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

Climate : Telemetry : Clay Soil : BioSciences : GIS & Mapping
Risk Analysis : Ground Remediation : Moisture Change
Data Analysis : Numeric Modelling & Simulations : Software

Edition 138

November 2016

The Clay Research Group

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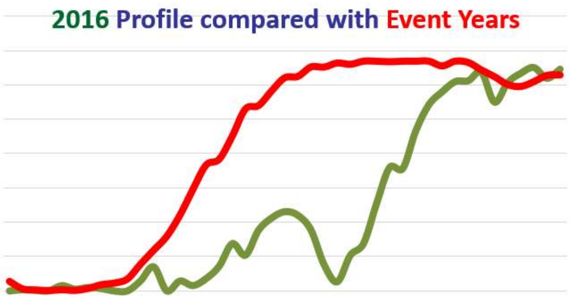
Edition 138, November, 2016

SMD Update

SMD Data provided by the Met office for Tile 161, Medium Available Water Capacity, Grass Cover



The SMD profile remains high, running alongside and even exceeding the average for event years, reflecting the recent dry weather. Almost certainly too late to deliver a significant increase in root induced clay shrinkage claims.

Events and Social Networks

September and October have been busy months. The Subsidence Forum held a well-attended Training Day on the 20th October. A successful event looking at the Twitter feed. Our colleagues at TDAG are holding a Tree Conference on the 18th November.

Mention of social networking brings us to the increasing use of social media in general. IBM, OS and the BGS are all making huge strides in this area, refining their models to take account of information contained on social networks.

That said, plans by insurers to check Facebook when providing quotations has met with a temporary set-back. Facebook have apparently blocked such checks.

Visits to the CRG web site

September 2016 was a record month in terms of visits to the CRG web site.

Contributions Welcome

We welcome papers and articles from readers reporting on topics relating to domestic subsidence. Legal updates, arboricultural matters, geotechnical advice and case studies etc.

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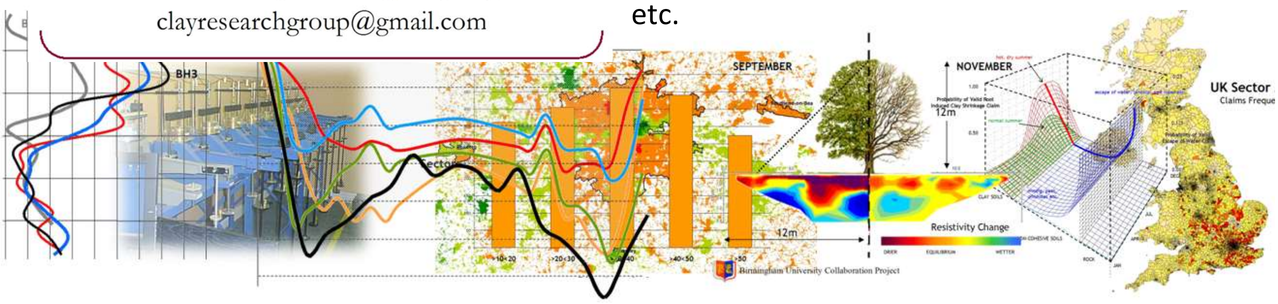


What does Tom Cruise have to do with Subsidence?

Tony Boobier, former WorldWide Executive, IBM Analytics.
Author of '**Analytics for Insurance : The Real Business of Big Data'**

I don't suppose Tom Cruise is a subscriber to CRG, but if he was, then he would reprieve his role in the movie Jerry McGuire when he said 'Show me the money'. It's a valid request. Let me explain.

Over the years we have increasingly wanted to understand the factors which contribute to subsidence damage, by analyzing trees, crack patterns, soil conditions. There is still some uncharted territory, namely the homeowners reaction to the damage and perhaps how long they are willing to tolerate a problem before reporting it.

Maybe behavioural analytics is as critical as arboricultural analytics?

But all that aside, don't we need to step back and ask about the value of what's being done by way of research into the cause of subsidence?

Let's look at a few specific areas

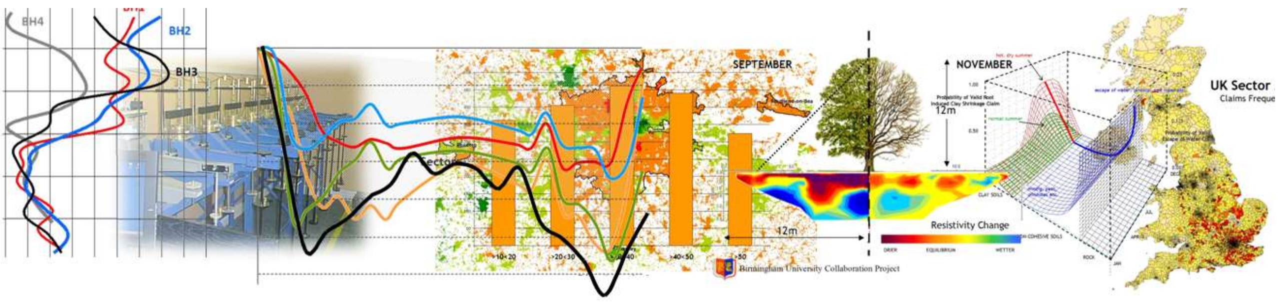
Resource Management. Let's suppose that there was a major subsidence event, much the same as we had at the back end of the last century. (I refer to it in those terms to reinforce the fact that, in honesty, a subsidence event hasn't happened for a long, long time).

Where are the skills and experience remaining in the industry? Analytics could play a vital part in automating the process, reducing delay and ensuring mitigation starts in a timely and effective way, and therefore reducing claims cost.

Customer Retention. We all know that customer loyalty is heavily affected by service delivery, so if an analytical approach improves customer service, then perhaps there will be less customer churn, and insurance company marketing can focus on growing the customer base, not just backfilling for disaffected ones.

Zero Claims Leakage. One of the next 'mega trends' in insurance is known as 'innovating to zero' which (amongst other things) includes improved subrogation. Can analytics help the industry innovate to zero?

Put another way, can zero leakage ever be obtained without it? Will negotiation with third parties about liability become a thing of the past?



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Tom Cruise and Subsidence *… continued*

Super Suppliers. Increasingly the insurance industry will recognize the importance of the supplier as part of the 'virtual enterprise'. Better analytics will help insurers optimize their supply chain – and (dare I say it) – negotiate the best deals (but for whom?)

Risk Management. It's natural to think in terms of accumulation of physical risk, but think also about the impact on risk capital, or 'solvency'. Solvency II is all about insurers putting enough money aside to ensure they can meet their claims.

This money is put aside in the form of 'capital' such as assets, bonds and the like. But 'Capital' isn't free, so insurers need to understand the physical and therefore financial risk, to remain solvent. That's why reserving is so important.

So, subsidence has an impact on insurer solvency. Better subsidence analytics helps insurers operate more effectively from an investment management viewpoint.

