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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 136

September 2016

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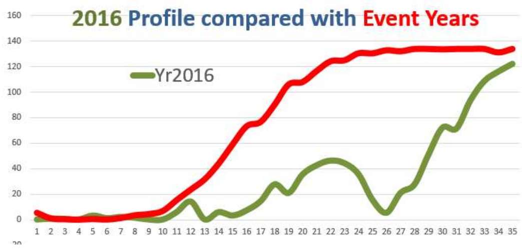
Edition 136, September, 2016

SMD Update Chart



Soil Moisture Deficit plot showing soil drying for 2016 compared with event years. A late rise but unlikely to trigger a significant increase in claim numbers. Data supplied by the Met Office for Tile 161, Medium AWC, grass cover.

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Before or after the Event?

A method of identifying which tree will cause what damage, where and when, eludes us as predicted by Giles Biddle in his two volume book "Tree Root Damage to Buildings", published in 1998.

Tony Boobier came to the same conclusion many years ago, and reinforced this view in October 2012 (CRG newsletter 89) when he said, "Over the years it has become clearer that the impact of trees on property cannot be determined with absolute certainty but only that the probability of certain outcomes can be identified, but that is a perfectly valid stance, in that insurance has never been about certainty but rather about probability".

The approach has changed. Our models certainly refine the identification of properties at risk – a property on London clay, within influencing distance of a tree is a higher risk than another with no vegetation nearby, or on a non-cohesive soil. The **A***i* application looks at how to resolve complex claims once damage has occurred.

In this edition, we look at using combined probability theory to predict whether, following notification of damage, a claim is likely to be valid and if so, the most likely operating peril. Comparing outcomes with initial predictions delivers a confidence factor.

How reliable was the initial estimate?

Over coming months, the newsletter continues the examination of the decision tree approach, and considers whether cubes are better than trees. Probabilistically.

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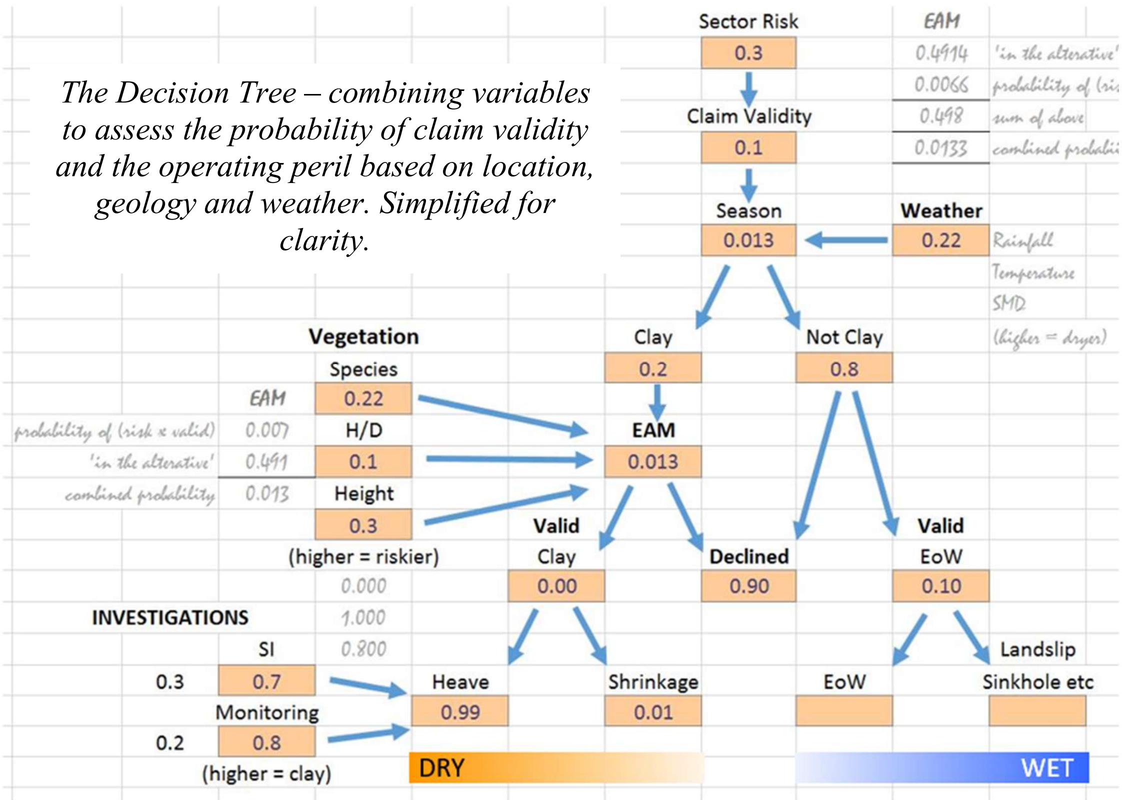
A Probabilistic Decision Tree

Although there is a natural resistance to objective analysis by so-called **A*i*** systems, the decision making process of individual specialists has to be grounded in science and experience, and taking as an example a typical root induced clay shrinkage claim, it requires a combination of dry weather, shrinkable clay and vegetation. Within each, there is variability.



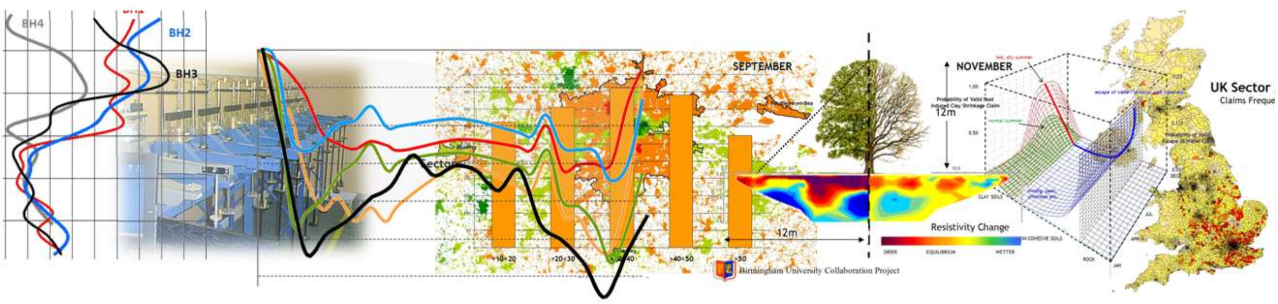
The Decision Tree – combining variables to assess the probability of claim validity and the operating peril based on location, geology and weather. Simplified for clarity.

The temperature might be high, but intermittent showers can reduce the risk. Soils are rarely homogenous and as for trees – the variability even within a species is considerable. Health, age, location, environment and maintenance all play a part.

What is clear from an examination of hundreds of thousands of claims is that there are patterns. The decisions of specialists aren't based on guesswork.

Above, a decision tree that incorporates most of the elements. The age of the property has been excluded as has description and location of crack damage. Important factors that are dealt with in later issues.

The following pages explore the initial steps.



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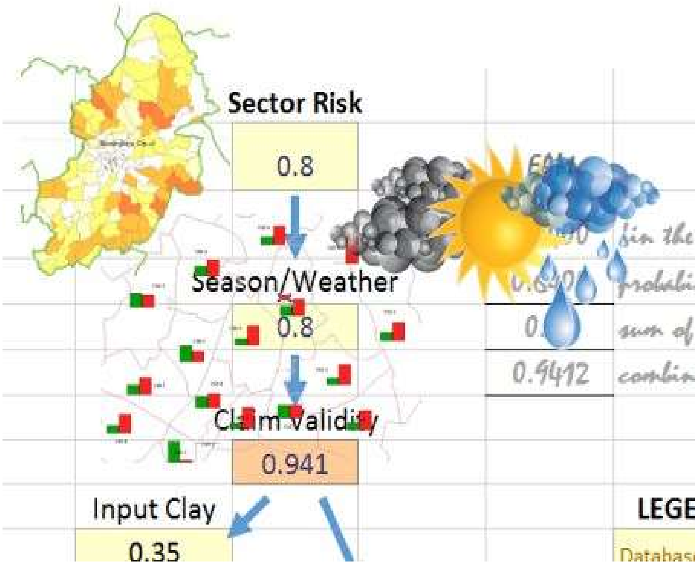
The Rating System



In the illustration, the selected sector is high risk with a score of 0.8 on a normalised scale of 0 – 1, with 1 being the highest risk.

A high score in the weather option indicates a hot, dry period. Lower scores indicate wetter conditions.

