The Clay Research Group

RESEARCH AREAS

Climate Change ◆ Data Analysis ◆ Electrical Resistivity Tomography
Time Domain Reflectometry ◆ BioSciences ◆ Ground Movement
Soil Testing Techniques ◆ Telemetry ◆ Numerical Modelling
Ground Remediation Techniques ◆ Risk Analysis
Mapping ◆ Software Analysis Tools
Artificial Intelligence

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The Clay Research Group

CONTENTS

Issue 161, October, 2018

2018 – Surge Year?

The indications are that 2018 is delivering high claim numbers and may indeed be a surge year, bearing in mind the low starting point of 12,000 claims notified in 2017.

Several colleagues estimated that we may see around 20,000 subsidence claims based on notifications towards the end of August. This does raise the question of whether warming will lead to high numbers going forward.

It is highly unlikely that this year's numbers will reach the 50,000 figure more often associated with the term 'surge'. As ever, the future remains uncertain despite our attempts to model it.

Warmer, Drier. Modelling the Risk of Subsidence.

Subsidence has been a volatile peril with a steady decline over the last 10 years, despite global warming. The Met Office report that 15 of the 16 warmest years on record have occurred since 2000 ("Our changing world: Global Indicators"). Can we model the impact of warmer and drier weather? If we can, does it have any relevance?

The BGS have produced a climate model at 1:50,000 scale ("British Geological Survey GeoClimate: clay shrink swell dataset") which seeks to identify the risk of subsidence damage based on the medium emissions scenario of the UKCP09 climate projections provided by the Met Office.

(http://ukclimateprojections.metoffice.gov.uk/)

Cranfield have also developed a dataset (LandIS – Land Information System) describing the risk of clay shrinkage taking into account global warming predictions. Visit their web site for further information and view 1:250,000 scale maps:

http://www.landis.org.uk/soilscapes/

In this issue, we re-visit our own work in this area.

Even if predictions are made, will underwriters be able to make use of them? Nobody is setting rates for what might, or might not, happen in 50 years-time, so apart from an intellectual exercise, is there any practical benefit?

More inside.

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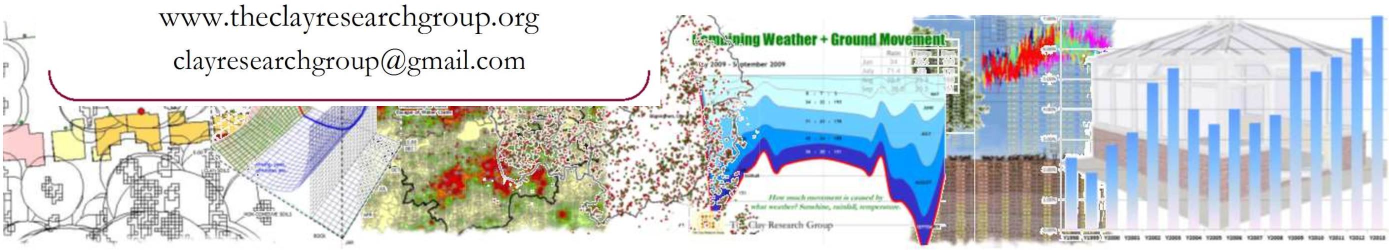

