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
Electrokinesis Osmosis
Intelligent Systems

Edition 147

August 2017

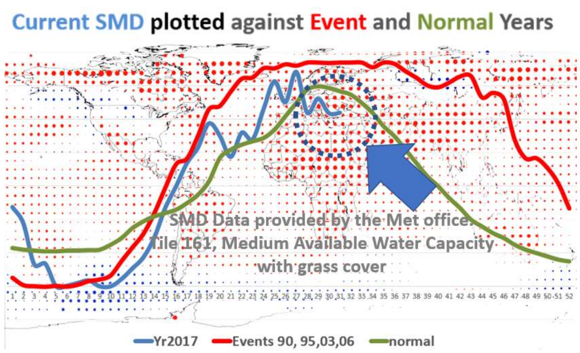
The Clay Research Group

CONTENTS

Edition 147, August 2017

SMD Update

The threat of 2017 being an event year is falling away as intermittent and regular rainfall reduces the soil moisture deficit in the south east.



THE CLAY RESEARCH GROUP
www.theclayresearchgroup.org
clayresearchgroup@gmail.com

Modelled Root Zones in OS Tile TQ29

Last month's edition looked at mapping the canopy area of trees in OS tile TQ29. This month the modelled root zone is estimated. What appears to be a particularly high-risk area turns out not to be, emphasising the importance of combinations over individual elements.

Intelligent Systems

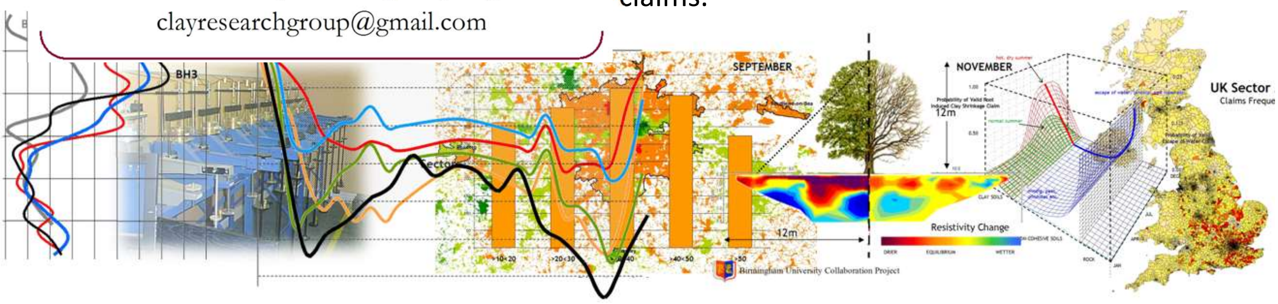
More on the topic of intelligent systems, reinforcing the theme of working with combinations of elements. The brain maps specific items on its surface, which are then analysed by a complex matrix of interconnections. This is how it learns. 'Future proof' systems will need to emulate this.

Met Office Temperature and Rainfall Anomaly Maps Reviewing 2003 and 2006.

The combination of hot weather and low rainfall provided a clear explanation for the surge of claims in 2003, but less so in 2006. Met Office anomaly maps are reproduced to try to understand what the triggers were.

Mapping and GIS

Concluding the series on mapping risk in recent editions, showing the elements that can be mapped, their relevance and in this edition, how they are combined to deliver value to both underwriters and adjusters handling subsidence claims.



The Clay Research Group

Modelled Root Zone Analysis, OS Tile TQ29

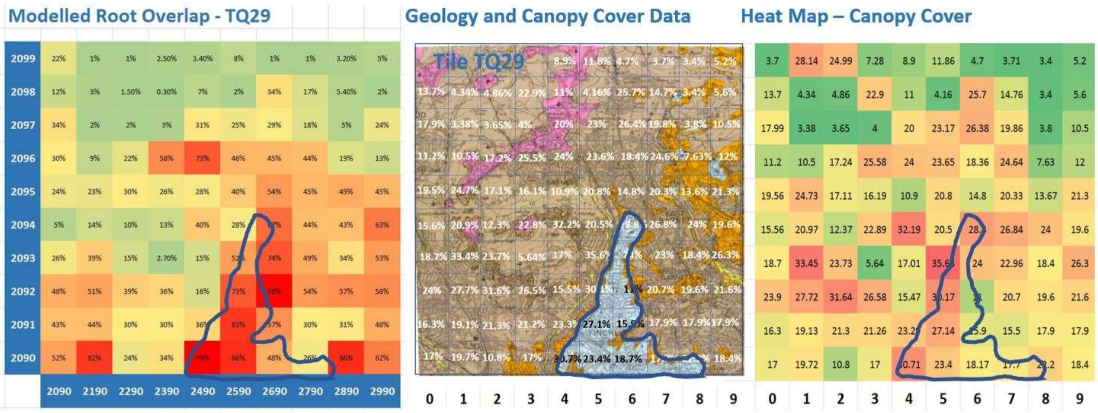
Last month's edition included the measurement of the tree canopy area in OS tile TQ29 using our LiDAR dataset. This led to considering what the modelled root zone might reveal at the same location.

Right, the output in the form of a heat map showing the modelled root zone area, revealing tile TQ2490 as the densest and perhaps riskiest (subject to housing population and geology).

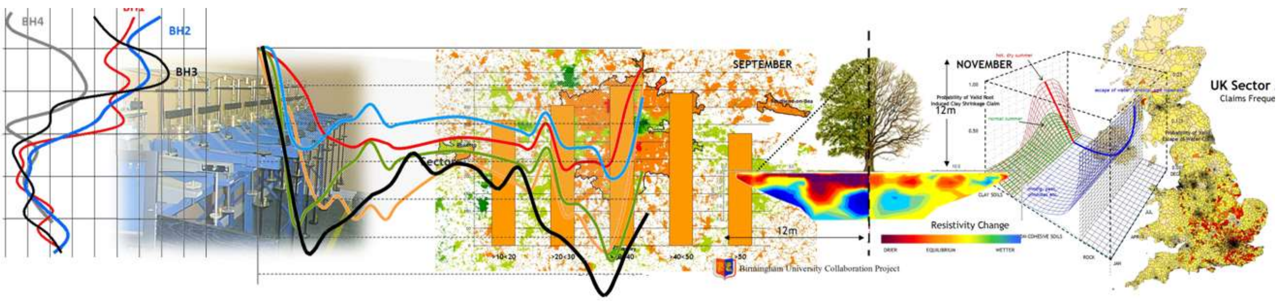
All tiles with a score exceeding 80% root area are shaded red. Below, the tile placed alongside the BGS 1:50,000 solid and drift map (centre) and the output from last month's edition showing canopy area (right).

Modelled Root Overlap - TQ29

2099	22%	1%	1%	2.50%	3.40%	8%	1%	1%	3.20%	5%
2098	12%	3%	1.50%	0.30%	7%	2%	34%	17%	5.40%	2%
2097	34%	2%	2%	3%	31%	25%	29%	18%	5%	24%
2096	30%	9%	22%	58%	73%	46%	45%	44%	19%	13%
2095	24%	23%	30%	26%	28%	40%	54%	45%	49%	45%
2094	5%	14%	10%	13%	40%	28%	67%	44%	43%	63%
2093	26%	39%	15%	2.70%	15%	52%	74%	49%	34%	53%
2092	48%	51%	39%	36%	16%	73%	98%	54%	57%	58%
2091	43%	44%	30%	30%	36%	83%	57%	30%	31%	48%
2090	52%	82%	24%	34%	99%	86%	48%	26%	86%	62%
	2090	2190	2290	2390	2490	2590	2690	2790	2890	2990



The apparent risk in an area (outlined - Finchley) with high density housing and the highest modelled root zone is abated when reference is made to the geological map. These apparently 'high risk' tiles are underlain by drift deposits, rather than outcropping London clay, illustrating the need to take into account all contributory elements when making assessments.



