Digging deep

An integrated range of analytical techniques for forensic use on soils – called SoilFit - could become a valuable tool in police operations, reports Damian Small.

Doctor Lorna Dawson, Senior Researcher in Soil Science at The Macaulay Institute in Craigiebuckler, Aberdeen, is leading the project designed to unearth from soil secrets that might reveal vital clues to aid crime investigation.

Hosted by the Macaulay Institute, and involving a team of researchers from across the UK, the SoilFit project aims to integrate state-of-the-art soil analytical fingerprinting methods, national databases, GIS and appropriate statistics to match soil forensic samples to likely geographical origin. "We are coupling improved chemical and biological identification methods with UK forensic database information to help pull clues from the soil," said Doctor Dawson.

"This project brings together conventional, improved and new soil analytical techniques for forensic use on UK soils, and aims to develop new intelligence and evidential tools for the benefit of the police and the judicial system."

Doctor Dawson said: "The main objective of this project is to increase the range of situations where information from soil can be used in criminal investigations. This will be achieved through the combined use of improved analytical fingerprinting methods, effective use of databases and through ensuring that a robust statistical approach is adopted."

Forensic scientists currently use numerous conventional soil analysis methods, such as colour, texture, microscopic observations (including palynology) and mineralogical measurements. "Our team will integrate such methods with the latest chemical identification techniques, such as organic analysis (GC-MS), high-resolution powder X-ray diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), electron microscopy (QEMSCAN) and molecular microbiology of soil DNA."

Soil particles readily adhere to, and transfer from, clothing/shoes/vehicles/tools, and can therefore be treated as trace evidence.

Along with the team's partners, which include the National Soil Resources Institute (NSRI) and other agricultural, biomathematical and science organisations, they are aiming to design and test a decision support tool to help investigators choose the most appropriate soil characteristics to focus on, dependent upon sample size, condition and pre-treatment. Doctor Dawson informed us of the marker selector initiative.

"We are characterising the mineral, organic and living components of the soil and examining which combinations best discriminate different soil and land use types. For example, when trying to locate which heather moor peaty-soil evidence has

come from it might be the differences in soil minerals that leads police to the site. Alternatively, an object buried or hidden in a sandy, arable soil on a common rock type could be best located through the use of indicators that reflect subtle changes in cropping history, such as plant waxes and soil DNA.

"This project will objectively determine which combination of analytical approaches would be most fruitful for use depending on upon the circumstances."

Doctor Dawson explained the benefits SoilFit will bring in assisting police investigations.

"Attributes of trace samples will then be correlated to the characteristics of soil samples held in the databases for England and Wales, Scotland and Northern Ireland.

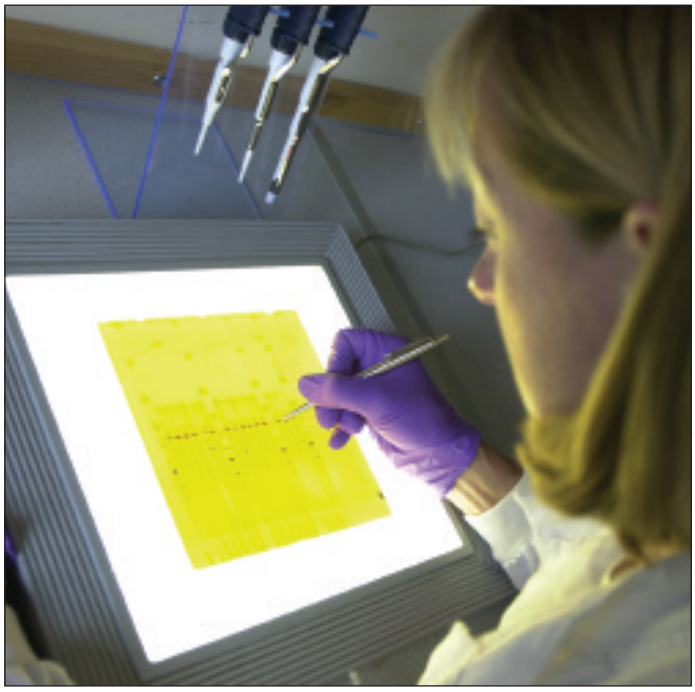
"We are trying to utilise the three databases in one; coupled with GIS capability, we can 'smart map' the results allowing database users to match soil forensics to determine likely geographical origin," said Doctor Dawson.

The fact that samples are located spatially using their National Grid coordinates means that, by grouping individual locations, the database with GIS can map where those soils and land use types are present. Doctor Dawson explained that by combining soil attributes with vegetation attributes, it is possible to narrow down locations where particular soil and vegetation characteristics are present.

"Comparison of data from a soil forensic sample with associated data held in several databases will provide important intelligence clues. The ability to match samples with a defined probability will be greatly improved.

"These forensic techniques will assist police officers in more rapidly and accurately locating missing persons, murder victims, or objects connected with crime, while also giving a known statistical power to the evidential value of soil in court," she said.

