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 134

July 2016

The Clay Research Group

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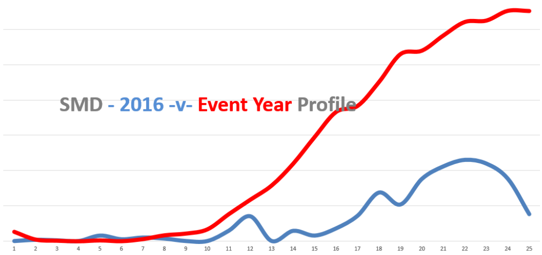
Edition 134, July, 2016

SMD – little risk of surge year



SMD comparing surge profile with 2016 using data from MORECS 40 x 40km grid square 161, Medium AWAC, grass cover. Met Office suggest June was the wettest for many parts of the country since records began in 1910.

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Avoiding Events Years

This month we review SMD data 'in reverse' to see how much moisture is needed to reduce the risk of event years. By using the event year SMD as a baseline, comparison with normal claim years tells an interesting story.

Geological Risk

On page 2 the geological risk by series is compared with exposure. Peat might be the riskiest of soils, but how many houses does it support? If peat presents the highest risk, which geological series is the safest?

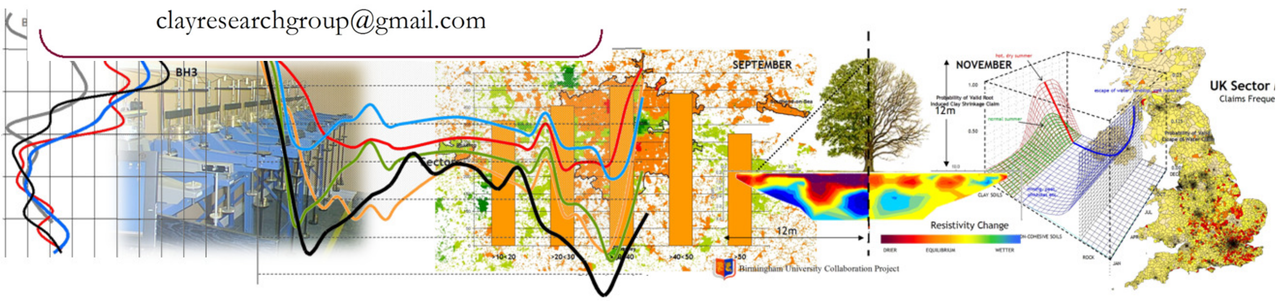
Artificial Intelligence

In June, the Harvard Business Review explained "Digital, mobile and AI Technologies are affecting growth, scale, and profit potential for companies in every industry. So the question isn't whether your organization needs to change, but when and how much."

We continue our rather fragmented analysis by looking at the learning module. How does the system identify robust data and how does it update itself when change is required? Introducing the sigmoid function.

Climate Change

Exposure resulting from a warming world may not be as we feared. It's getting warmer and yet domestic subsidence claims are falling.



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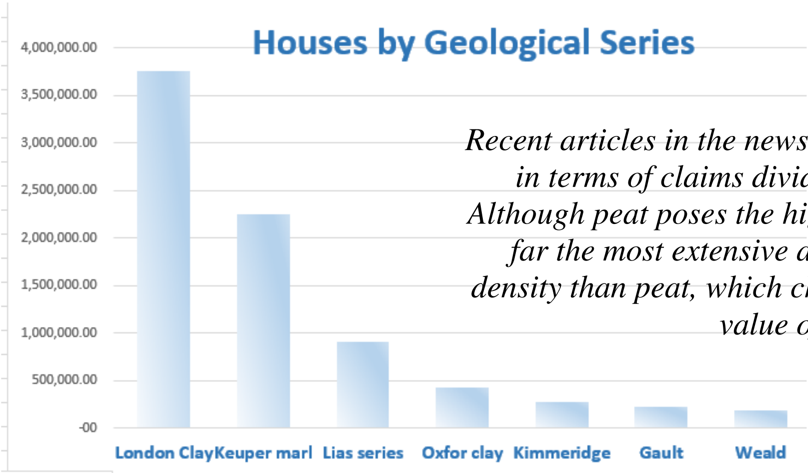
Geological Risk Reconciled

In the last edition we published a table of risk relating to the geology based on claims frequency by series. The sample used for analysis covers five years, including one event year. This reflects the risk over the average term of a household policy.

Having a score is one thing, but account needs to be taken of distribution and variance across the UK. London clay might be risky, but how much of the UK does it cover and how many houses have it beneath their foundations?

The risk table doesn't reflect this adequately. Where does the 5% of total premium spend that subsidence accounts for go? If London clay has a rating of 0.79 on our table, but claim costs of settling these is 20% higher than their alternative (escape of water), how is this accounted for?

How do we apply the risk table and account for the unequal distribution across the UK? If the average UK premium is 'x', some areas of London are much riskier. At the top of the scale high risk areas could attract an increase of ten times the national average.



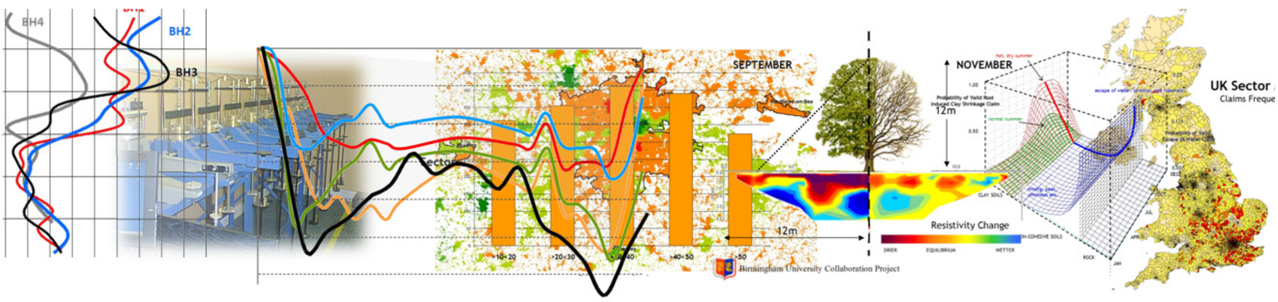
Recent articles in the newsletter have explored the risk in terms of claims divided by geological series. Although peat poses the highest risk London clay is by far the most extensive and has a higher housing density than peat, which changes the risk and severity value of losses.

A risk rating of 0.79 (see edition 132) is interesting, but does that cover 5% of the country, or 80%?

London clay has by far the greatest exposure. It is riskier in terms of claims/houses, but it also accounts for a larger percentage of claims than any other series – by a long way.

Pity the poor underwriter. Worrying about distribution by geology, risk by year and all variable by month. Not to mention the Sum Insured as a function of rebuilding cost.

The 5% of the premium spent on subsidence is an average. We need to be looking at total spend / distribution by series taking into account exposure. The table provides the tool to achieve this.