Claim Validity follows the same protocol with high scores reflecting higher numbers of valids from the claims database. A lower score indicates more declinatures. In the example, all scores combined would point towards a valid claim. Further along the decision tree, we consider vegetation, soil and weather in the Environmental Assessment Module, or EAM.

All UK postcode sectors have a risk and validity score.

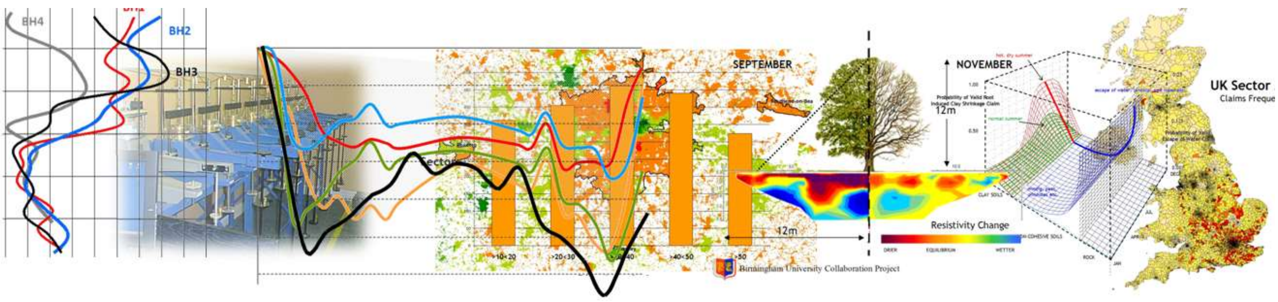
Weather scores relate to Soil Moisture Deficit relating to Tile 161, as supplied by the Meteorological Office, with winter represented as '0' and the long, dry summer months (i.e. moisture deficit of 134mm) = '1'.

Intermediate months have scores that are variable by prevailing weather conditions.

CUBES or TREES?

Decision trees provide a linear logic but are less effective temporally. They don't resolve developments over the life of the claim as effectively as we need, which is where the cube adds value. The initial decision tree values reside in the first layer. Subsequent layers store outputs from investigations, monitoring and finances. The cube provides an archive of the claim history in digital format, combining spatial and temporal data.

The decision tree deals with FNoL and Triage. It calculates probabilities based on whatever information is available. Over time, the cube delivers a 3D view of the claim that can pattern match and take account of uncertainty. Not all things are known – some may be based on estimates. More next month.



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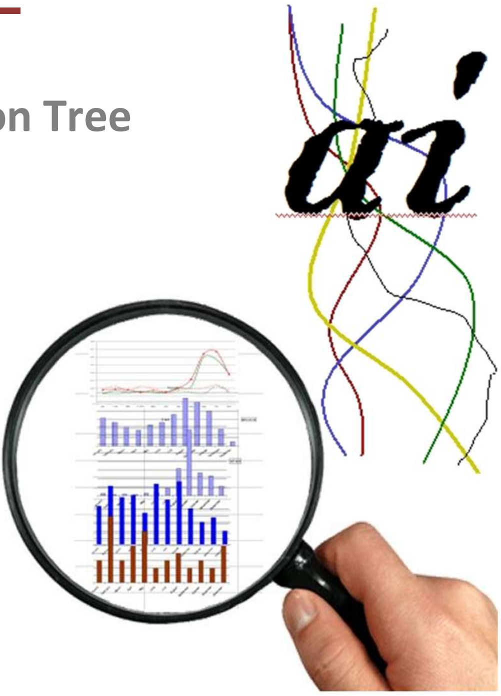
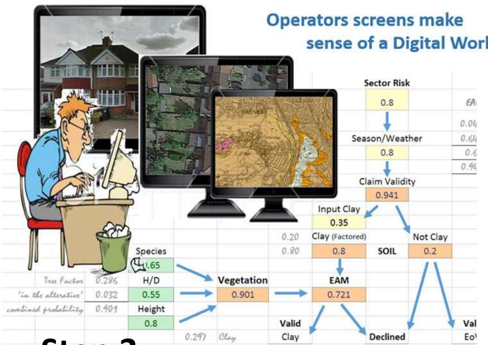
First steps along the A*i* Decision Tree



Step 1.

On notification, the system reviews claim data from the postcode sector. Is it high risk? Is the soil clay? Of the claim population, how many have been valid?

The system refers to a library of 'date of notification' signatures for a range of perils – subsidence, heave, escape of water etc. – see earlier newsletter. This identifies the most likely operating peril in the sector which, when combined with current weather and geology, sets the initial probability.



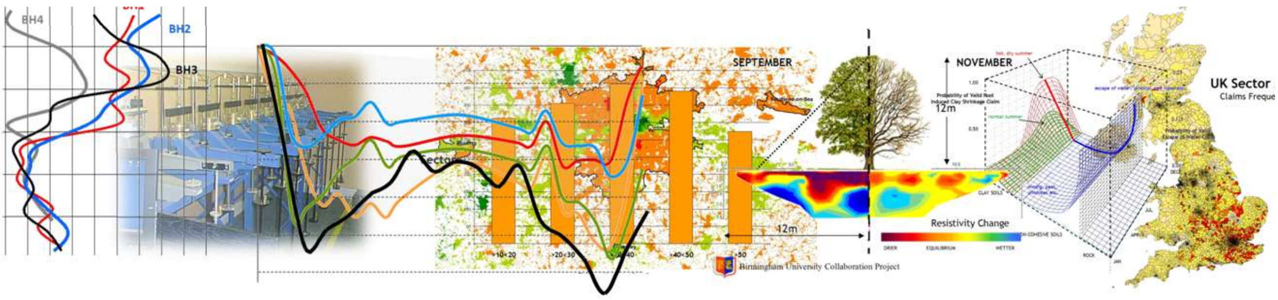
Step 2.

Data can be entered by anyone party to the claim and with the necessary log-in authority. The homeowner may prefer a 'do it yourself' approach but it would be just as useful to the claims handler, engineer, arboriculturalist, site investigation team or monitoring agent.

Step 3.

The A*i* application is continually assessing and updating probabilities behind the scenes, both to assist in determining the peril and likelihood of claim validity, but also to receive input further along the process from the Environmental Assessment Module (EAM) and results of any investigations. In summary, the initial assessment looks for matches against a range of characteristic signatures. Do past claims in this sector peak in the summer or winter months, or are they level throughout the year? Is the soil a shrinkable clay and is the weather dry, or are the soils in the sector non-cohesive and is it raining?

Top, the characteristic signatures for a range of perils based on date of notification. Bottom, combined probabilities bringing the disparate data together.



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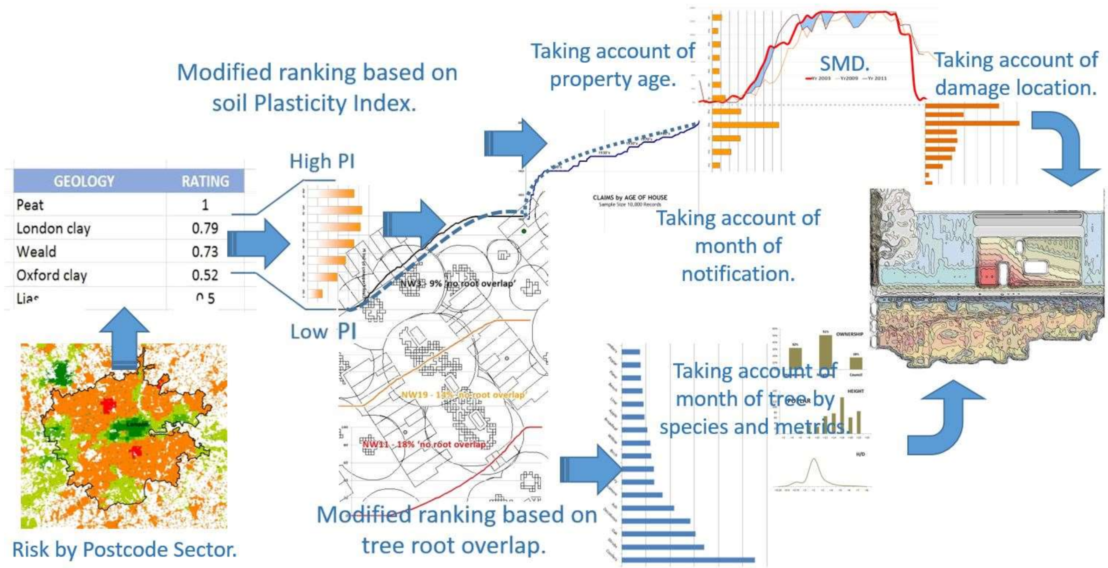
The Environment Assessment Module

Producing a decision tree is particularly complex for resolving probabilities associated with subsidence claims as several elements – mainly those relating to the environment – vary seasonally and are linked. See graphic below. For example, clay soils have a risk related to rainfall, which in turn triggers or abates the risk posed by vegetation depending on tree physiology 'on the day' and local atmospheric conditions.