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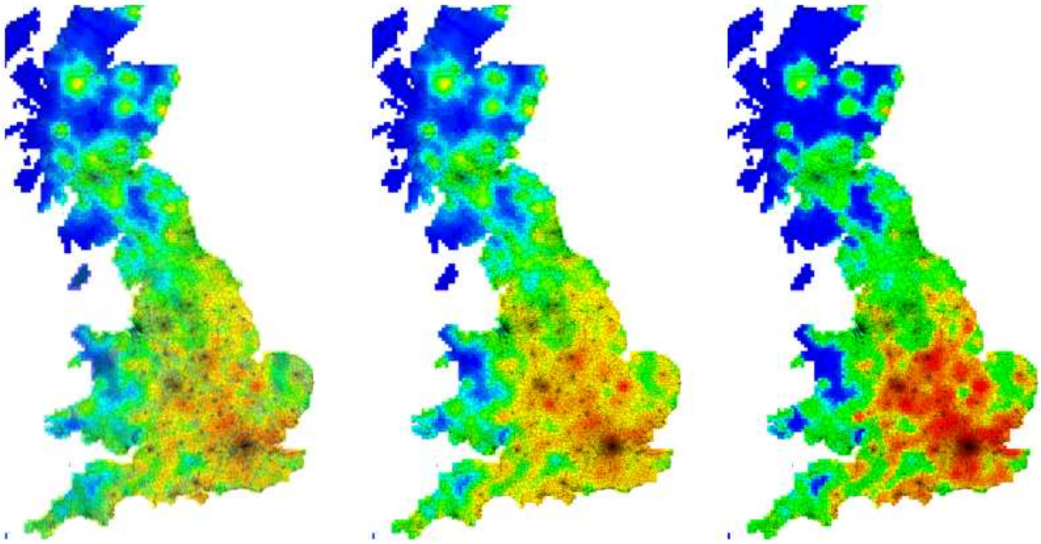
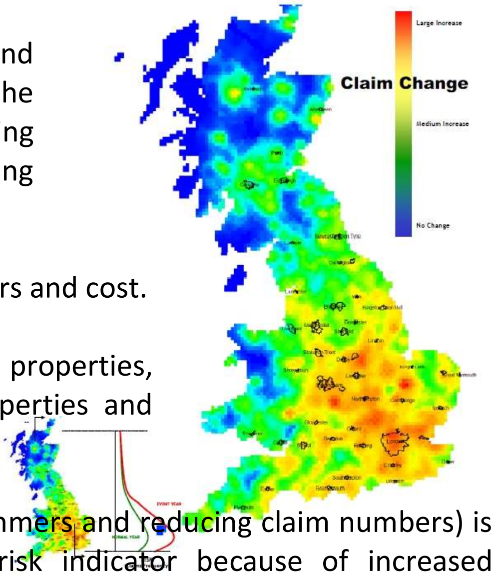
Modelling the Risk of a Warmer and Drier Climate

Subsidence accounts for around 4% of insurers total claims spend in a normal year. What is the risk going forward, taking into account the predictions of a warming planet?



The illustrations above indicate the regions in the UK that would suffer most (the areas shaded grades of yellow changing to red with increasing risk) indicating outcropping clay.

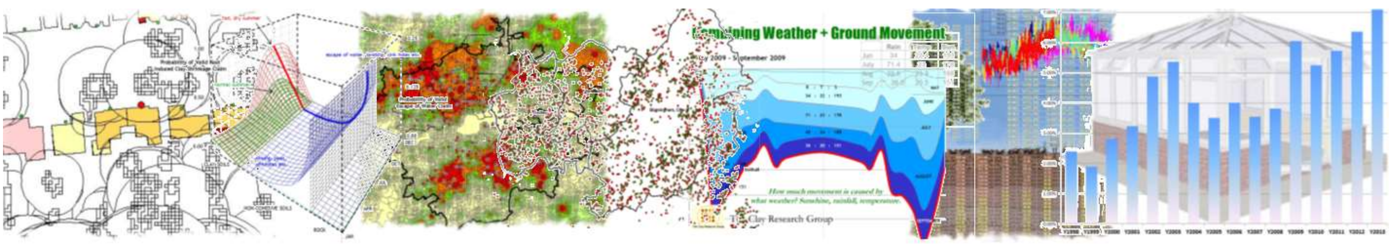


To the extreme left of the series, a normal claims year and centre, an event year. At the end of the series, the modelled risk of clay shrinkage in 50 years time reflecting the increase if climate predictions of sustained warming and drier conditions prevail.

Right, how this has been translated in terms of numbers and cost.

The risk varies as a product of the soil shrink/swell properties, housing frequency and demographics – age of properties and possibly value etc.

What has become clear over recent years (record summers and reducing claim numbers) is that the warming estimate alone isn't the best risk indicator because of increased atmospheric moisture and the physiological response of trees. Relative humidity may deliver more value.