Zero Friction Processes. Let's wind the clock forward to an environment of device and 'self-service' of the claims process. Of course, not all customers will want this, but some will. The same decision trees and decision cubes will support traditional and 'digital' procedures.

Friction-free decisioning which is analytically driven will increasingly ensure the right thing is done at the right time.

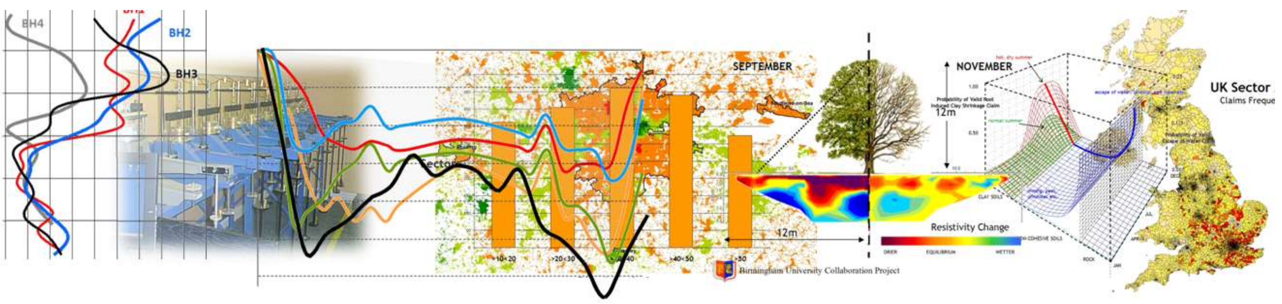
So. 'Show me the money'. How do you quantify these things? There is a concept that insurers will move away from being reactive to being proactive. There's massive cultural and organizational issues involved which won't come easily.

The CRG work will form part of that transition.

But change often requires calculation of the ROI – and how do we realistically calculate the saving of things that we have prevented from happening? And if we can't 'show the money', then how do we convince the 'bean counters'?

Maybe we need to take each of the scenarios mentioned above and put a figure against them. Who would be so bold? (I might be, and I'm sure there are others!!).

Tom Cruise – the Patron Saint of Subsidence? Who would have thought it?



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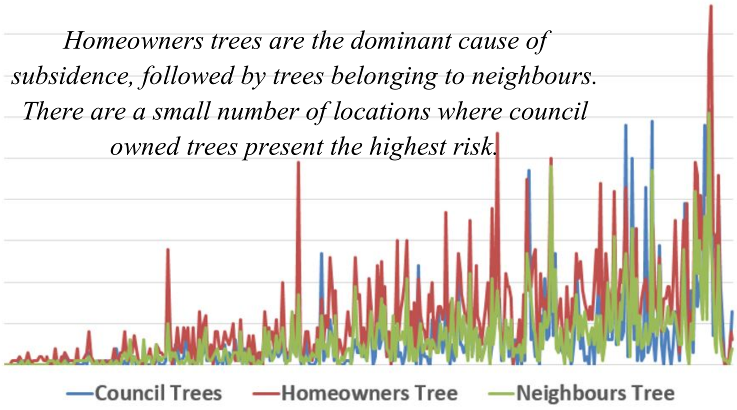
Spatial Relationships and Diagnosis

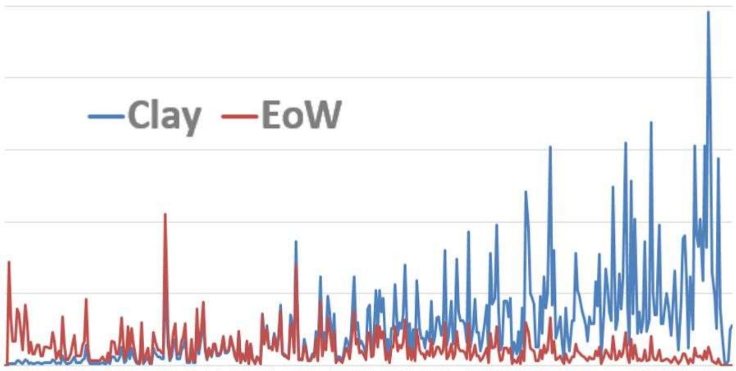
When the data says … "on average, council trees account for around 11% of root induced clay shrinkage claims" we tend to apply this across all sectors when in fact, there is considerable variance.

Is there a link between tree ownership and location in relation to the incidence of subsidence? The top graph reveals significant variation in terms of tree ownership by location. On average, council trees account for around 11% of notifications but in some locations (very few) they are the dominant cause, and elsewhere, the least likely to be involved.

The difference is likely to be a result of variations in species, tree management programs, and age. Property age may also play a part.

In general, the dominant cause are trees in the homeowner's ownership – shown by red line – and an area assessment of this kind feeds into the **A***i* application using frequency analysis.



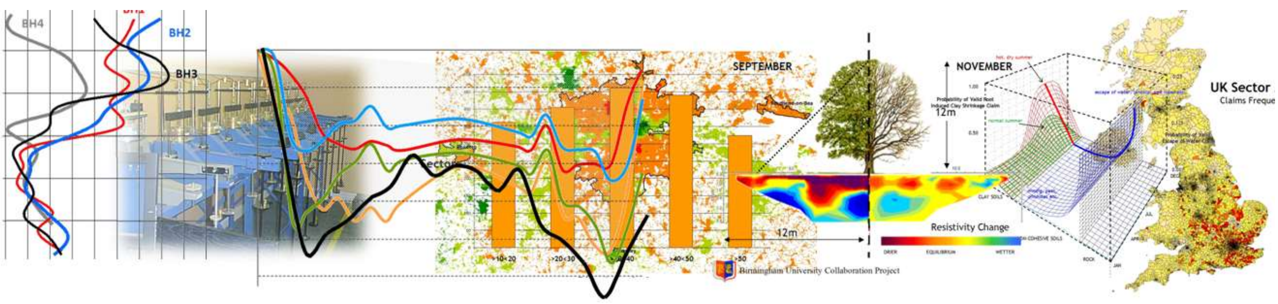


Similarly, by understanding claim frequency in relation to location – and specifically the geology – the user can determine the most likely operating peril.

Here the graph identifies (a) if a claim is likely to be valid and (b) the most probable cause.

To the left of the graph, the most likely cause is water escaping into the ground from a fixed appliance and to the right, the most likely cause is root induced clay shrinkage, with a higher likelihood that the claim will be valid.

This sort of spatial analysis allows correlations to be determined. Higher claim frequencies are related to clay soils with a higher PI, and the risk varies by species of tree, age, height and maintenance. The analysis delivers area specific probabilities, ready for system integration.



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Digital Imaging of Root Zone Moisture Content Change over Time. The Aldenham Oak.

Below we re-visit the detailed study of moisture content change in the vicinity of the Aldenham oak, undertaken by the team from Southampton University using the neutron probe.