Seasonally, the variation can be significant. In a normal claim year declinatures may run at 80% in the winter, and reduce to 20% in a surge summer. Overall the average is around 50% across the UK, although this varies widely by region, season and geology.

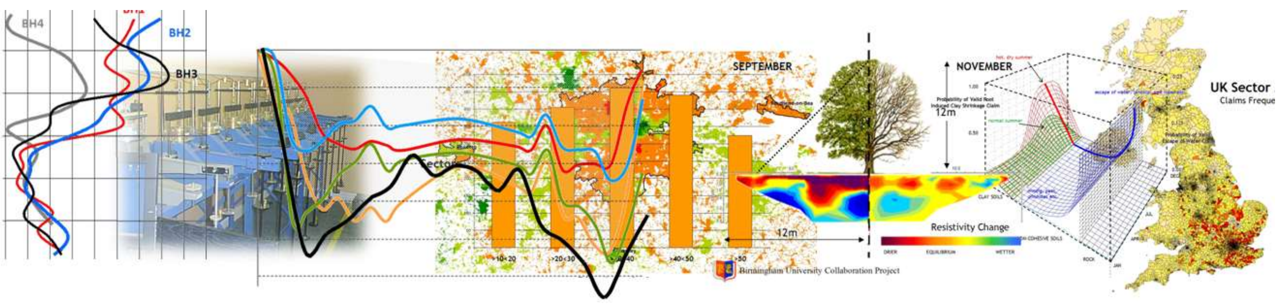


Instead of struggling to put these into a linear model, we have created an Environmental Assessment Model (EAM) that resolves the interaction to deliver a single value to insert into the decision tree.

See following pages.

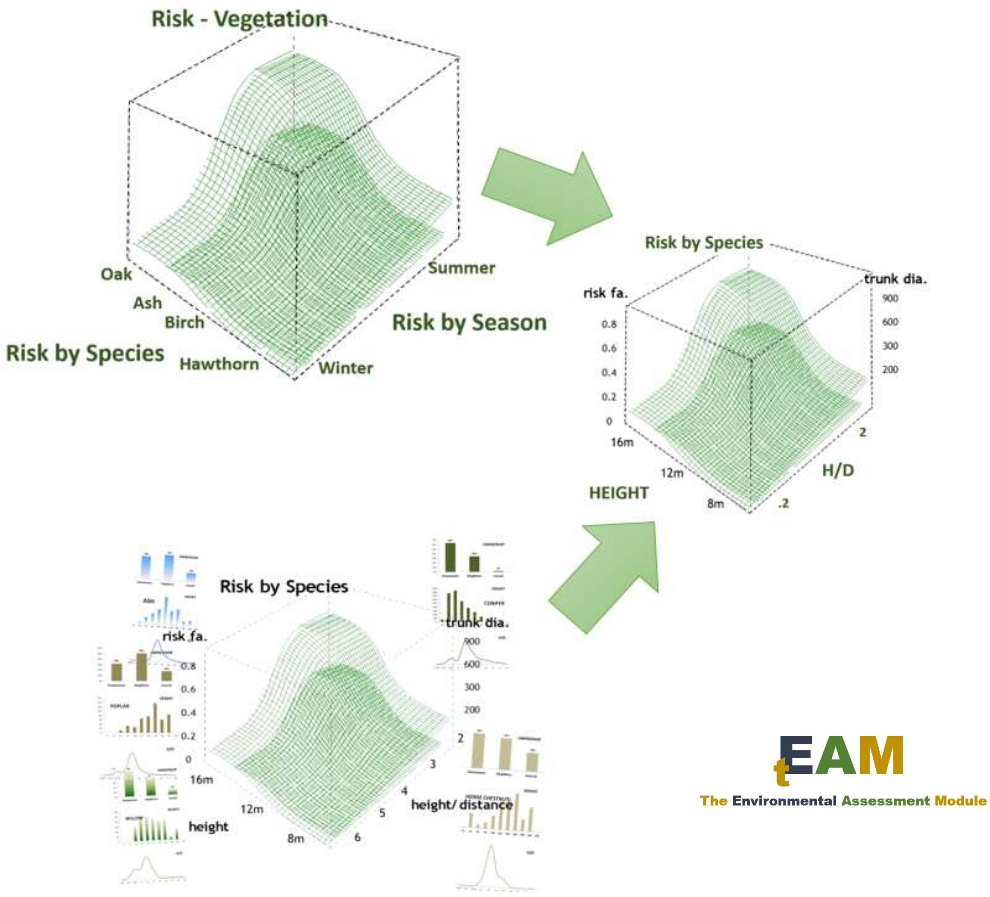
In summary, the height and species of a nearby tree links to the H/D ratio and where available, trunk diameter are all combined and once resolved, factored with the geology and prevailing weather conditions at the time of damage (rather than date of notification).

This doesn't mean that all trees with identical, or similar values, will cause damage. The output is used to asses, when damage occurs, "is the nearby tree the likely cause?"



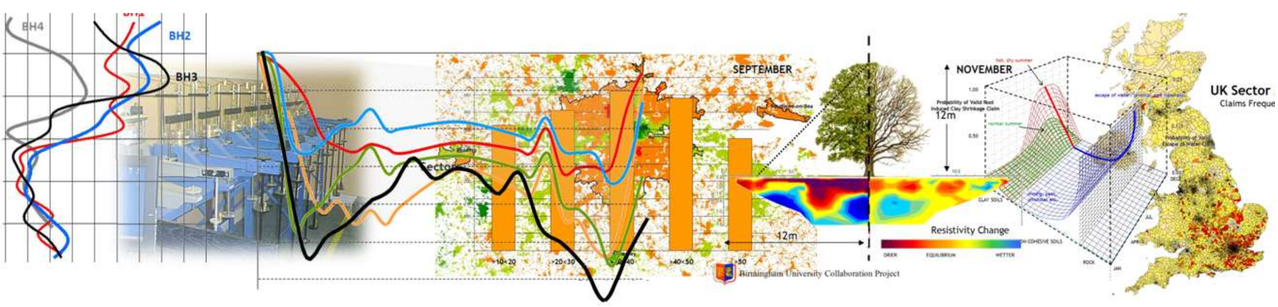
The Environment Assessment Module - Vegetation

The sketch below illustrates the construction of the vegetation element. Referring to our database of over 40,000 records (bottom left), graphs of distribution deliver values for the risk by species (top left), and then pass the output across for analysis by the tree metrics cube (centre, right) which takes account of tree height, H/D and trunk diameter.



The output is then merged with two other elements – weather and soil – for further analysis.

Trees don't cause problems on non-cohesive soils even in dry, hot years. On the other hand, the absence of vegetation on a clay soil can be an indicator for heave. See following page.



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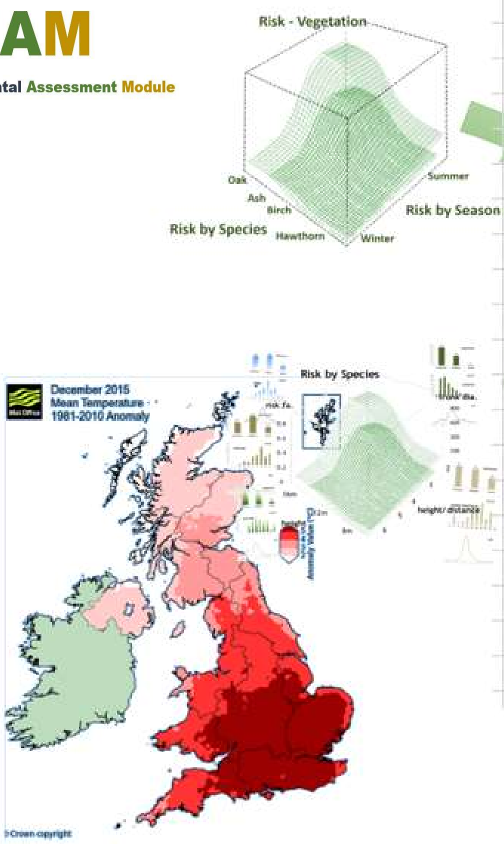
The Environment Assessment Module
Combining the Elements

