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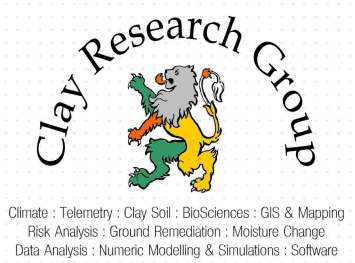
RESEARCH AREAS

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 137

October 2016

The Clay Research Group

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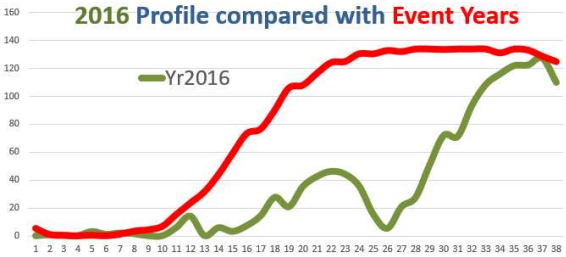
Edition 137, October, 2016

SMD Updater – Indian Summer?

SMD Data provided by the Met office for Tile 161, Medium Available Water Capacity with grass cover.



The Indian Summer came – and went. A brief spell of dry weather late in the year rarely delivers a significant increase in claims, perhaps due to plant physiology and the peak water uptake of trees. This year heavy intermittent rainfall quelled any suggestion of a late event.

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www.theclayresearchgroup.org
clayresearchgroup@gmail.com

"Analytics for Insurance"

by Tony Boobier

Congratulations to Tony Boobier on the publication of his excellent book, '**Analytics for Insurance : The Real Business of Big Data**'.

Published by Wiley and available for delivery from Amazon – see link below. The book provides a clear description of the use and benefits of Big Data and analysis by a leading figure in the world of domestic subsidence.

https://www.amazon.co.uk/Analytics-Insurance-Business-Wiley-Finance/dp/1119141079

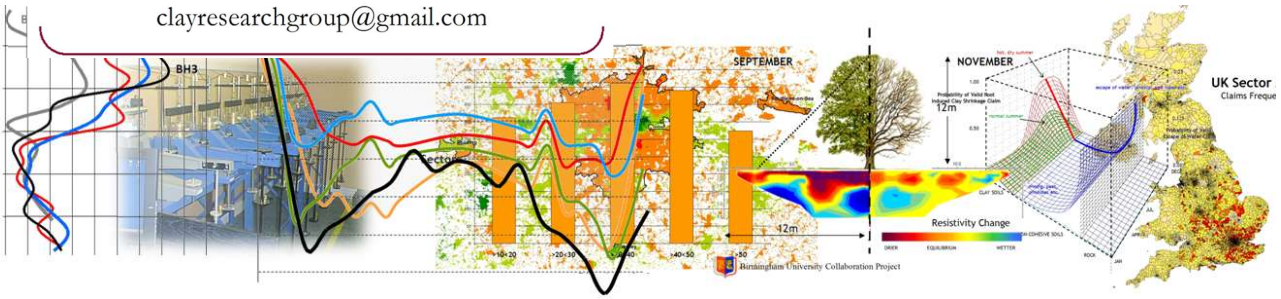
Subsidence Forum Training Day

The Subsidence Forum training day is to be held at the offices of the Building Research Establishment, Garston on the 20th October.

The program can be downloaded from their web site (www.subsforum.org.uk) or the CRG web site by selecting the 'newsletter' tab and then 'Subsidence Forum Training Day' document.

Contributions

Contributions and comments from readers are welcome. Examples of unusual claims or circumstances and perhaps analysis of data to improve our understanding of risk in terms of domestic subsidence. We also welcome comment from experts in our field relating to innovation and the adoption of technology.



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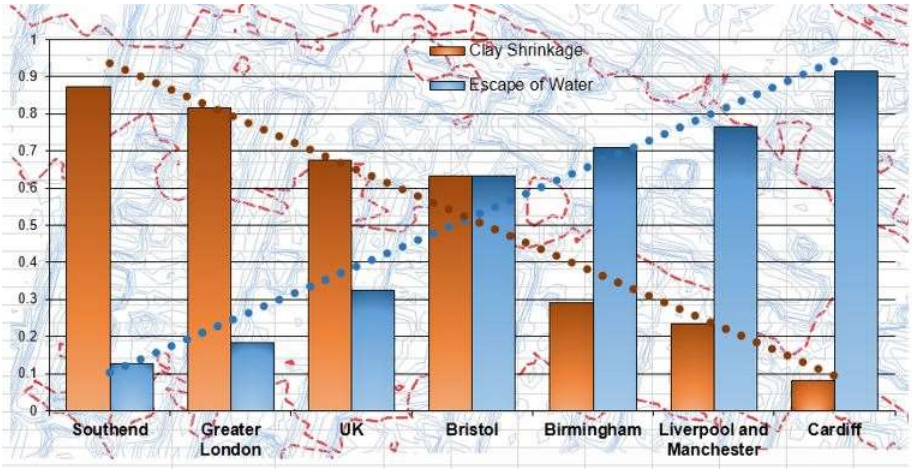
Peril by City – Valid Claims