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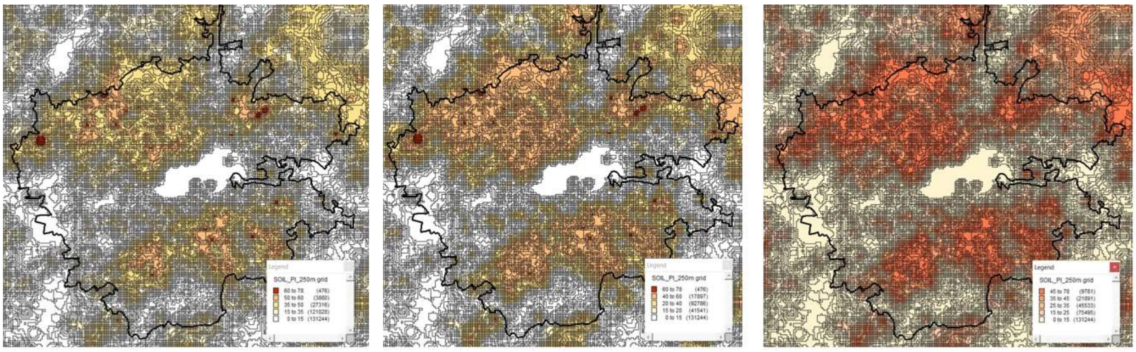
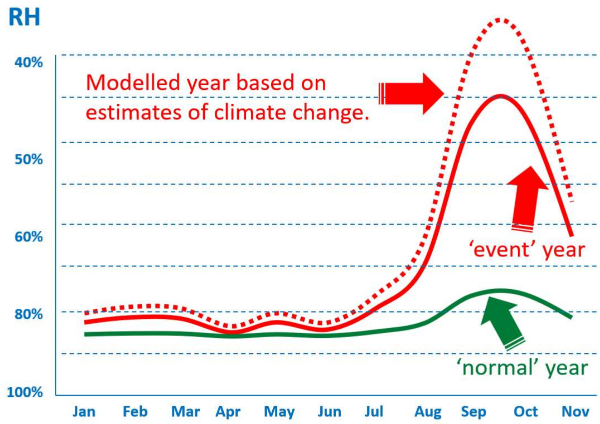
Modelling the Subsidence Risk of Climate Change

At a more granular level, risk has been modelled on a 250m grid, linking interpolated soils data with past claims experience, and increasing anticipated claim numbers in accordance with the graph below, plotting normal years alongside event years and then modelling a possible future scenario in accordance with the shrink swell properties of the clay soil. See following page.

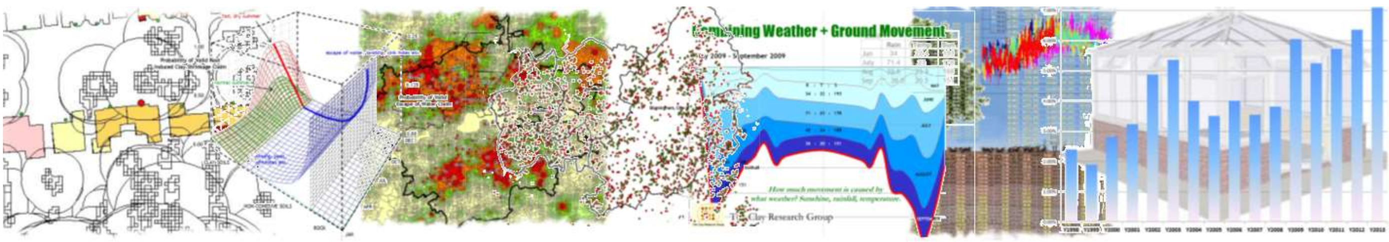


The curves below, right, plot claim notifications by month, (which can be factored by the spatial distribution) using the shrink/swell properties to provide an idea of loss. The red dotted line reflects the enhanced clay shrinkage risk using modelled climatic conditions (particularly relative humidity).

