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 140

January 2017

The Clay Research Group

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Edition 140, January, 2017

Big Data – the backlash

Several articles in the technical press recently about issues with data driven applications. The monthly journal of Engineering and Technology headlines "how flawed analytics leads to false conclusions and poor decisions". They quote Jim Adler of the Toyota Research Institute as saying "in the vacuum of no decision, any decision is attractive".

It's a major consideration when building A_i applications. The end-user needs to understand the underlying rules to use efficiently. More to follow.

THE CLAY RESEARCH GROUP
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2016 – on reflection

Warmer, wetter, sums it up. One of the warmest years on record, with intermittent rainfall sufficient to supress claim numbers.

See quotation from Met Office web site on page 13.

Fewer claims overall, which is good news for homeowners and insurers, but it does put pressure on suppliers.

THE SUBSIDENCE FORUM

DISSERTATION INITIATIVE 2016

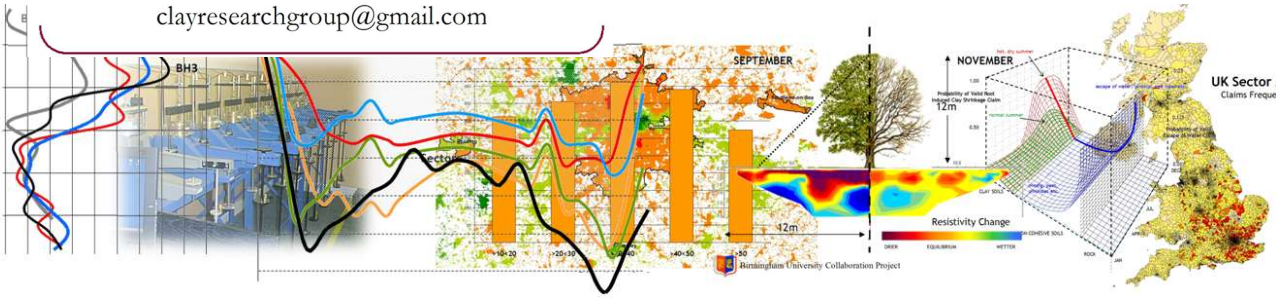
The Subsidence Forum announced the Dissertation Initiative with a view to encouraging research into subsidence.

The winner of the £500 award went to Robert Orr from Portsmouth University for his submission: "Investigation into the surface settlement caused through tunnelling: with focus on the Crossrail Project in Bond Street."

"Highly commended" went to Harry Gordon (also from Portsmouth University) for his submission "An analysis of ground stability in the vicinity of gas storage salt caverns at Edfe's Hole House Farm, Cheshire, UK."

The Forum plan to offer the award again in 2017, inviting Universities from all over the Country to submit projects.

http://www.subsidenceforum.org.uk/



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Recognition and Thanks

Our thanks to Aldenham School for allowing us the continued use of the research facility and for welcoming teams from Birmingham, Keele and Southampton Universities to undertake novel research into the measurement of root induced moisture change in the vicinity of the oak and willow tree.

The work has contributed towards the success of two PhD students and delivered knowledge that has been useful to subsidence practitioners across all specialist interest groups. The research has formed the subject of several published papers.

Numerous experts have shared their knowledge and expertise over the years, including contributions to the newsletter from Richard Driscoll, Peter Osborne, Tony Boobier, Richard Rollit, Tim Freeman and others. Alerts on current topics of interest are regularly provided by Dr. Jon Heuch and Keiron Hart.

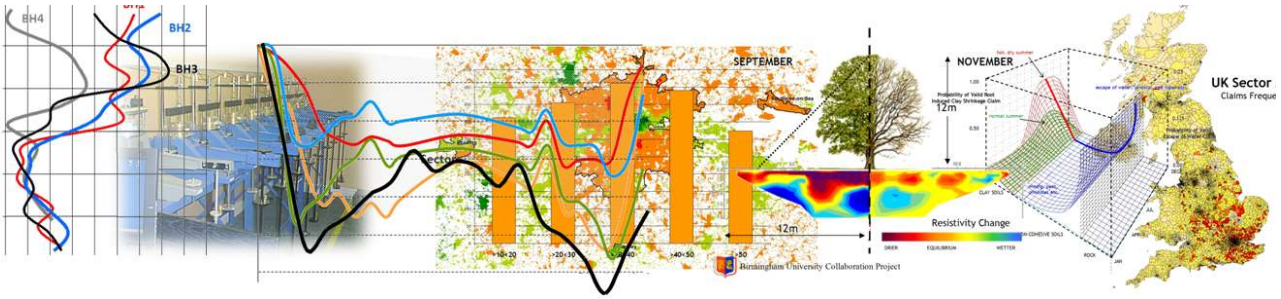
The annual subsidence conference held at Aston University has provided a platform for speakers to share their expertise, although the number is too great to list them all. The conference has on average five or six speakers and has been a regular feature for the last 12 years or so.

Several groups publicise the CRG newsletter, including the RICS, The Subsidence Forum etc.

Subsidence Management Services are the primary sponsors, meeting the operating costs of the CRG. Crawford & Company fund GeoServ Limited taking precise levels at regular intervals.

The objective is to explore new approaches to domestic subsidence across all disciplines. By sharing the outcomes, the industry makes itself more attractive to its client base and reduces the stress experienced by the homeowner.

Moving to a 'see and fix' solution will involve all fields of expertise. The engineer dealing with the claim will hopefully have an improved insight into regional variations and expectations. Arboriculturalists are actively involved in debating the topic (in fact, the most active of the groups) and are already moving towards adoption of LiDAR surveys and considering remote assessments etc. Monitoring and soil testing will benefit from automated interpretation to enhance diagnosis, and perhaps remotely one day.



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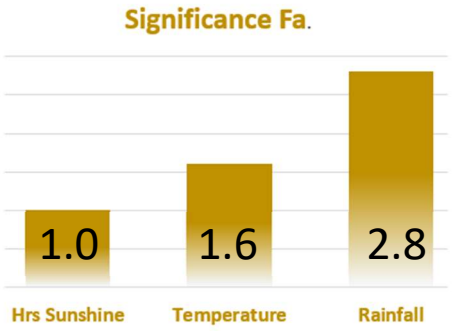
Weather Elements

What delivers an event year in terms of the various weather elements – temperature, rainfall or hours of sunshine?

An analysis of the summer months from June through to September, inclusive, provides an indication of the contribution of each.

Rainfall (or absence of) is the most significant factor with a difference between the average for event years compared with normal years of 2.8.