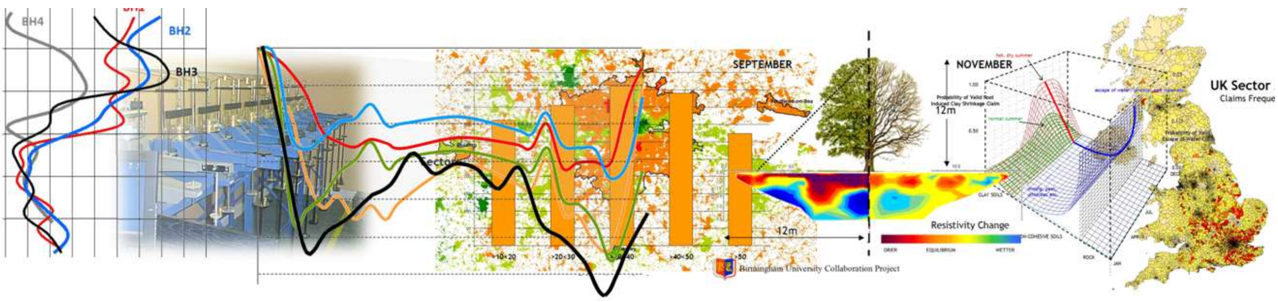
Below, values for the geology (table, right) and weather (map, bottom left) are added to the EAM to deliver a single probability value supporting or denying the likelihood that the claim could be root induced clay shrinkage.

EAM
The Environmental Assessment Module



Geology	Frequency
Peat	0.99
London clay	0.79
Weald	0.73
Cklay-with-Flints	0.69
Oxford clay	0.52
Lias	0.5
Amptill	0.5
Landslip	0.49
Oolite	0.48
Gault	0.44
Barton	0.43
Keuper marl	0.42
River Terrace	0.41
Chalk	0.41
Alluvium	0.36
Till	0.31
Brickearth	0.3
Coal	0.27
Limestone	0.23
Sands and Gravels	0.15

The values are integrated to derive a single probability combining the individual components.



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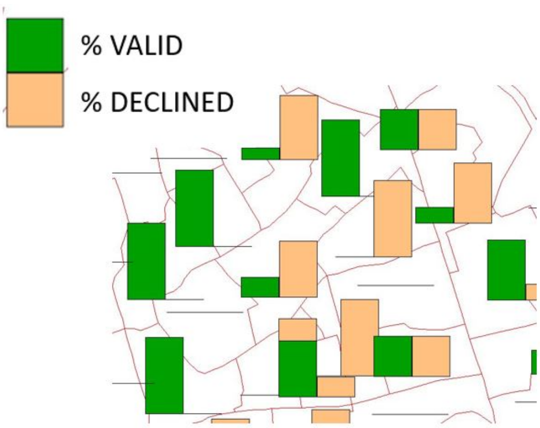
Environment Assessment Module

The starting point is the postcode sector value based on an analysis of the claim database. Has the sector received many claims, and if so, what percentage were valid and of those, what was the most frequent peril? See example of output below.



Output from the 'likelihood of claim validity' database plotting 'percent valid -v- percent declined' by postcode sector.

Here, an assessment has been made to understand the likelihood of claim validity.

It can be seen that in some sectors over 90% of claims received were determined to be valid following investigation. In other sectors, over 90% were declined, varying by season.

Below, the method of combining probabilities. Risk values for tree by species and metrics is factored against both soil and weather to deliver a risk index.

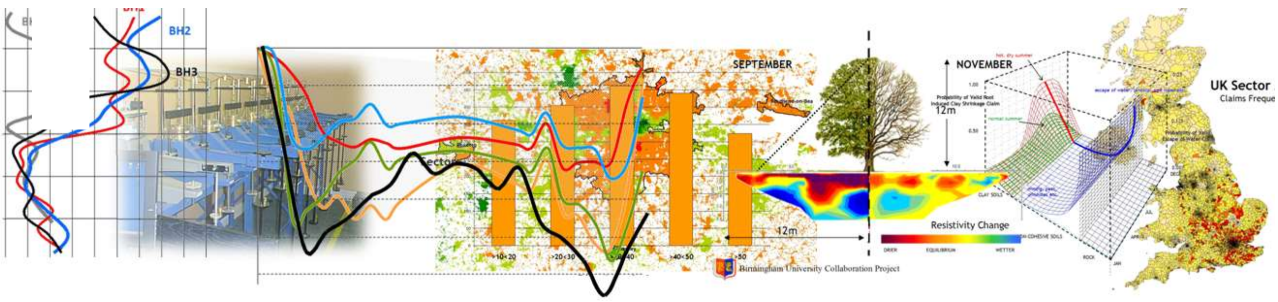
The output is then factored against the sector values using the ratio between valid claims and declinatures.

In the example right, the scores are shown on a scale 0 – 1. The value of 0.2 for 'soil' confirms it has low shrink/swell potential. The weather value of 0.2 reflects wetter conditions.

The outputs are factored against the 'count of claims' and 'percent valid' scores for each sector to deliver the likelihood for each heading. The claim is 70% likely to be valid. There is a 68% chance it is related to a combination of wet ground and non-cohesive soil and only a 2% chance of it being clay shrinkage. The chances of it being a declinature are 30%.

	VALID clay	VALID drains	DECLINED
SPECIES	0.65	0	0.35
H/D	0.77	0	0.23
SOIL	0.2	0.8	0.8
WEATHER	0.2	0.8	0.8
	0.02002	0.64	
	0.03033241	0.969668	
OUTPUTS	2%	68%	30%

Simplified output from the combined probability module resolving the interaction between trees, soil and weather.



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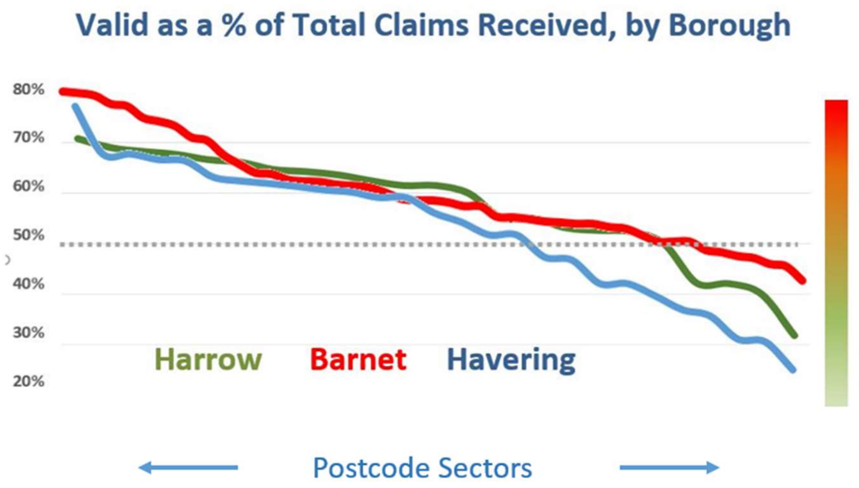
Valids and Declinatures by Sector

Below, a plot showing the percentage of claims accepted or declined by postcode sector for each of the named London Boroughs. Barnet has some sectors where the prospect of a claim being valid is 80%. Most have a greater than 50% prospect. The sample has not been selected 'by season' and the numbers will fluctuate depending on the weather - higher in the summer, and lower in the winter.

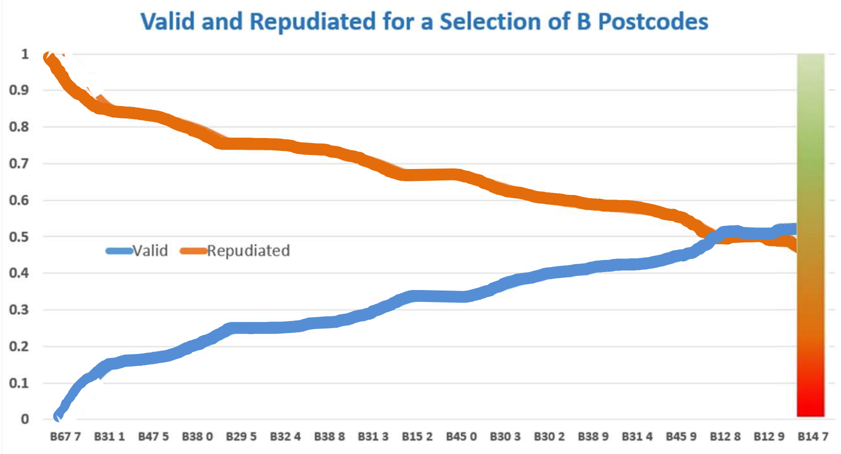
Around 70 – 80% of claims received in some London postcode sectors are accepted as valid – the percentage varies with the season for sectors on outcropping clay soils.