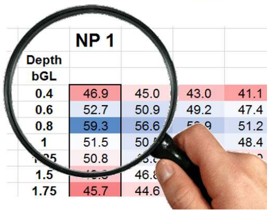
The image below registers moisture content readings taken in August 2006, thematically shaded. Red represents drier zones with data interpolated between the 5 stations (NP1, NP2 … etc.) from which readings were gathered. Variable geology at tube 3 (NP3) meant that readings were only taken to a depth of 2.5m in this one location. Elsewhere, readings were taken to depths of around 4mtrs.

The stations are 5mtrs apart, with NP1 situated 5m from the oak and NP5 situated 25mtrs away.

Drying associated with grass ground cover extends to a depth of around 1m.

In contrast, root drying extends to a depth of around 3mtrs, peaking between 2-2.5mtrs bGL

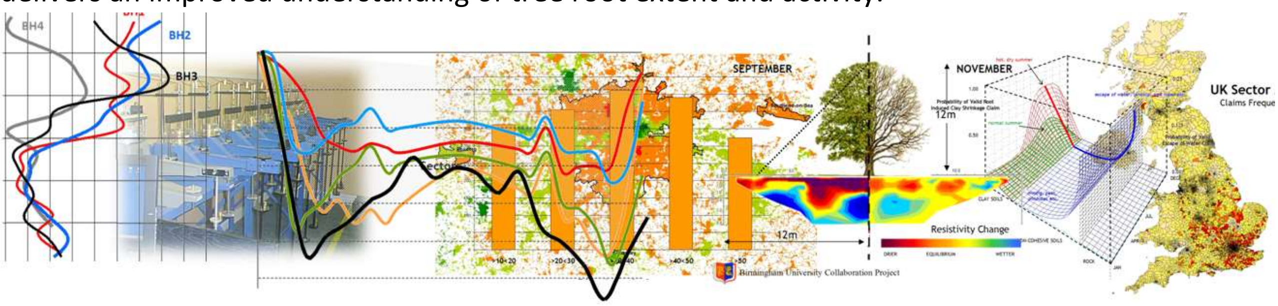
Depth	NP 1					NP2					NP3					NP4					NP5
0.4	46.9	45.0	43.0	41.1	39.2	37.2	40.0	42.7	45.4	48.1	50.8	48.0	45.2	42.3	39.5	36.7	36.6	36.5	36.4	36.3	36.2
0.6	52.7	50.9	49.2	47.4	45.7	44.0	44.6	45.3	46.0	46.7	47.3	47.9	48.4	48.9	49.5	50.0	50.4	50.9	51.3	51.7	52.1
0.8	59.3	56.6	53.9	51.2	48.5	45.8	44.4	43.0	41.6	40.2	38.8	41.0	43.2	45.5	47.7	50.0	50.7	51.4	52.1	52.9	53.6
1	51.5	50.5	49.5	48.4	47.4	46.4	46.2	45.9	45.6	45.4	45.1	44.5	44.0	43.4	42.9	42.3	42.3	42.2	42.1	42.1	42.0
1.25	50.8	48.8	46.9	45.0	43.0	41.1	43.6	46.1	48.5	51.0	53.5	50.9	48.3	45.7	43.1	40.6	42.7	44.7	46.8	48.9	51.0
1.5	48.8	46.8	44.8	42.9	40.9	38.9	40.9	43.0	45.0	47.1	49.1	47.0	44.9	42.7	40.6	38.5	39.4	40.2	41.1	42.0	42.8
1.75	45.7	44.6	43.6	42.5	41.4	40.4	40.5	40.7	40.9	41.0	41.2	40.3	39.5	38.6	37.8	36.9	37.7	38.5	39.2	40.0	40.7
2	44.4	43.3	42.2	41.1	39.9	38.8	41.2	43.6	45.9	48.3	50.7	48.3	46.0	43.7	41.3	39.0	41.3	43.7	46.0	48.3	50.6
2.25	47.9	44.5	41.1	37.7	34.3	30.9	35.8	40.7	45.6	50.5	55.4	53.2	51.0	48.9	46.7	44.6	46.0	47.5	49.0	50.5	52.0
2.5	52.4	49.2	45.9	42.6	39.3	36.1	35.8	35.5	35.2	34.8	34.5	38.0	41.4	44.8	48.2	51.6	51.9	52.2	52.5	52.8	53.1
2.75	53.6	53.4	53.1	52.8	52.6	52.3										51.4	51.6	51.8	52.0	52.2	52.4
3	53.7	53.4	53.1	52.9	52.6	52.4										50.3	51.0	51.7	52.4	53.1	53.8
3.25	53.1	53.0	52.8	52.7	52.6	52.5										50.3	50.7	51.1	51.5	51.9	52.4
3.5	51.3	51.5	51.7	51.9	52.1	52.3										50.8	51.0	51.2	51.4	51.6	51.8
3.75	49.1	50.3	51.5	52.6	53.8	55.0										50.3	50.6	50.8	51.0	51.2	51.4



All data courtesy of Southampton University.

The soil in the vicinity of the oak is variable, but predominantly London clay with an average PI across the site of between 43% and 48%. Moisture contents were measured both in the summer and winter months to measure the change that occurred.

The extent and efficiency of roots to extract moisture is an elusive science. Numerous authors have postulated the extent based on wind-blown tree fall, where root systems are partially exposed. Others have relied on excavation. Measuring moisture change over depth and time delivers an improved understanding of tree root extent and activity.



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Combined Probability Analysis

Gathering data and working together would speed up the process as well as produce a cross-industry agreement that might otherwise falter due to lack of understanding or distrust. There is an advantage here in working together and very little by way of commercial risk or loss of competitive advantage. The following is illustrative only.

Data as Entered

	SPECIES	HEIGHT	DISTANCE	DBH	SOIL	WEATHER
Claim 1	0.10	0.40	0.3	0.3	0.22	0.6
Claim 2	0.54	0.37	0.6	0.22	0.61	0.3
Claim 3	0.66	0.88	0.3	0.61	0.73	0.54
Claim 4	0.20	0.72	0.54	0.37	0.22	0.39
Claim 5	0.73	0.26	0.66	0.88	0.61	0.41
Claim 6	0.38	0.43	0.20	0.72	0.66	0.88
Claim 7	0.55	0.22	0.39	0.52	0.20	0.72
Claim 8	0.29	0.61	0.41	0.18	0.3	0.61
Claim 9	0.66	0.73	0.65	0.33	0.7	0.73

Step 1. Construct a simple grid listing the items shown left, including tree species, metrics, soil and weather. Agree categories of risk for each against published tables referring to the work of Giles Biddle, OCA, NHBC and BRE etc.

Once agreed, all subscribers enter data and at intervals, a combined probability analysis is undertaken and the results shared with participants. This simplified list assesses combined probabilities for a limited number of elements.