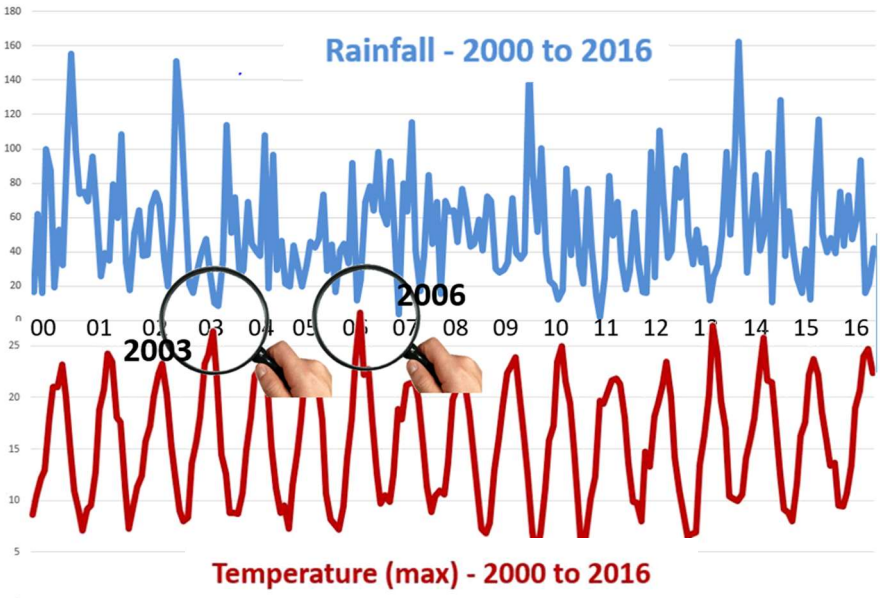
Next is temperature at 1.6, followed by hours of sunshine, which reveals little correlation between either of the two states



The significance of individual elements in determining claim numbers indicates that rainfall is the most significant.

The latter shows no evidence of a link to event years even when calculated on a month by month basis. That is, we could find no evidence that any particular month played a dominant role in enabling us to better predict event years in advance.

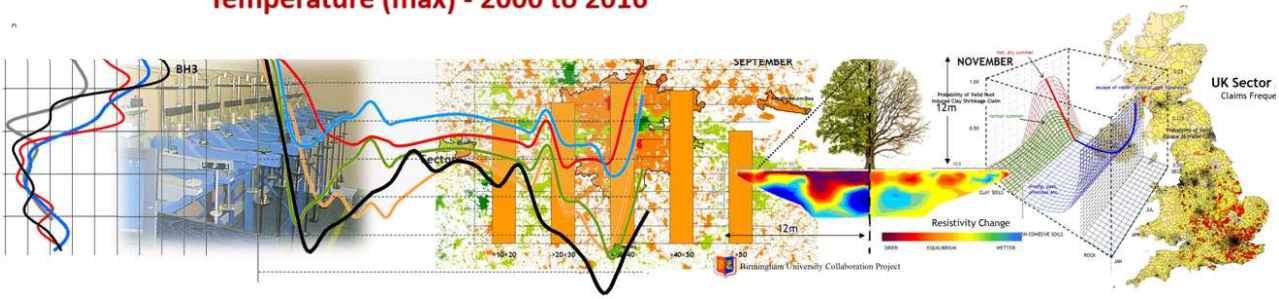
Spotting Patterns in Weather Charts



Left, rainfall (blue) and temperature (red), plotted for years 2000 through to 2016, inclusive.

The magnifying lens points to the near convergence in event years – 2003 and 2006.

2013 has a similar profile, but with slightly more rain. 2007 and 2011 have low rainfall but lower temperatures.



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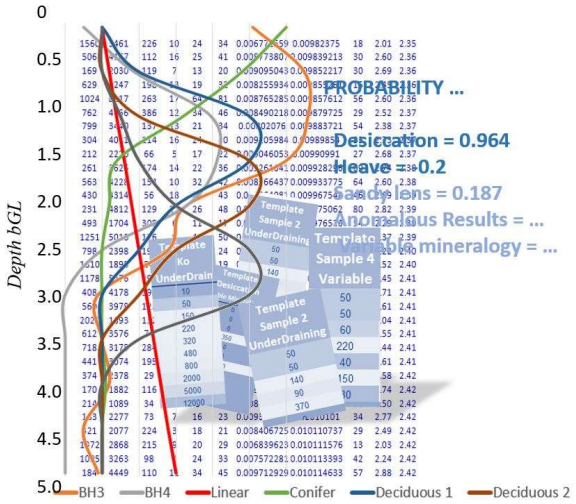
Soil Test Results Interpretation Module

The August 2015 newsletter (edition 135, page 8) explained that "the application is also able to handle the input from investigations, soil testing and monitoring, by referring to a library of characteristic signatures." The soils module of the A_i application analyses a wide range of results – penetrometers, oedometers, suctions etc., - and the library includes profiles for desiccation, under-draining, anomalous results (poorly calibrated filter papers or excess suctions) and variable soil mineralogy – the Weald clay is a good example where stratifications can produce evidence of suctions in layers.



An extract from the library of characteristic signatures profiling desiccation, under-draining, variable mineralogy etc.

Conifers typically produce shallow suctions but so do other, less aggressive or immature species.

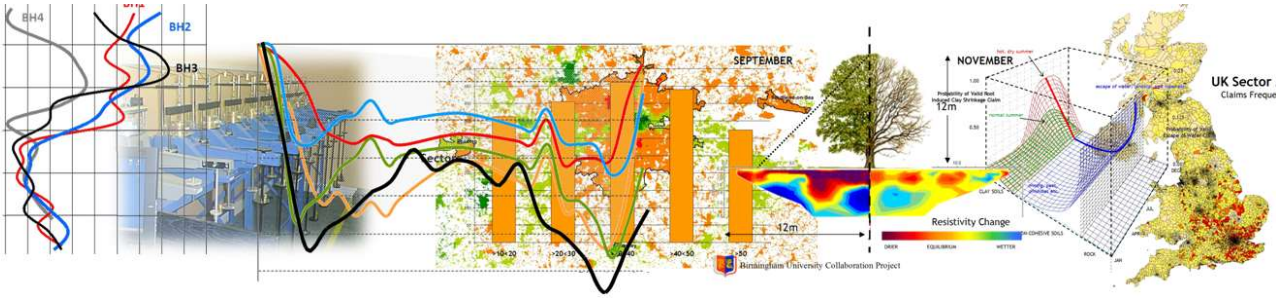
At the other end of the scale, mature oaks, planes and willows might produce deep seated desiccation, typically peaking at 2 – 2.5mtrs below ground level.

By pattern matching the actual results against this library, an objective score is delivered instantly. Cases where ambiguity exists delivers a 'refer to engineer' message. Typically where the results don't match any from the library, or contain an irregularity as mentioned above.