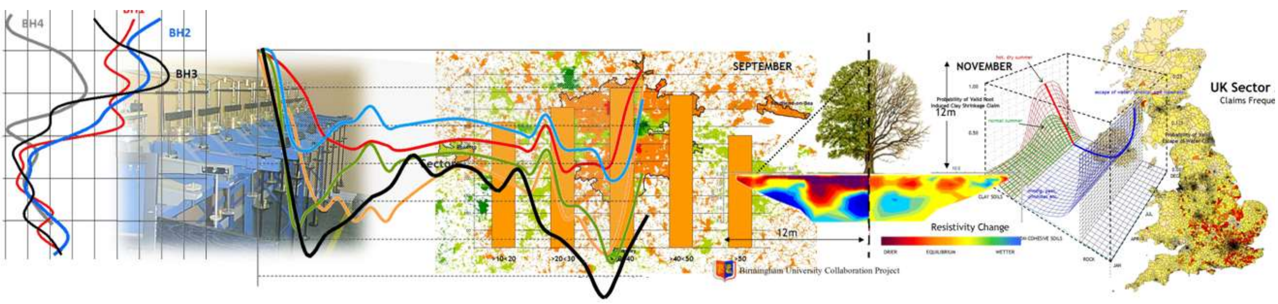
In this example, the three Boroughs have comparable profiles.



Below, a similar plot for a selection of postcodes in the Midlands showing the mirror image of valid and declined percentages. At the extreme, B67 7 indicates that the chances of any claim being repudiated are high. Nearly 100%. The missing element is understanding the number of claims to obtain a confidence value. Is the assessment made on the basis of a single claim, or tens? The higher the number, the greater the confidence factor.

The above situation is almost inverted elsewhere in the UK. This selection of postcodes from the Midlands suggests a higher repudiation rate probably associated with the variable geology. It also reflects the output from a smaller sample. The postcode 'B67 7' contains 9 claims in our sample.





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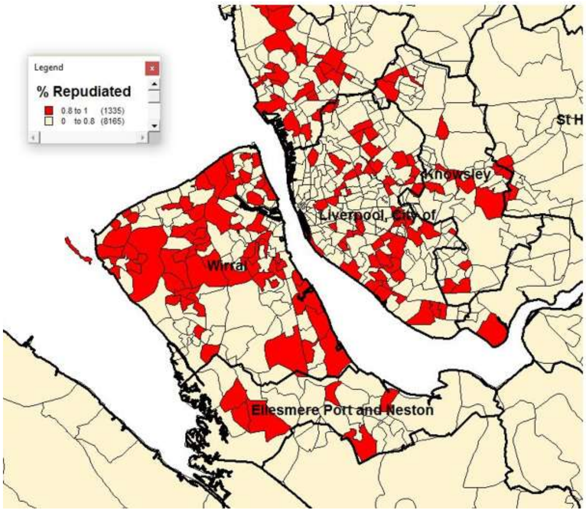
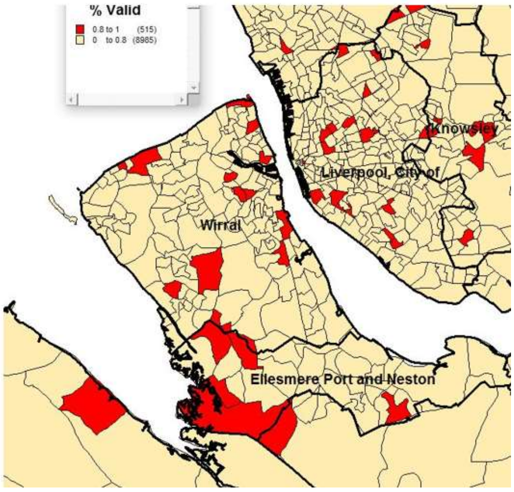
Valids and Declinatures by City

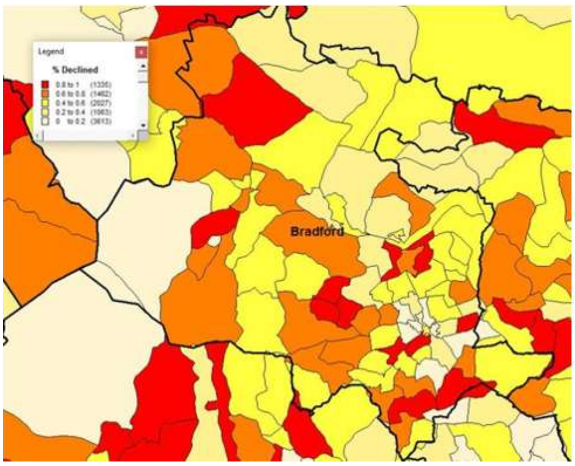
Continued from last edition. Below, maps illustrating the postcode sectors where the number of valid claims, or declinatures, exceeds 80% for the records we hold. The analysis has been carried out using a sample of just over 60,000 claims, representing two 'normal' claim years – i.e., not surge. The map of declined claims is to the left, and valids to the right.