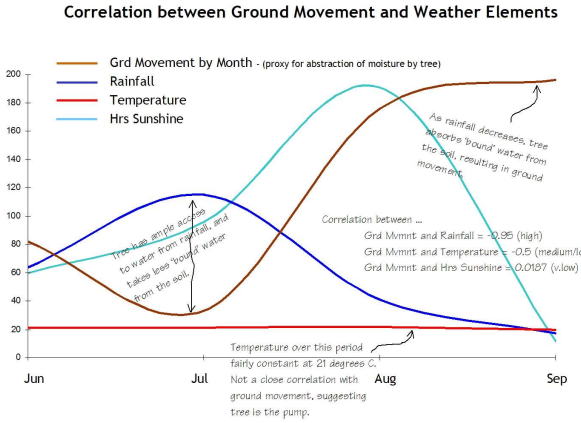
The graph below plots the distribution of valid claims by city, by peril – escape of water (blue) or clay shrinkage (brown) - expressed as a percentage of the total. The probability that a valid claim will be due to clay shrinkage is twice as likely as escape of water across the UK as a whole and four times greater than leaking drains in the London area. In Cardiff, the odds change and a valid claim is 9 times more likely to be due to leaking drains than clay shrinkage.



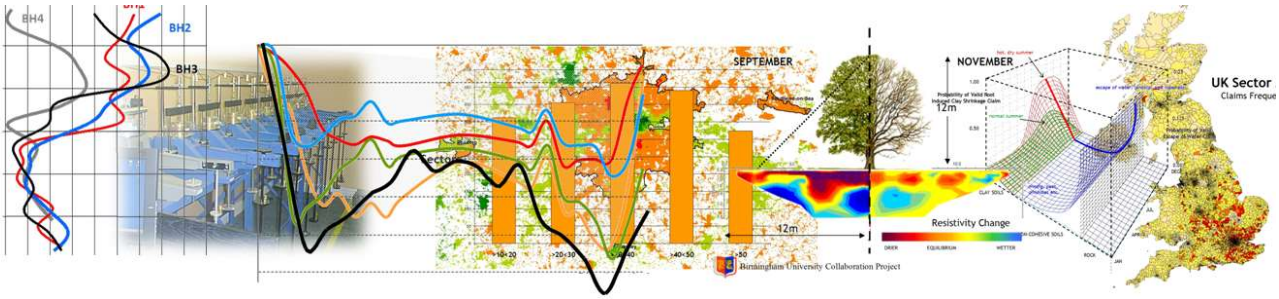
This is a 'by city' analysis and the distribution can be refined still further by taking account of the underlying geology.

What Drives Ground Movement?

Something we have discussed before, but an important element in understanding the link between weather and ground movement. Is it (ground movement) driven by temperature, hours of sunshine or rainfall?



Clearly all combine to play a part although rainfall (or absence of) is perhaps the most significant factor, delivering a correlation of 0.95 in our study. In contrast, the correlation between ground movement and temperature was 0.5 and hrs of sunshine, 0.0187.



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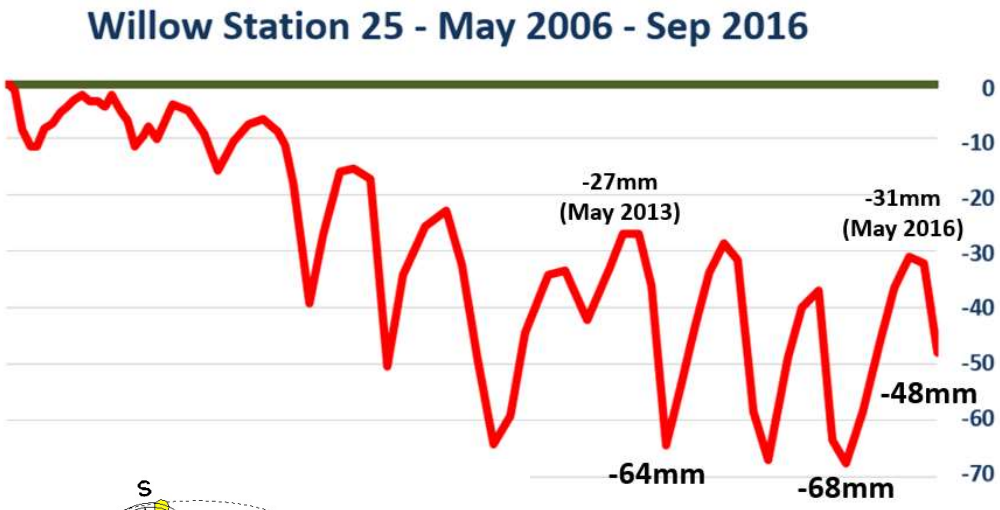
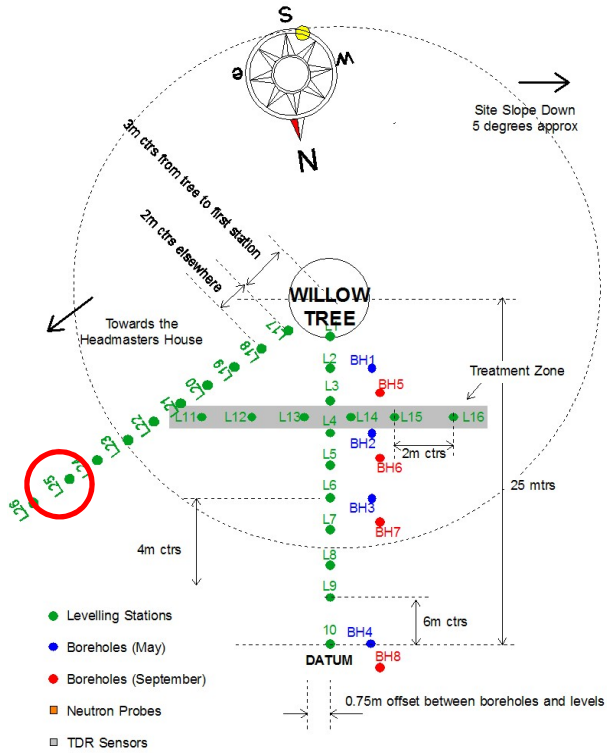
Aldenham Willow – Movement at Station 25 over 10 yrs.