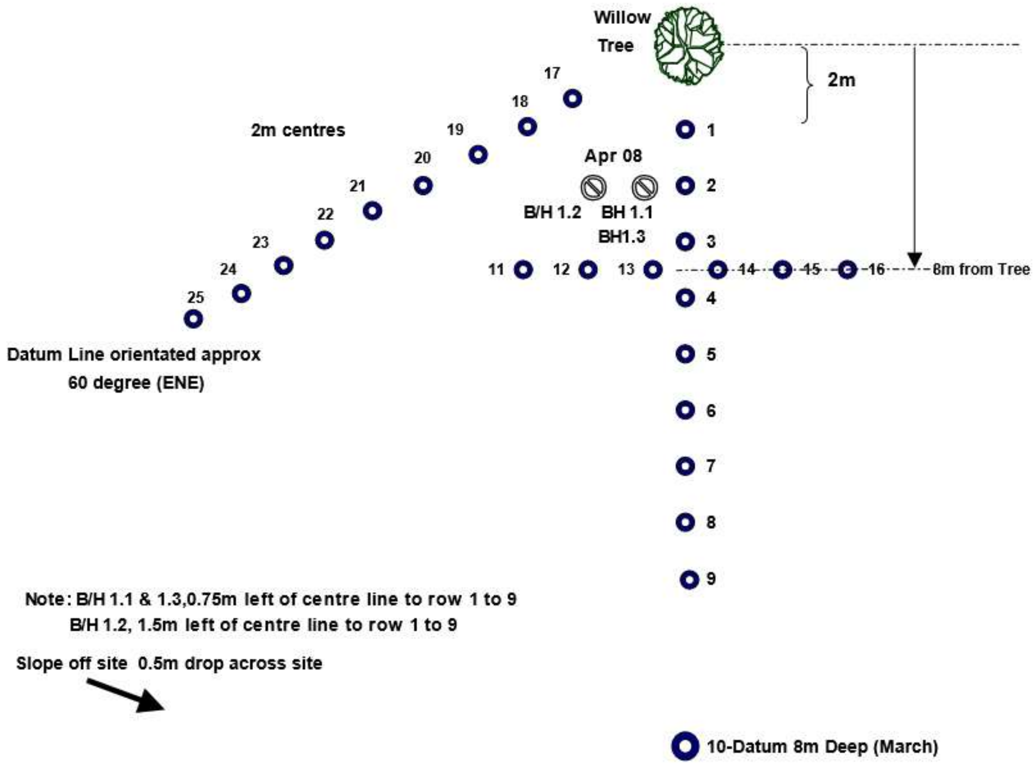
The Clay Research Group

Sample Disturbance and Soil Testing

The following article has been prepared from site investigations and soil testing undertaken by Mat-Lab Limited at the site of the Aldenham willow in April, 2008. Mat-Lab were exploring the effect of sample disturbance on estimates of desiccation and swell potential under the supervision and guidance of Clive Bennett, their MD.

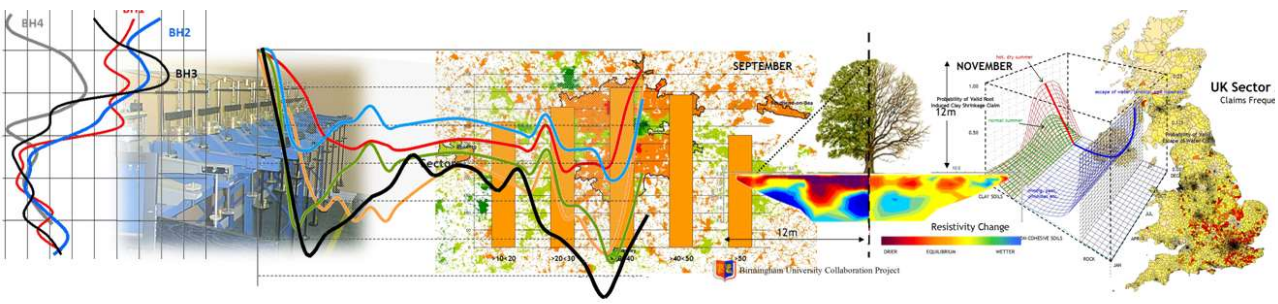
Below, the location of the three boreholes, situated 4m from the tree. BH 1.1 retrieved undisturbed samples, BH 1.2, disturbed and BH 1.3 undisturbed and then remoulded in the laboratory.

The results appear on the following page.



The Site of the Aldenham Willow

Site plan showing the two levelling arrays, the location of the deep datum (Station 10 sunk to a depth 8mtrs bGL) and the three boreholes around 4mtrs from the tree and situated in the vicinity of level station No. 2.

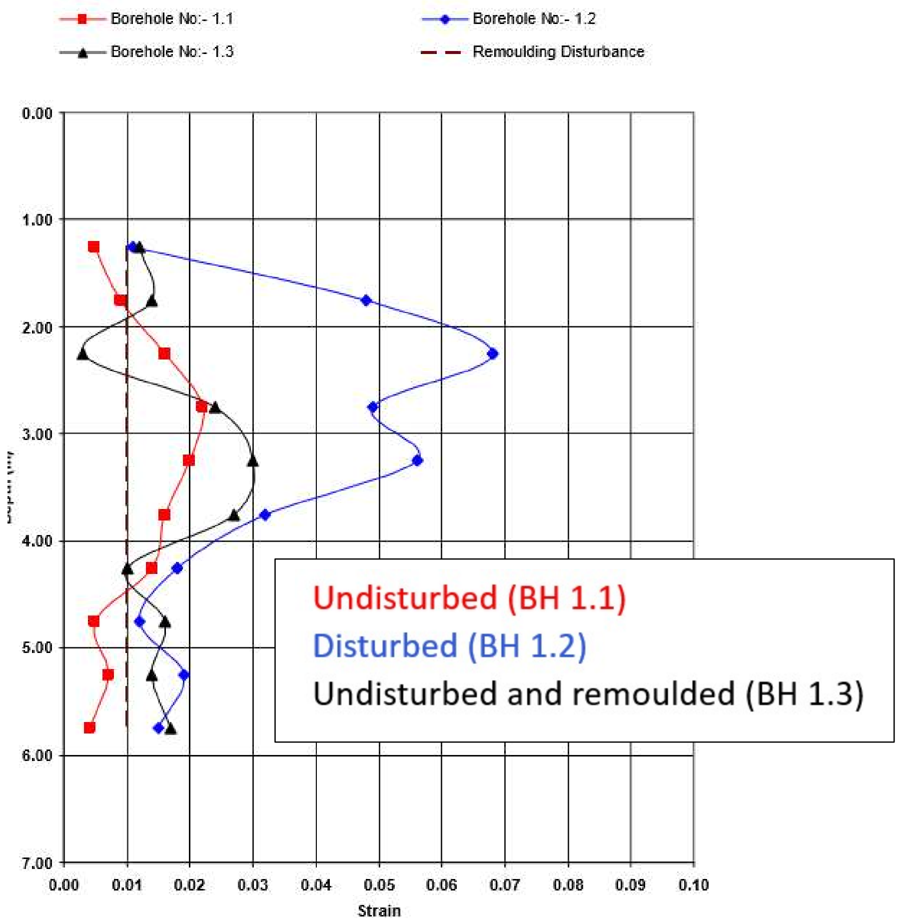


The Clay Research Group

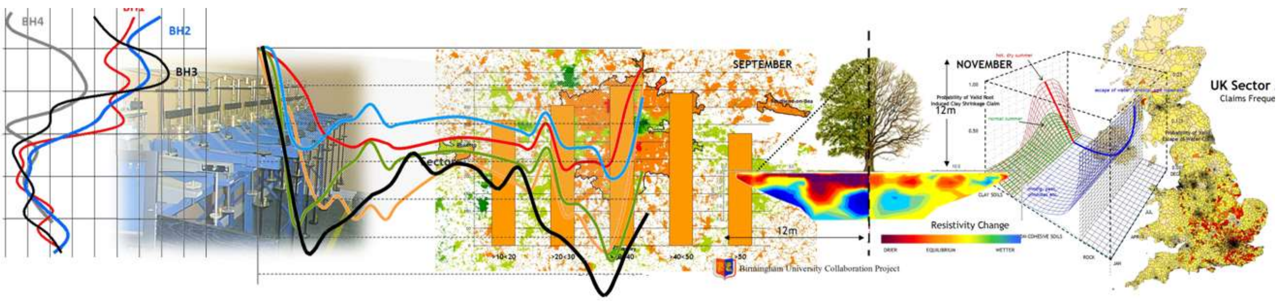
Oedometer Test Results

The oedometer test results are plotted below, complete with legend. The undisturbed and 'undisturbed and remoulded' graphs have comparable profiles.