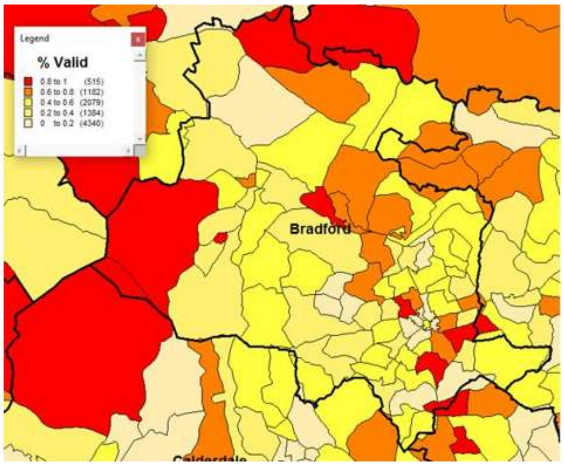
Liverpool

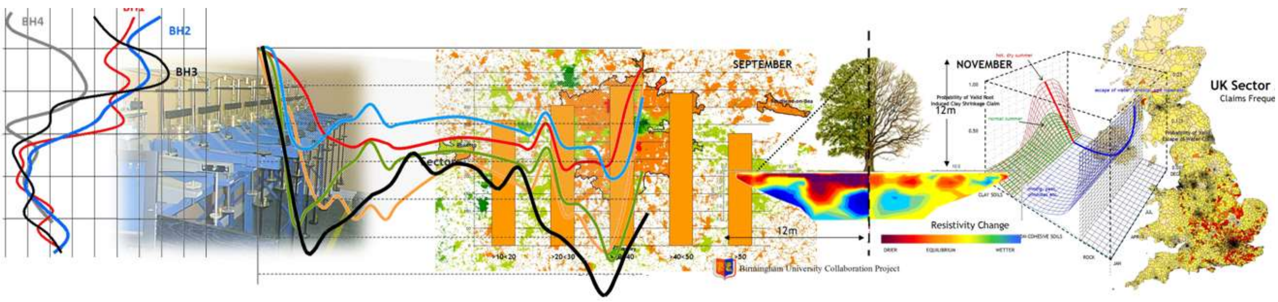




Bradford







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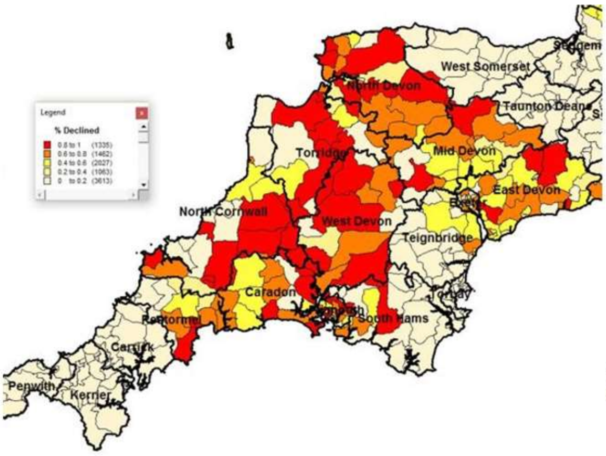
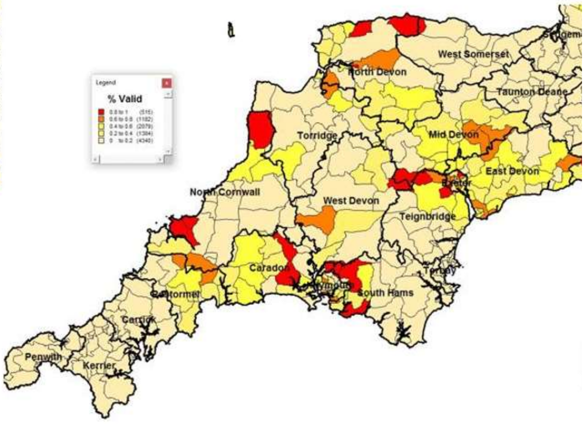
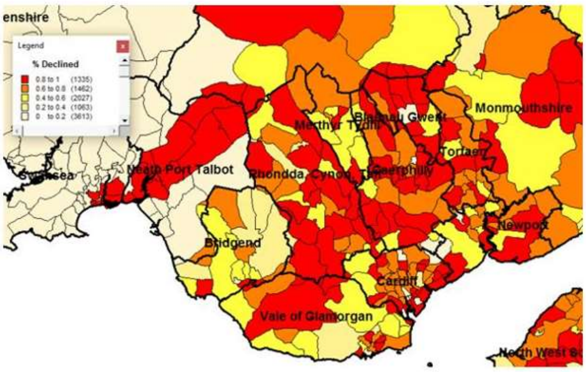
Valids and Declinatures by City.

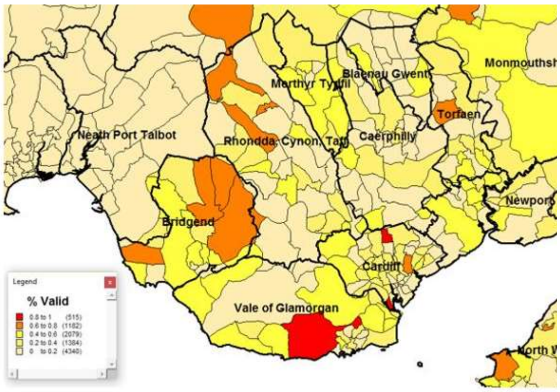
Cornwall and Devon



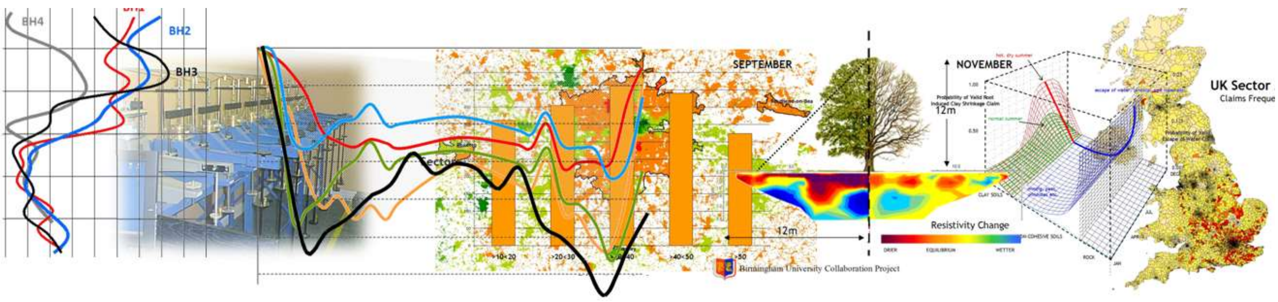


South Wales



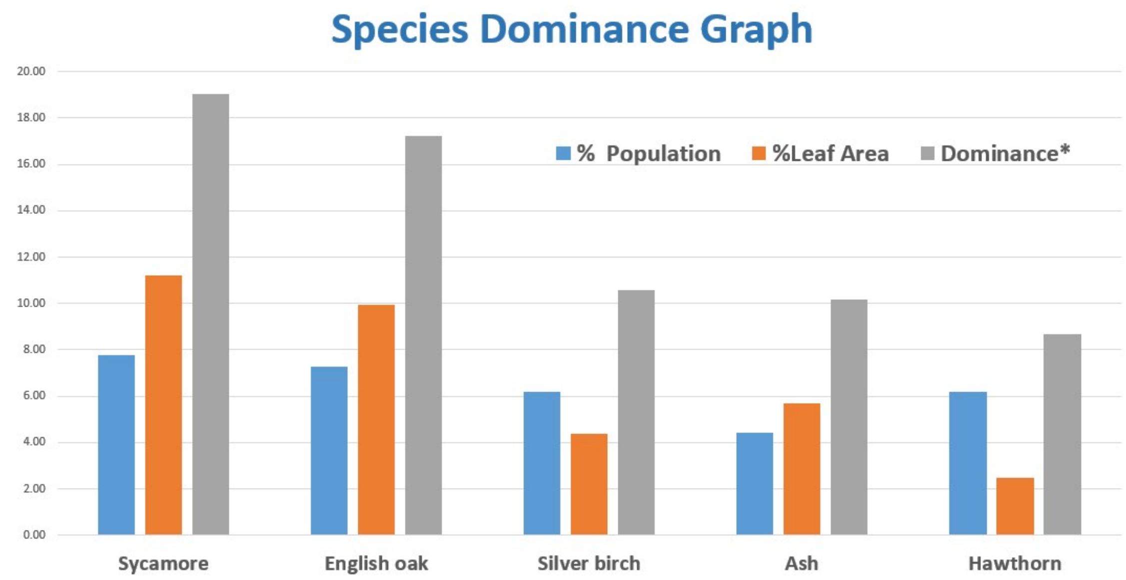


From the above and previous editions we see that there are high rates of valid claims in London, whilst in Liverpool, South Wales, Newcastle, Edinburgh, Cornwall and Devon there are high rates of declinatures. Future editions illustrate the use of this analysis.



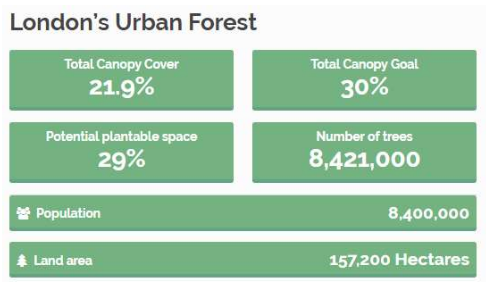
Tree Data – the i-Tree study

The i-Tree web site contains lots of useful information relating to trees. Below, the dominance by species. Elsewhere, land use, ground cover, trees by DBH (Diameter at Breast height), leaf and bio-mass etc. In total, we counted around 18 Excel worksheets, each containing detailed information from various i-Tree studies.



Above data provided by Treeconomics and Forest research, available at http://urbantreecover.org

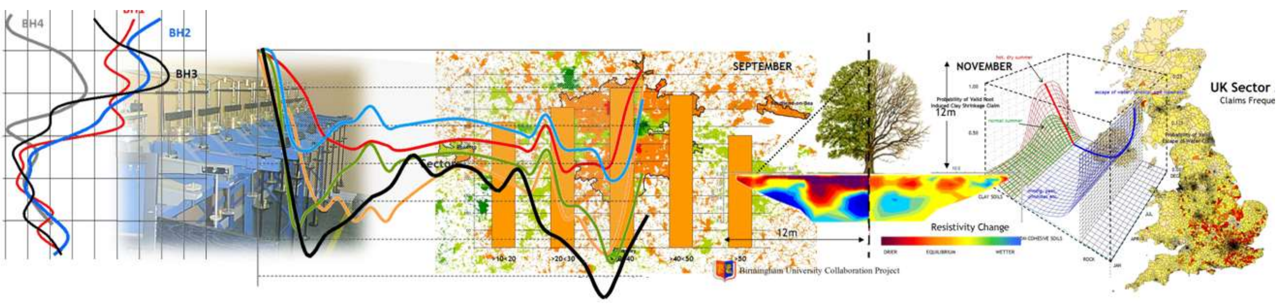
The sites are well worth a visit and there are a number of reports and datasets available for download, relevant to the field of domestic subsidence.



Local Authorities are gathering more data on trees, reflecting their importance. Although subsidence is a relatively minor factor there is a potential to improve our understanding of risk.