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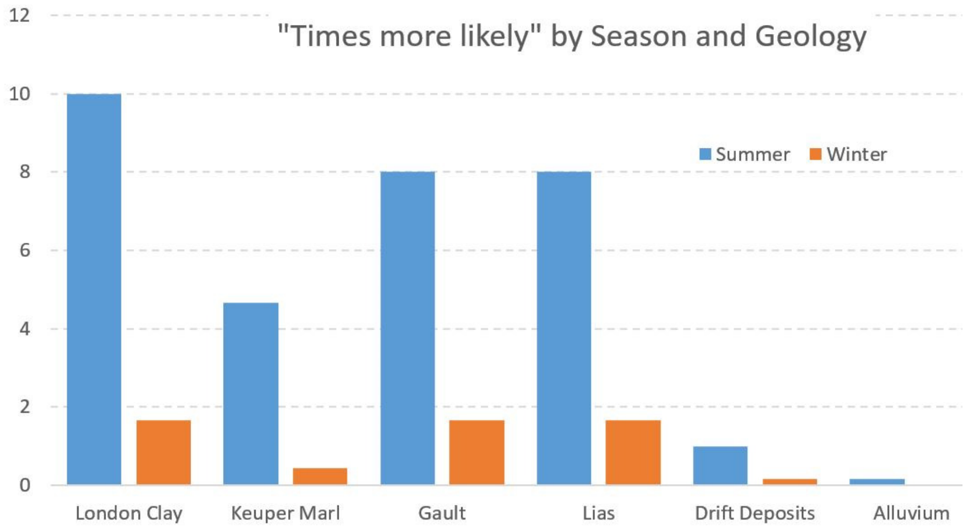
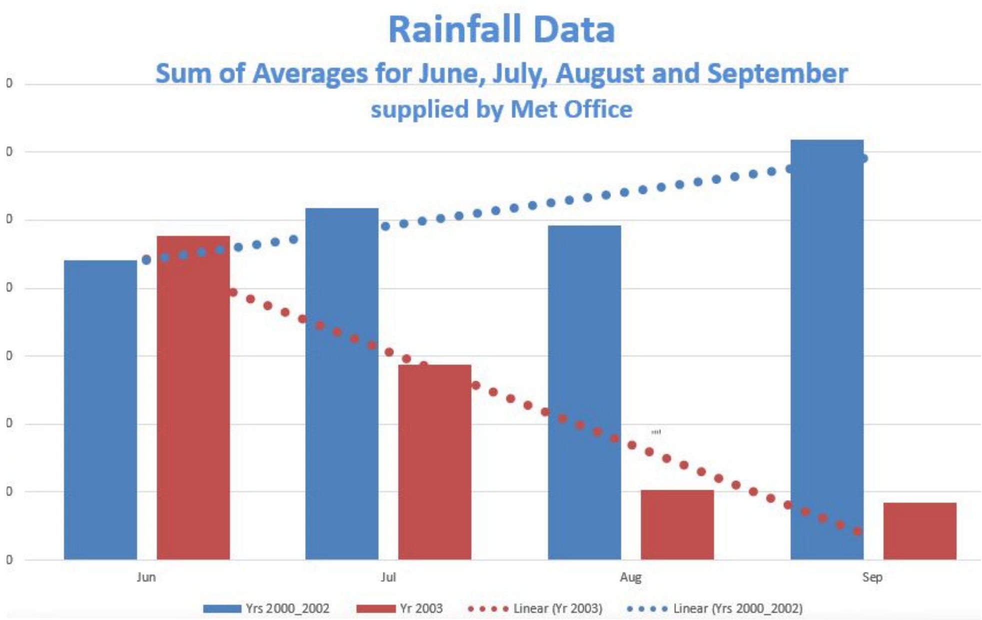
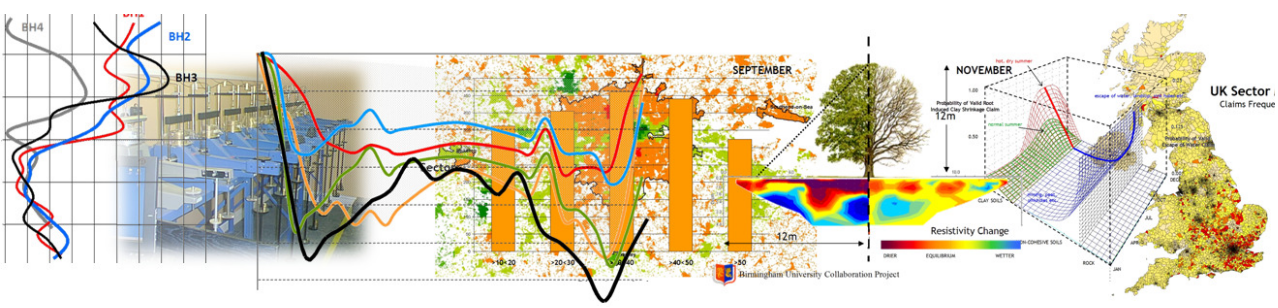
From the Archive

Sorting through pictures and graphs collected over the last 10 years has revealed some interesting snapshots. Over the next few months one page of each newsletter will be devoted to printing these hopefully self-explanatory images, starting below…







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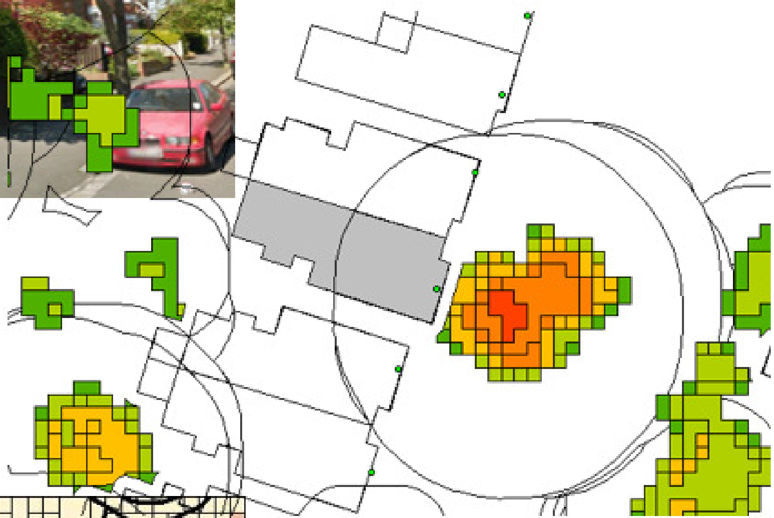
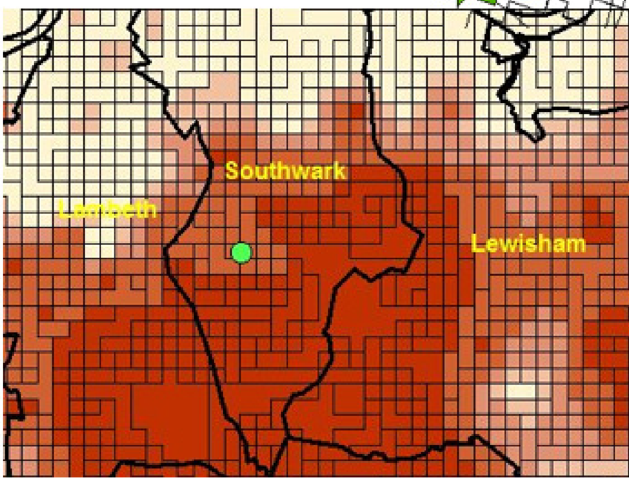
Intervention Technique - Update

Here is an example of a claim where the Intervention Technique was installed in the summer of 2013. The property has been precise level monitored to determine its performance. As can be seen from the Street View image, left, two tall trees (the cause of the original movement) have been retained.