In contrast, the results from the disturbed samples deliver far higher values, leading to an over-estimate of swell potential. The results are not surprising, but the value lies in (a) quantifying the difference between tests and (b) validating that the test delivers reliable results when the samples are remoulded.

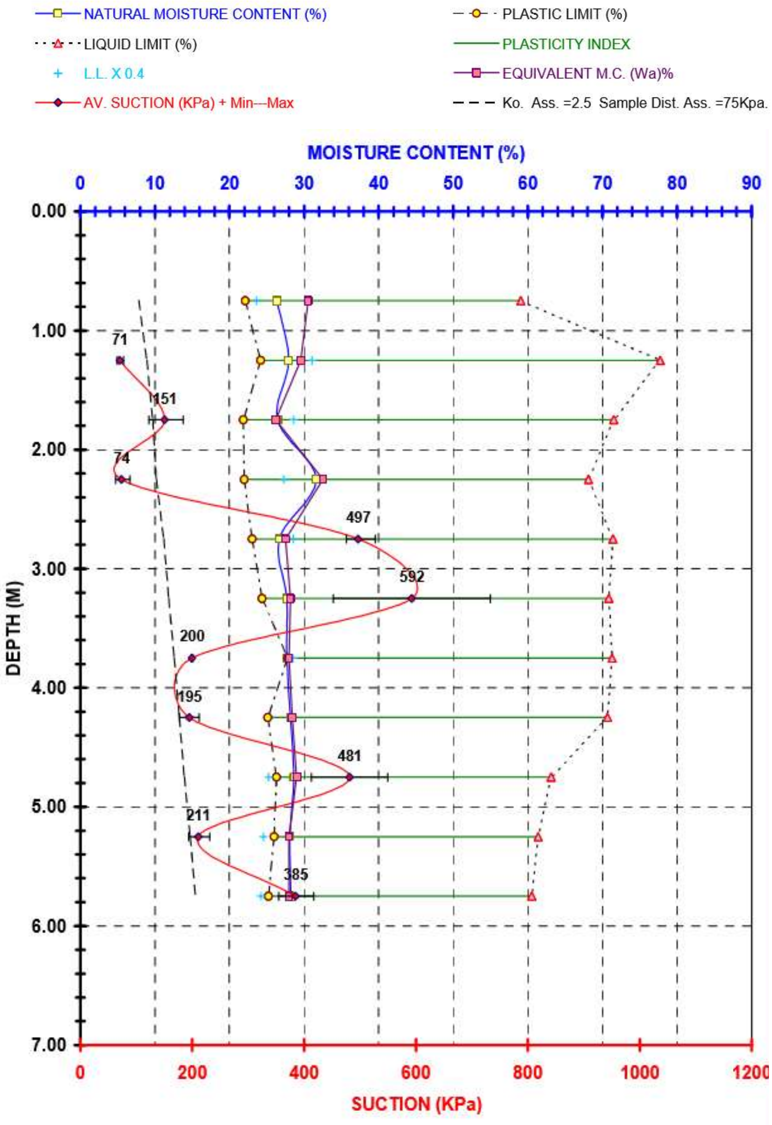


Oedometer Estimates of Desiccation and Swell Potential
Peak desiccation between 2 – 3.5mtrs bGL. Undisturbed and 'undisturbed and remoulded' samples produce similar results. Disturbed samples record over double the strain of the undisturbed samples.



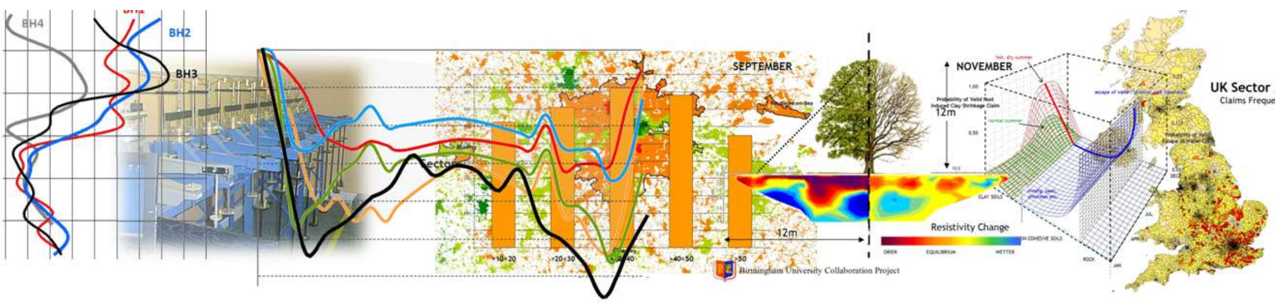
Soil Suctions – Undisturbed Samples

Testing the undisturbed samples using the suction test revealed strains of 592kPa. Comparing the easy-to-see results of the suction test with the moisture content variations reveals the benefit of the former.



Suctions, Moistures and Atterbergs.

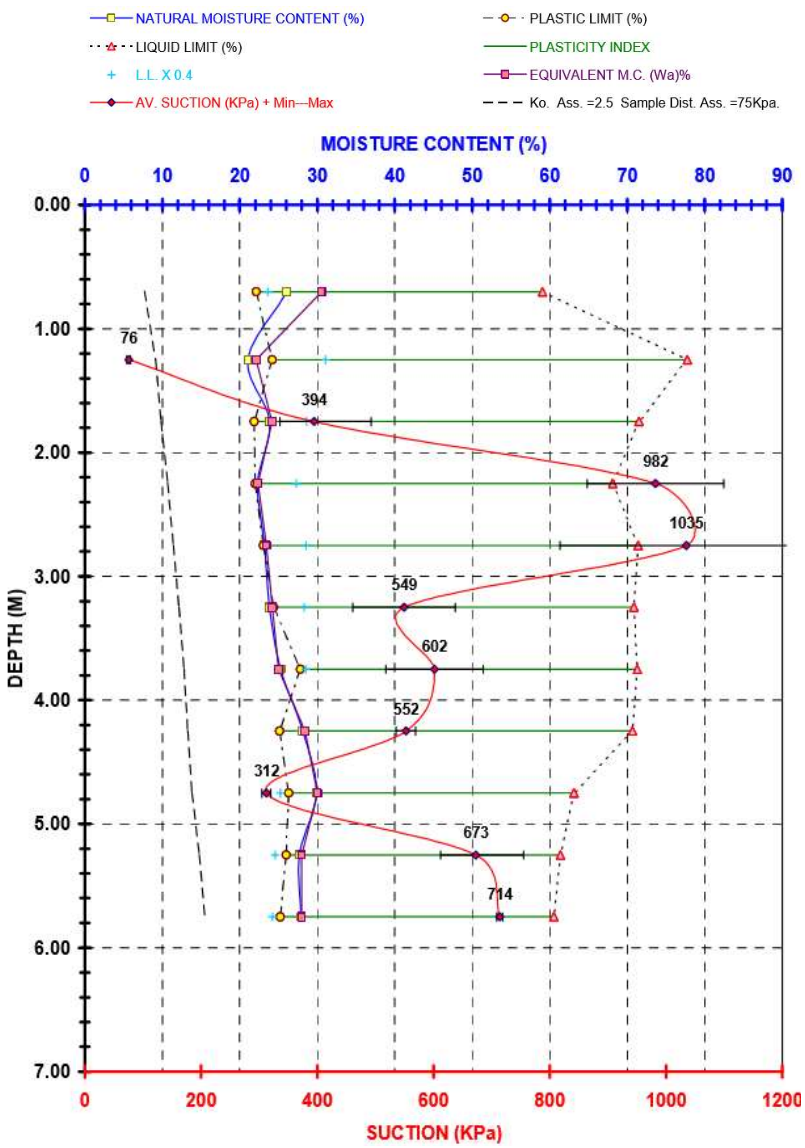
The results from testing the undisturbed samples using the suction technique confirm desiccation at a similar depth below ground level. Comparisons between the moisture content profile and Atterberg Limits deliver less clear results.