Probability Analysis

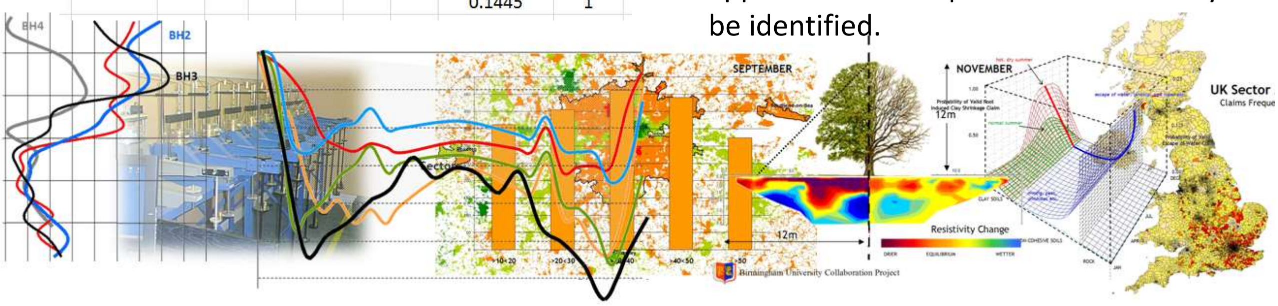
	SPECIES	HEIGHT	DISTANCE	DBH	SOIL	WEATHER		Combined Probability
Claim 1	0.10	0.40	0.28	0.31	0.22	0.55	0.0004	0.0029
Claim 2	0.54	0.37	0.55	0.22	0.61	0.29	0.0043	0.0296
Claim 3	0.66	0.88	0.29	0.61	0.73	0.54	0.0405	0.2802
Claim 4	0.20	0.72	0.54	0.37	0.22	0.39	0.0025	0.0171
Claim 5	0.73	0.26	0.66	0.88	0.61	0.41	0.0276	0.1907
Claim 6	0.38	0.43	0.20	0.72	0.66	0.88	0.0137	0.0945
Claim 7	0.55	0.22	0.39	0.52	0.20	0.72	0.0035	0.0244
Claim 8	0.29	0.61	0.41	0.18	0.29	0.61	0.0023	0.0160
Claim 9	0.66	0.73	0.65	0.33	0.66	0.73	0.0498	0.3445
							0.1445	1

Combined permutations of the elements are re-ordered to derive the factors that, when combined, deliver a rank order of risk indicators.

Revised Rank Order

	SPECIES	HEIGHT	DISTANCE	DBH	SOIL	WEATHER		
Claim 9	0.66	0.73	0.65	0.33	0.66	0.73	0.0498	0.3445
Claim 3	0.66	0.88	0.29	0.61	0.73	0.54	0.0405	0.2802
Claim 5	0.73	0.26	0.66	0.88	0.61	0.41	0.0276	0.1907
Claim 6	0.38	0.43	0.20	0.72	0.66	0.88	0.0137	0.0945
Claim 2	0.54	0.37	0.55	0.22	0.61	0.29	0.0043	0.0296
Claim 7	0.55	0.22	0.39	0.52	0.20	0.72	0.0035	0.0244
Claim 4	0.20	0.72	0.54	0.37	0.22	0.39	0.0025	0.0171
Claim 8	0.29	0.61	0.41	0.18	0.29	0.61	0.0023	0.016
Claim 1	0.10	0.40	0.28	0.31	0.22	0.55	0.0004	0.0029
							0.1445	1

This simplified analysis doesn't take account of any crown reduction work undertaken, general tree health or paving etc., and will no doubt deliver sometimes contradictory outputs, but the starting point is to deliver a systematic and perhaps more scientific approach to the topic so that these may be identified.



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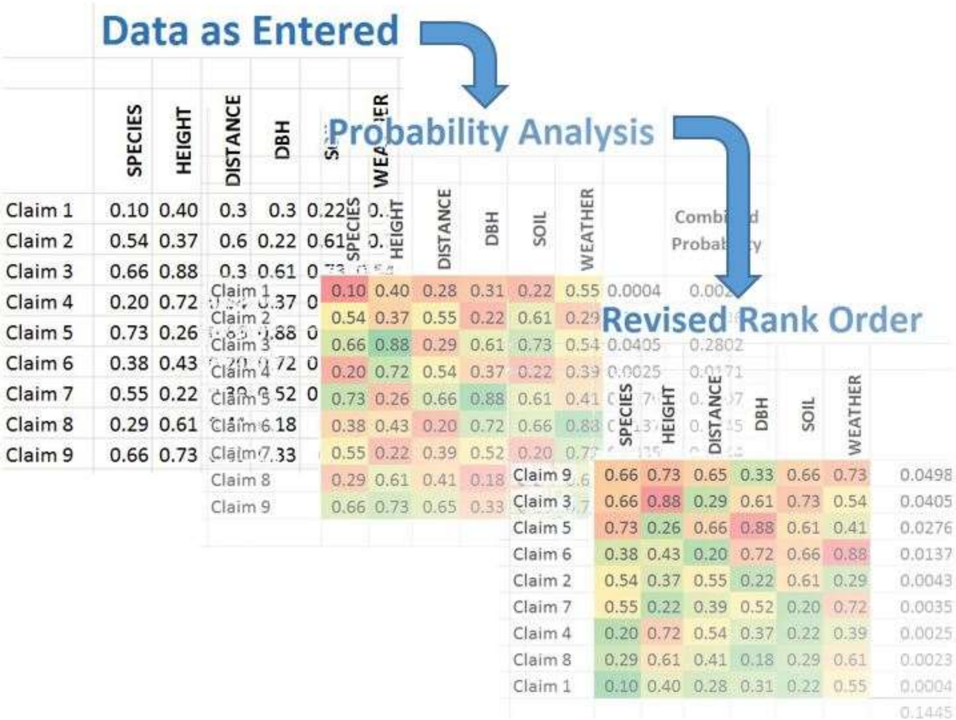
Combined Probability Analysis

The analysis described on the previous page and below doesn't rely on complex maths. It is a straightforward "this combination of elements puts this claim at that risk". It has the potential to assist in delivery of a digital solution and reduce claim life. There may be fewer parties to the claim in some cases and the outcome would be objective.