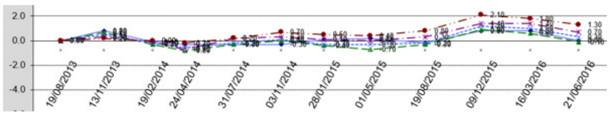


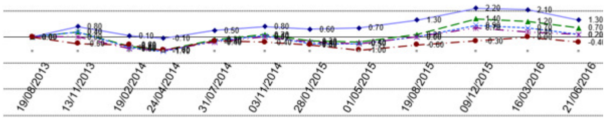
Right, a LiDAR plot of the property and trees. Below, an extract from our 250m tiled geology built from data obtained from site investigations.

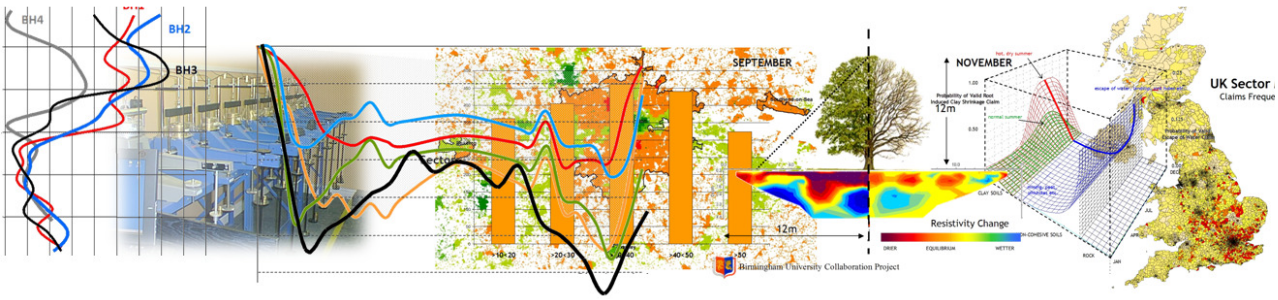


Below, graphs of movement from the date of treatment, commencing in August, 2013.

Minor differential movement, not exceeding 2.5mm between stations, recorded in the zone of tree root influence. The exercise has been carried out over a period of higher than average rainfall.







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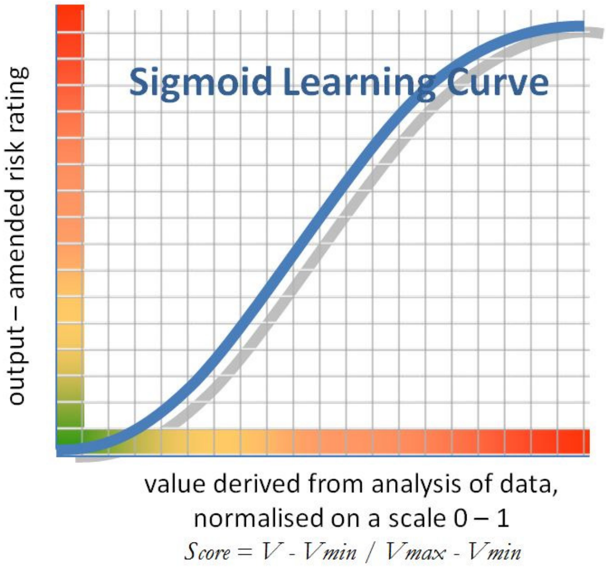
Artificial Intelligence – The Learning Module

The sigmoid learning curve is the means by which our system takes account of its experience and adjusts its understanding of the world.

Imagine plugging this into a claims database where no analysis had been undertaken. Initially, its values for all vegetation (for example) might be set at 0 (vegetation doesn't pose a risk), or 1 (all vegetation poses a risk).

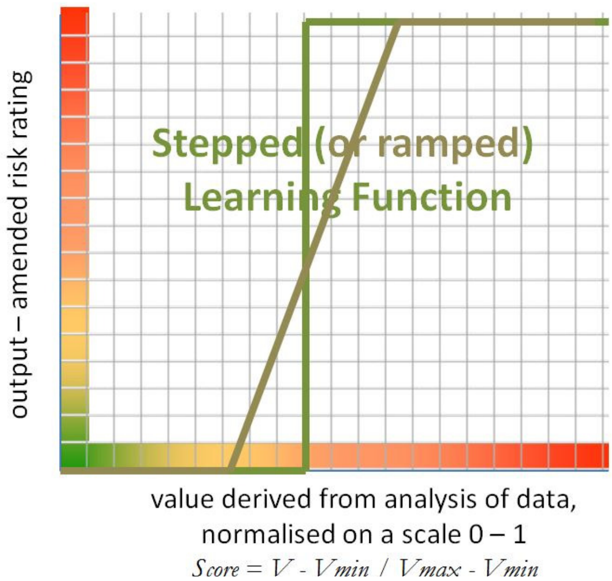
Over time and by analysing the database its ratings would change.

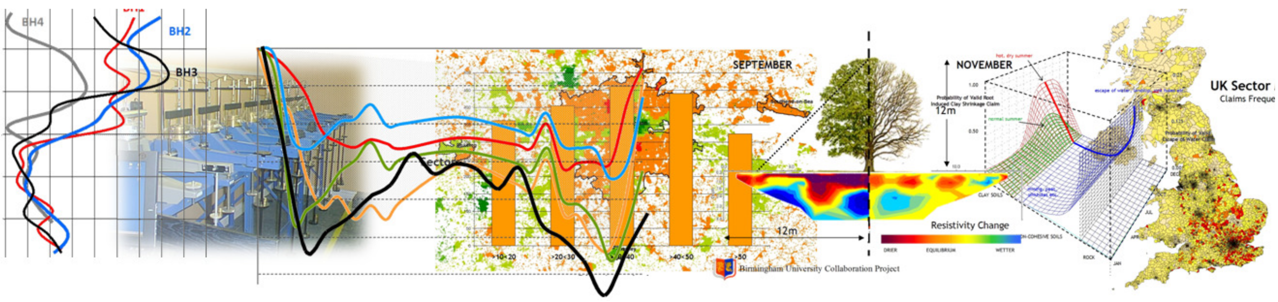


The nature of the sigmoid curve delivers small changes initially, but as the data in support of the need for change increases, then the speed of change (the slope of the line) increases.

The rate at which change takes place can be adjusted, as shown on the graph, left. It could be instant (the vertical line) or much slower initially, increasing as the need arises.

Every element can have an individually tailored function.





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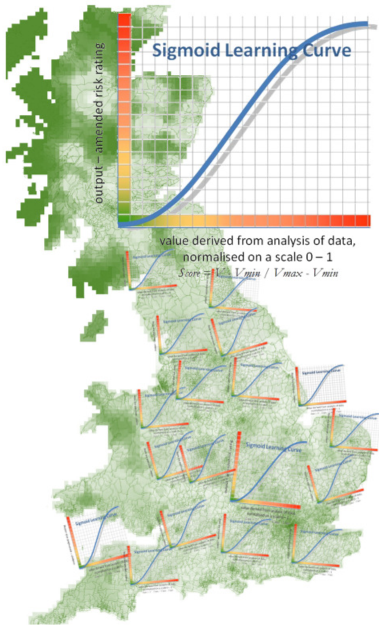
As an example, how does the curve cater for surge years? Does it suggest a rate increase every time we see an increase in claim numbers, with rates adjusted downward immediately following a normal year?