Professor Karl Ritz, Chair in Soil Biology at the National Soil Resources Institute, Cranfield University, underscored the potential of a combined database capability. He said: "This is very much a multi-disciplinary initiative and one of the most important aspects from a soil database perspective is for the first time we are starting to put together soils data across the UK.



"There is an obvious drive to accomplish this because of the benefits it will bring. The SoilFit project has provided the opportunity for the databases in England, Wales, Scotland and Northern Ireland to connect into a single practical application. Hitherto, the databases were quite distinct. It is a challenging task but we are making good progress in achieving our goal."

Doctor Crawford Jordan, Agri-Food and Biosciences Institute (AFBI), Belfast, Northern Ireland, also emphasised such benefits. He said: "The databases created through the SoilFit programme will represent an important step forward in the fight against crime and terrorism in this country and abroad.

"Northern Ireland, in the form of AFBI, is pleased to participate in this exciting programme. We have offered up AFBI's unique combination of geo-referenced, soil databases and archived samples for the Province to support the SoilFit programme. For the first time, the soils databases of the England & Wales, Scotland and Northern Ireland soil surveys will be integrated to provide a single, geographic, UK-wide database of soil properties which can be searched and, importantly, mapped with equal ease.

The main objective of this project is to increase the range of situations where information from soil can be used in criminal investigations.

"The usefulness of this database will be further enhanced by inclusion of the new soil specific data resulting from application of the novel SoilFit analytical techniques (such as QemSCAN). The new databases will provide an additional tool in the armoury of the forensic scientist allowing more specific queries to be addressed which should narrow down the geographic possibilities resulting from any forensic investigation involving soil."

Today, said Doctor Dawson, there is general recognition that trace evidence (fibres/fluids/particles) found at a scene of crime can be instrumental in providing criminal intelligence to police investigations. Soil particles readily adhere to, and transfer from, clothing/shoes/vehicles/tools, and can therefore be treated as trace evidence, potentially linking or eliminating suspects to/from a crime scene.

Doctor Dawson feels that today the use of soil in criminal investigations has generally remained limited to comparison of broad scale soil composition. She said: "More-over, there is still a general lack of awareness among the legal profession and police forces as to the true potential of soil forensic science."

The SoilFit team, encompassing a large multi-disciplinary group of experts from across UK academic and law enforcement organisations, aims to raise the profile and application of soil forensics, both nationally and internationally.

Doctor Dawson said: "We are also collecting fresh soils so we can home-in on zones that haven't already been covered and create a database relating to soils that are located on urban fringes, woods and park areas on the outskirts of cities for example, to discern what methods work best in such semi-urban circumstances."

Although the three-year project is in its early stages (beginning in January this year), they plan to use its benefits on an international scale and Doctor Dawson's team are already working together with experts on an international scale.

"We are collaborating with scientists from other countries and are currently working closely with forensic soil science experts in Australia, New Zealand and America. We aim to set up a comparative sample analysis scheme to see if methods and approaches developed in the UK can be applied to soils from other countries.

"Working with Dr Rob Fitzpatrick, Director of the Centre for Australian Forensic Soil Science (CAFSS), we intend to set up an international database to tackle the threat of terrorism; a crime, which moves over international borders," said Doctor Dawson.

The National Centre for Policing Excellence (NCPE) will act as a key advisor to the SoilFit project, ensuring the research is directly relevant to the forensics community.

Joanne Ashworth, Head of Physical Evidence at the National Centre for Policing Excellence (NCPE) sits on the SoilFit project group to represent police user requirements to ensure that any product that is developed is fit for purpose and can be implemented into policing.

She said: "Over the last two decades most forensic research effort has been put into DNA techniques, which have obviously become powerful tools in crime investigation. However, this has meant that other evidence types have become the poor relation, particularly in relation to innovation and development. Projects such as this could provide a product, which would contribute to the ever growing arsenal of weapons in the fight against both serious and volume crime. Who knows, soil evidence could become the 'new DNA'."

The need for a co-ordinated approach to soil forensics in the UK was identified by David Barclay, latterly Head of Physical Evidence National Crime and Operations Faculty, UK.

He told us: "When I was head of physical evidence at the National Crime Faculty, we realised from lots of cases that there wasn't a good scientific way of looking at soil in the UK. There wasn't a unified place in the UK that could provide a service to investigators.

"The project is a good example of science in practice, rather like DNA. DNA provides a way of identifying people, but we need a way of obtaining more physical and forensic evidence out of soil."

We are coupling improved chemical and biological identification methods with UK forensic database information to help pull clues from the soil.

Mr Barclay pointed out that use of the databases will provide a bespoke service to an extent, as specific information such as what plants grow in a particular area (palynology) will be bolted-on to the databases depending on the specific case evidence. However, statistics and the strength of evidence will depend very much on the database, he added.

He refers to SoilFit as a 'giant loom', which weaves together all the various threads of soil forensics to provide much stronger evidence than before.

"SoilFit is built on a formal and scientific basis. Previously, there was no real peer review and soil forensics consisted of individual experts from various fields such as geology and palynology, many of them working in isolation. It is now housed in a reputed scientific institution where techniques can be thoroughly tested."