The output will be a score, on a scale 0 – 1, with 0 being 'no evidence of desiccation' and 1 being 'positive evidence of desiccation'. Anything above 0.6 is usually regarded as being positive identification.

The output also includes the most likely peril. For example, if there is no vegetation on the Environmental Assessment Module (EAM), but high suctions, the system might recommend exploring heave. This will direct further enquiries.

On the following page, an example of a signature typically associated with conifers. It also characterises a range of shallow rooting systems – shrubs and smaller trees. The underlying data table contains the library signature in the left column ('Conifer Template') and the results from the actual test data in the right hand column ('Data Entered').



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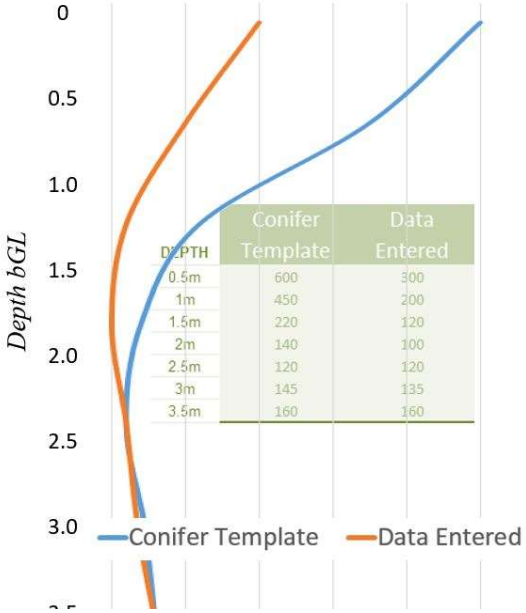
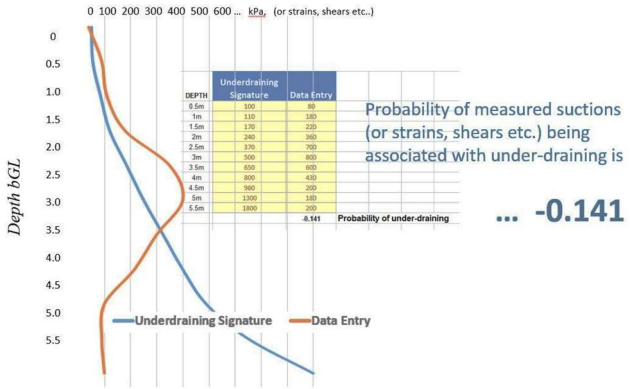
Soil Test Results Interpretation Module … *continued*

The results of the soil tests are shown by the orange line in the example below, and the library signature, blue. The correlation in this example is 0.93.



A very close match and clear evidence of desiccation. The application uses simple rules to distinguish outliers for all perils and detect excess or linear suctions resulting from poorly calibrated filter papers etc. For example, the upper value for grass in terms of suctions/strains and depth of desiccation will alert the user and avoid confusing tree root activity with grass driven evaporation.

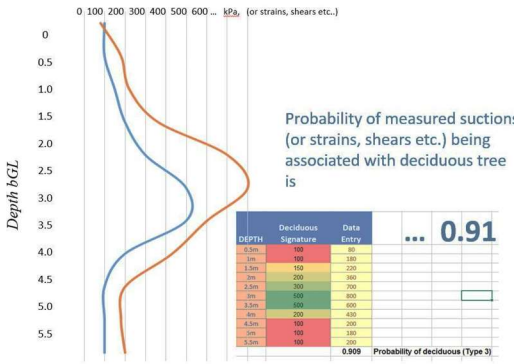
The system generates a 'refer to engineer' note for exceptions, listing the possible conflicts. "Suctions exceed 1,500kPa" for example.



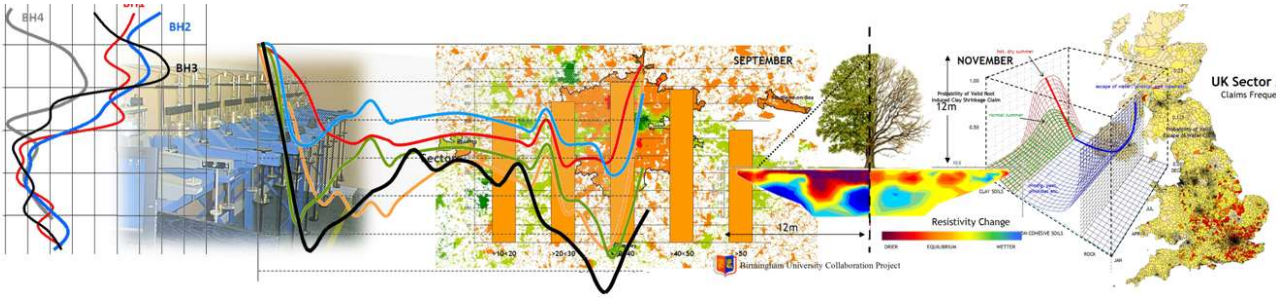
The blue line traces an under-draining profile from the library and the orange, the results of an investigation.

Further example, left. The blue line is the characteristic signature of an under-draining profile, and the orange line the profile from the soil tests. Analysis reveals the profile is not representative of under-draining, with a score of -0.141.

Right, there is however a positive correlation with the 'root induced clay shrinkage' library signature, and the application suggests that the cause is associated with a mature deciduous tree due to the depth and amplitude of the bulge. The chance that the soil results are due to under-draining are estimated at -0.141 and 0.91 for root induced desiccation.



The results positively identify root induced desiccation.



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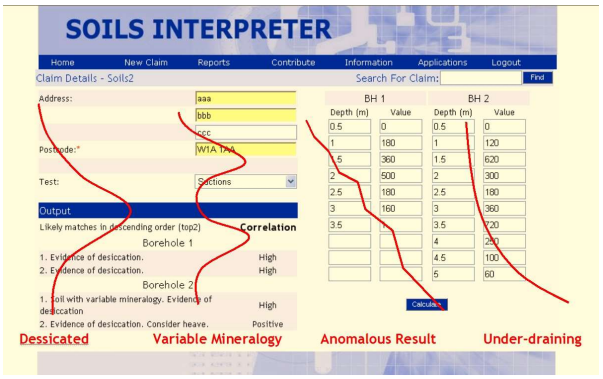
Soil Test Results Interpretation Module … *continued*

In summary, the chance that the orange profile on the previous page is due to under-draining = -0.141 and the probability that it is associated with root induced clay shrinkage = 0.91. The system doesn't just identify causation (i.e. evidence that vegetation is implicated) but lists the likelihood of alternative causes.