	Normal Year (all claims)	Event Year (all claims)		Increase in Surge
Jan	3016	2829		0.94
Feb	3661	3022		0.83
Mar	2694	2910		1.08
Apr	3613	2428		0.67
May	3226	2781		0.86
Jun	2613	2428		0.93
Jul	2952	3280		1.11
Aug	3145	5080		1.62
Sep	3226	10289		3.19
Oct	3952	10787		2.73
Nov	2823	6077		2.15
Dec	1581	3489		2.21
	36,502	55,400		



Above, left, claim numbers for a normal and an event year, together with the factored increase for surge months. Superimposing the possible increase taking into account climate change (graph, right) predictions delivers an estimate of possible claim numbers and values going forward – see red dotted line.



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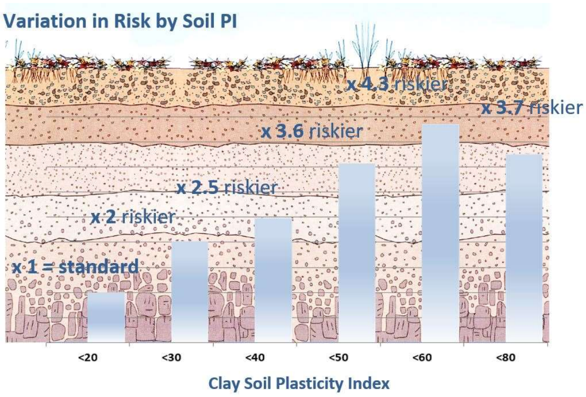
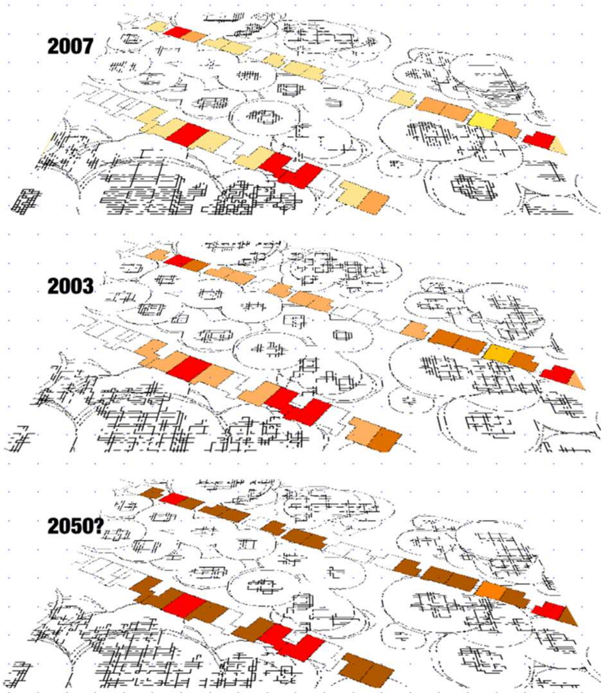
Building the Future by Looking at the Past



Previous analysis has shown that clay risk is linked to the Plasticity Index of clay soils - the higher the shrink/swell potential, the greater the risk. The table left allows the risk to be quantified, reflecting that a PI of say 60% is ‘x’ times riskier than a PI of 20%, 30%, 40% … etc.

Linked to the grid (previous page) it is possible to construct a detailed map plotting the potential risk over a range of climate changes at a granular level.



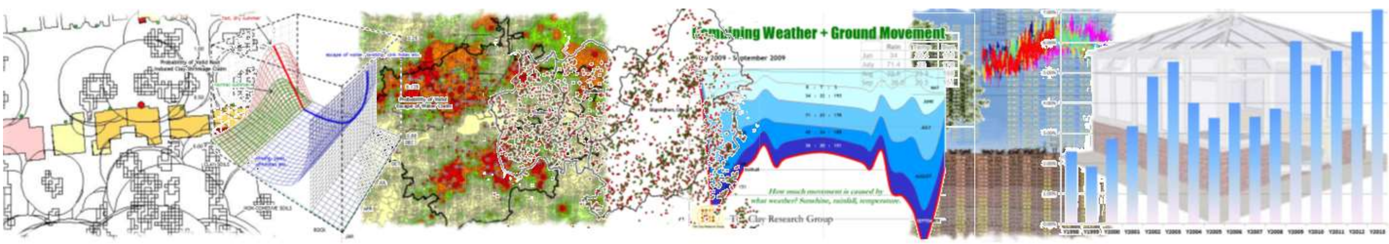
The image, right, is taken from edition 83, April 2012 and shows how we might model subsidence risk on a house-by-house basis, taking account of a changing climate using the above approach.

