Monitoring soil contamination over large areas, long periods of time possible thanks to geophysical measurements

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Large amounts of industrial contaminants, such as mineral oil, chlorinated hydrocarbons and heavy metals, are hidden in the soil and ground water across Europe. Until now, there was no easy way of mapping their distribution and follow their development in the ground. Under the SoilCAM project, funded by the EU, scientists have explored a combination of methods to gain a reliable and accurate understanding of the physical, chemical, and biological behaviour of these soil contaminants. These methods could eventually be used to study the

distribution and monitoring of bioremediation and geo-chemical processes over a long period of time.

"By improving our understanding of how the biochemical and geological processes are interlinked and driven by the boundary conditions, such as rain and temperature, we are able to suggest new and improved ways of combining methods in order to get a better control of contaminated sites," explains Helen French, project coordinator based at Bioforsk, the Norwegian Institute of Agricultural and Environmental Research, at Ås outside Oslo. This system has, so far, been tested at Oslo airport, where the challenge was to monitor pollution from de-icing chemicals used on aircrafts and runways in winter. It has also been tested in a second testing site is in Trecate, Italy, where scientists monitored a historical oil spill from petroleum wells, dating back from 1994.

In addition to combining existing instrumentation, scientists developed new technologies, for example a prototype of an ultra-fast complex resistivity meter for borehole and surface investigations, called Polares. It is designed to relate soil pollutants to certain geophysical parameters such as the electrical conductivity and induced polarisability. The innovative aspect of Polares is the possibility to make observations at high frequencies, which gives a better potential to detect soil pollution, as more date is available over a wider frequency span. "Induced polarisation clearly is the most promising geophysical method to track contamination," Andreas Pfaffhuber, head of Geosurveys sections at the Norwegian Geotechnical Institute (NGI) in Oslo, Norway, tells youris.com.

Remote access to some of this information as well as modeling with new geophysical software for 2D and 3D data processing as well as solute transport modelling, could ultimately help provide a system for optimised monitoring with classical sampling techniques. Experts recognise that this approach constitutes progress compared to previous

technologies. "By combining different mapping and monitoring techniques, the SoilCAM project has managed to provide a fuller picture of the situation under the soil's surface as well as the substructures," says Torleif Dahlin, professor of engineering geology at Lund University, Sweden. Indeed, he adds: "By using traditional methods mapping the subsurface at certain points, you cannot tell how the permeability of the underground structures is distributed. This makes it very difficult to know how contamination moves and affects the soil and groundwater."

Thus, this approach can also provide an early warning system showing when there are large changes in hydraulic or contaminant situation, according to French. "We hope – within a couple of years – to be able to offer these as practical tools for providing early warning systems and better spatial coverage," she says, "hence avoiding or reducing [contamination] at sites affected by pollution from heavy industry, building sites and transport infrastructure."

Before this technology can be more widely applied, Pfaffhuber warns, prior testing of each site is key: "as it is still not 100% clear, how geophysical properties and contamination interact, there will always be a certain remaining risk that the method won't work at the client's particular site." He sees potential additional applications, for example, in the management of ground water resources, tailing dams, leakage through river dams, landslides particularly in the case when permafrost thickness is the cause. "Yet the likelihood for such an implementation," he concludes, "is largely determined by the industry's acceptance of [what would be for them] an unknown technology."

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