Getting down to earth

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Tim Farewell reflects on the many different ways soil has an impact on our daily lives

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Recently, I've had the pleasure of working alongside amazing people who are protecting and distributing our water resources, growing food for our tables, looking after our roads, preventing gas leaks and even with those who are insuring our properties.

I love the passion that these people have for their work. They put in the hours to keep us fed, watered and safe. More and more, I?m seeing the value of cross-sectoral working ? how one set of experiences speaks so clearly to a completely different industry.

All these people have something in common. Their work, their assets, their risks are related to the soil. Some of the links are more clear than others ? for example, certain crops will grow better on particular soils and under the right weather conditions, roads on unstable soils are likely to fail more quickly and iron pipes in corrosive soils are likely to degrade faster. More complex soil relationships include the pathways for agri-chemicals through the soil and into watercourses or the potential for cavities or sinkholes to form under roads and houses.

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One of my favourite examples of slightly obscure soil risks involves a burst water main. The first that people knew about it was when the road started to flood. Along came the maintenance van to repair the main when, to their surprise, it fell through the road into a cavity formed by the highly pressured water in this sandy, loosely structured soil.

Unfortunately, the van also broke a gas main in the hole, so the whole area was evacuated. The basement of the local authority offices also flooded ? ruining thousands of official records. All because of a sandy soil.

My point is that understanding the soil is really helpful if you want to protect your assets, customers and reputation, to maximise the long-term profitability of your land or reduce maintenance costs.

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Soil is the foundation for most of our infrastructure and is itself a highly complex and responsive ecosystem. When we think about life in soil, we tend to picture earthworms or moles, but actually the soil is teeming with life.

Imagine a field full of sheep. If you put all those sheep together on a big set of scales, they would only equal 1% of the mass of all the microscopic animals in the soil under their feet. And there may be 3 different soils in that field, each of different depths, textures ? sand, silt, clay, peat ? and associated risks.

Given that soils are complicated and highly spatially variables, is it any wonder so few people really understand them?

Making sense of stagnogley podzols

Scientists haven't helped. We have great names for our soils, such as "stagnogley podzols" or "paleo-argillic stagnohumic gley soils". But to be frank, soil maps with labels like these don?t really give people the information that they need to make a good decision.

When I started my job here at Cranfield University about 12 years ago, I was exactly the same as many of our clients. I was a geologist turned geographic information systems specialist, charged with helping clients use soil maps to solve their problems. I too got lost in the terminology and complexity and would go home most nights with a question or 2 for my wife, a geographer, as well as spending most of my coffee breaks quizzing my brilliant colleagues, many of whom had 4 or more decades of field experience.

But over time what I learned was that, if we could create versions of soil maps that I could understand, there was a good chance our clients could understand them as well. So we set out to convert the raw soil maps into ones that indicated subsidence risk, crop suitability, or how easy it would be for a pesticide to leach into the groundwater.

So, when we are now approached by a new land manager, town planner or infrastructure operator, we can provide them with maps to answer their specific questions. Once they have the evidence, they don't need to waste their time guessing what environmental risks they might face ? or worse, ignoring them altogether ? but can get on with their jobs.

Subsidence

One of the soil risks that I find most fascinating is ground movement and subsidence. Clay soils, for instance, have a far greater volume when wet than dry. Houses, pipelines or roads built on clay are thus subject to greater ground movements and stresses in the summer and autumn when these soils shrink and swell with changing moisture conditions.

Our clay ground movement map answers the following 2 key questions.

1. How much can the soil shrink and swell?
2. Is the summer going to be sufficiently hot and dry to dry the soil out?

To answer these, we assembled 2 maps ? one of soil volumetric shrinkage potential and the other of potential soil moisture deficit. By combining them we created climate-adjusted subsidence models, such as our Natural Perils Directory, which are now in use by many insurers and the majority of water companies.

Climate change is highly topical ? and rightly so, as weather is already a key driver of infrastructure degradation and failure. So with colleagues Steve Hallett and Oliver Pritchard, I modelled how the subsidence risk might change over the next 15?35 years.

We spent about a year running climate simulations, and from the 40TB of data in the directory data sets calculated the future soil moisture deficits across the UK. Then we replaced our existing climate models with these future scenarios. We found that the subsidence risk is set to increase towards the 2030s and 2050s, particularly in the South East of England. These long-term views on risk enable infrastructure companies to plan their network maintenance to ensure the highest resilience.

Trees

Trees can affect subsidence risks by acting like pumps in the soil, drying it out more quickly and deeply than grass or small vegetation would. So when I found out that aerial mapping firm Bluesky had a National Tree Map showing every tree over 3m in the UK, my interest was piqued.

Figure 1: Ageing pipes are more susceptible to failure under the tree canopy

So we created a new version of our subsidence model that incorporated the effect of local trees. Those of you who work with spatial data can imagine some of the struggles we had integrating millions of tree polygons into a full national soil map ? but the results were encouraging.

We tested our models by assessing the impact of trees on Anglian Water's mains failure rate. We found that trees hardly increased the rate of failure, but when combined with highly shrinkable soils, they boosted it by up to 40%.

In practice, trees in the urban environment don't pose a great risk to water infrastructure in most places ? in fact, they provide a huge number of benefits ? but in certain places ageing pipes are more susceptible to failure under the tree canopy (see image above).

Soil solutions

I?m always encouraged when people recognise that they need to identify and mitigate environmental risks. It's great to be able to help them.

If you want to understand the soil and how it affects you look at our free soils map and get in touch if you have an environmental risk you'd like us to consider. We love helping people to solve practical problems.

Tim Farewell is Senior Research Fellow at Cranfield University

Further information

Related competencies include:

- Land use and diversification
- Management of the natural environment and landscape
- Sustainablity

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