With little hope of accuracy, and assuming access to all industry claims for specified years, the model could be ‘run backwards’ to identify the risk and refined based on results to improve its accuracy.

Which style and age of house, on what geology, with what species of tree (from the claim record) and what tree metrics (height, distance and modelled root zone) presents the highest risk?

Then run the model forwards to identify the risk by individual property, taking into account various scenarios for warming and drying. By adding a data column to each property indicating the risk, the model could be both predictive and deliver ‘live’ values by month.

Running the model back through 2003 and 2006, and then forward year by year could refine the risk values using probabilistic analysis. Comparing “What are the chances of …?” with outcomes.



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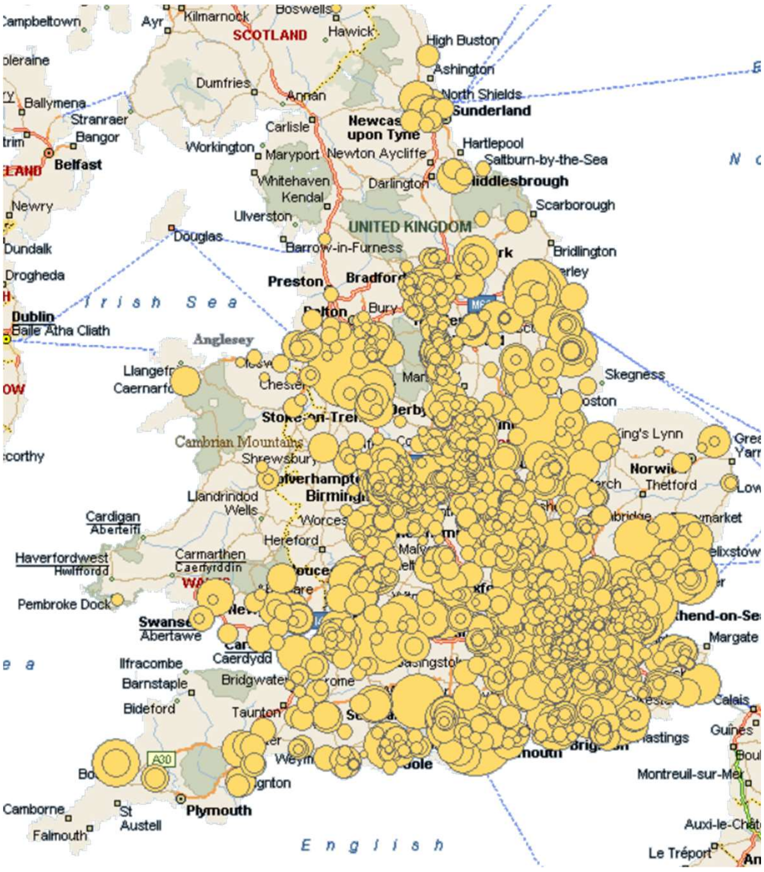
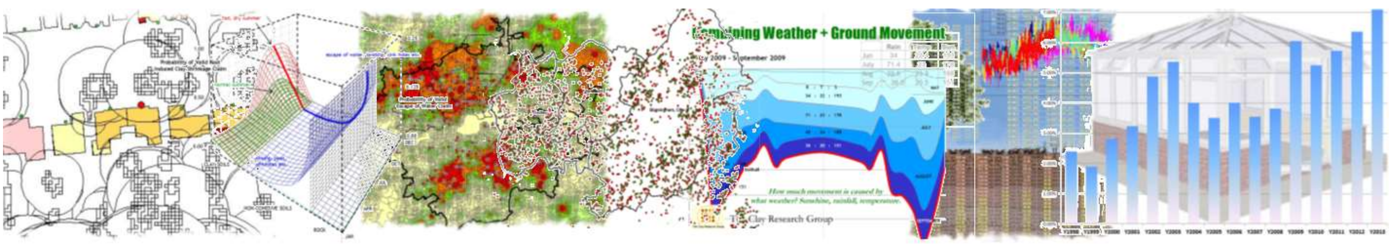
Mapping Risk using Claims Data from Site Investigations

There are areas where clay soils exist that don't appear on our map, and strangely this adds value. Insurers have a different requirement when mapping the UK geology to geotechnical engineers. Perhaps those areas with no values have a different risk demographic that the map picks up by default.