Is the curve uniform across the country? If not, what influences change?



In fact, there are several thousand referrals to sigmoid curves in our system covering various locations and elements. There may be little need for change in areas of the country on granite, but significant differences year by year on clay soils.

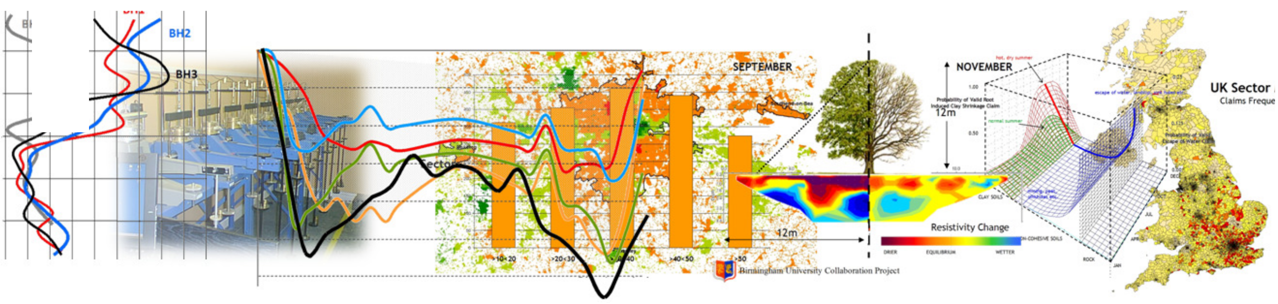
The lower risk categories remain fairly constant (apart perhaps from landslip and chalk which will show an increase in risk with wetter weather) but the shrinkable clay series are particularly sensitive to dry weather.

Using the 0 – 1 rating as representing a 1 in 5 surge situation, 'normal' years would be adjusted down to 0 – 0.5, reflecting fewer claims and lower settled costs using ABI data for the spend on subsidence as a percentage of total claim spend on all perils. This is dealt with in detail in the forthcoming September issue, newsletter 136.

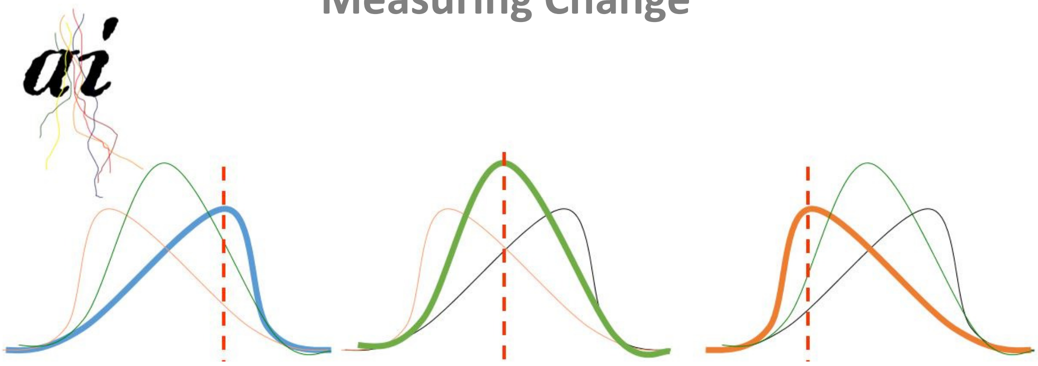
The system may appear cumbersome, requiring learning modules for every element and every sector as shown in the schematic above. In fact, there need only be one central processing code through which each element passes continually for review.

In terms of subsidence the dynamic functions include weather – taking account of current and projected SMD – and the resulting influence, specific to clay soils and vegetation, determined using combined probability analysis.

Risk factors for weather would be changed to cater for the current month and year.



Measuring Change



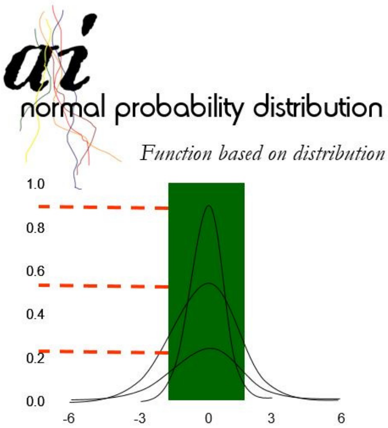
Starting Value
(High Risk)

Learning Cycle

Final Value
(Low Risk)

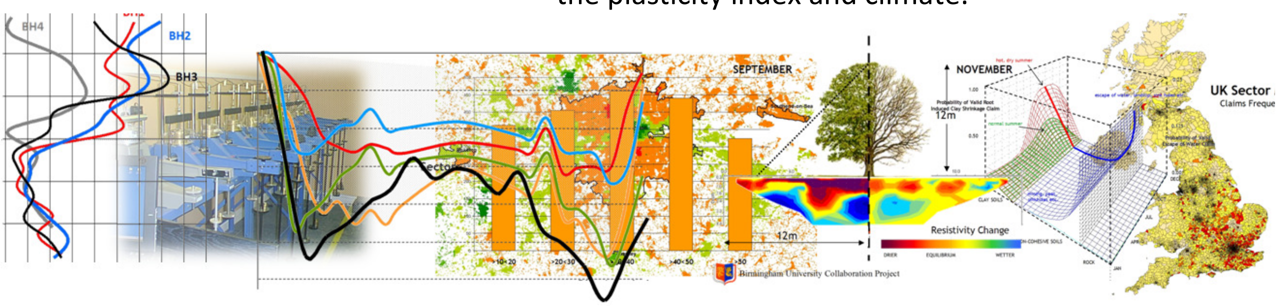
The system detects changes in values by using distributions as shown above. Left (blue), a plot of the system's view of the world as it might be when initially set up. Over time, that view may change. Centre, an intermediate view possibly reflecting an event year or some other change in one or more of the datasets – or perhaps more data has been added. Right (orange), a modified view over time plotting a change in the risk value, taking into account the longer return interval of surge associated with the wetter weather for example.

Distribution Analysis



The learning module uses distribution analysis to detect change and calculate revised probabilities as described above and resolve the strength of the signal, left. The system knows if the particular piece of evidence is weak or strong, and can assign a value if required.

For example, climate change may deliver increased temperature averages but account needs to be taken of rainfall. Risk changes over time but also the signal within a risk is variable – see left. For example, London clay may present a high risk on our geological table but that risk varies within the series as a function of the plasticity index and climate.



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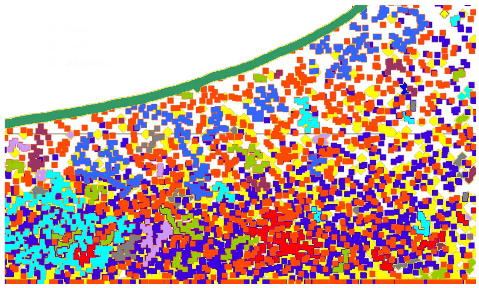
Implementation of the Learning Modules

Our approach uses a 1 in 5 frequency for event years and is conservative – that is, it would produce higher premiums than are needed to reflect the current risk. The frequency now might be around 1 : 10 bearing in mind the last event year was 2006.