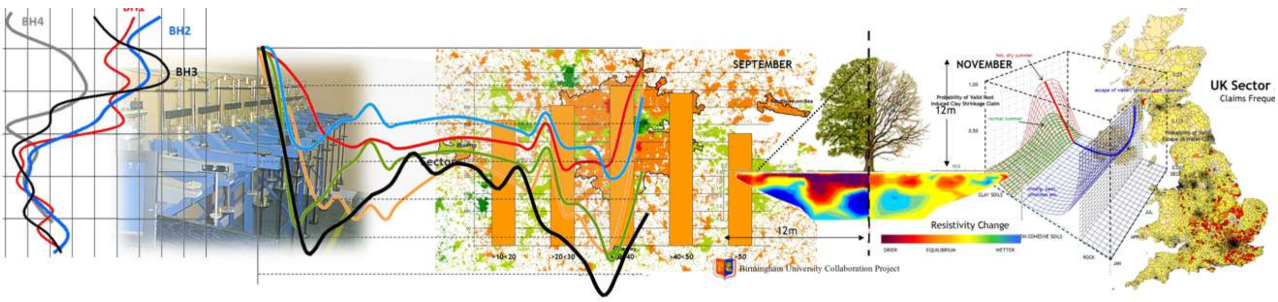


	SPECIES	HEIGHT	DISTANCE	DBH	SOIL	WEATHER	
Claim 9	0.66	0.73	0.65	0.33	0.66	0.73	0.0498
Claim 3	0.66	0.88	0.29	0.61	0.73	0.54	0.0405
Claim 5	0.73	0.26	0.66	0.88	0.61	0.41	0.0276
Claim 6	0.38	0.43	0.20	0.72	0.66	0.88	0.0137
Claim 2	0.54	0.37	0.55	0.22	0.61	0.29	0.0043
Claim 7	0.55	0.22	0.39	0.52	0.20	0.72	0.0035
Claim 4	0.20	0.72	0.54	0.37	0.22	0.39	0.0025
Claim 8	0.29	0.61	0.41	0.18	0.29	0.61	0.0023
Claim 1	0.10	0.40	0.28	0.31	0.22	0.55	0.0004
							0.1445

The heat charts above show Claim 1 as the initial entry. After re-ordering for combined risk, it falls into 10th place. Claim 9 takes the top position. Moreover, we can improve our understanding of 'which elements sit where' in deriving the risk by colour shading.

The above charts are purely illustrative and not based on actual claims, but they do recognise that species, soil and weather are important for the top three places, and DBH (Diameter at Breast Height) and maintenance regimes play an important part.

This is an extension of the work that has gone before in the field of vegetation/soils/weather with the added benefit of combining the elements objectively in a statistical framework. The above values are purely for illustration and have not been taken from actual claims.



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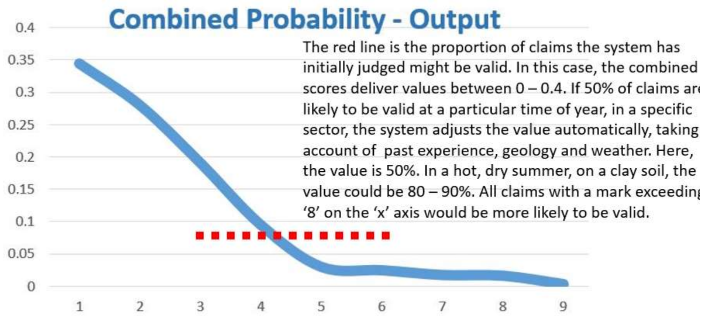
Learning from Experience

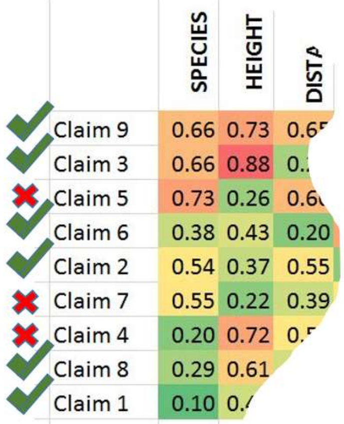
In the example on previous pages, individual scores have been combined to deliver a probability of whether the claim is likely to be valid or not. The benefit of this approach is that the individual factors can be refined and improved over time - the learning module.

As each claim is determined following investigation etc., the initial assessment will be confirmed or rejected. For entries that are found to be incorrect, what revised permutation or combinations would identify the peril and outcome? Which elements need adjustment?

What factor would have to be applied to each element to arrive at a correct outcome? How does the system improve the initial scores? If the weather element is reduced, does that enhance the outcome?



If the adjusted outcomes work most of the time, but not always, a confidence factor can be added. "It works 80% of the time" might guide the level of further investigations, but not as many as "it only works 20% of the time". The former could suggest a desk-top study of the risk data and viewing the site (Google, LiDAR etc.) plus photographs from the insured.



		SPECIES	HEIGHT	DISTA
✓	Claim 9	0.66	0.73	0.6
✓	Claim 3	0.66	0.88	0.
✗	Claim 5	0.73	0.26	0.6
✓	Claim 6	0.38	0.43	0.20
✓	Claim 2	0.54	0.37	0.55
✗	Claim 7	0.55	0.22	0.39
✗	Claim 4	0.20	0.72	0.5
✓	Claim 8	0.29	0.61	
✓	Claim 1	0.10	0.4	

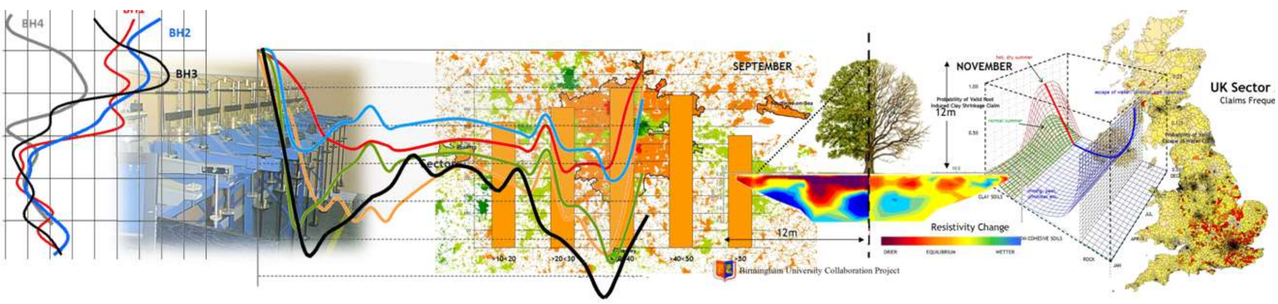
Initial assessments compared with outcomes. As the factors have been derived from historic claims data, this learning period should deliver value.

The latter – "it hardly ever works" (i.e. as low confidence factor) – might trigger site investigations of varying degrees of complexity. On non-cohesive soils, perhaps just a drainage investigation. On clay soils, site investigations and soil tests. In most cases these can be directed from the desk.

The exceptions will require an inspection. Third Party trees are a good example, and other complex situations – voids and landslips.

Left, initial assessments compared with outcomes. A 'tick' indicates the initial, system driven, assessment was correct. Claims 5, 7 and 4 were initially judged to be valid clay shrinkage, but investigations revealed the damage was old, or due to shrinkage and the claims declined.

What changes to which items would improve the score?