For example, perhaps they contain modern houses with deeper foundations, fewer trees, resulting in fewer claims.



In that sense, the CRG map may have more relevance, gathering data in areas of risk. The fact we have data in a particular postcode is in itself a risk indicator.



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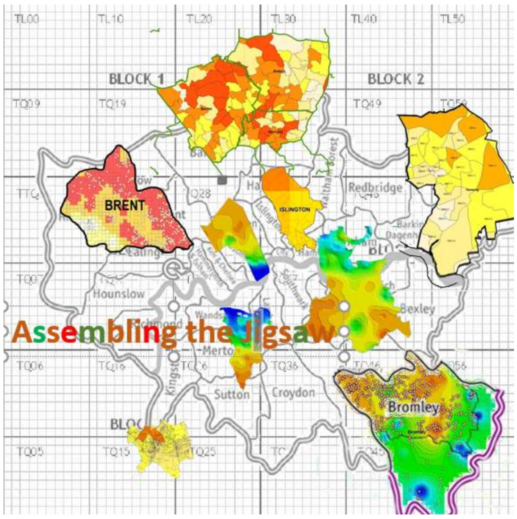
Jigsaws – Ai and the Real World

Gathering data is the first step. "How many claims, under which peril at what time of the year" to which we can add "on what geology, in what weather" etc., before refining with "age of house, details of vegetation, crack location" etc.

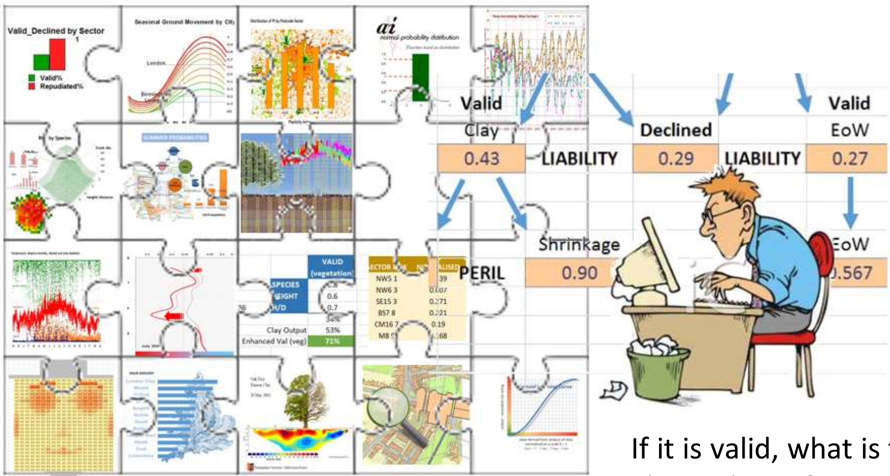


Building an understanding of how the individual elements connect to one another and their relevance – their 'weighting' – is the next step in building an Ai system.

The combination of geology, weather, vegetation etc, confounds a binary solution unfortunately. Our world becomes a bit 'fuzzy'. No single element can predict the outcome.

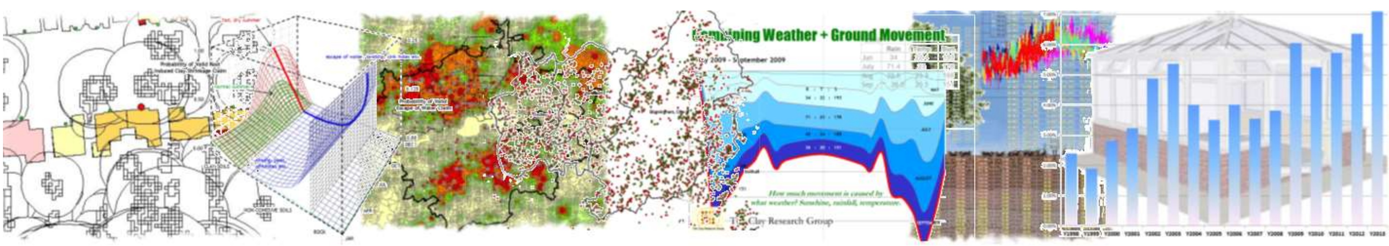
This is where we turn to combined probabilities. "What are the chances of this diagonal crack being indicative of a valid claim given that it appeared in a spell of warm, dry weather, in an area with a high claim incidence, on clay soil with a tree nearby?" Does the probability increase the older the house?