Below, an updated graph showing ground movement at levelling Station 25 of the Aldenham willow, relative to the initial reading taken in May, 2006. There has been gradual subsidence overall, with a periodic signature still evident.

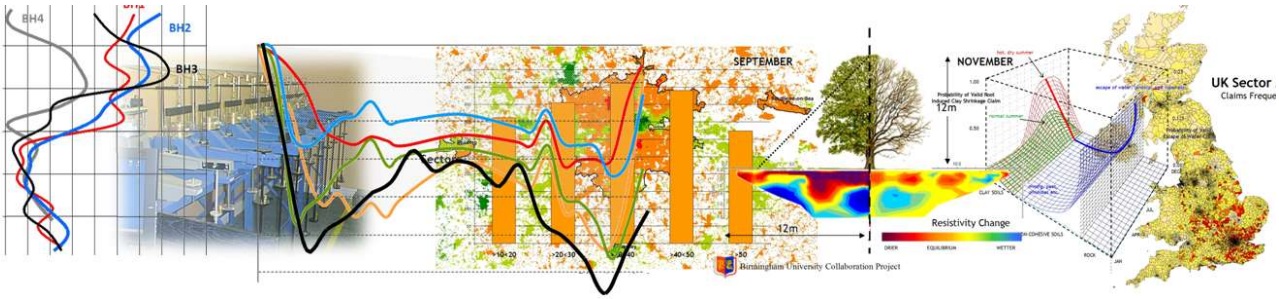




Station 25 has not recovered fully since May 2006. The figures show subsidence that has taken place around September of 2013, 2015 and 2016. Incomplete recovery over the winter months has left the station below its starting point each year. The two values for recovery recorded in the spring of 2013 and 2016 still show a negative value of around 30mm.

We might anticipate a slowing of seasonal movement over time as a deficit establishes itself (or an existing one increases), which could, we assume, result in water stress and deterioration in the health of the willow.

Left, the location of the levelling stations around the Aldenham willow with Station 25 circled in red



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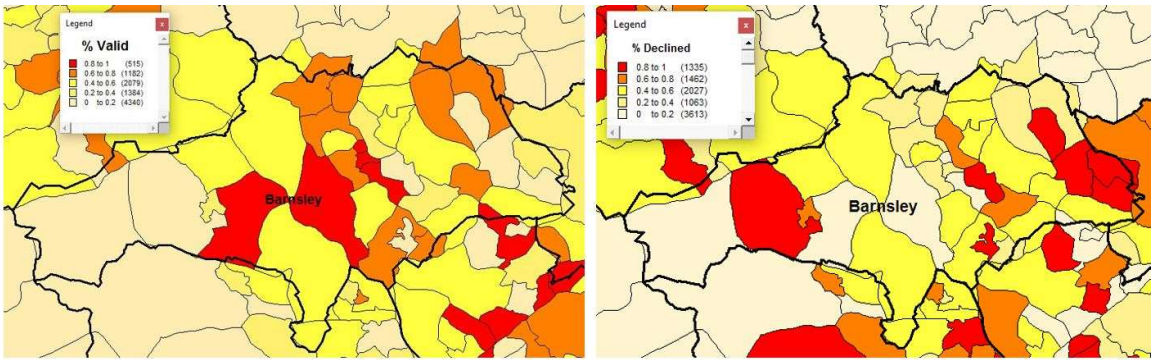
Valids and Declinatures by City

