A box of tricks set to revolutionise soil-based salinity measurements

Nick Harris and Keith Smettem performing a real-time demonstration of chloride sensors mounted in a soil column.

Ms Ully Fritsch
Email: ully.fritsch@uwa.edu.au

What do you get when you team up an electronics and electrical engineering wizard from the University of Southampton (UoS) with scientists from UWA.

Well, in the case of Dr Nick Harris (UoS), Winthrop Professor Keith Smettem and Professors Neil Coles, Ed Barrett-Lennard and Mark Rivers (all from UWA) you get a revolutionary sensor capable of measuring chloride in the soil and of linking up with other sensors to create a wireless network (of sensors) which can be used to collate and relay the measurement readings and to control the time intervals at which measurements are taken.

With financial support from the World University Network (WUN) and the Biotechnology and Biological Sciences Research Council (BBSRC), Harris elected to spend a sabbatical semester at UWA to work with Coles and Rivers, and developed a novel sensor which can be placed into the soil, to carry out non-destructive testing/measurements of sodium chloride levels (which make up a high proportion of the overall soil salinity).

This non-destructive form of soil-based testing and the use of sophisticated network technology (e.g. Bluetooth) to collate and transmit data, is likely to dramatically change the way (soil-based) research is conducted.

"Traditionally soil-based measurements involve taking samples and transporting them to the laboratory for analysis, which is very labour – and cost-intensive, and therefore it usually means spot checks only, with samples taken every 2-3 months," explains Harris.

"The removal of a (soil) sample from its natural environment also means that the same sample can only be measured once, so the traditional (destructive) method is not suited to measure changes in a sample over a period of time."

By contrast, Harris' 'box of tricks' – the actual sensor connected to a small unit represents a device which you can almost plant and forget: the battery-powered unit can operate for (up to) two years and can either transmit data/information by short range radio, in this case Zigbee, to a laptop within 100 m range, or store the data on a memory card, to collect later. Many other options are possible, such as Bluetooth, or linking to the mobile phone network, or even satellite. However, the networking technology only allows information to be transmitted. The key to successful distributed sensing is to have low-cost, reliable sensors, sensing the things that you want. In this case, the sensor itself consists of a ceramic tile covered by successive layers of glass, platinum, silver chloride and silver. Changes in the external sodium chloride level cause a change in the equilibrium of a well-known reaction between the silver and the silver chloride layers which manifests itself in a change in voltage, which can then be measured. The current device allows up to seven sensors to be connected at a time to a single transmitter, allowing simple multi-point measurements.

Harris expects soil-based sodium chloride sensors to be of benefit in a wide range of applications:

"At plant level, probes can be positioned at continuous levels of depth to determine, for example, the salt concentration to which roots are exposed and whether the concentration changes with the depth of the soil, or in different weather conditions; we could measure how well a plant performs at a particular concentration and change the salt content for a few days and observe the effects. On a bigger scale, sensors could be placed at different locations in a catchment field, to observe any changes in the level of salinity within a field over time, allowing hydrological models to be calibrated."

"The (soil-based) chloride sensor represents a first step in integrating the science of networked information to provide us with perfect information on the things we want to measure at a low cost, over a long time."

Harris, Rivers and Coles are co-authors in a recent paper published in Computers and Electronics in Agriculture www.sciencedirect.com/science/article/pii/S0168169913001063