The Clay Research Group

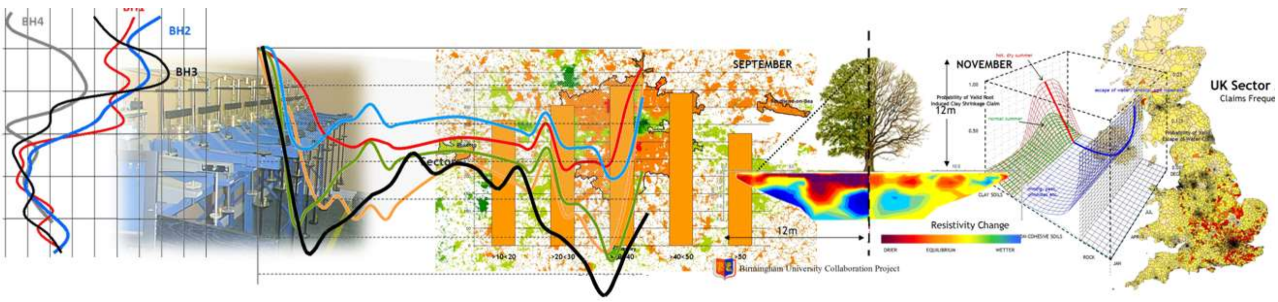
Soil Suctions – Disturbed Samples

Suctions from disturbed samples peak at 1,035kPa, compared with 592kPa for the undisturbed samples discussed on the previous page. Sample disturbance increases apparent levels of desiccation. A significant amount when considering potential for heave and damage.



Suctions, Moistures and Atterbergs.

The results from testing the disturbed samples using the suction technique confirm desiccation at a similar depth below ground level to undisturbed sampling. Comparisons between the moisture content profile and Atterberg Limits deliver less clear results with little evidence of desiccation between 2 – 3mtrs bGL.



Estimates of Heave Derived from the Different Soil Sampling and Testing Techniques

Estimates of swell carried out by Mat-Lab varied as shown in the table below. Disturbed samples gave estimates in the region of 60mm +/- 5mm. Undisturbed samples yielded results between 20 – 30mm and the remoulded oedometer, 15mm.

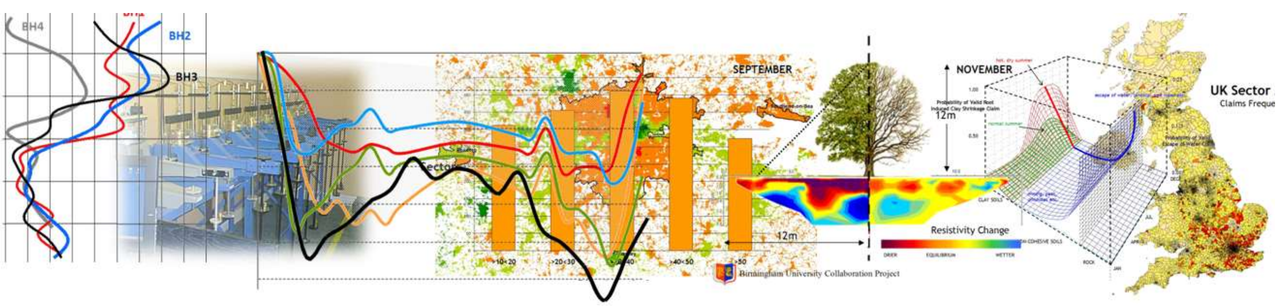
Oedometer (undisturbed)	Oedometer (disturbed)	Oedometer (remoulded)	Suctions (undisturbed)	Suctions (disturbed)
30mm	**65mm**	**15mm**	**21mm**	**56mm**

The variation is significant and could influence the discussion between parties when seeking tree removal, estimating the potential for future movement and recoveries in contested claims.

Below, ground movement at Station 2 (the station nearest the boreholes) from May 2006 to January 2017. The arrow marks the time the site investigations were undertaken.

Seasonal ground movement produces a regular ‘rhythm’ of around 30mm since the summer of 2006. Ground subsidence reached nearly 50mm comparing the position in September/October 2006 with the readings in January 2017. The green dotted line plots 15mm of recovery estimated using the remoulded results from the oedometer and 65mm from the disturbed samples (red dotted line).

Was there really a moisture deficit that would result in 65mm of swell in April 2008, as indicated by the oedometer results for the disturbed samples? Or is the actual figure closer to 20mm using the undisturbed/remoulded figures? **Next Month:** What is the modelled estimate of movement? Is there another way – quicker, cheaper and as reliable?



The Association Matrix

The question 'what does a valid/declined claim look like' from a digital perspective has been the subject of previous articles and the aim here is to step through an example to clarify the process. Below, a much-simplified illustration showing the master template (left), containing a range of rules and characteristics signatures against which actual claims (centre and right) are compared to see how closely they resemble valid and declined claims and the most likely operating peril from an historic dataset.

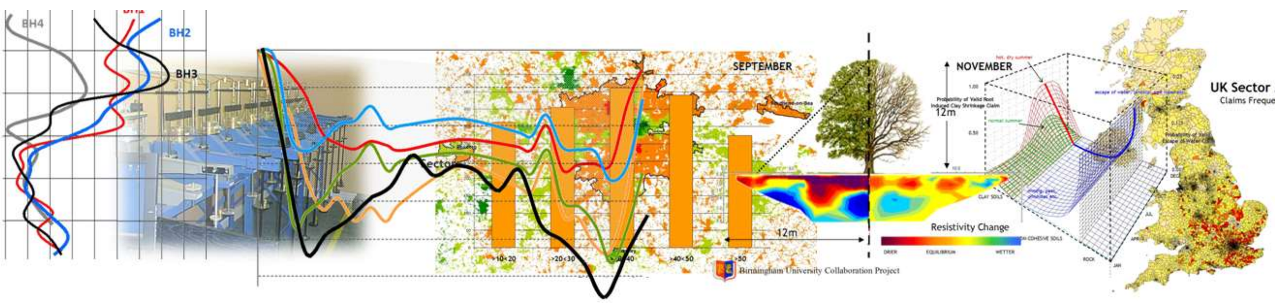
TEMPLATE						Claim 'A'						Claim 'B'						
CORRELATION						0.6						0.03						
1	1	1	1	1	1	0.83	0.6	0.3	0.6	0.7	0.6	0.2	0	0.3	0.4	0.2	0.3	Escape of Water
0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.7	0.9	0.5	0.6	0.4	0.1	0	0.3	0.6	0.2	0.3	
0.6	0.6	0.6	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.7	0.5	0.6	0	0.2	0.4	0.3	0.4	
0.3	0.3	0.3	0.3	0.3	0.3	0.366	0.3	0.4	0.6	0.2	0.3	0.18	0	0.4	0.4	0.2	0.1	
0.3	0.3	0.3	0.3	0.3	0.3	0.18	0.3	0.4	0.4	0.2	0.1	0.366	0	0.4	0.6	0.2	0.3	
0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.2	0.2	0.4	0.3	0.4	0.5	1	0.5	0.5	0.7	0.5	
0.8	0.8	0.8	0.8	0.8	0.8	0.1	0.2	0.3	0.6	0.2	0.3	0.9	1	0.9	0.5	0.6	0.4	
1	1	1	1	1	1	0.2	0.3	0.3	0.4	0.2	0.3	0.83	1	0.3	0.6	0.7	0.6	Clay Shrinkage
CORRELATION						0.03						0.56						

Figure 1

Left, the underlying 'master template'. Middle and right, examples of two claims with different outcomes. Claim A (centre) is judged to be the results of escape of water with a score of 0.6 compared with 0.03 for clay shrinkage. Claim B, right, scores 0.56 for clay shrinkage and 0.03 for EoW.

The master template combines data that assists in determining both the likely peril and probability of whether the claim will be valid/declined. For the purpose of the example, the top of the matrix has characteristics that are often associated with escape of water claims (blue shading) and bottom, clay shrinkage (brown).

Data would be auto-populated from the claim database. Year of construction, month of notification, geology, damage location, environment etc. As the claim progresses, data is added; results of monitoring, soil testing and so forth.



The Clay Research Group

The Association Matrix *... continued*

Using correlation techniques, comparisons are made between the underlying master template and the claim entries to derive probabilities. In the above example, Claim A (centre) is 20 times more likely to be the results of an escape of water. In contrast, Claim B is over 18 times more likely to be clay shrinkage.

Obviously, extremes have been used to illustrate the approach. Actual outputs are rarely as clear.

The benefit is that, over time, the system refines it's understanding of what a valid/declined claim looks like. By matching outcomes with initial estimates, the system gradually recognises cells that have value, and those that do not. We have named this the Association Matrix. See Figure 2 below.