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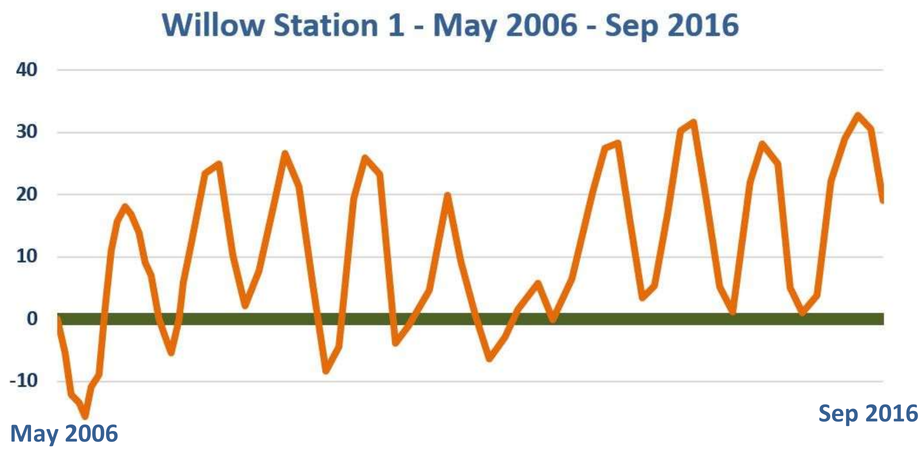
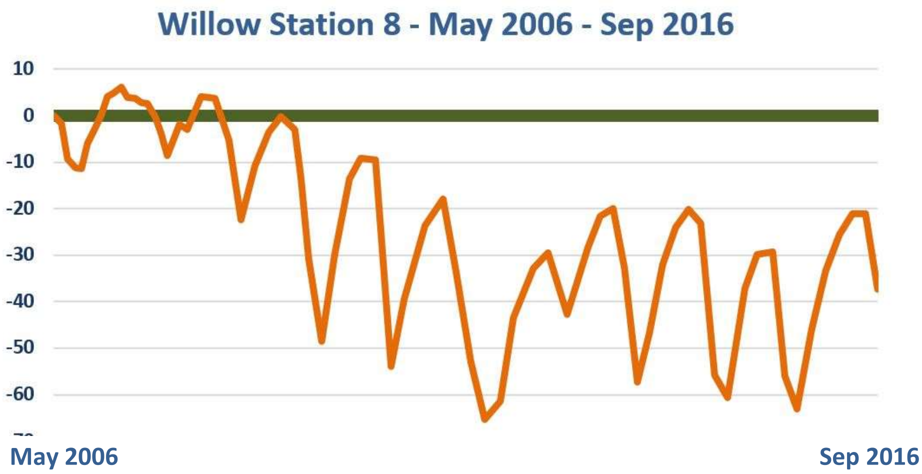
Ground Movement by Station – Aldenham willow

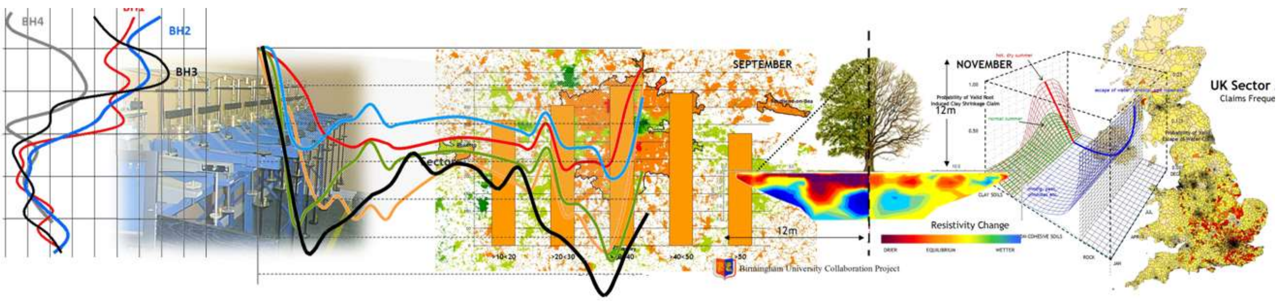
Below, graphs recording ground movement over the last 10 years from the Aldenham willow, plotting movement near the tree (top – Station 1), and at the root periphery (bottom, Station 8). Station 1, nearest to the tree, suggests there was a persistent deficit on commencement of the readings that has been (or is in the process of) being replenished, with the soil rehydrating to field capacity. Seasonal movement amounts to around 30mm.



To the end of the same array, the furthest station away from the willow (Station 8, below) reveals the establishment of a persistent deficit with only partial recovery in the winter months.



These graphs illustrate the difficulty in making assessments 'on the day'. Two stations going in opposite directions. The one closest to the tree rising by 30mm and the one furthest away subsiding by 60mm.



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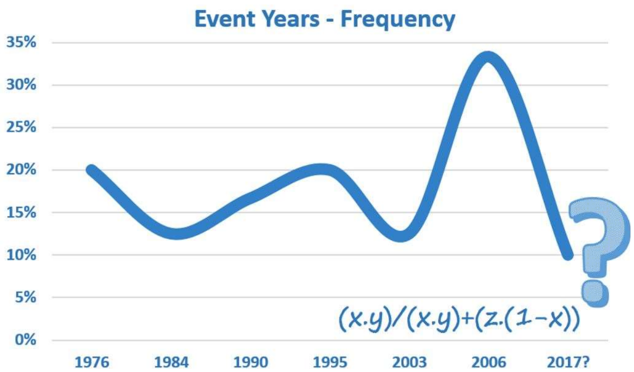
2017 - Event Year?

We feel compelled to try and forecast the future and recently our main sponsors raised the question of whether 2017 was likely to be an event year. What were the odds?

There are (at least) two schools of thought. The first might adopt a Bayesian approach, enter the prior position and then factor in possible outcomes to deliver an estimate.

Since subsidence was added to the home insurance policy in the early 1970s there have been several event years. 1976, 1984, 1990, 1995, 2003 and the latest in 2006. The gaps between them were 5 (from policy inception to 1976), 8, 6, 5, 8 and 3 (between 2003 and 2006). An average of 5.8 years up until 2006 with a maximum of 8 years.



A Bayesian approach using past data as a prior (i.e. frequency of event years), and then factoring in possible outcomes.

The frequency of past event years (i.e., 1 every five years = 1/5 = 0.2. One event ear every 8 = 0.125) delivers the graph above.

Based on the probability formula (see graph), the likelihood of 2017 being an event year is low. It's substantially less than 50-50.

The other school of thought?

The author of the 'The Black Swan', Nassim Taleb, might accuse us of being foolish, and it would be a difficult charge to refute.

After all, we know past events aren't predictors of the future and particularly when the main driver – the weather - is itself unpredictable and in a state of almost constant change.

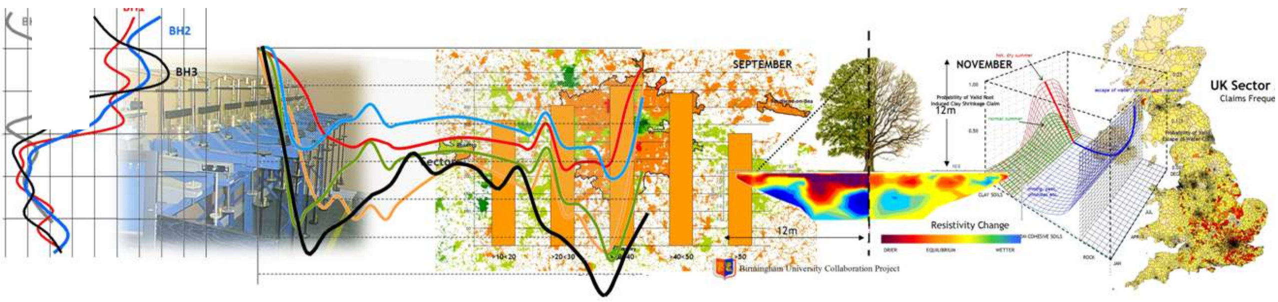
Guessing what will happen tomorrow requires a degree of skill, and even expert's forecasts for a week ahead can be fraught.