Subsidence is a relatively small percentage of insurers' spend, accounting for around 4 – 5% in a normal year according to data published by the ABI. Small tweaks in the subsidence account are unlikely to influence premiums significantly.

However, an insurer using an AI system isn't going to restrict it to handling the subsidence peril alone. Below, an example of an 'all perils' graph. Getting the learning module(s) right is therefore essential.

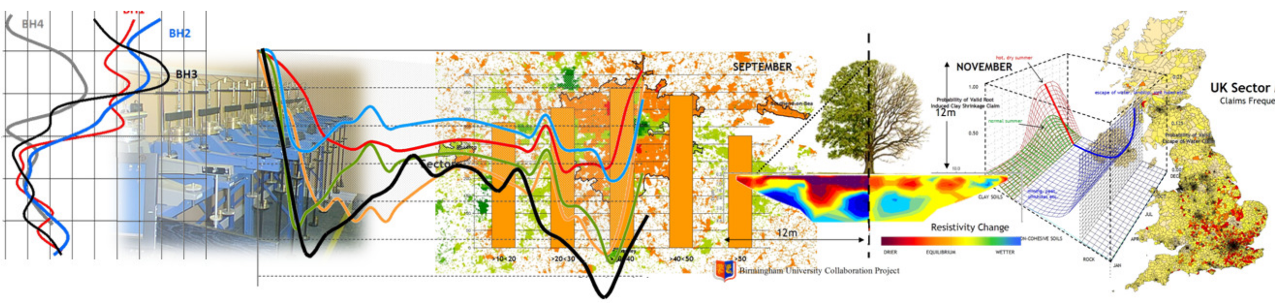
First, account needs to be taken of the portfolio. An insurer with a predominantly NW bias will have a different view of the UK to one with a SE bias. Analysis of the insurers' individual and unique claims history is therefore a starting point.



What factors are likely to change? Which elements will the learning curve influence/control? For the subsidence peril, the geological risk is prime but each element in the risk table is unique. For example, rock is a low risk peril and remains so whatever the weather. In contrast, sandy soils suffer in wet years and clay soils in dry years. Increases in rainfall could result in changes to how we view non-cohesive soils perhaps.

Event years are driven by clay soils and their risk changes literally by the month. This means that the underlying risk table has to be dynamic. In surge years, London clay might be 0.81 on our risk scale, and in normal years that reduces to 0.56, with gradations within that series dependent upon the PI.

The learning curves are designed to take account of this. Data from every postcode sector is referred to a learning module that 'understands' its response to change. Sigmoid, ramped or inclined linear scale modules handle differing needs.



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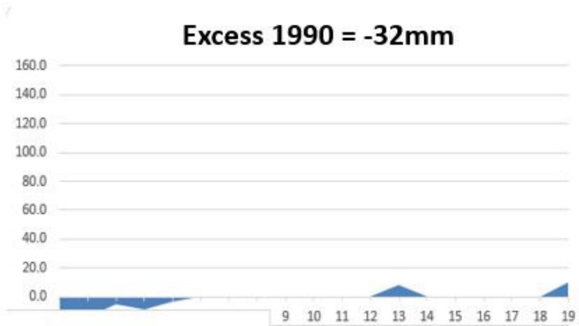
Using SMD Data in a Different Way

We refer to SMD data from tile 161 in the SE of the UK, for Medium Available Water Capacity soil with grass cover. This provides background climate data taking into account rainfall, hours of sunshine, temperature and wind speed etc.

The maximum value for this specification is a deficit of 134mm and is achieved in busy event years, characterised by 1990 and 2003.

The question arises, how much rainfall would be needed to avoid an event year? If the base line is 134mm, what value below that (i.e. how much water would be needed) to reduce the risk?

For example, would 20mm of rainfall 'save the day'? Or would we need 200mm? How much watering would be needed using some form of irrigation technique – or the Intervention technique – to provide a safeguard?



As a starting point, and to validate that SMD has a role in creating busy years, 2003 has been compared with 1990. Both years had around 55,000 subsidence claims notified.

The term "excess" refers to the amount of moisture in excess of that recorded in 2003, and the plot (bottom, left) shows there was little to distinguish between 2003 and 1990.

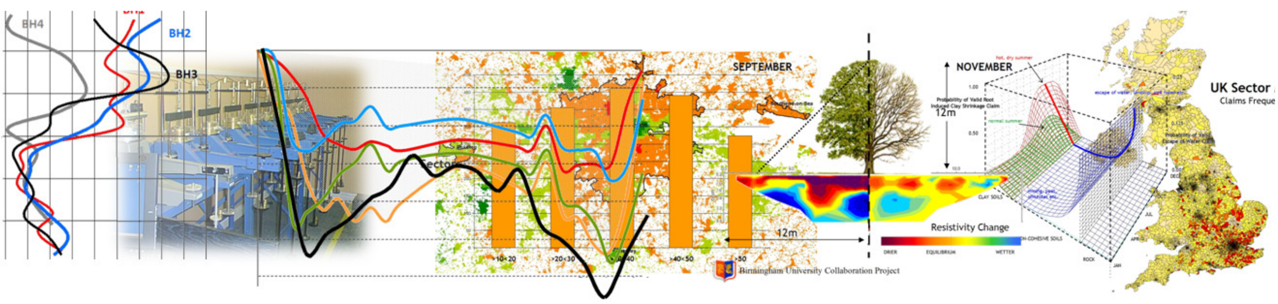
In fact, in 1990 there was a nett deficit of 32mm. In other words, 1990 was drier than 2003 by a small amount. 32mm of rainfall would have been needed to match 2003.

Both years were very close in terms of claim numbers and soil moisture deficit and on the following page we look at a variety of 'normal' claim years to determine the amount of water needed to avoid, or reduce the risk of, surge.

How much water is needed over a four-month term to reduce the risk of an event year? Is it 20mm, 200mm – or more?

Data for week 25 through to 40 (inclusive) has been used to reflect the summer months and avoid confusing the model with autumn or winter rainfall.

This period captures the months when trees come into leaf to the peak for claim notifications – May to September.