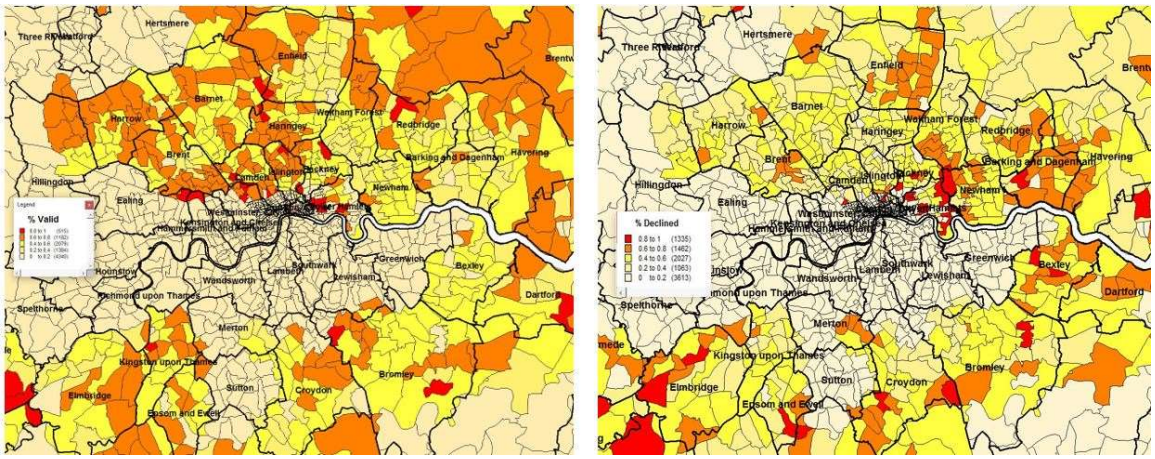
Below, (continued from previous editions) maps illustrating the postcode sectors (shaded red)where the number of valid claims, or declinatures, exceeds 80% for the records we hold.

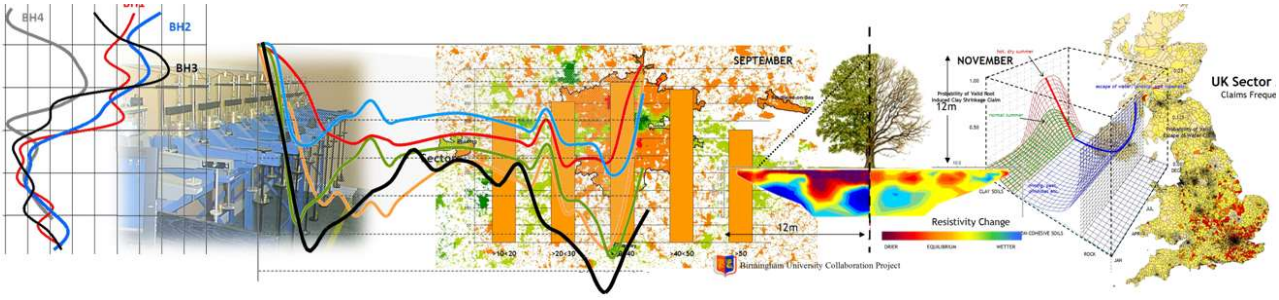
The analysis has been carried out using a sample of just over 60,000 claims, representing two 'normal' claim years – i.e., not surge. In both images, the map of valid claims is to the left, and declined to the right.

Barnsley



London





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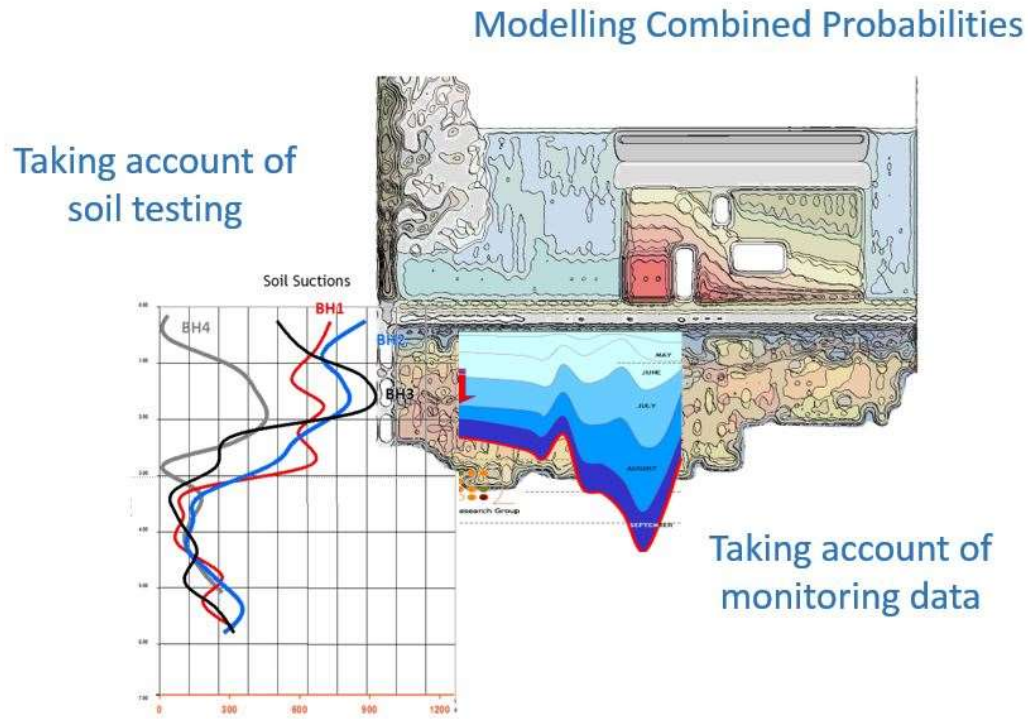
The Environment Assessment Module - Vegetation