The assessment will be made by the A_i application behind the scenes. See output screen, right. Guidance is provided at the bottom, left hand quarter of the screen.



We no longer have to refer to the excellent work of Cutler and Richardson, Dr. Giles Biddle, BRE or NHBC tables. Our own database of over 40,000 records will no doubt be challenged.

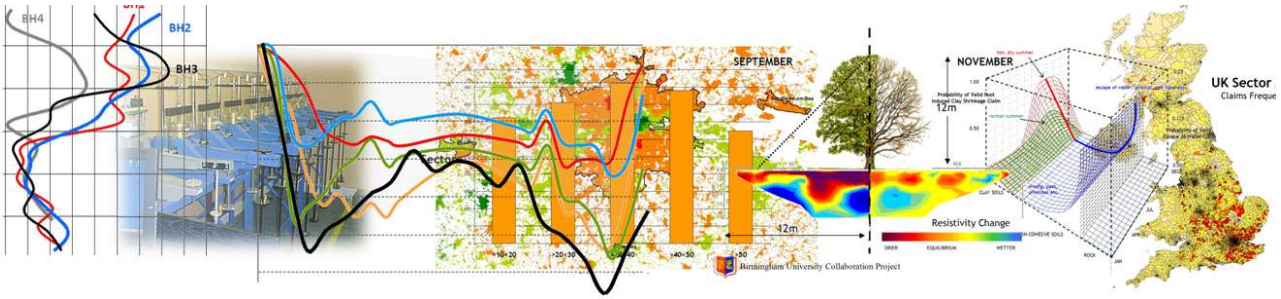
Instead, the system will assess each claim and determine not only the risk by species, but also the inferred H/D and height factors – hopefully against a table of planting frequency – all by season and prevailing weather conditions.

Both the input and output should be shared with the community and the results published at regular intervals to improve our understanding of decisions that the application is making. Effectively a live version of Giles Biddle's excellent two volume work using data from actual claims on clay soils from across the UK with minimal effort.

The next stage will be linking databases – soils, vegetation, weather, tree management, monitoring - to develop an understanding of what levels of desiccation are generated by which species under what weather conditions. Something we might do on individual claims but disparate approaches simply fuel the debate in cases where there are disputes.

Adding outputs to a LiDAR survey, walking the streets from our desks courtesy of Google and building on our knowledge would help all parties to the claim.

Imagine a screen showing the LiDAR survey with live weather feeds and seeing outlines of trees glowing green, amber and perhaps red would bring us up to date and the system would refine its understanding of risk by searching out elements that are significant – i.e. result in claims.



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2016 – looking backwards … and forwards

The January 2016 edition of the newsletter contained the following quotation when reflecting on 2015. *"The FCA … highlighted the need to offer easier access to the tech-savvy homeowners who might prefer to use E-mails etc., to notify claims and perhaps have access to claim progress using web based applications."*

This provided the focus for much of the year.

Using analytics to explore what was achievable in terms of triage, diagnosis and just how far A_i might take us over the next ten years.

The Internet of Things might be a starting place, with sensors sending information to the homeowner and their insurer, detecting foundation movement or perhaps moisture change at the junction between root systems and buildings.

Both relatively easy to do and something that we have devoted time to over the last 10 - 12 years.

Cost and low reliability were issues then, but how long are we going to send people out to monitor building movement and moisture change when we can already switch the lights on at home whilst working at the office and detect if there is milk in the fridge when we are out shopping?

Fewer clay shrinkage claims over recent years as a result of increased rainfall has reduced the friction between insurers, Local Authority arboricultural officers and homeowners and provided a glimpse of a different future.

One involving the routine investigation of water related claims; leaking drains and so forth, with the odd landslip/sinkhole for headlines?

Where does this leave the development of A_i systems? Root induced clay shrinkage claims are the main driver of innovation in terms of available digital data, technical input and indemnity spend.

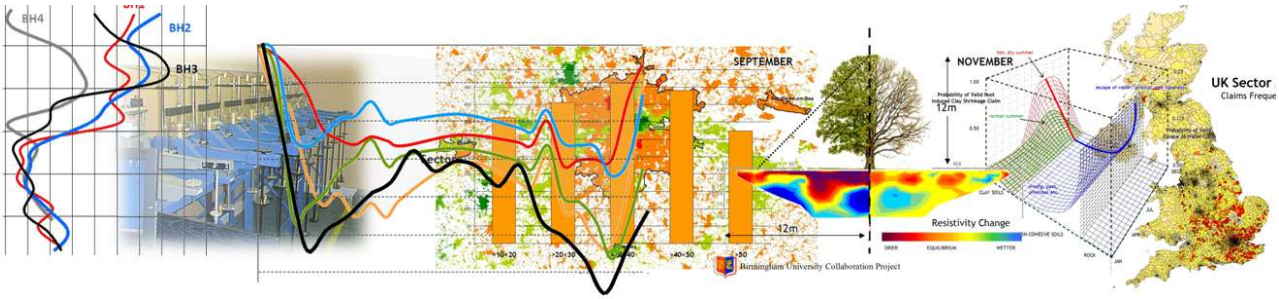
If current weather patterns continue, is there any real benefit in A_i? Or will the drainage investigation crew take a video of both the drains and property damage to transmit back to an office based engineer?

A system driven approach is inevitable. IBM Watson has already improved the diagnosis of certain medical conditions, driverless cars on the horizon, virtual reality headsets record and enhance imagery and all combined with remote sensing data.

20 years ago, aerial photographs were something of a novelty in the field of domestic subsidence and rarely used. Google has changed that. We can get in a virtual car and drive down almost any street in the UK from the comfort of our desk. PDF documents and Emails are the means of communication.

Is the future really going to be digital? It already is. Homeowners can track their claim on the web, databases are gathering valuable information that will help practitioners deliver higher standards of service.

Welcome to 2017.



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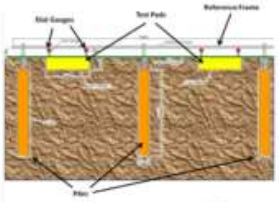
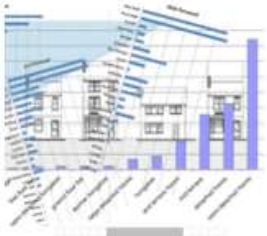
Looking Back – 2016 ... *continued*

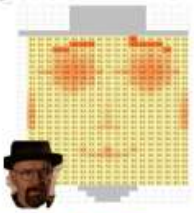


The **January** 2016 edition carried detail on the EKO research undertaken by Tom Clinton from Birmingham University towards his PhD under the supervision of Professor Ian Jefferson.