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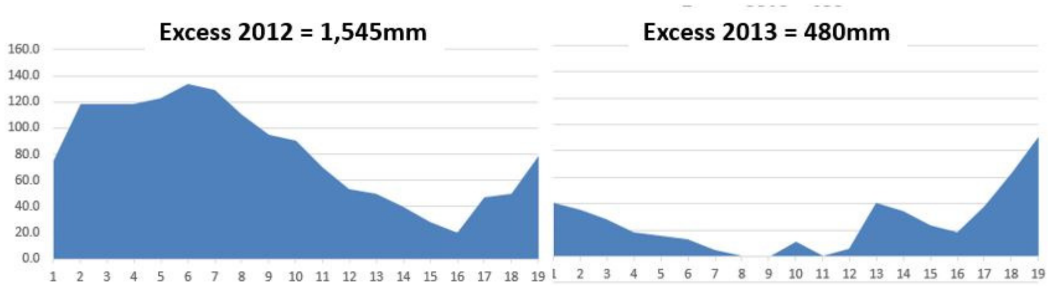
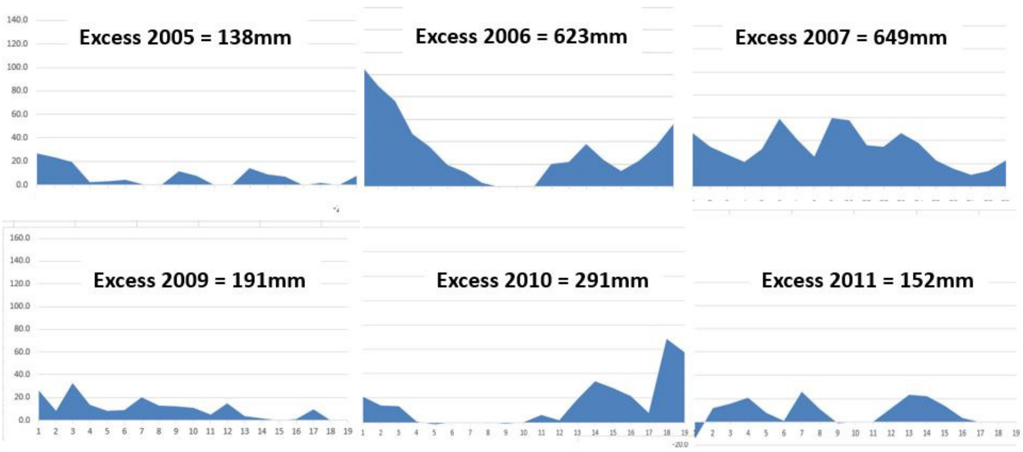
Below, a selection from other, mainly ‘normal’, claim years. 2012 was particularly wet with an excess in the period of 1,545mm. In 2013 there was a slightly smaller excess reaching 480mm, but sufficient to keep claim numbers at a normal level. Now we have some idea of how much rainfall is required to avoid high claim numbers.

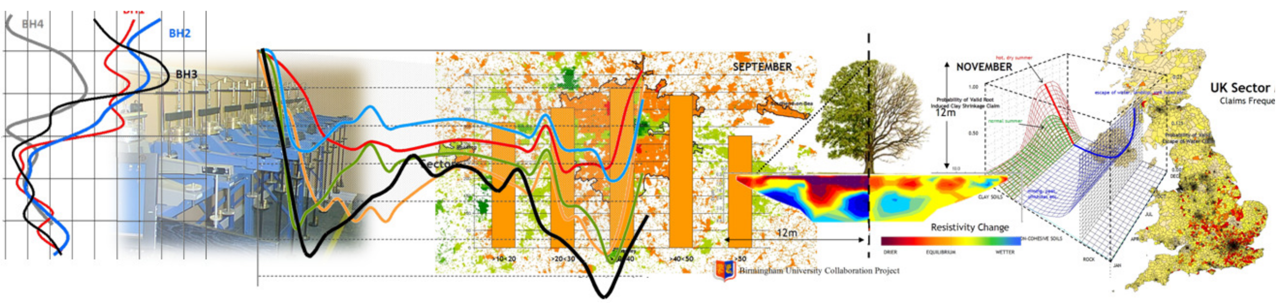


Or, how much water we might need to supply by alternative means. This information is useful in respect of approaches like the Intervention Technique storage chambers or irrigation. How much water do we have to add to the ground, in the influencing distance of tree roots, to reduce the likelihood of damage occurring to a nearby structure?

Below, other unexceptional years with a record of excess moisture and it can be seen that 2005, 2009 and 2011 less than 200mm moisture over the 15-week term was needed to avoid an event year. The ‘saw tooth’ profile of these years – regular, intermittent rainfall of fairly low order – appears beneficial. Around 13mm a week on average, or 50mm a month.



From an analysis of the above charts it can be seen that around 200mm of water added to the soil in the vicinity of tree roots should reduce the risk of subsidence. Regular but small amounts of rainfall are clearly beneficial.



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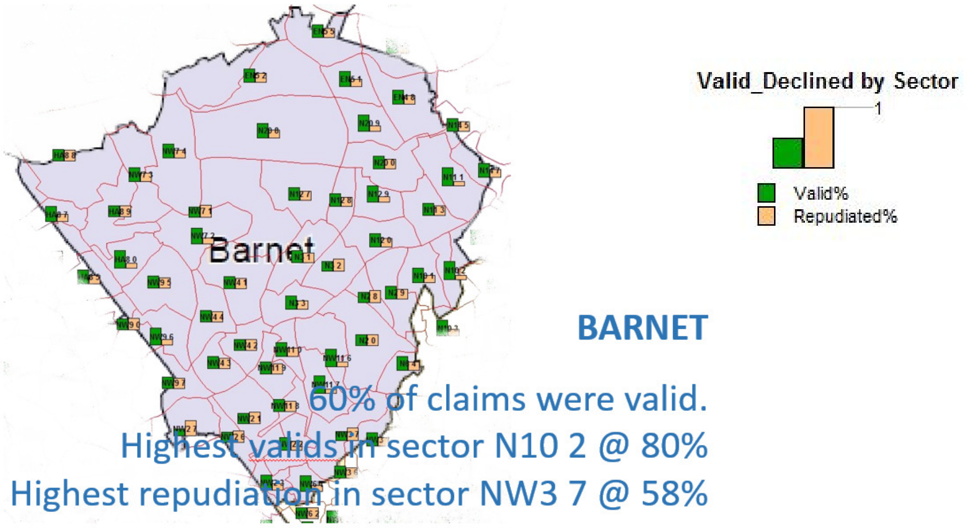
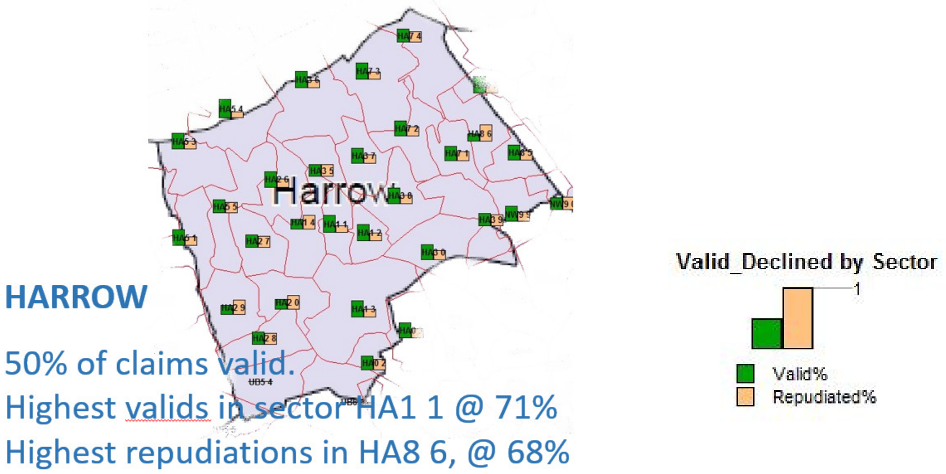
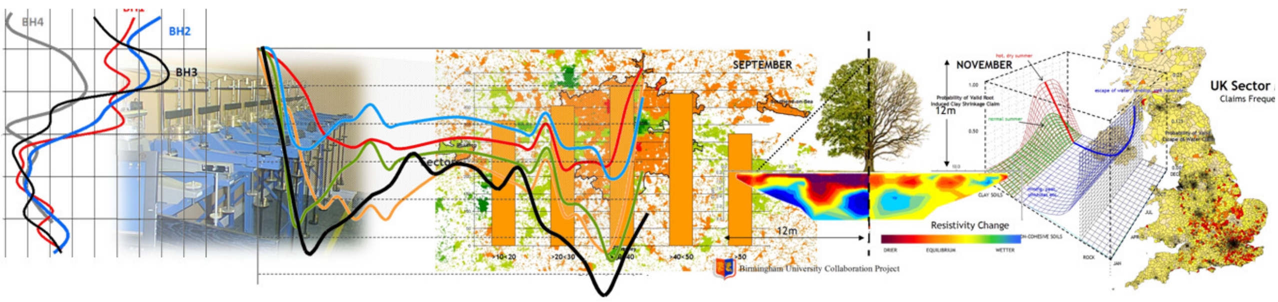
Valid -v- Declined by District and Sector

