Guaranteeing yields

A measurement system provides precision data on soil properties

Farmers can now precisely determine the efficiency of their land thanks to a new system developed by the Leibniz-Institute of Vegetable and Ornamental Crops. High resolution soil maps are generated based on data from a system developed by Delphin Technology.

I’m standing in the middle of a test field belonging to The Leibniz-Institute of Vegetable and Ornamental Crops (LGZ), surrounded by a lush expanse of meadows, crops and woodlands just south of Berlin. I’ve just been told why a rolling system of electrodes has been given the name "Geophilus electricus" – a species of centipede. They are shaped similarly, move similarly and can both see into the soil. The measurement system has been developed as part of research at the IGZ aimed at establishing a scientific basis for efficient horticulture methods. Asparagus, kohlrabi, cloves, daffodils and the like need to be high quality, affordable and sustainably produced.

To achieve this requires high resolution data on soil properties. "Efficient farming that matches local conditions increasingly needs to take into account the variable properties within soil across each section of land to optimize the use of fertilizers, irrigation systems, sowing methods and tillage depths", explains Dr. Jörg Rühlmann, a project leader at IGZ. This requires techniques far beyond drilling to obtain data on soil. Seventy-five years ago, Germany's agricultural land was divided up into 50 × 50 meter sections. Drilling of up to 1 meter took place and samples were taken, analyzed and mapped. This information is still being used today. Today, measurement techniques are being applied to deliver additional and more accurate information. "This enables us to treat the land in a way that ensures a more ecologically friendly and efficient agriculture", emphasized Dr. Rühlmann.

Using Geophilus electricus to see inside soil

The "Geophilus electricus" measurement system has been built to achieve this aim, and is a joint project between the IGZ, Potsdam University (Institute of Earth and Environmental Science, Dr. Lück) and Delphin Technology. It examines the electrical conductivity of soil, a property that is affected by the soil's water content and grain size, as well as its salt content and temperature. The measurement data can then be used to ascertain the soil's overall properties. "Geophilus enables us to map soil variations over small areas and to optimize the use of fertilizers, water, seeds and fuel", says the expert. Six pairs of pivoting metal discs, set up one behind the other, and electrically isolated from one another, are used as rolling electrodes. The first pair feeds current into the soil; the remaining five measure voltages in the soil at five different depths. "The greater the distance between the feed and the potential electrode, the deeper the view into the soil", explained Dr. Rühlmann. A depth of 2 meters is currently possible.
To obtain meaningful measurements and to then generate 3D mapping charts, requires measurement hardware and software coupled to the system of electrodes. IGZ opted for Delphin Technology, based in Germany's Bergisch Gladbach. The flexibility of its development services was a decisive factor in going for this medium sized company. "In contrast to the majority of geophysical measurement equipment, Delphin's systems are not based on specific stand-alone systems but on the standard, industrial-grade equipment available on the market", stated Dr. Rühlmann's. Delphin's standard products include the TopMessage hardware and ProfiSignal software, both of which are being used here. "The hardware, firmware and software interfaces can be varied according to needs and therefore adapted to exactly what we want, including personalized documentation of data and results", said the project leader. Ongoing technical developments can be integrated included those to the Geophilus: "A major benefit is the system's extendibility. Additional sensors are easy to integrate into the measurement system."

And it is not just extendibility that IGZ demand from its measurement system: it also needs to be robust and resistant to wind, weather and shocks, capable of independent operation and able to transmit data via WLAN. Furthermore, the system must acquire geographical coordinates via GPS and simultaneously record them to the measurement data from the specific measuring points. All these needs must be provided from system that is as compact as possible. The system also provides an export function to Google Earth enabling a convenient way to portray the data. Another important factor was measurement speed. Results need to be observable while recording is taking place, and fast mapping is also necessary.

Single mapping for multiple gains

Mapping takes place just once. Farmers then benefit year after year because they no longer farm a field as a unit but according to management zones. These zones are individually farmed – this can be achieved by loading the maps into the onboard computers of modern farming equipment with GPS connectivity. "Precision farming means achieving an optimal compromise between high quality and quantity yields, minimal environmental contamination, sustainability and profit", was Dr. Rühlmann's summing up.

The project has already successfully completed an initial test phase. 1000 hectares of arable land in Trebbin has undergone detailed mapping. The farmer is now using the data to optimize the fertilizing and irrigation of his fields. Agricultural advisory boards can also benefit from these developments. Mappings from Geophilus can deliver the data for models that calculate recommended fertilizing quantities. Archaeology is a further field that can gain from Geophilus. Geophilus's gentle measuring method makes it ideal for mapping ancient routes and burial sites. Dr. Rühlmann: "To do the kind of high resolution mapping needed here just requires miniaturized rolling electrodes and a slow moving vehicle – the Delphin system can remain virtually as it is."

Potential uses

Agriculture is the most obvious area to benefit from a mapping of soil variations. Optimized fertilizing, sowing, tilling and irrigation are then achievable. Agricultural research institutions can use the mappings when evaluating field trials. The re-cultivation of former slag heaps from open cast mining can also benefit from mapping. Other potential uses are in archaeology, construction site surveys and landfill sealing. Mapping can also benefit golf and sport field management by optimizing its fertilizing, irrigation and drainage systems.