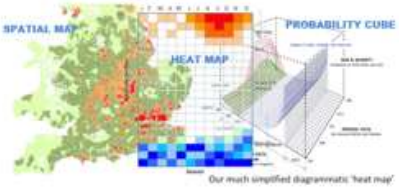
NASA shone light on the complexity of mapping vegetation. Apparently, it's how you look at the data. As the article pointed out, "Ambiguity and interpretation exist across all areas of data collection and interpretation and sometimes it may be influenced by what you hope to find."



This is a growing area of concern across the field of analytics, and not confined to mapping vegetation. Just how reliable are the underlying data and is the interpretation biased? Users of applications rarely have a full understanding of how it was gathered, what it really says and the sometimes subconscious motive of those who undertake the interpretation. More on this in 2017.



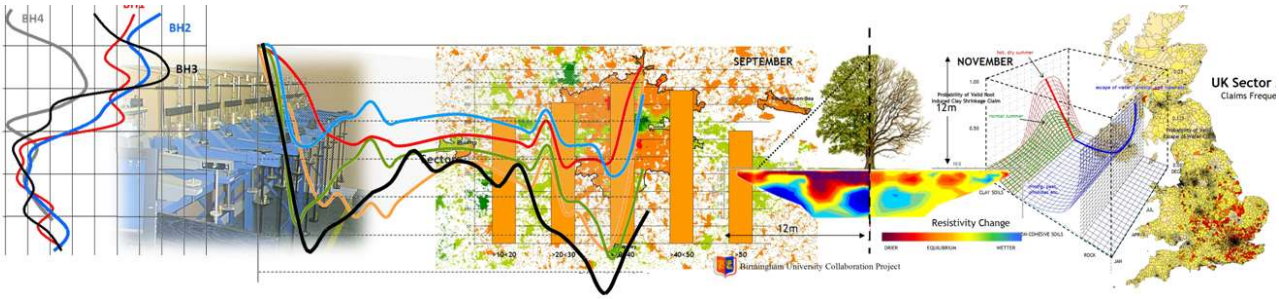
The edition also has an extract from the BGS web site relating to gathering information using social media.



The **February** edition outlined our approach to **A*i***, listing the elements and modules. Picking up on the threads of January, each of the modules was described and the theme was developed through the year. More on this topic in 2017.

March edition looked at pattern recognition to understand what a valid claim looks like. Does the data deliver an image that can identify the peril? Can an application recognise a valid or declined claim, and identify the peril – clay shrinkage, escape of water, landslip etc.?

Walt from Breaking Bad was used as a poor example of the technique. Part of the assessment reviewed neural networks, looking at how brains and intelligent applications may be similar – in a very, very trivial way.



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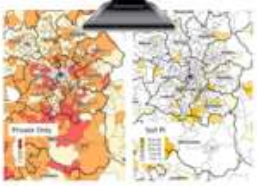
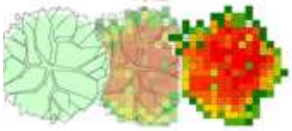
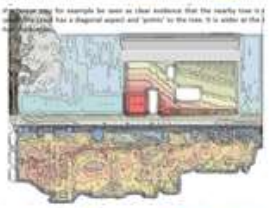
Looking Back – 2016 ... *continued*







It also contained a discussion around the data, existing applications that would be integrated into an A_i system and an example graphing foundation depths of subsidence damaged houses.

The March edition also contained a report on the Sheffield Council tree case, reviewed a claim where the Intervention Technique had been used and mapped mining compensation areas.

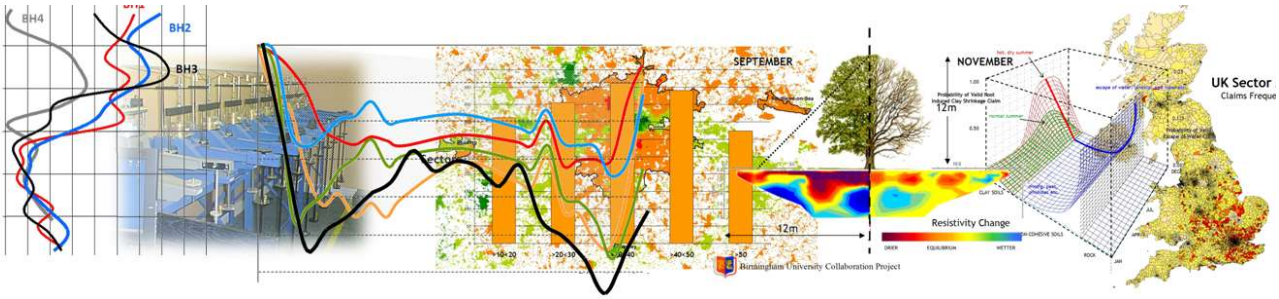
April outlined the UKCRIC grant application. A group of 13 UK universities and the British Geological Survey combined to apply for funding to build a buried infrastructure interaction test facility. Unfortunately, the application wasn't successful in this instance.

The edition contained several city maps plotting, at postcode sector level, the risk compared with the national average. We might talk about an average claims frequency, but where can it be found? How do Birmingham and Liverpool compare with the UK average?

A map of the count of escape of water claims was also included, along with several reports of tree related cases from the press. Derby Council, Camden Council (Camden were looking at claims involving Diana Quick and Bill Nighy and now, Bill Oddie – see page 15), plus notes on urban heat islands, difficulties in modelling the climate and research pointing out the poisonous gases emitted by some vegetation.

May contained a lengthy outline of what an A_i claims handling system might look like from triage through to scheduling. Several screen shots and a numeric risk ascribed to every geological series with peat at the top of the table.

June continued the theme with a table of geological risk and further screen shots and explanations of how a digitised floor plan might be the starting point for vulnerability modelling. The plan had vulnerability maps for various property styles and considered how other digital elements – trees, drains etc. - would interact.



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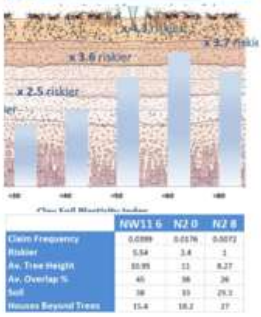
Looking back – 2016 … *continued*

The word ‘might’ introduced the idea of using combined probability modelling. Not from the standpoint of ‘this house is vulnerable because it is on clay with trees nearby’, but ‘this house has developed cracks, what are the combined probabilities that trees/drains etc., are the cause?’.

In **July** the focus changed to how the system might be regarded as ‘intelligent’. Could it learn from experience, and if so, how?