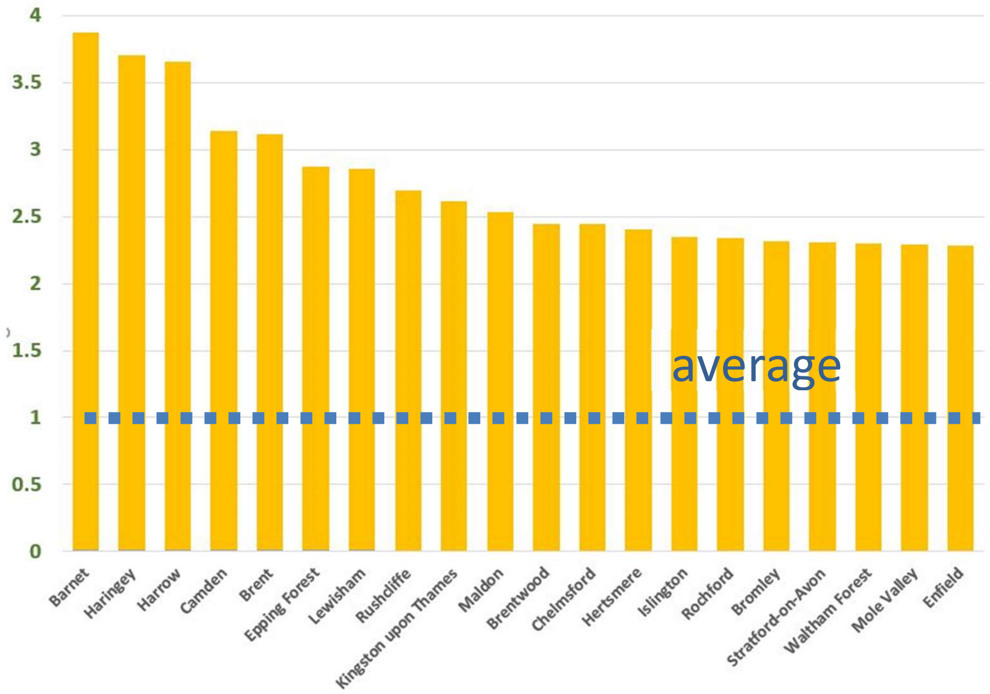
The publication "Valuing London's Urban Forest" outlines the results of the i-Tree Eco Projects, counting and valuing London trees plus estimating the canopy area and volume, carbon sequestration and storm water alleviation etc. See table, left, for an example.

Apparently, the most common trees planted in inner London are birch, lime and apple. In outer London they list the sycamore, oak and hawthorn. Tree canopy cover is estimated to be around 20%, although estimates do vary as one would expect.



'x' Times Riskier by District

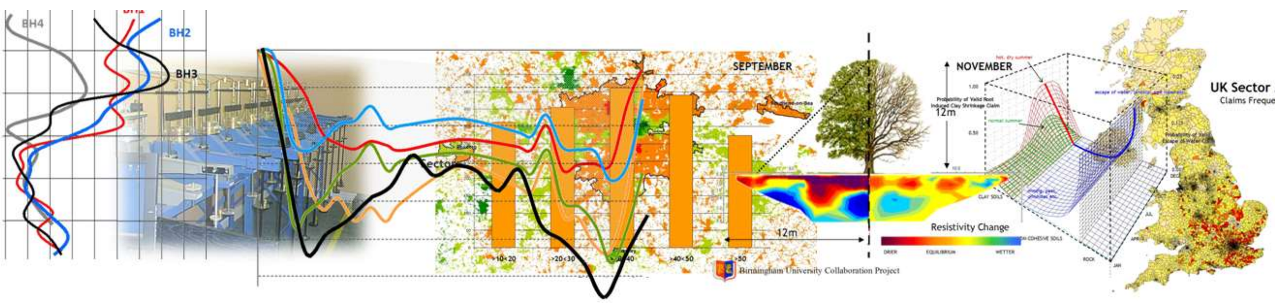
We know some districts are riskier than others, but by how much? The bar graph below tells us that for the specific claim sample over a given period, Barnet was 3.86 times riskier than the average, Haringey 3.68, Harrow 3.64 and Camden 3.18 times riskier than the UK average.



These values are conservative side (i.e. more onerous than may be the case) because the 'average-by-district' analysis includes nearly 3,000 postcode sectors with no claims recorded, which supresses the average. The real values will be reduced if account is only taken of sectors with a measureable risk.

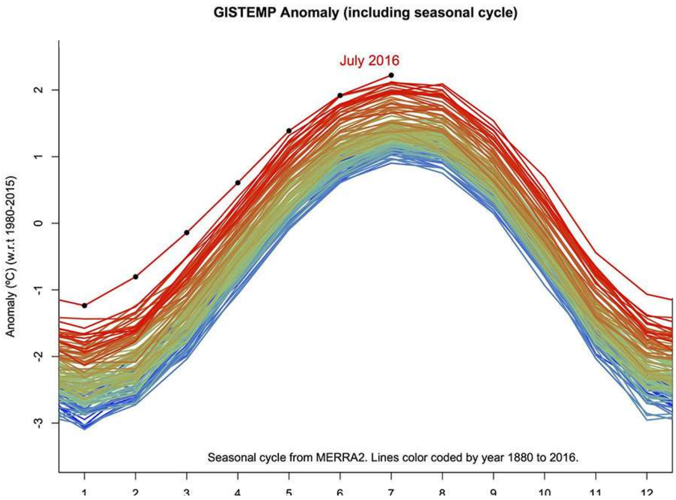
There are also the usual caveats around data analysis. Claims recorded by postcode sector can deliver incorrect readings as sector boundaries don't coincide with district outlines. Using centroids is easier from a mapping perspective, but doesn't account for the situation where the density of claims falls in an adjoining district.

Also, although the district appears to be high risk it is often the case that the claims cluster to a particular area, leaving the remainder of the district low, or even very low, risk.



NASA GISS Surface Temperature Anomaly Data

According to data collected by the NASA's Goddard Institute of Space Studies (GISS), 2016 temperatures are higher than at any time in the last 136 years. See graph below for details. The current record period of warming stretches back to October 2015.



http://data.giss.nasa.gov/gistemp/news/20160816/

Position of Jet Stream Influences Summer Rainfall

Hall R., Jones J., Hanna E., Scaife A., Erdélyi R.

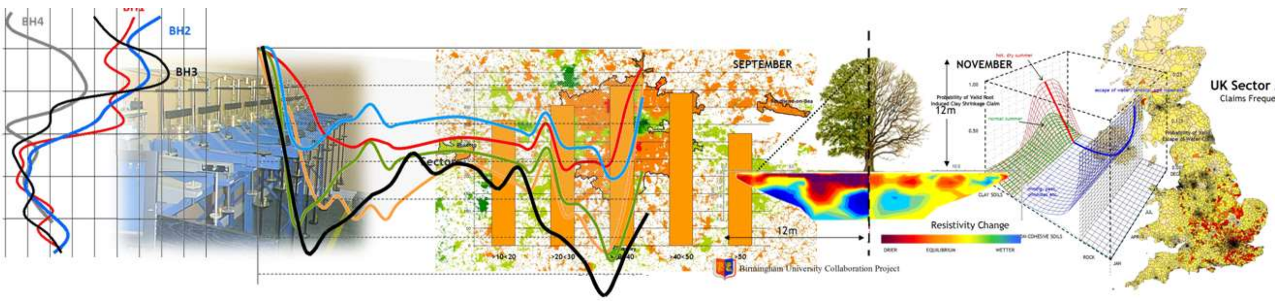
Drivers and potential predictability of summer time North Atlantic polar front jet variability.

Climate Dynamics, August 2016

PhD student Richard Hall from Sheffield University has published the results of research in the August edition of Climate Dynamics, working with experts from the Met Office, including Professor Scaife, Head of Long Range Forecasting and Edward Hanna, Professor of Climate Change at the University.

The findings suggest the latitude of the Atlantic jet stream in summer is influenced by several factors including sea surface temperatures, solar variability, and the extent of Arctic sea-ice, indicating a potential 'long-term memory' and predictability in the climate system. The paper suggests that the findings might improve summer climate predictions by around 35%.

http://www.metoffice.gov.uk/news/releases/2016/summerjetstreammystery



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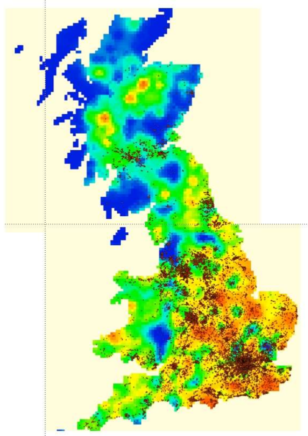
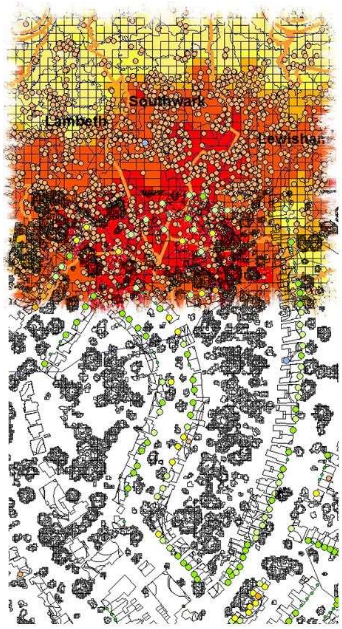
CRG REVIEW - 4

Continuing a review of the work of the CRG over the last 10 years.