Our model needs to build a digital image of what various categories of claim look like. The articles in recent issues of the newsletter are part of that recognition system. As can be seen from the extracts above, every tile is different. Each has a characteristic profile.



We (and the model) can see that a claim in a certain part of the UK has a far higher likelihood of being valid or declined. What are the individual circumstances?

If it is valid, what is the most likely peril? The risk is factored by the soil, the weather and the sector history.



Modelling

Many professionals express disdain at the thought of modelling the complex interaction between roots, clay soils and the weather to estimate the likely amount of ground movement that might take place, and as a consequence, the possibility that the damage under investigation is associated with root induced clay shrinkage.

And yet modelling these complex data is an everyday function in the academic world, as can be seen from a brief review of one publications (Vadose Zone Journal) recent papers:

"Quantifying Soil Water and Root Dynamics Using a Coupled Hydrogeophysical Inversion"

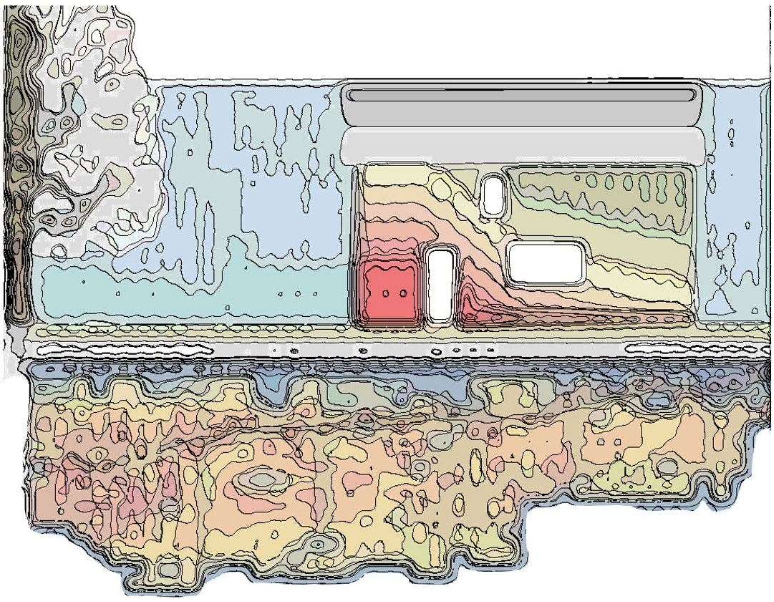
"Statistical Characterization of the Root System Architecture Model CRootBox"

"A New Simulation Framework for Soil–Root Interaction, Evaporation, Root Growth, and Solute Transport"

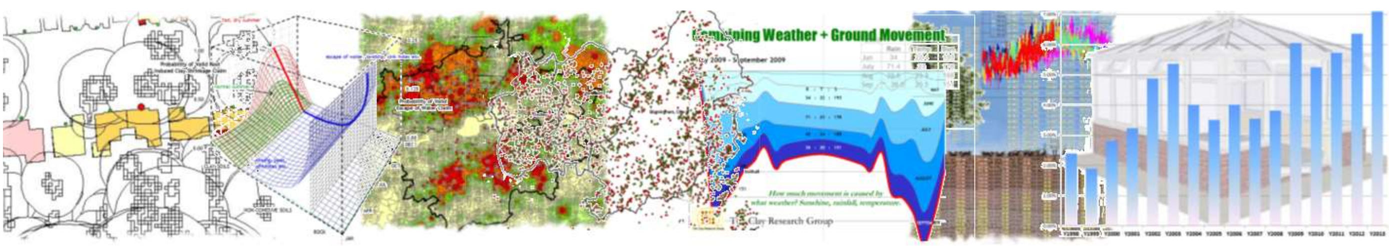
"Magnetic Resonance Monitoring and Numerical Modeling of Soil Moisture during Evaporation"

Is the diagnosis of subsidence really so much more complex than any of the above topics that rules can't be applied?