This example is one-dimensional and simplistic. The actual model would take account of temporal and spatial data – and again, measure their significance. Which cells change, and does that change form part of the decision process? Which elements can be discarded as background noise? What combinations provide the best indicators? The significance of individual cells and combinations is determined by comparison with outcomes. It is a 'self-scoring' system.

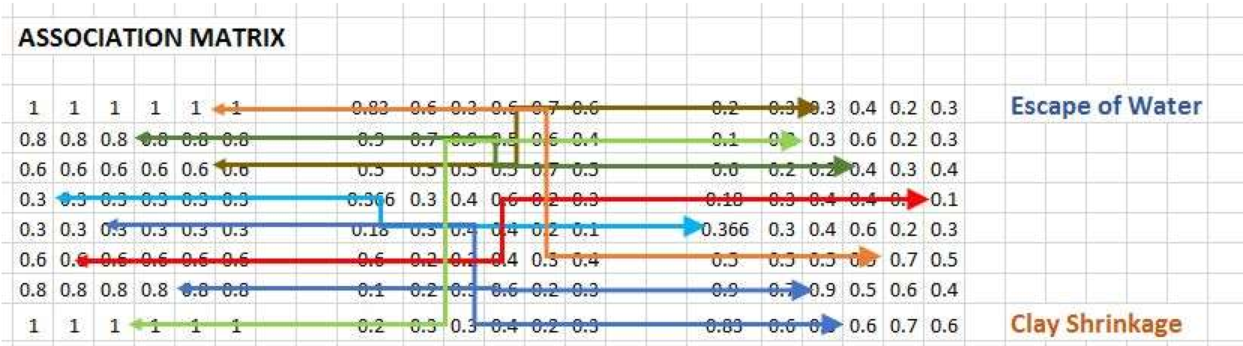
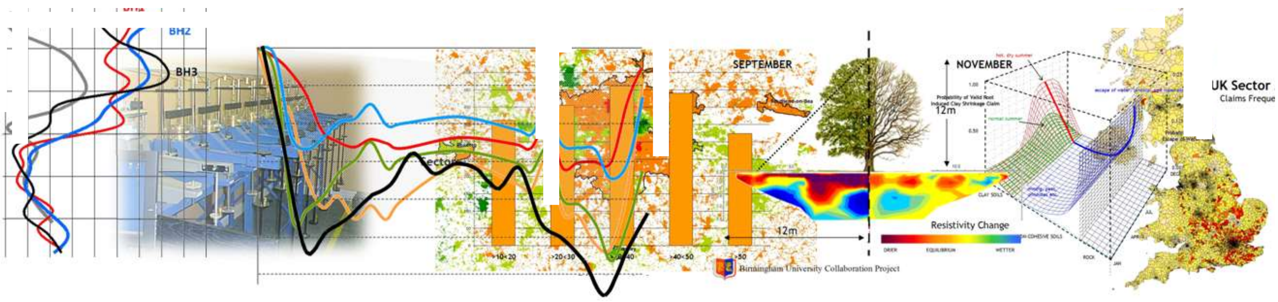


Figure 2

The Association Matrix joins different cells to emphasise links where they add value. "Is there a nearby tree?". "Does monitoring reveal a periodic signature?". Weightings for outputs when combining value refines the outputs still further, as was seen in the root mapping example on page 2.



The Association Matrix *... continued*

This is a neural approach insofar as it is messy; areas of the ‘brain’ are mapped with known functionality, but other fields may have links that, as yet, remain unrecognised.

On the following page, graphs outlining some background data.

If a homeowner reports damage to the corner of their home, the chances are around 70% that the claim will be valid. In contrast, if damage is restricted to a ceiling or floor, the odds fall to between 8 and 15% respectively.

This is based on analysis of around 10,000 claims, of which 58% were valid and the remainder were declinatures.

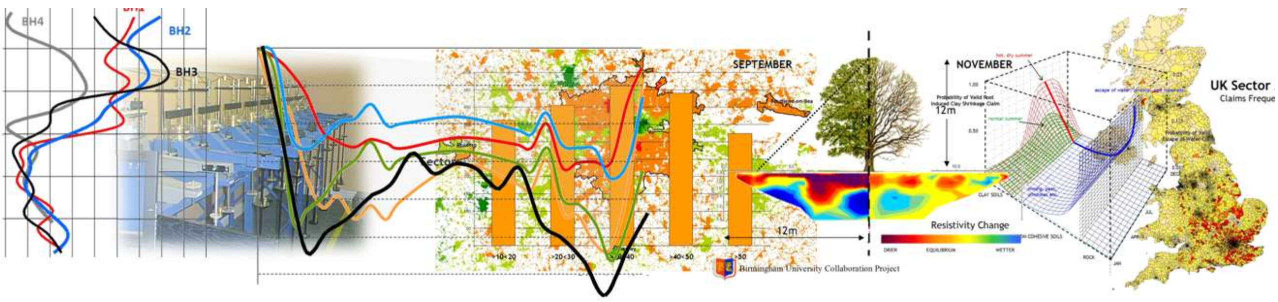
The technique is not without its difficulties. Filtering for strings like ‘side wall’ returns ‘side wall of garage’, ‘side wall of porch’, and ‘side and rear walls’ but might miss ‘gable’, ‘flank’ when in fact the damage was actually the corner but described as the junction between the flank and front or rear two walls.

The word ‘addition’ is vague and used in different ways by engineers. It sometimes refers to the rear wing building of a terrace-style property, or single storey outbuildings etc., and sometimes, an extension.

Porches, bay windows, conservatories and extensions all figure in the top 10, along with garages. Unsurprisingly, structures with shallow foundations.

A careful review is essential in such a study. All cells should contain a verifiable record to avoid the “the computer it says no” output, but also combine and exchange values to deliver its decision. This should be transparent and delivered in the form of a report that can be clearly understood and validated.

Understanding how many claims fall into each category is also useful in determining confidence levels. If the sample only included 2 utility rooms say, and both claims had been valid it might suggest that the next claim mentioning a utility room was bound to be valid, which would of course be wrong.



The Clay Research Group

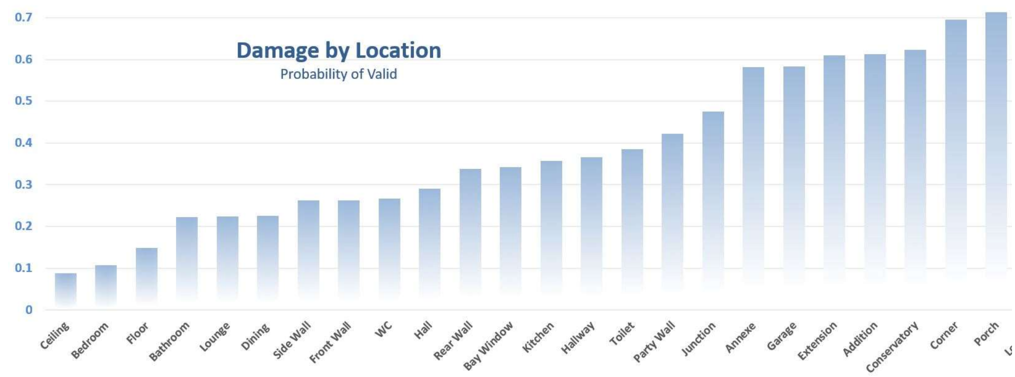


Figure 3

The likelihood of a claim being valid, by location. Most likely to be valid will be corners, junctions, extensions and projections – bay windows and porches etc. Least likely to be valid are floors, ceilings, bedrooms, bathroom and lounge etc.

The table below lists, in the same order as Figure 3, the number of cases in the sample. The higher the value, the greater the confidence we might have in the systems output.