Our reliance on probability formula to estimate what will happen 12 months ahead is a waste of time unfortunately.

We find formulae attractive. Substituting 'I don't have a clue' for 'x', 'y' or even 'z' is far more attractive and makes us feel we play a role. In fact, we don't. The values are often a subjective assessment with values nudged in the direction of the user's prejudice. Their 'gut instinct'.

So, to return to the question, "will 2017 be an event year" we would reply the chances are 0.36728, followed by 'we don't have a clue'.

Which is correct? Use xy/xy+(z(1-x)) to derive a probability.

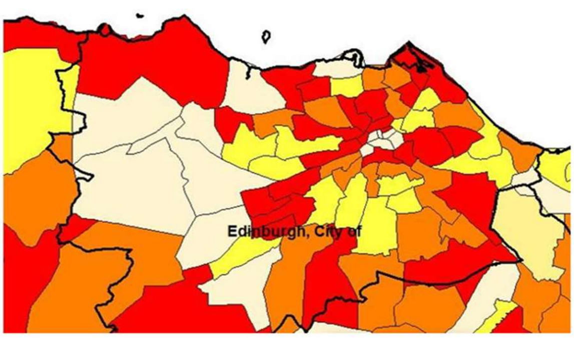


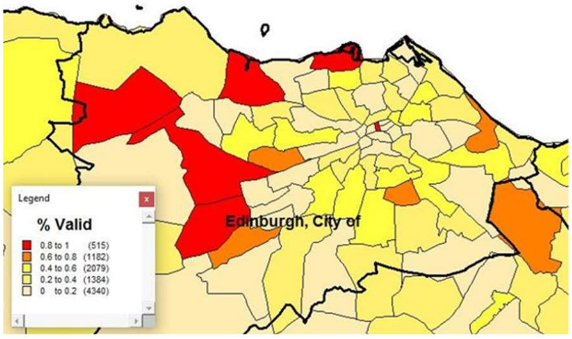
The Clay Research Group

Valids and Declinatures by City

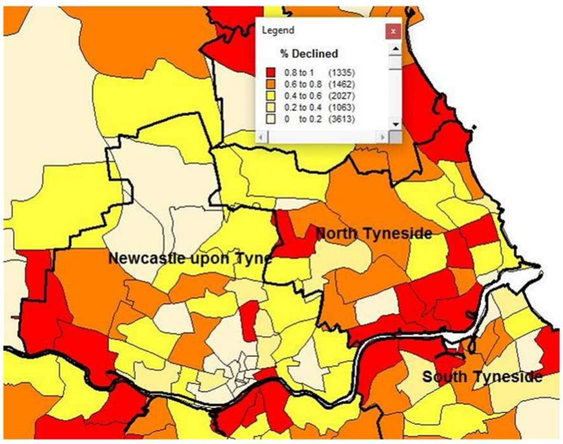
Continuing our analysis of the UK to understand the distribution of valid and declined claims by postcode sector, below are maps illustrating where the number of valid claims, or declinatures, exceeds 80% from the records we hold. The analysis has been carried out using a sample of just over 60,000 claims, representing two ‘normal’ claim years for the industry – i.e., not surge. In both images, the map of declined claims is to the left, and valids to the right.