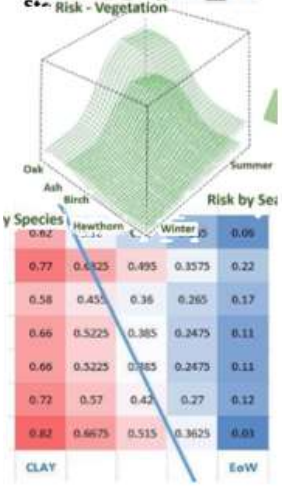


An article on the Soil Moisture Deficit (SMD) explored a different way of understanding the deficit associated with event years.

Exactly how much water was required to turn an event into a normal claim year? It appears that regular, intermittent rainfall of fairly low order – would be beneficial. Around 13mm a week on average, or 50mm a month.

This is useful when considering solutions like the Intervention Technique.

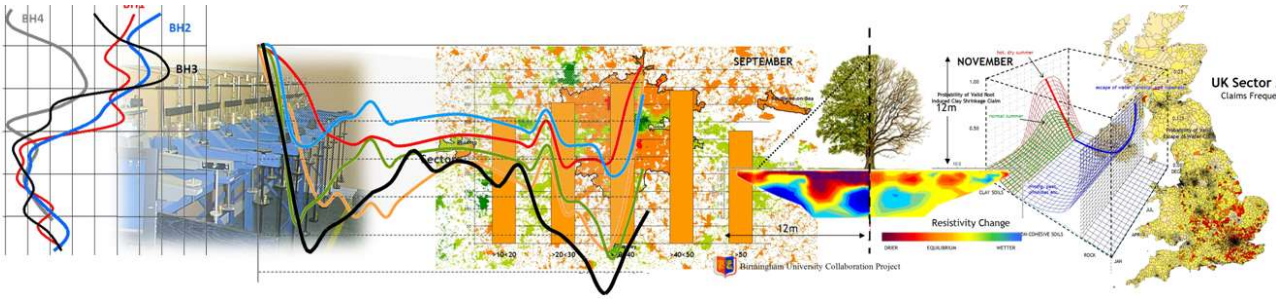
The **August** edition mapped the distribution of valid and declined claims across the UK and contained an article exploring the difficulties surrounding how risk is estimated – a recurring theme.



Vegetation, geology, weather and vulnerability all combine to make prediction difficult, if not impossible. The edition also included an analysis of three postcode sectors to see if there was a correlation between claims, tree heights, modelled root overlap and soil PI. The analysis also considered the risk to houses outside the zone of modelled tree root influence.

September discussed the probabilistic decision tree. Each of the initial steps was taken in turn, with explanatory sketches and an outline of the objective.

More on mapping of valid and declined claims by city (Liverpool and Bradford) and area (Devon, Cornwall and South Wales) with supporting graphs. Adding values to refine our assessment of risk and plotting how much riskier one district compared with another, all compared to the UK average.



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Looking back – 2016 … *continued*

October edition added Barnsley and London to the series of 'declined -v- valid' risk maps. The Environmental Assessment Module was explored in some detail together with more on the topic of A_i, including the pattern recognition function.

November. Record number of visits to the web site. 6,175 in one month. Article from Tony Boobier entitled "What does Tom Cruise have to do with Subsidence?" relating to data, assessing risk and the business benefit.

Digital imaging of the Aldenham oak tree root zone, revealing the extent of drying along one array. A deeper look at combined probability analysis.

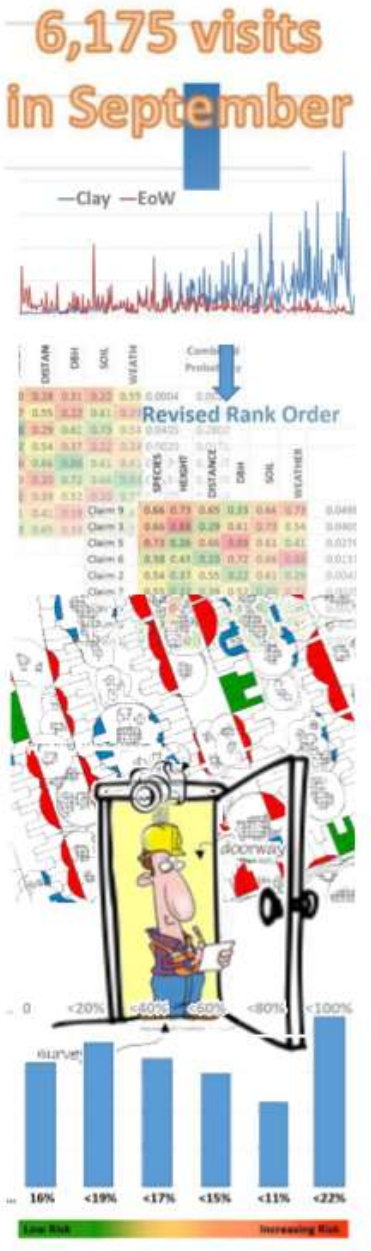
More cities on the 'valid and declined' analysis by city, at sector level, this month including Edinburgh, Newcastle, Bristol and Nottingham. Is 2017 likely to be an event year? Another look at probability – including the downside.

December. Continues the theme of doing more from our desk. The Ripon sinkhole, root overlap modelling. Augmented reality, innovative underpinning and the 80m tall sequoia tree.

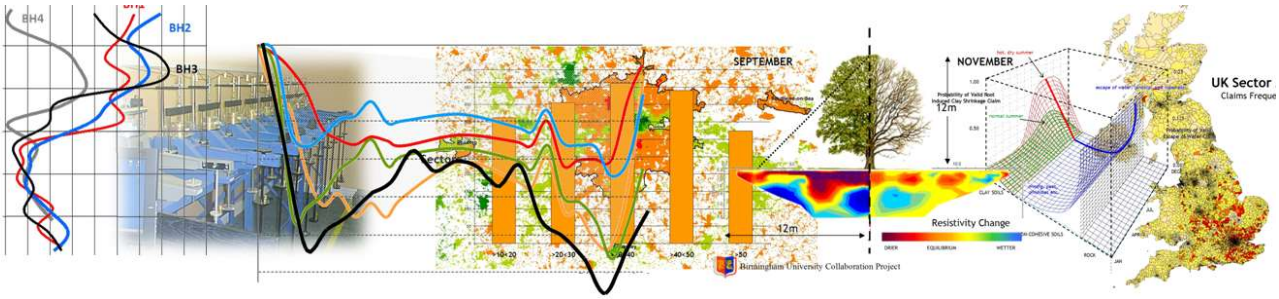
2016 - Summary. Most editions report on published research from a wide range of journals, together with occasional contributions from colleagues.

Most claims – probably over 95% - are associated with water. Too little (root induced clay shrinkage) or too much (leaking drains, water services, sinkholes, sulphates, landslips etc.).

Water is the key.