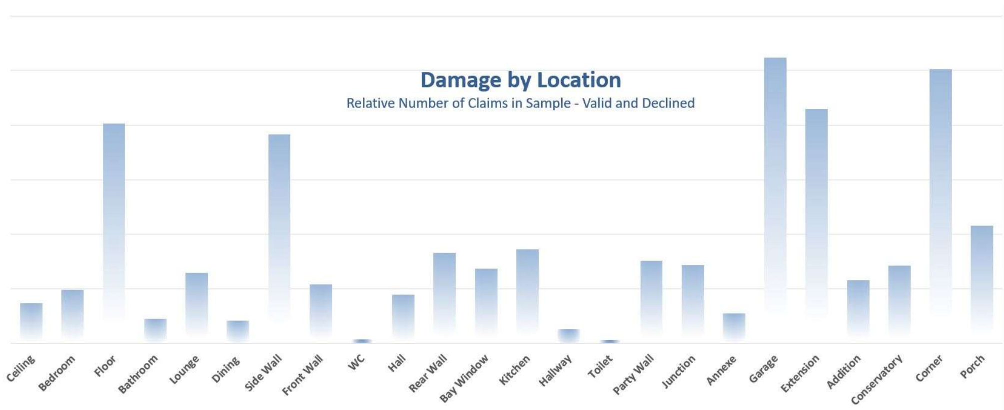
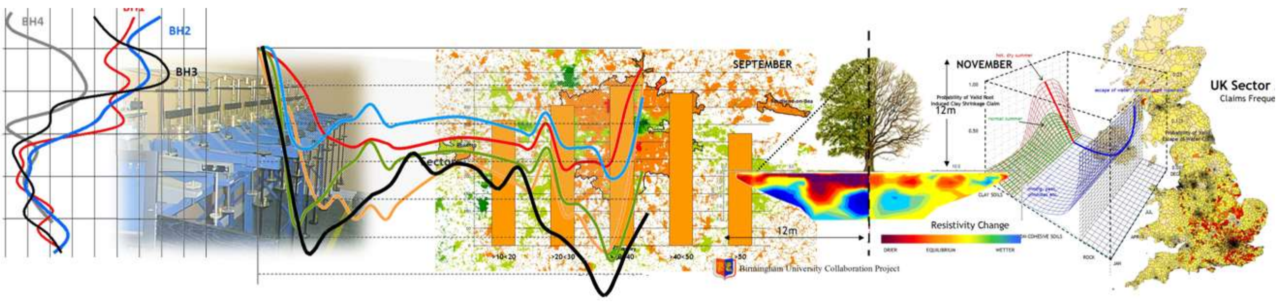


Figure 4

Figure 3 shows the likelihood of a claim being valid, but how many were in each category? Above, Figure 4 lists the relative distribution in the same order as Figure 3. The higher the number of claims in each category, the greater the confidence in the result.



The Association Matrix *... continued*

Combined, the two tables deliver a confidence value. ‘Corners’ are high risk and the sample contained lots of them, only exceeded by garages. Porches are high risk in terms of the number of valid claims from the total, but there are far fewer of them.

At the opposite end of the scale, the sample contains lots of claims for damage to floors, but relatively few proved to be valid. Others areas attracted fewer claims and were less likely to be valid. For example, ceilings and bedrooms.

Turning now to the matter of learning. The matrix uses combinations and permutations between cells. Initially this provides chaotic outcomes. These are stored in separate tables and then matched against claim outcomes. If sufficient contradictory evidence becomes available, the system updates using the sigmoid curve approach outlined in Issue 134, July 2016 and elsewhere.

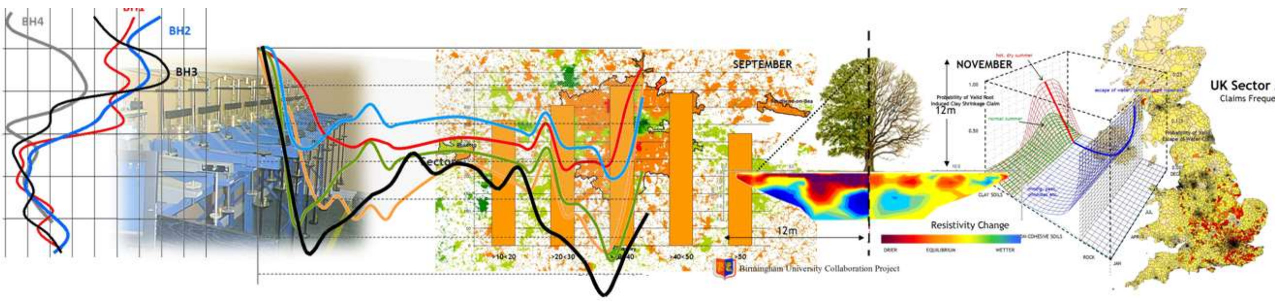
The results of the eventual claim decisions are matched against the Association Matrix template until the relevant cells (those delivering results that match claim outcomes) are identified.

The benefit of this approach is that if every piece of data is entered and the system will identify which are relevant. What matches between which cells deliver the correct result?

In summary, the Association Matrix is the template against which claims data is compared. The diagrammatic profiles on previous pages have been used to illustrate the purpose and provide an insight into the underlying objective.

Far from aiming to replace staff with computers, the foregoing may be regarded as essential tools to professional subsidence claims handlers and engineers. The system contains the information they need, but they don’t currently have access to it.

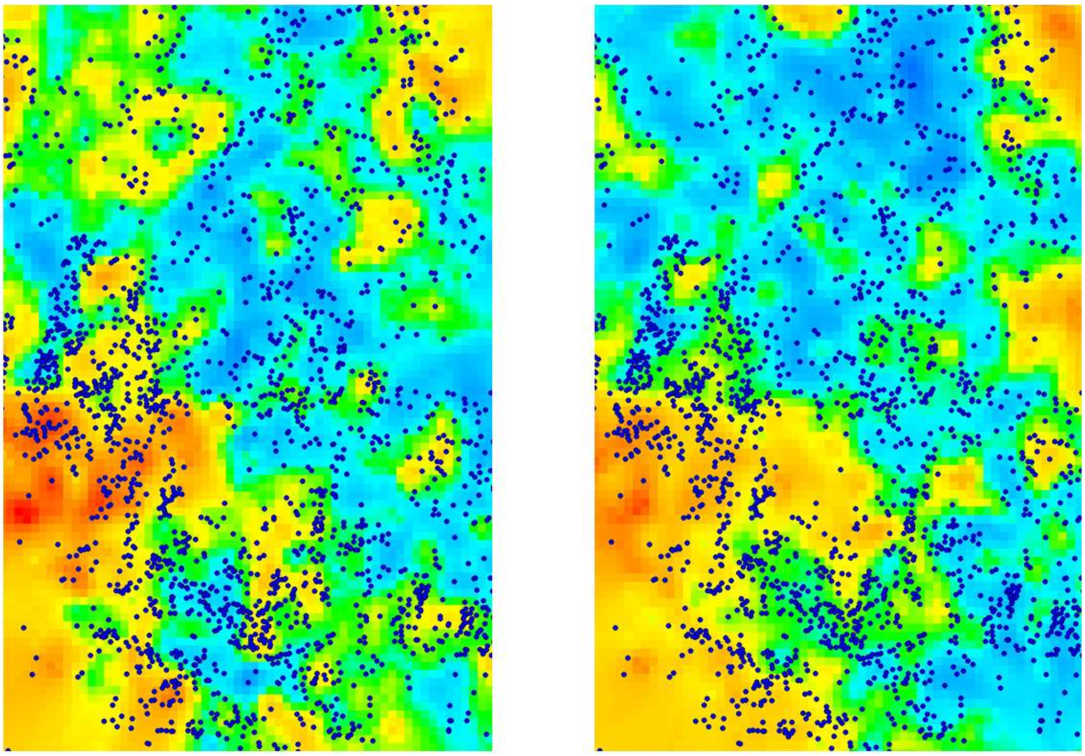
Published in a user-friendly way, complete with detailed explanations and graphics, the approach would also help homeowners to report and perhaps handle their own claims on the web, and understand the background to the decision-making process, supported by the claims professional.



The Clay Research Group

Researching Risk using Correlation Techniques

On the same theme – identifying risk - the following approach would be useful. Plot tree-related subsidence claims against a variety of backdrops. Geology first of course, followed by tree metrics and species.

