au/).

Price will depend on the size, location to nearest airfield, speed of aircraft and flying height. Examples of costs incurred in relation to GRDC research projects in 2003/04 were roughly $30 per line kilometre.

Pre-existing surveys are available to the public at Geoscieces Australia (http://www.ga.gov.au). Most surveys available from this site are probably not at the resolution recommend for PA, but these do exist and could be of use in certain areas.

There are two ground based gamma-radiometrics units currently in service, predominantly for research purposes. One is owned by the Department of Primary Industries in Victoria and the other by the University of Sydney.

Currently, there is one commercial contractor providing a ground-based radiometric service in Western Australia. Others not known to the author may service the eastern states.

Ground penetrating radar

Ground penetrating radar (GPR) is conceptually similar to electromagnetic induction (EMI) – a pulse of energy is directed at the ground by one antenna, and the interaction between that energy and the soil is received or detected by another antenna (a 'reflection' in the case of GPR). Similarly, it is suitable for near surface investigations (less than 10m in the best of circumstances). GPR is influenced by many of the same factors as EMI, particularly water content; wetter soil reduces how far the signal can travel. Another factor is the frequency of the transmitted pulse. The higher the frequency the finer the detail, but the deeper the radar will be able to penetrate.

Uses in agriculture

GPR's main strength is the ability to provide a cross section of the soil profile. Ground penetrating radar can pick up hardpans, which can help establish rooting depth and upper and lower drainage limits. An example is shown in Figure 1.

The main issue with GPR is the general lack of interpretative experience available for agricultural purposes in the Australian context. There is increased interest in the possibilities of GPR for agriculture and the Victorian Department of Primary industries has carried out experiments using GPR with the Birchip Cropping Group.

Most GPR work is done in the exploration industry (Fugro would be one of the larger providers). I am aware of one commercial provider to agriculture in Western Australia, and as noted above DPI Victoria is doing work in Victoria. It is likely that as more work is done in the eastern states with GPR many of the ground EMI and gamma-radiometric data providers will offer GPR surveys, as well.

Acknowledgements

The section on Gamma-radiometrics is adapted from Matthew Adams, Paul Rampant, Gabby Pracilio - Department of Land Information WA. Source: Australian Grains Industry Precision Agriculture Manual, Section: Gamma-radiometrics.

For more information

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