The original research undertaken by academics at Aldenham and elsewhere has been particularly relevant to our field of interest. ERT measures moisture change in the vicinity of trees. EKO moves water from one location to another, and changes the chemical composition of the soil.



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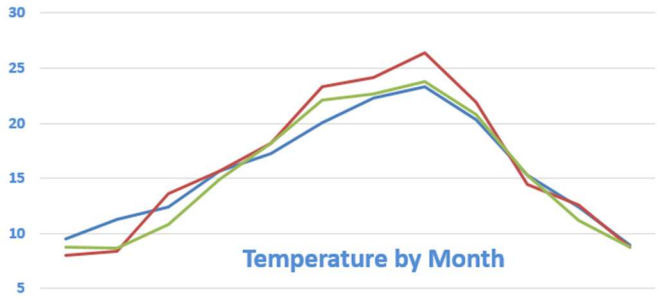
The seduction of Averages

Averages are seductive. They allow a glimpse into sometimes complex data and can give a misplaced idea that we understand what's happening. The average family consists of 2.4 people, 0.016 dogs, 0.009 cats, 0.00032 budgerigars etc., and yet we have never met such a family. Fortunately, perhaps.

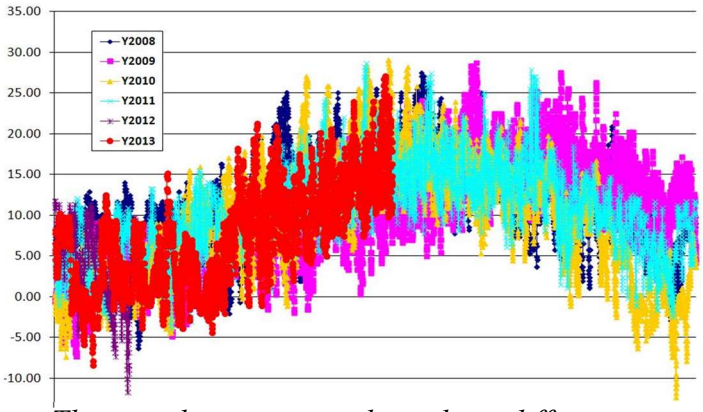
We draw some comfort when we reiterate that the average subsidence frequency is 'x'. In fact, that represents a very small proportion of the UK, averaged over a year. A specific year, weather dependant. Yes, the frequency may be correct, but it can be grossly misleading. For example, around half of the claims registered by the ABI are declinatures. In some years.

Look at the weather as an example. Right, how we see temperature data year by year. Smoothed lines represented by monthly averages.

Easy to plot and compare with other years. Warmer in the summer might correlate with a claims event year. Like the average family, averages are easy on the eye.



Averages are easy on the eye, but sometimes misleading.

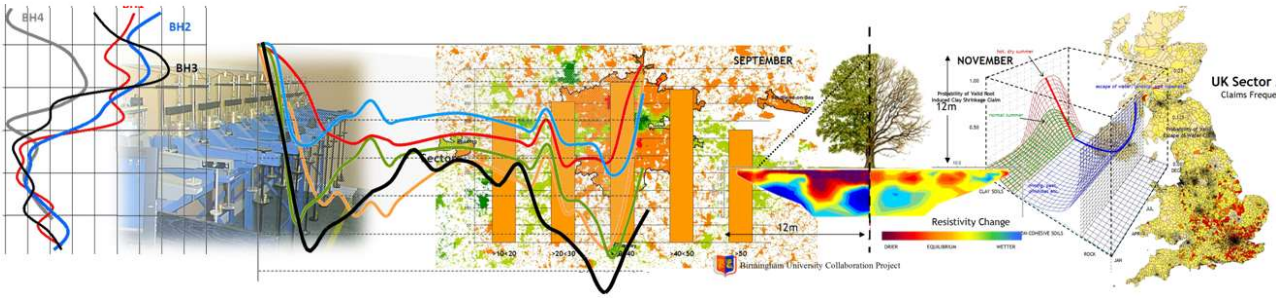


The actual picture reveals peaks at different times, with differing durations and perhaps wider fluctuations to confound analysis.

Left, just some of the data collected from the Aldenham site over several years. Wind and gust speed, direction, relative humidity, rainfall, solar radiation etc., all play a role.

Peaks differ by year and are of varying duration and amplitude. 'Max temp', 'min temp', 'average temp' conspire to complicate any meaningful analysis, or conversely provide rich pickings for anyone wanting to support a particular view.

Estimating how these elements act in combination on vegetation complicates matters further. Rainfall is a clear and obvious element when looking at subsidence and plant physiology, but hours of sunshine, relative humidity etc., all play a part.



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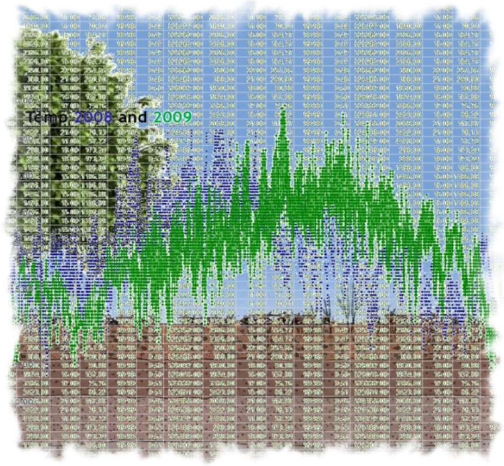
Averages … *continued*

The Met Office recognise the problem associated with averages on their web site when they say … ”Rainfall for each UK region for 2016 is comparable with the average annual values. However, within the ‘average year’ we have had some extremely dry and wet months.”

“The UK recorded much drier than average conditions in October and December with both months recording less than the anticipated rainfall for each month (38 % and 58 %, respectively). The wetter months of 2016 (when compared with the average from 1981–2010) for the UK were January and June (148 % and 139 %, respectively)”. And of course, within each day/week variations can skew the raw data.



Yes, the year may have been drier or wetter on average, but the outliers may tell the story.

A better approach for those interested in modelling subsidence may be to recognise composite patterns that match particular outcomes.