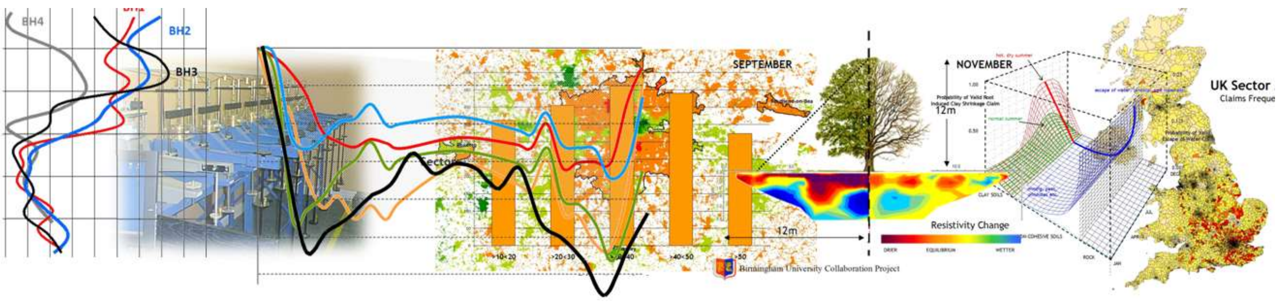


Valid subsidence claims plotted on a thematic map of public (left) and private (right) trees, shaded in height categories with known values for H/D.

Claims (blue dots) plotted onto a thematic map of public trees (left) and private trees (right). Trees are plotted both by density and height but other options – H/D and species (if available) for example – need to be tried to see which offers the most powerful correlation.

Are claims clustered around the red shaded areas where there are taller trees? What combination delivers the best correlation with risk?

Step through the year adding weather elements – rainfall, temperature, hours of sunshine, relative humidity, wind speed etc., to refine the model still further.

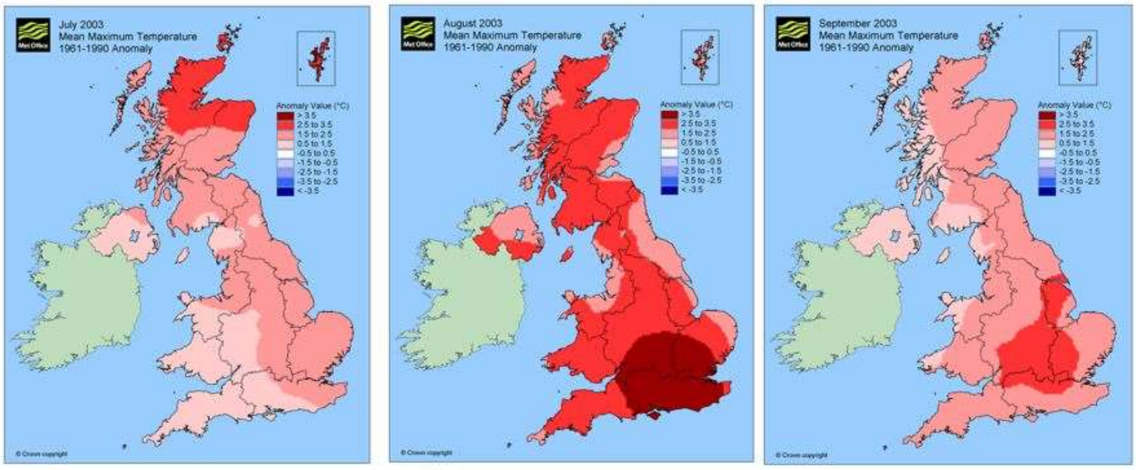


The Clay Research Group

Met Office Max Temp Anomaly Maps – 2003 and 2006

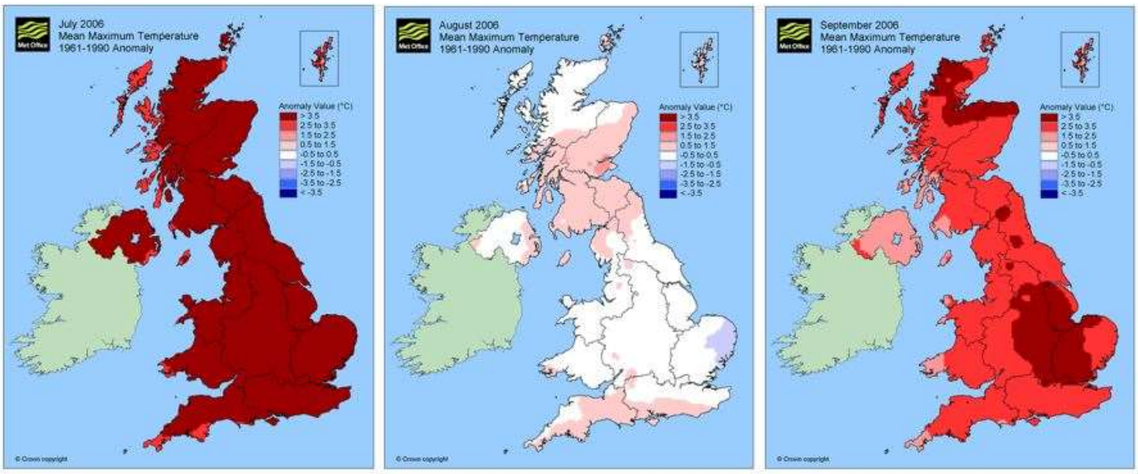
On this and the following page anomaly maps from the Met Office showing prevailing mean maximum temperatures and rainfall for the years 2003 and 2006 are reproduced to try to understand the triggers to these two event years. Below, in the SE, July, August and September were warmer than the 30-year average in 2003. In 2006, July and September were warmer, and August similar to the 30-year average.

2003 – Met Office Mean **Max Temp**. Anomaly Maps as % of 1961 -1990 Av.

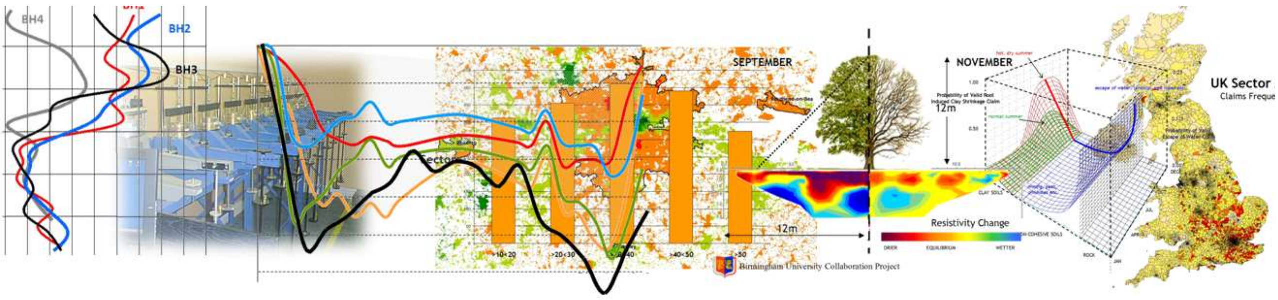


JULY AUGUST SEPTEMBER

2006 – Met Office Mean **Max Temp**. Anomaly Maps as % of 1961 -1990 Av.