The CRG subsidence risk models are perhaps the most advanced in the market. Where does the risk lie and what is the variation on a normalised scale? What does it have to do with the geology? Associating claims, geology and weather has delivered significant benefits in terms of triage, diagnosis and handling as well as allowing us to model the impact of climate change – in whatever form it might take in a changing world. Wetter, drier etc.



Claims and Frequencies



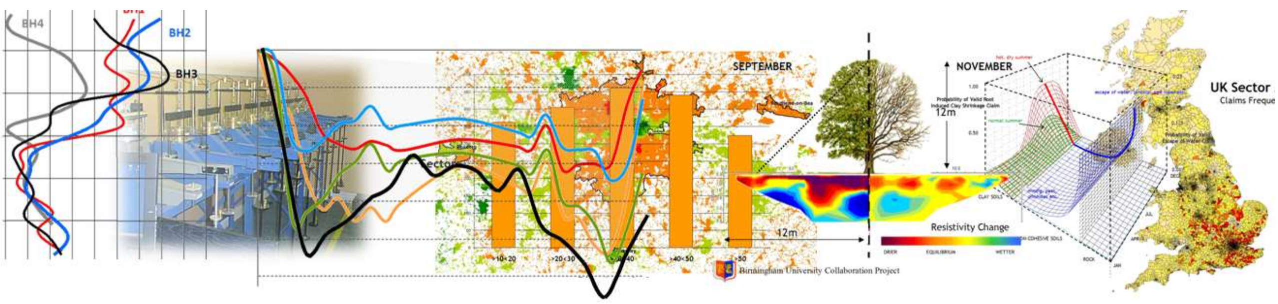
Left, mapping the data to understand spatial relationships has been central to developing an understanding of risk. The upper part of the map plots claims (yellow dots) superimposed onto the 250m geological grid showing the shrink/swell characteristics of underlying clay soil.

The lower section of the map shows the LiDAR image, plotting houses and trees by location, height and extent of canopy cover.

Addressing software is available to plot risk by individual property, or to locate houses where there has been damage. Or perhaps an assessment based on the probability model described earlier in this newsletter.

Bringing things up to date, the CRG are now using so-called Big Data to develop $\mathbf{A}_i$ systems to provide support to both claims handlers and engineers. Over the next three or four months the newsletter delves deeper into the algorithms behind the $\mathbf{A}_i$ system and includes a series of maps illustrating how risk varies across the UK.

Why are claims more likely to be accepted as valid in some locations and rates of declinatures so high elsewhere? If that is the case, how can systems help to improve service delivery and shorten claim lifecycles?

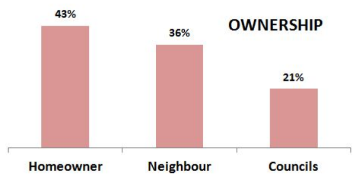


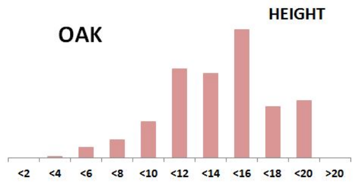
The Clay Research Group

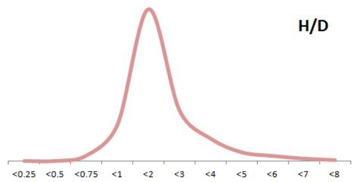
CRG REVIEW - 5

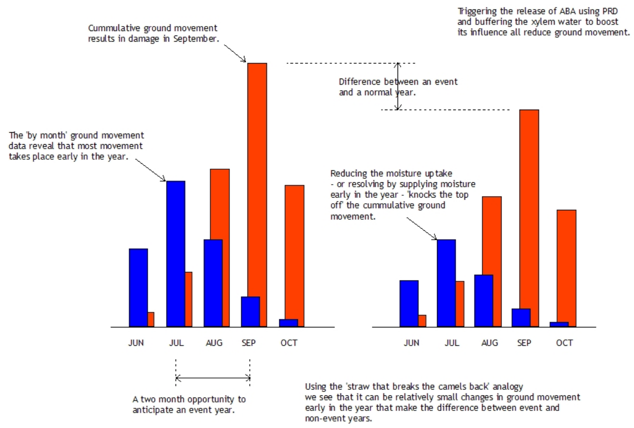
Analysis of over 40,000 records relating to the involvement of vegetation in clay shrinkage claims to reveal (a) ownership, (b) height and (c) H/D profiles, by species.

Possibly one of the largest samples analysed in relation to root induced clay shrinkage claims, improving our understanding and resulting in a 'rank order of risk' table for incorporation into an A_i system, all on a normalised scale.







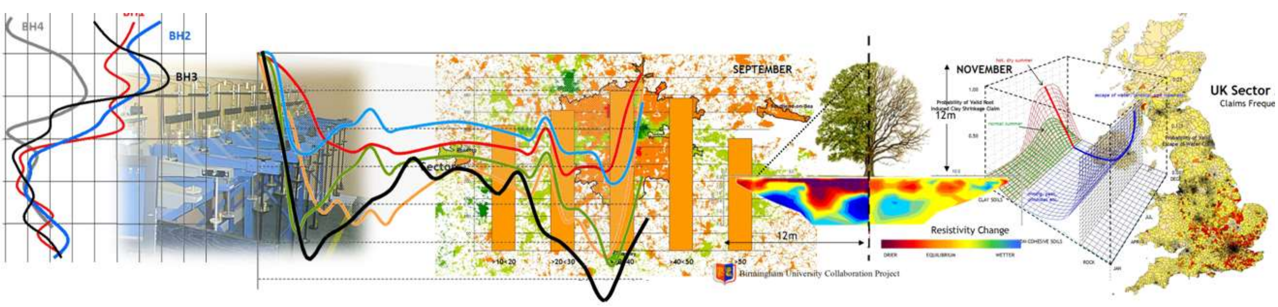


Development of the Intervention Technique to allow the retention of mature trees in cases where the soil composition and H/D ratio permit.

Using research from the field of plant physiology the objective has been to trigger the production of 'effective Abscisic Acid' – the drought response hormone – to reduce moisture uptake without damaging the tree. An environmentally friendly solution that removes the conflict between parties when trees are in Third Party ownership and speeds up claim resolution to a 'see and fix' situation, particularly relevant at times of surge.

Using SMD data, recent editions of the newsletter have explored how much rainwater is required to convert an event year into a normal claim year.

The technique has now been used on well over 100 claims successfully, some of which are being monitored to determine the long term performance. Claims where the Intervention Technique have been used typically involve mature oak trees.



The Clay Research Group

CRG REVIEW - 6

Early work on developing telemetry was undertaken around 2005 – 2006. Here (left) Richard Rollit and Jon Grey get to grips with the relationship between angles of rotation and vertical displacement. Understanding the benefit of tilt sensors and how they could transmit data from remote sites to a central server for automated analysis was an exciting period that was complemented by adding TDR moisture sensors at the site of the Aldenham oak.

Changes in moisture content and ground movement were recorded using buried devices, 24/7, whatever the weather and at a reasonable cost.

Over the years the CRG has introduced dedicated software for handling and modelling subsidence claims. The insurers' claims' departments now have a direct link to the field engineers. Both can share an electronic file and the claims handler can measure 'how many, of what sort, where, when and at what cost'.

Data gathering has been automated, along with the production of routine reports and correspondence.

Now we have an objective idea of the risk posed by trees by species and distance from damaged properties, together with a link to the shrink/swell properties of clay soils associated with changes in weather.

Our understanding of risk and distribution generally has improved. The knowledge base of the local surveyor/engineer, working in a particular location has been widened. We now have an idea of risk across the UK, at postcode sector and unit level.

Gathering and analysis of data has led to the development of a range of applications (see right) to interpret soils, monitoring and weather data and modelling of ground movement for a wide range of combinations taking into account vegetation.