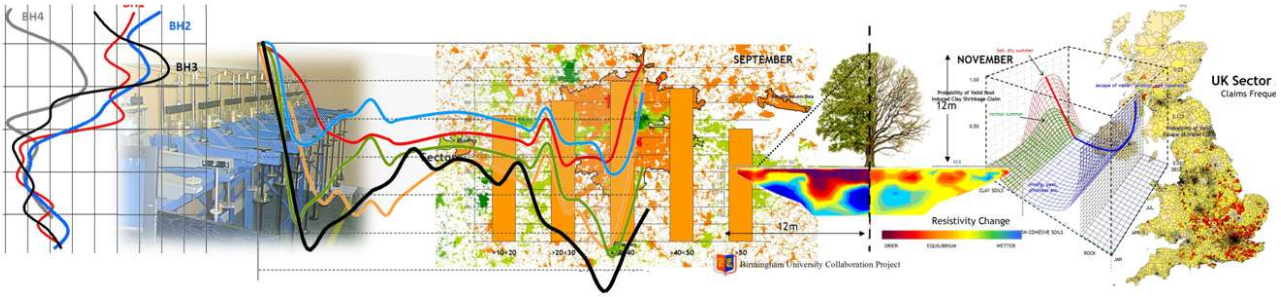
“What does a valid claim look like?” The dominant one may appear (for example, low rainfall) but more subtle correlations may exist elsewhere, unseen amongst the data.

Evidence that averages are alive and well

Ignore the previous pages. Averages are fine and we have evidence from our correspondent in Toronto, Canada.

Here is the property that proves it is possible to have fractions of houses.

The street contains 109 properties, and here is the evidence that, one average, that delivers 54.5 houses.



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Back to the Future

Thanks to Keiron Hart of Tamla Trees for advising us of research undertaken at Ball State University, Indiana to assess whether Google's Street View application could be used to identify tree species.

“The exercise recorded the locations of 597 street trees, identified trees to the species level, and estimated diameter at breast height. Over 93 per cent of those documented in the field survey were also observed in the virtual survey. Furthermore, virtual tree identification agreed with field data for 90 per cent of trees at genus level, and for 66 per cent at species level, with this being less reliable for small trees, rare taxa, and for trees with multiple species in the same genus.”

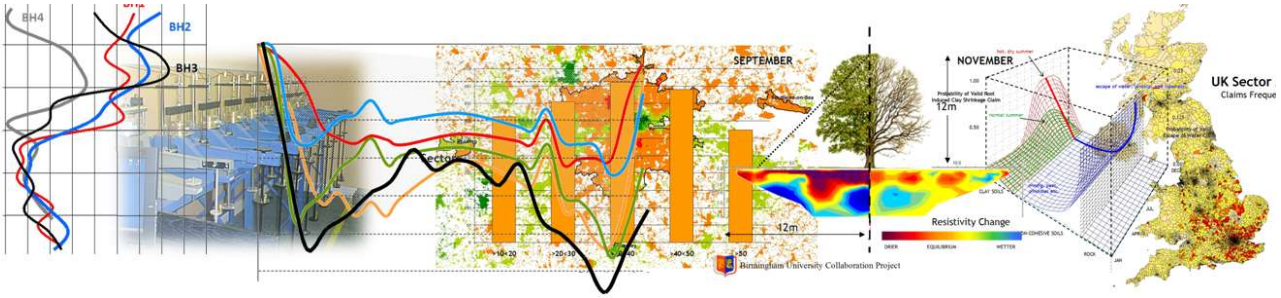
"In general, tree diameter was underestimated in the virtual survey, but estimates improved as the analyst became more experienced," the researchers noted, and concluded: "Virtual surveys in Street View may be suitable for generating some types of street tree data or updating existing data sets more efficiently than field surveys." The findings are published in *Urban Forestry & Urban Greening*.

Left, an extract from a presentation the CRG delivered to a meeting of the Subsidence Forum in 2007, outlining the technique, but without the validation undertaken along the lines of the research described above.

This may help Tree Officers surveying street trees where the tree is visible on Google Street View, but will be of less use when dealing with private trees in rear gardens.

The Journal, Urban Forestry and Urban Greening, also contains an article on the probability of roots damaging underground drainage systems - see Emilia Kuliczkowska, Anna Parka, “Management of risk of tree and shrub root intrusion into sewers”, January, 2017.

The journal abstract outlines the researchers approach … “data were used to develop two methods: one for determining risks related to root intrusions into sewers and sewage flow blockage and the other for establishing the category of probability of root intrusion into sewers with structural defects.” They conclude that their approach is an important aid to the management of sewer systems.



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Health & Safety

Report from Keiron Hart, Tamla Trees

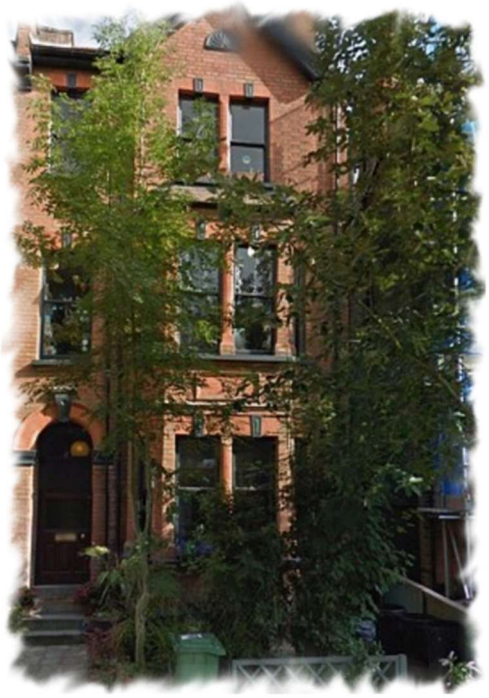
Thanet District Council has been fined after a worker was left with permanent injuries after being diagnosed with hard arm vibration (HAV).

Canterbury Crown Court heard how a worker from Thanet District Council was diagnosed with HAV after visiting his GP. Symptoms of the condition can include tingling, pins and needles, numbness and pain in the hands. This affects sleep when it occurs at night and sufferers have difficulties in gripping and holding things, particularly small items such as screws, doing up buttons, writing and driving.

An investigation by the Health and Safety Executive found that the worker would typically spend up to 6 hours a day using a range of powered equipment including mowers and hedge cutters, depending upon the season. He was not under any health surveillance or told how he should report his symptoms.

Thanet District Council pleaded guilty to breaching Regulations 6(2) and 7(1) of the Control of Vibration at Work Regulations 2005 and was fined a total of £250,000 and was ordered to pay £18,325.84 in costs.

Bill Oddie's Home -v- Trees Dilemma



Newspapers report that Bill Oddie's home in Camden has been damaged by subsidence. Experts have visited site and apportioned blame to three trees in his front garden.

Bill, a former Goodie, author and sometime presenter of Springwatch, is a staunch conservationist and the proposal that the trees must be felled to solve the problem presented a dilemma.

'I'd prefer to live in a tree, really. It pains me every year when they cut the trees back, but at the same time as I get older I am getting more and more reasonable. 'People make such a fuss about cutting one down - they say there's the ozone layer getting thinner. 'But let's deal with things that are clear and are genuinely affecting every park and nature reserve.'