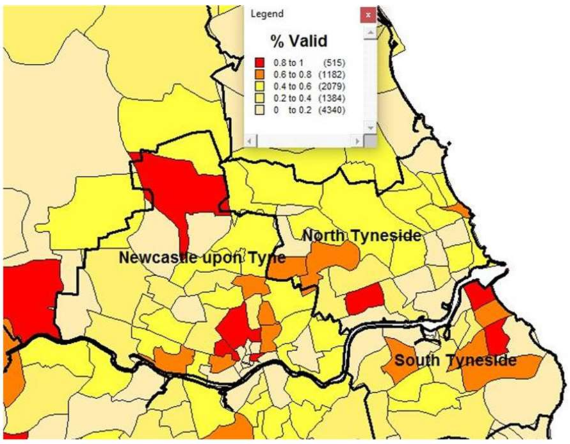
Edinburgh

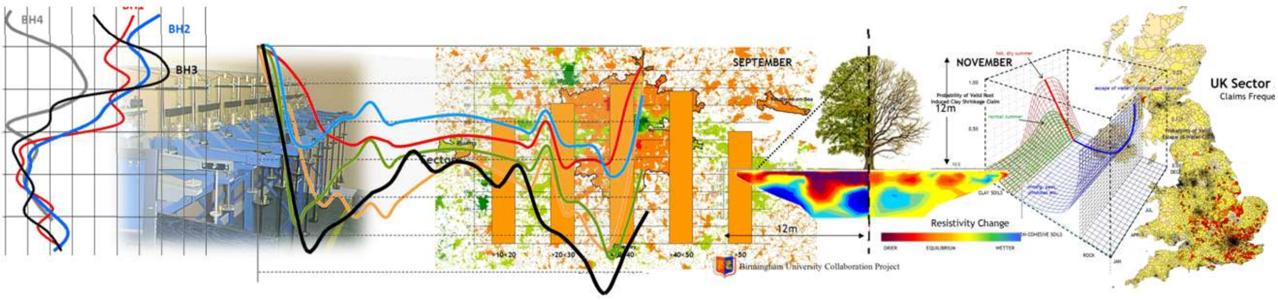




Newcastle

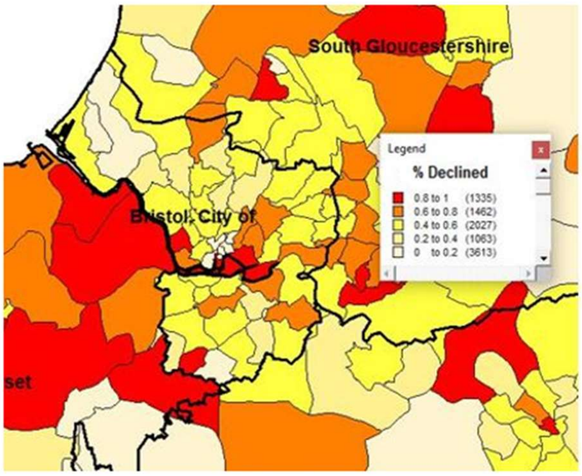


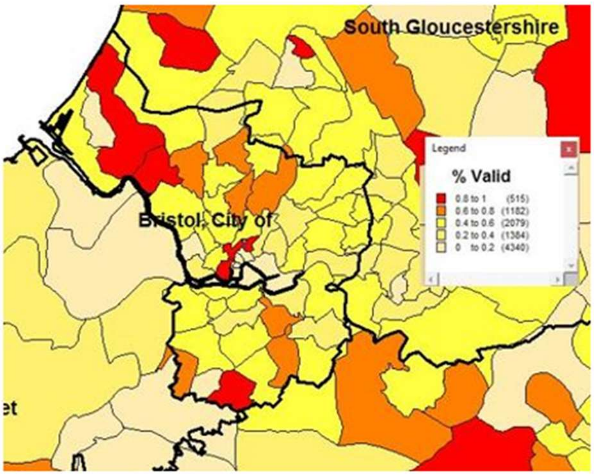




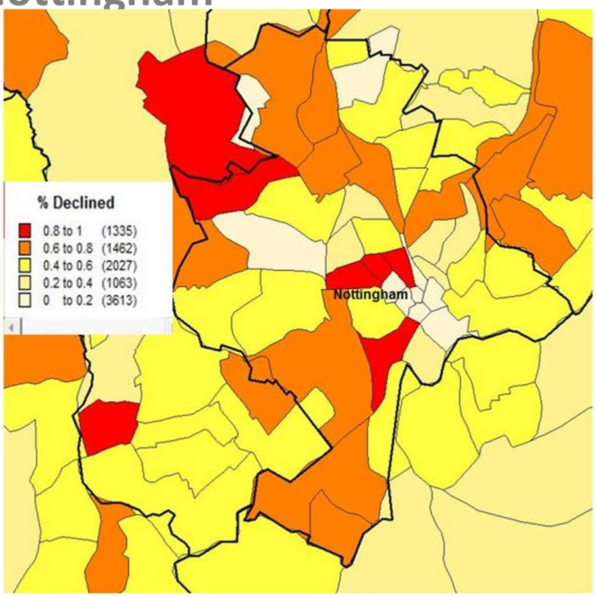
Valids and Declinatures by City - *continued*

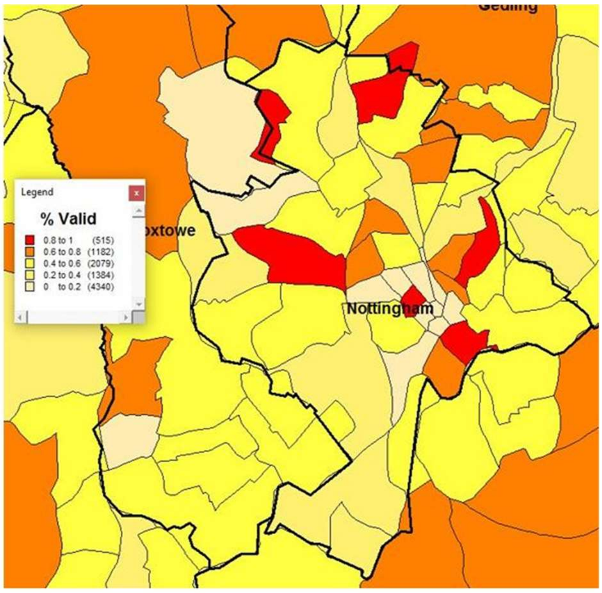
Bristol

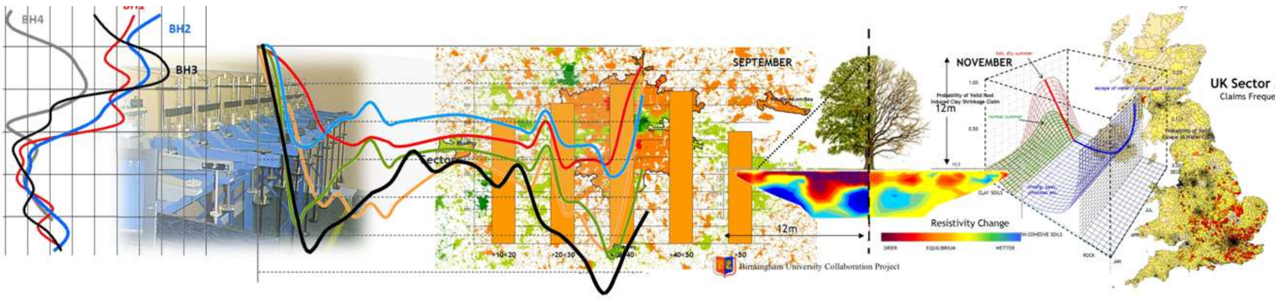




Nottingham







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Met Office Contract

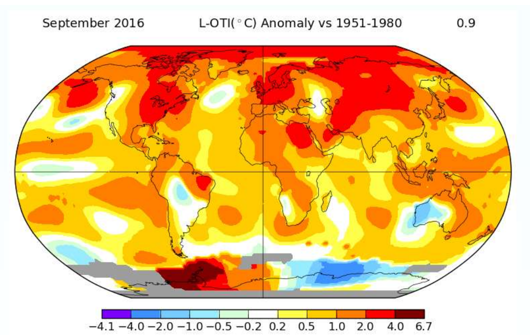
Following loss of the BBC contract, the Met Office have announced they will be providing weather services to ITN's Channel 5, commencing in June 2017.

Work has been undertaken by the Met Office to improve the graphic delivery using 'Visual Cortex' graphics by their partners, Presentation Cartograph.

Reports confirm Meteo, Europe's largest supplier of weather data, as the new provider to the BBC. The Met Office have worked with the BBC since 1922.

Goddard Institute of Space Science

Anomaly data compares the global temperature worldwide for September, 2016 with the average for the term 1951-1980.

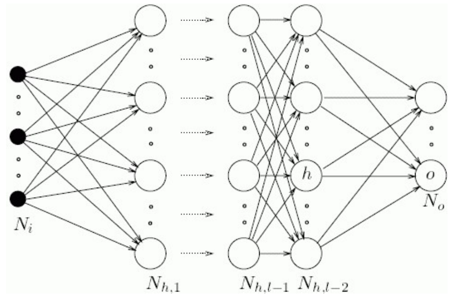


The UK may have been warmer, but predictions suggest that a cold spell may be on the way.

Intelligent Systems

Massachusetts Institute of Technology. "Technique reveals the basis for machine-learning systems' decisions: Making computers explain themselves." ScienceDaily. ScienceDaily, 28 October 2016

Traditionally, artificial intelligence applications deliver outputs, but it is rarely clear how they arrived at their decision.



Researchers from MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) are delivering a presentation exploring methods for accompanying outputs with the decision-making process to clarify how answers were arrived at.

Next month.

Dr. Jon Heuch throws some light on the relationship between fluctuating trunk diameter and diurnal sap flow as featured in the October edition of the newsletter – edition 137.

Heuristics. Making sense of uncertainty. Can **A*i*** systems resolve unclear outcomes?

Bacteria to the rescue. Is there a way of automating the resoution of subsidence caused by running water and sandy soils?