An analysis of just over 60,000 claims (equivalent to two 'normal' years) reveals the following. Across the UK, 2,844 sectors had no claim records. 49% of claims were valid and 51% were declined. There is considerable variation between sectors.



These maps form part of a series to be published over coming months examining districts across the UK, commencing with north London. Around 60% of claims were valid from our sample in Barnet (above) and 50% from the Harrow sample. The highest and lowest risk sectors are also identified.





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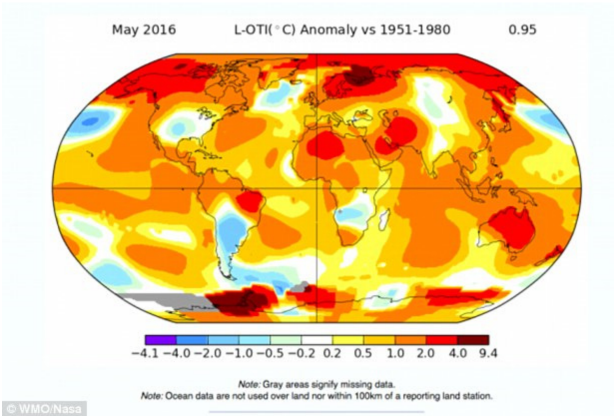
NASA UPDATE - A WARMING WORLD

The first four months of 2016 were the warmest globally in 136 years. The World Meteorological Organization said the data reveal 370 straight months of warm or warmer-than-average temperatures with the Northern Hemisphere seeing the largest increase.



The U.N. weather agency reports this as evidence of a 'fundamental change' in the global climate. In recent times we have seen both continued warming, and unusually high rainfall in parts of the US and Europe.

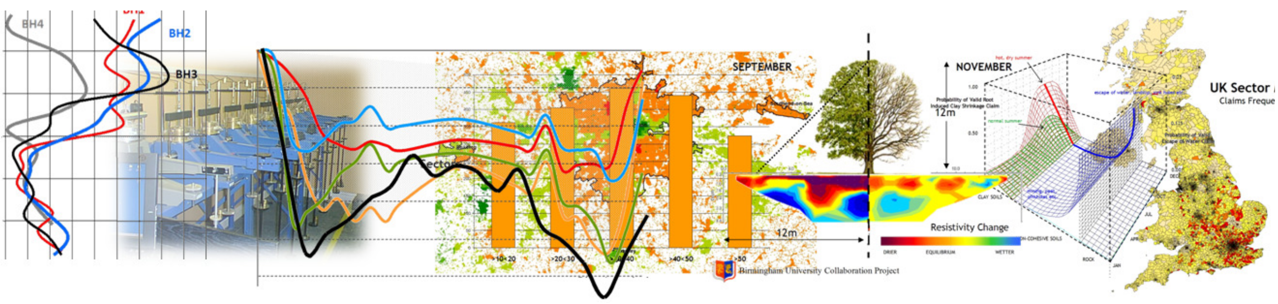
NASA records show that this May was the hottest on record, and the Northern Hemisphere spring has been the hottest spring ever.

Worst hit according to NASA were the Arctic, Finland (the Finnish Meteorological Institute reports that the average May temperature was between three and five degrees warmer than usual in most regions) and Alaska. Apparently, the Greenland ice sheet started to melt unusually early.

The all-time record for the average temperature in May was broken at about 20 observation stations.

May's exceptional warmth was accompanied by extreme weather events including abnormally heavy rains throughout Europe and the southern United States. In late May, France witnessed exceptional rainfall and flooding.

Dr. John Christy, director of the Earth System Science Centre at The University of Alabama in Huntsville explained that "while there is a clear warming signal in the satellite temperature data, caution should be used when trying to extrapolate long-term conclusions about climate change based on months and years whose temperatures are obvious outliers driven by El Niño warming events".



10th Anniversary of the CRG at the Aldenham Site

Aldenham has become one of the leading research centres into domestic subsidence in the UK, exploring alternative methods of investigating and treating root induced clay shrinkage and bringing together experts from a wide range of disciplines including geotechnical, plant physiologists, telemetry specialists and monitoring experts.

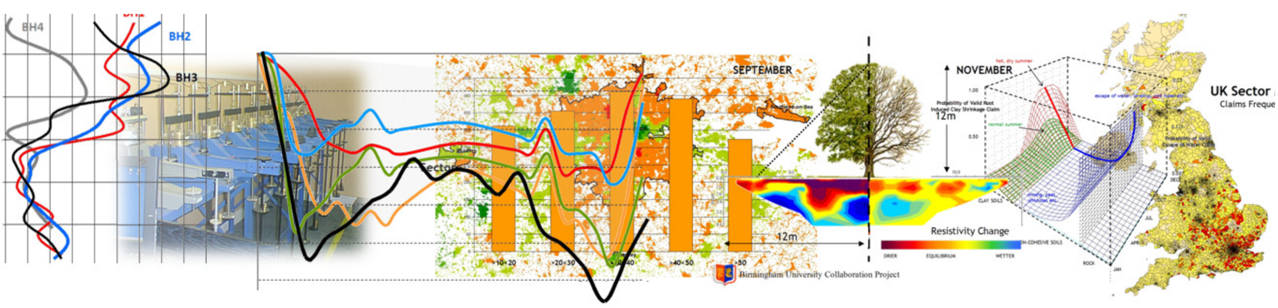
The first site investigations and soil tests were undertaken in March 2006. Precise level readings followed in May and the first Neutron Probe readings were taken in August of the same year. There has been a great deal of activity since and on the following pages we list the various threads running through the work of the CRG and colleagues at the research site.

Little would have been achieved without access to the Aldenham site in north London. This has been a focal point with excellent facilities, security, geology and vegetation where such work could be undertaken over a long term. The forward thinking staff at Aldenham School have provided support over the ten-year term and allowed access to the sites of the willow and oak.