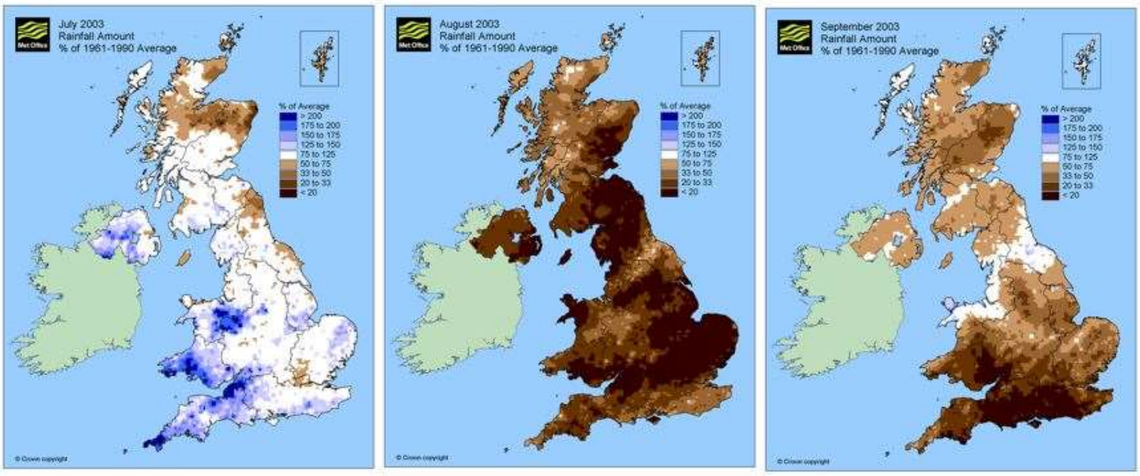
JULY AUGUST SEPTEMBER



Met Office Rainfall Anomaly Maps – 2003 and 2006

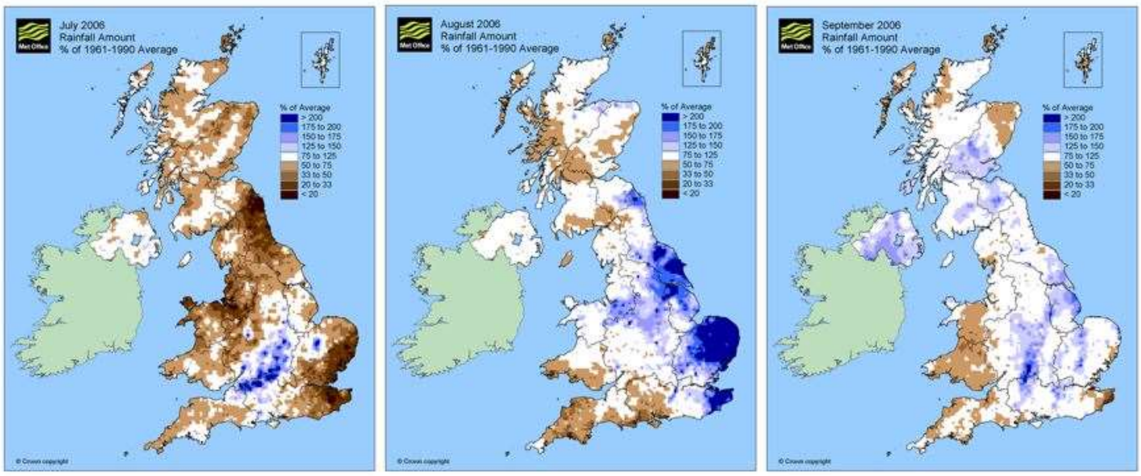
Again, focusing on the SE area, in 2003 August and September were much drier than the 30-year average. In 2006, July was drier and August and September slightly wetter in parts. In summary, 2003 was warmer through July to September, and drier in August and September. 2006 was warmer and drier in July. In terms of claims, the ABI report 54,000 claims in 2003 and 48,000 in 2006.

2003 – Met Office **Rainfall** Anomaly Maps as % of 1961 -1990 Av.

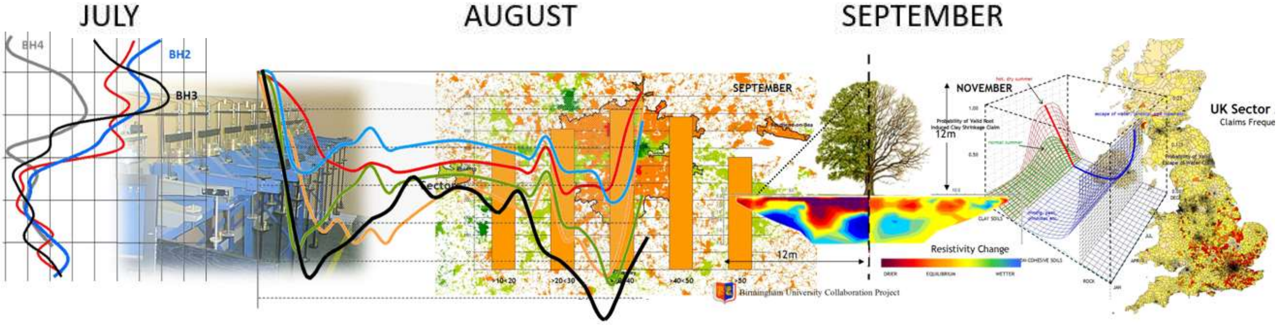


JULY AUGUST SEPTEMBER

2006 – Met Office **Rainfall** Anomaly Maps as % of 1961 -1990 Av.



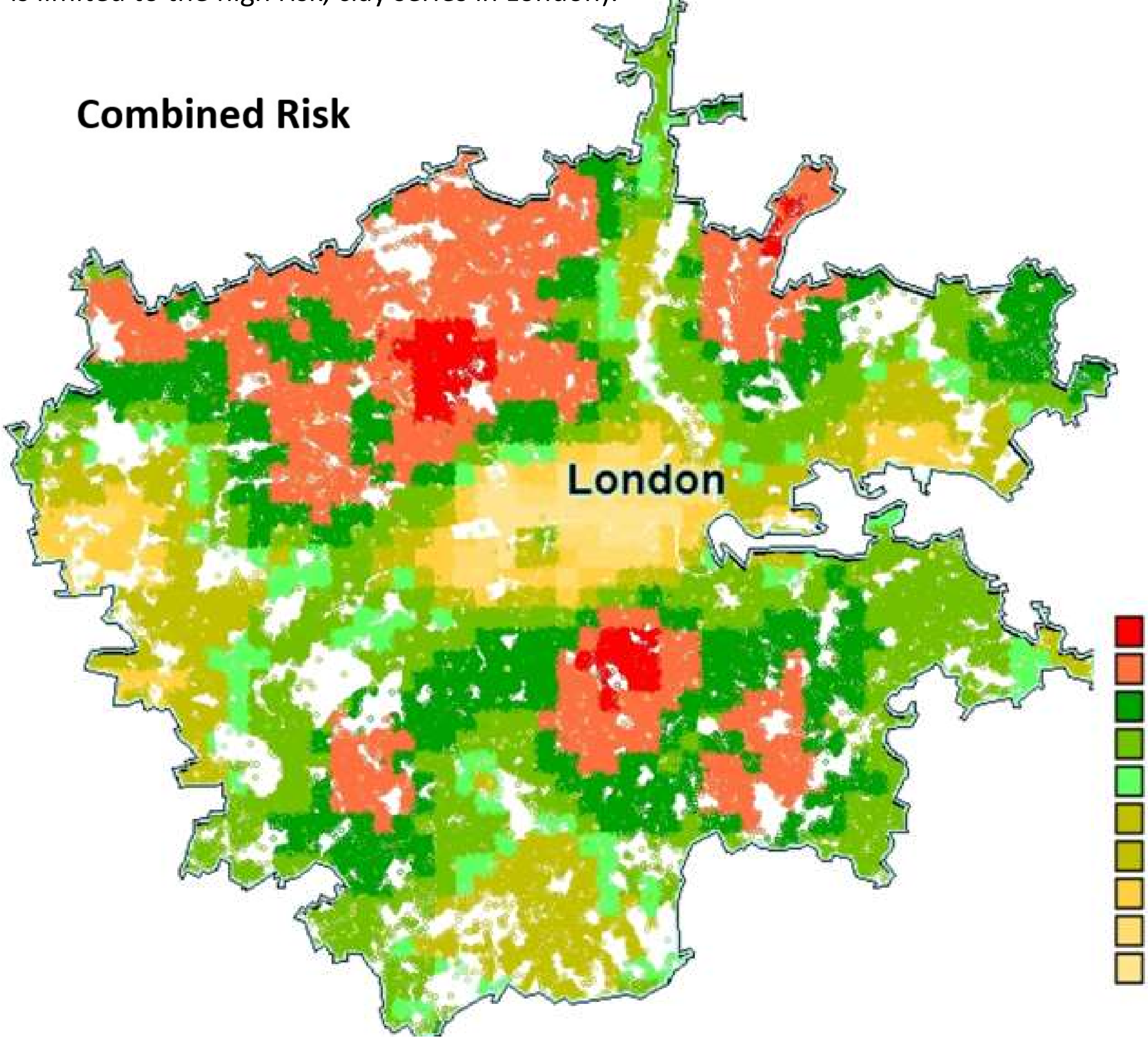
JULY AUGUST SEPTEMBER



The Combined Risk of Subsidence

Past editions have mapped the risk and location of soils, both by PI and '% passing', distribution of private housing, claim distribution and frequency, trees (both public and private), by peril (escape of water or clay shrinkage), severity (spend) etc.

Combining all of these produces the map below, showing the real risk of subsidence for the London area. Similar maps have been produced for the UK (apart from tree data which is limited to the high risk, clay series in London).



The maps deliver value to the underwriter in terms of loss and severity, and to the adjuster who needs to know where staff and resources (site investigation crews, monitoring) are to be deployed.