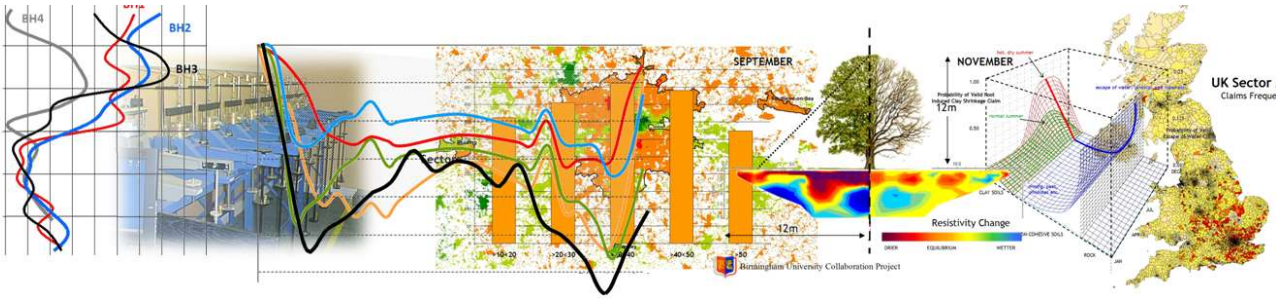
An **A*i*** system dealing with domestic subsidence claims needs to take account of the results of investigations. For example, monitoring and soil analysis. The profile of each is compared with a library of characteristic signatures (more on this in future editions) using correlation techniques to derive a normalised value on a scale 0 – 1.

For example, if the monitoring reveals a seasonal pattern with the building rising in the winter and subsiding in the summer, then it will have a high score – anything greater than 0.7 is usually regarded as significant, although this can be amended if the topic is hard to characterise – as we have tried to convey in the 'fuzzy' image below. Rules govern how this data is to be interpreted. For example, "if movement < 10mm, Then …Else", sort of logic.



Similarly, simple correlation analysis would identify whether a clay soil was desiccated or not, and when it is, similar rules apply. "if excess suction = 20kPa, then …". The system can detect high linear suctions resulting from poor calibration of filter papers, or the irregular pattern sometimes seen in the analysis of the Weald series.

In defined instances outliers would trigger a 'refer to engineer' instruction. Otherwise the outputs would be analysed using combined probability theory to confirm both cause and claim validity.



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First steps along the A_i Decision Tree- Part 2

Location Risk

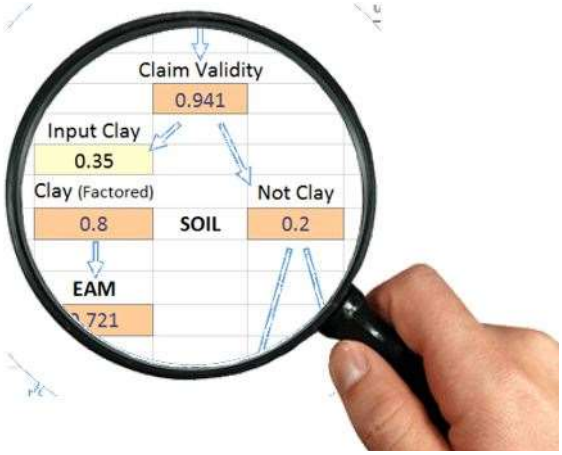
This element 'sets the scene', taking account of historic claims data at postcode sector level. See edition 136.

Data is auto-populated on entry of the postcode and delivers the risk in terms of claim numbers, percentage of valids and the current (at time of notification) weather value – perhaps the SMD or some algorithm taking account of rainfall.

Geology

This mode accounts for the enhanced risk posed by clay soils, taking account of the weather and vegetation.

The table of risk for soils appeared in Edition 136 (September) of the CRG newsletter. In this extract from the chart, the probability of a valid clay shrinkage claim is higher when vegetation is nearby.