We tend not to name individuals to avoid commercial pressures and avoid the group becoming a 'sales banner' for any specific company or group. That said, we have to recognise the role of Robert Sharpe for his support both in his time at Crawford and now at Subsidence Management Services. Paul Stanley has pushed the boundaries in just about every direction over the years and continues to do so. He has provided support at every stage, part funding Glenda Jackson's PhD and purchasing LiDAR imagery back in 2006 before it became recognised as having value in the field of tree management. Not to mention putting rotating cameras onto cars 10 years ago and his current venture into robotics and remote assessment.

Much interest and great benefit has accompanied work undertaken by our academic associates from the various universities listed on the following pages but also the leadership of the BRE (Richard Driscoll, Mike Crilly and Tim Freeman) and our colleagues, Tony Boobier (IBM) and Dr. Giles Biddle for support and encouragement.

Clive Bennett from MatLab Limited funded the cost of site investigations and soil testing over several years, as well as establishing the ground monitoring stations. John Peterson from Foundation Piling has made a significant financial contribution to the work undertaken by Tom Clinton at Aldenham. The major funding body is Subsidence Management Services. Cyril Nazareth (now at HBOS) has acted as liaison for the term of the project and we have received help from Crawford & Co., towards the cost of precise level monitoring and Paul Thompson who met the cost of setting up the weather station.



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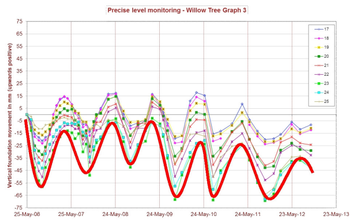
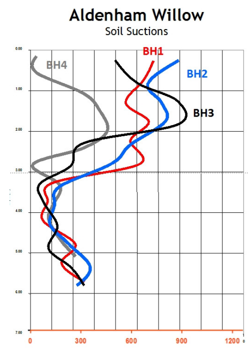
10 yrs at Aldenham. What has been achieved?



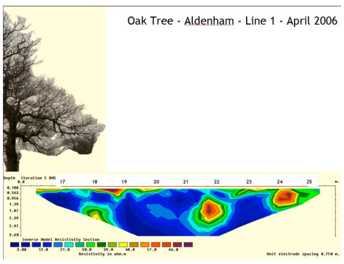
It's 10 years since the first precise level readings were taken at Aldenham. Possibly the longest term monitoring of the interaction between tree roots and ground movement. The precursor was of course the work of the BRE at Chattenden, Kent, under the direction of Richard Driscoll, Mike Crilly and Tim Freeman.

In addition, and courtesy of MatLab Limited, a series of investigations were undertaken using a wide range of soils tests. How did the oedometer test, using disturbed samples, compare with results using suctions, penetrometer and moisture/index property comparisons?



How close were the estimates of swell with actual recorded movements? What changes were recorded over time and between seasons?

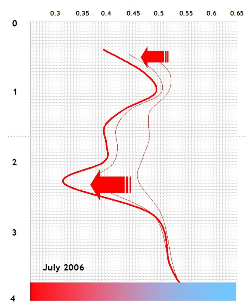
Over the 10 year term we have had the benefit of being joined by a number of academics. Two PhDs have been awarded based on investigations undertaken at the site. Birmingham, Keele and Southampton Universities have all played leading roles in researching new solutions.



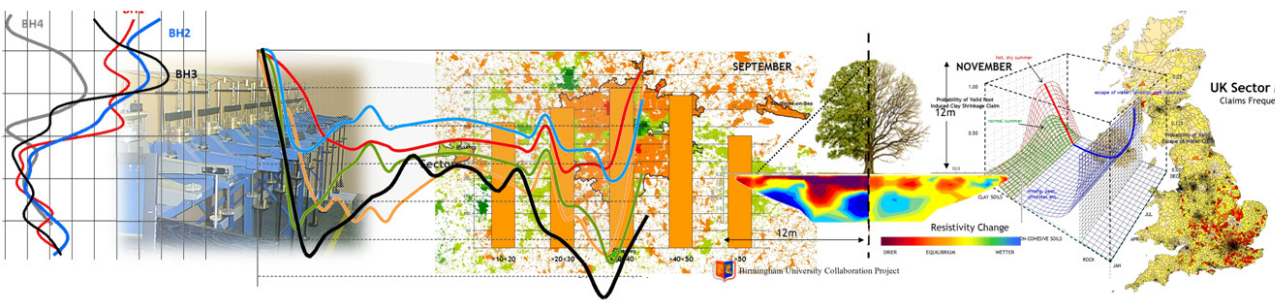
Dr. Nigel Cassidy from Keele and his successful PhD student, Glenda Jones, explored the use of electrical resistivity tomography (ERT) to image moisture change beneath the oak and willow trees at Aldenham.

This work was a development of our earlier introduction to ERT by Dr. Ron Barker from Birmingham University.

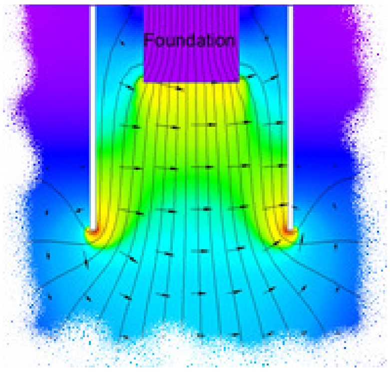
Professor William Powrie, Dr. Derek Clark and Dr. Joel Smethurst obtained definitive plots of moisture uptake throughout the year by season at the site of the oak tree, confirming the depth of peak root activity, enabling the production of a moving image of how the moisture deficit develops and re-charges.



Using the neutron probe they were able to measure accurately moisture change over time and quantify it at a molecular level.

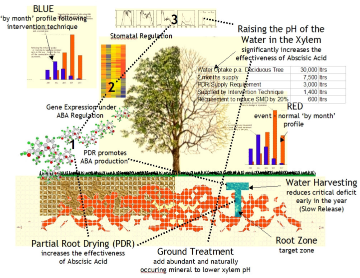


The Clay Research Group



The most recent work on site was undertaken by a team from Birmingham University headed up by Professor Ian Jefferson studying moisture movement below ground in clay soil using electro-kinesis osmosis (EKO). The study was carried out by Tom Clinton towards his PhD and involved setting up a test station in the rear garden of the headmaster's house at Aldenham. Concrete pad bases were set into the ground prior to applying the EKO treatment and the results (change in moisture content) were measured by Dr. Cassidy from Keele using ERT.

Furthering our understanding of plant physiology has been a theme over the years and eventually manifested itself in the development of the Intervention technique. Partial Root Drying (or in our case, Partial Root Watering) triggers the production and effectiveness of the naturally occurring hormone, abscisic acid (ABA). Applying this has allowed the retention of trees on a number of claims, some of which are being long-term monitored to determine its efficacy.



Sharing the output with the industry has been one of the leading objectives. One of the early meetings at Aldenham, with colleagues from Mott McDonald, Richard Rollit, Prof. Chris Rogers (Birmingham University), Gary Strong from the R.I.C.S., Glenda Jones PhD., Robert Sharpe, Cyril Nazareth, John Peterson (Foundation Piling) and Neil Curling from HBOS.

Right, a meeting with some of the London Tree Officers attended by Allan Tew, Ian Brett-Pitt, Richard Rollit, Jim Smith, Peter Osborne, Jake Tibbett, Andy Tipping, Kishan de Silva and Cyril Nazareth.

Just some of the visitors to the research site over the last 10 years.