We have to declare an interest as developers of several modelling applications, but the question remains, do we really know so little about the topic that when cracks develop in a building, it is beyond the wit of skilled professionals to make sensible deductions based on numeric analysis?



The objective isn't to condemn every tree within influencing distance of a property, but to estimate the probability that when damage does occur, the likelihood that the tree or drain is, or isn't, implicated and map out how matters are to be progressed. Is a site investigation needed, should soil samples be retrieved for testing, would drainage investigations help and is monitoring required?



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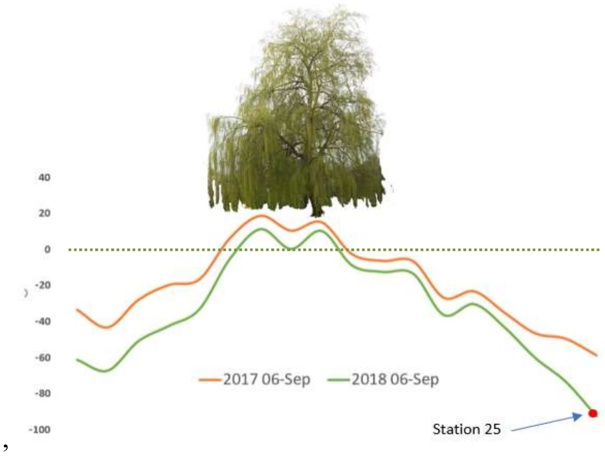
Aldenham Willow
Ground Movement over Time

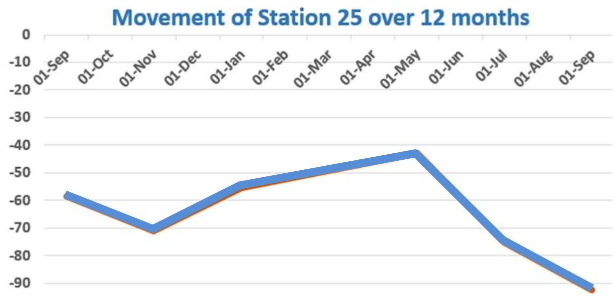


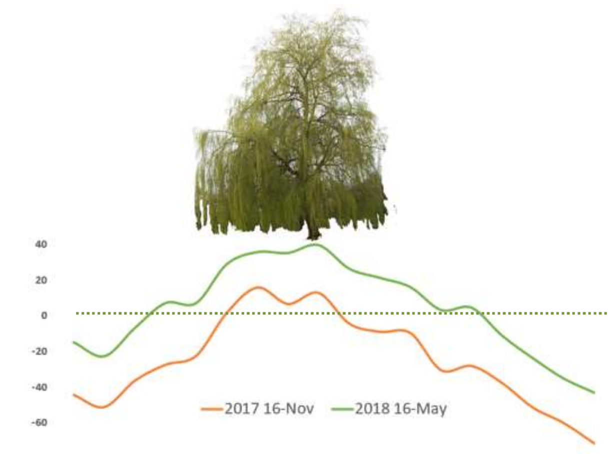
In September 2017, Station 25 was 58.4mm below the datum. 12 months later, the figure was 92.4mm.

The station subsided 34mm as a result of the trees response to the warmer and drier weather in the summer of 2018.

Station 25 has travelled the path shown, right, over the 12 months term.

The station subsided 12.9mm between September and November 2017, before rising 28.5mm in the winter months and then subsiding 49.5mm, bringing the total vertical travel to 90.9mm over one season.





The winter recovery cycle is shown, left, covering the period from the 16th November, 2017 (orange) to 16th May, 2018 (green).

Station 25 rose by 28.5mm, reflecting the average variation across all stations, which was just under 30mm and as can be seen from the image, the November and May profiles are similar indicating fairly even rehydration across the root zone.