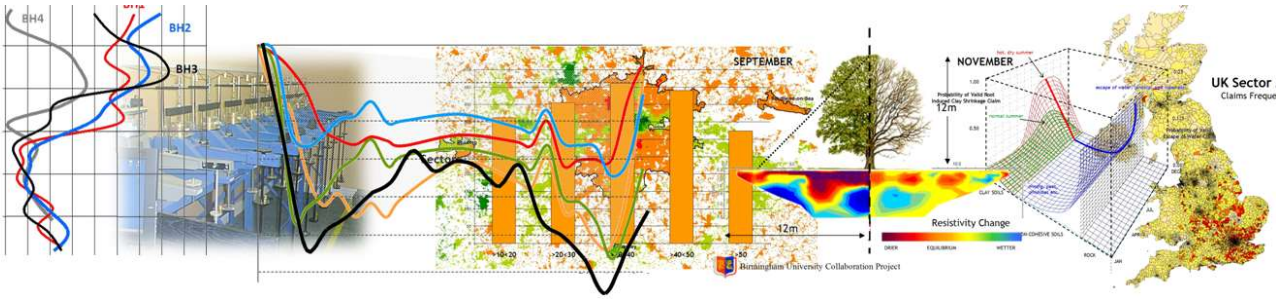


Vegetation

This is an important element, with vegetation accounting for over 70% of valid claims in some sectors.

The approach ranks all trees by species, and then by height and distance, all on a normalised scale of 0 – 1.

Further work is required, taking account of maintenance, environment and age.



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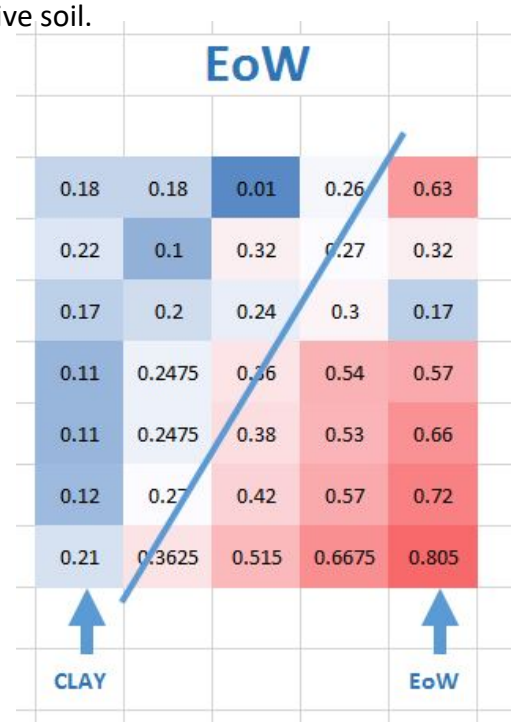
Heat Maps and Pattern Recognition

Returning to the theme of pattern matching and the benefits of being able to 'recognise Walt', introduced in edition 130 (March 2016) of the newsletter, below we assess the practical application for claims handling. For our purposes, we want the system to be able to recognise a valid claim when it 'sees' one, and match the peril.

The two examples illustrate how that can be achieved. Left, high scores to the bottom left-hand corner of the heat map indicate a valid claim, more likely to be root induced clay shrinkage than any other peril.

Below, a different outcome. Concentration of high scores to the bottom right of the map are indicative of an excess of water in a non-cohesive soil.

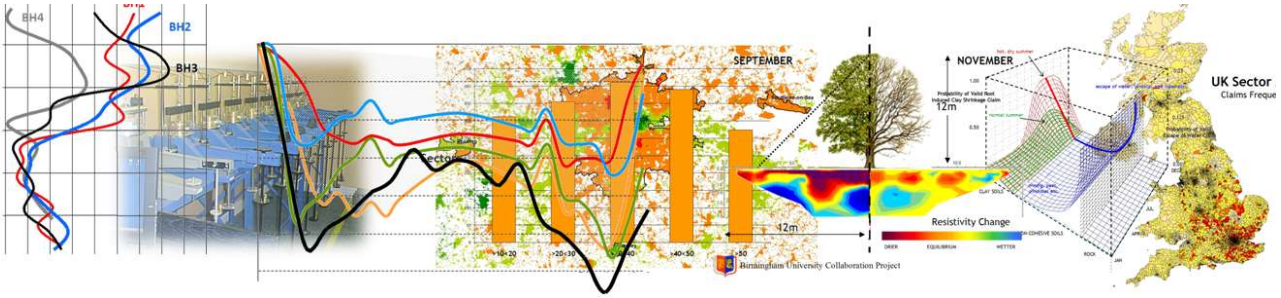


The outcomes are pattern matched against a library of heat maps and the correlation used to determine liability.

Each individual square relates to a specific aspect of the claim. Tree metrics, soil values, time of year, weather etc.

Most important, an assessment of crack damage.

Not all things are clear-cut and that is the case whether we are on site, or sitting at our desk undertaking a review. This is where a Bayesian approach adds value. Certainty can be elusive, and where the operator isn't sure (and that includes the homeowner), estimates are fine. Instead of "the crack looks fresh, but I can't be sure" could translate to entering '0.58' or '0.31' etc., in response to the query. The power lies in the combination, with some elements weighted.



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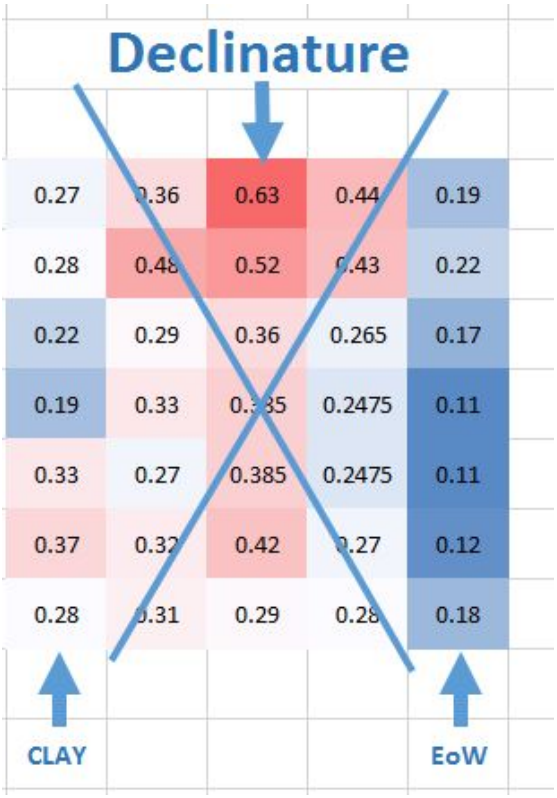
Heat Maps and Pattern Recognition

The largest area of complexity is distinguishing between valid claims and declinatures, rather than identifying the peril.

The heat map, right, shows higher scores to the top centre and these will capture claims on clay soils in wet years, perhaps with no vegetation nearby and the most likely explanation of damage would be historic movement, shrinkage etc., as shown on the graph below.

From a practical point of view, the claims are the ones most likely to require an inspection. Informing the homeowner that they have a valid claim and builders have been instructed to attend next week to carry out repairs is one thing.

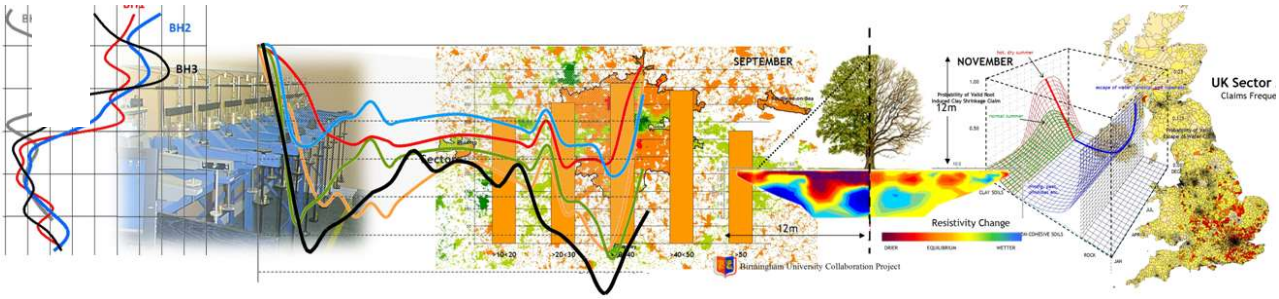
Declining a claim from the desk-top is far more likely to generate a complaint.



Photographs of the damage provided by the technologically adept homeowner and detailed discussions along with free access to the decision making process via the web based application might resolve some concerns, but is equally likely to generate others. For example, would a declinature harm the prospects for a potential house sale? How can insurers and their agents protect homeowners in such circumstances?

Probably only 1 in 5 claims is determined to be valid in the winter months. This (identifying and resolving declinatures) is an area of concern and one requiring further study.

Again, data can help to understand why claims in an area with a certain age of house (1950s for example) and non-cohesive soil (sands and gravels) can generate so many valid Escape of Water claims due to the age of the pipework and problematic soil.



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Vapour Pressure Deficit and Relative Humidity

Novick, K., et al **The increasing importance of atmospheric demand for ecosystem water and carbon fluxes**. Nature Climate Change, 2016

Research at Indiana University suggests that relative humidity has a greater effect on drought stress than soil drying. Whereas soil drying means there is less water available to the plant, atmospheric drying actively extracts moisture.

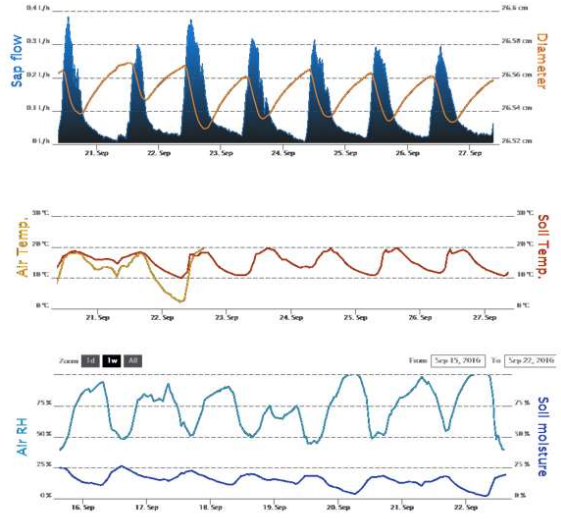
Humidity is rated as a more significant influencing factor on plant health than soil moisture.

Tree Physiology – A Detailed Study

https://treewatch.net/thunen-institute-forest-ecosystems/

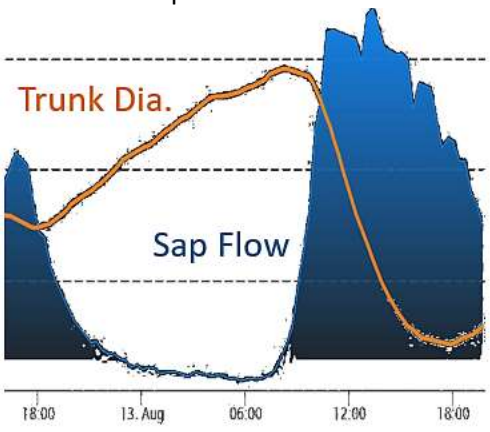
Thanks to Dr. Jon Heuch for alerting us to the above web site. The researchers at the Laboratory of Plant Ecology, Ghent University, Belgium, have been measuring diurnal changes in sap flow, trunk diameter and soil moisture in relation to the relative humidity, soil and air temperature over time to deliver some fascinating graphs.

Below, an extract from the site showing some of the available information. Users can view data over time by the use of slide bars. For example, on the 13th August, an increase in trunk diameter of 0.51mm was associated with a change in sap flow of 0.72ltrs/hr.



Jon noted that the fluctuation in soil moisture of 20% was perhaps more than we would anticipate diurnally although soil type wasn't identified.

It is also interesting to see the trunk diameter increasing between cessation and commencement of sap flow – see below.



Sap flow and trunk diameter fluctuations over a 24-hour period.

Is this a function of temperature (unlikely given that it commences in the evening of the preceding day) or perhaps cell turgor? Could it be linked with some form of water pressure regulation, increasing a pressure difference within the xylem to draw water upwards?

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Pressure Sensing Film

Wang, G *et al.,* "Application of Film-Like Sensors for K_0 and Pore Water Pressure Measurement in Clay During 1D Consolidation," *Geotechnical Testing Journal*.

Wang and his fellow researchers examine the FlexiForce sensor, "which is thin and flexible, was used to measure K_0 and the excess pore water pressure during a 1D consolidation test on kaolinite clay samples."

Effects of Planting Density on Tree Growth and Induced Soil Suction

C. W. W. Ng, J. J. Ni, A. K. Leung, C. Zhou, Z. J. Wang
Geotechnique.
Published online : August 9, 2016

The commonly held view is that groups of trees do not increase soil suction by way of competition. Rather, the soil suctions are limited by the capacity of the tree to extract moisture.

This paper explores the influence on soil suctions of groups of trees in silty sand (not clay), and the effect on their development. It is unlikely to be a reflection of mature trees on clay soils in the UK. The abstract from the Geotechnique web site is a little confusing in terms of recorded tree spacing (60mm 180mm) but the objective of the study is to "quantify any changes in tree growth and tree-induced suction during evapotranspiration and rainfall under different planting densities for non-mixed-species."

The abstract goes on to say "A tree species, Schefflera heptaphylla, which is commonly found in Asia, was planted in silty sand at spacings of 60, 120 and 180 mm, representing three different planting densities. For each case, three replicates were tested to consider tree variability. In total, the responses of suction for 297 seedlings subjected to drying and a rainfall event with a 10-year return period were measured.

The test results show that reducing the tree spacing from 180 to 60 mm induced greater tree–tree competition for water, as indicated by a 364% increase in peak suction upon evapotranspiration.

Such tree–tree interaction led to: (a) a 19–35% reduction in the leaf area index; (b) a 17–36% decrease in root length; and (c) an obvious decay of roots. Upon the rainfall event, the infiltration rate for vegetated soil with trees planted at a spacing of 60 mm was up to 247% higher than those for soil with a wider tree spacing, where mainly fresh roots were found. Although most suction within the root zone (i.e. top 100 mm) was lost due to increased infiltration at 60 mm spacing, suctions in deeper depths below root zone were largely preserved."