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 132

May 2016

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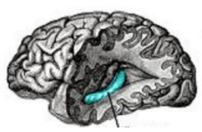
Edition 132, May, 2016

Artificial Intelligence and Neural Networks


Does your brain have a filing cabinet? Memories created in one area before being moved to another for storage during rest

UCL researchers studied rats' brains and found memories are formed in one part of the brain, then they are replayed and transferred to a different area during rest.

In edition 129 we outlined the relationship between the anatomy of the brain and the structure of intelligent systems. A few weeks ago, a paper was published in Nature Neuroscience by researchers at UCL (copy from press release above) explaining that the brain may have its own 'filing cabinet' with data being transferred to different areas.

THE CLAY RESEARCH GROUP
www.theclayresearchgroup.org
clayresearchgroup@gmail.com

Dynamic World

From mapping global currents to images of landslips on the Jurassic coastline, it's been a busy start to the year if you are interested in climate, risk and of course, subsidence. More inside - page 13.

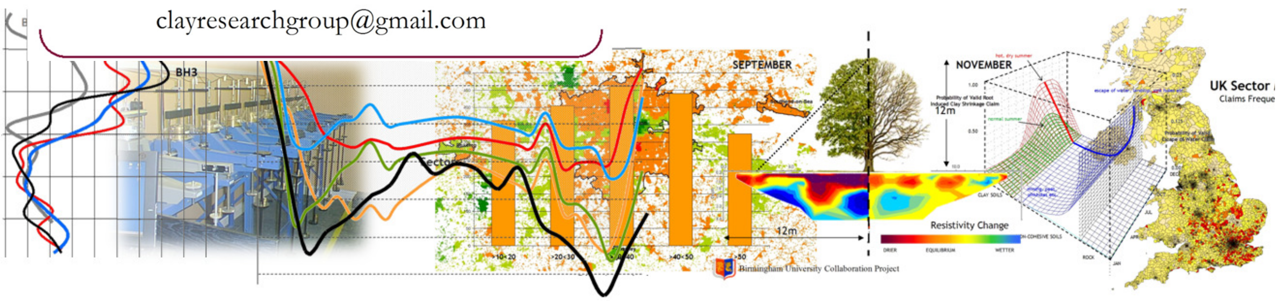
What is the Relationship Between Risk and Geology? Exactly?

On pages 3 - 6 the relationship between claim numbers, frequency, the likelihood of claim validity and causation is related to the underlying geology. Although the term 'exactly' is perhaps overstating the analysis, the output provides an insight into their relative positions in terms of risk and assists in improving our understanding of the subsidence peril.

Next Month

Next month the newsletter (edition 133) examines individual geological series to improve our understanding of risk. It explores the power of combined probability analysis to determine causation and likelihood of claim validity.

Edition 134 goes into more detail on the AI application, describing how the system learns over time and takes an inverted look at how to use SMD values to avoid event years. Just how much water would we need to add to the soil to turn a busy year into a normal one?



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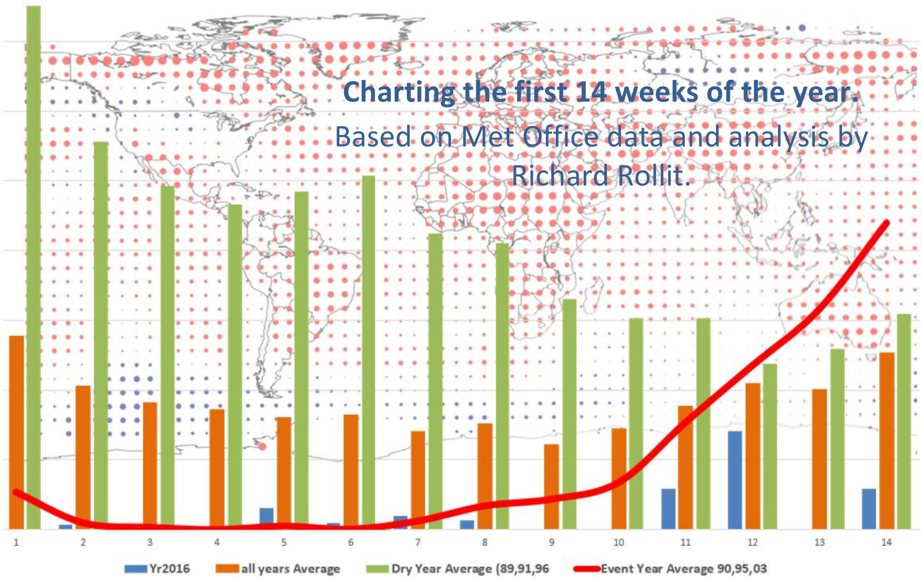
SMD – early part of the year

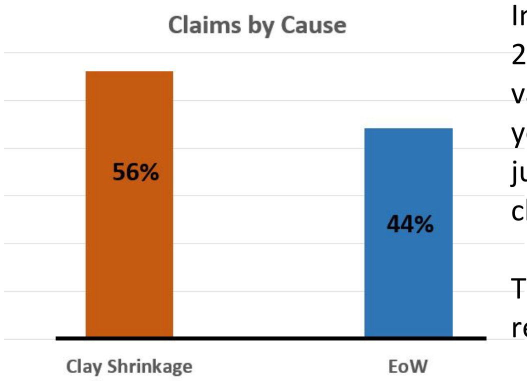


Above, a weekly plot of the soil moisture deficit for the first 14 weeks of the year for a range of conditions. The red line shows the event year average. Events often start with the soil fully hydrated, with a distinct drying trend commencing in April.

In contrast, years with average claim numbers (orange) show a small variation but little by way of a discernible trend.

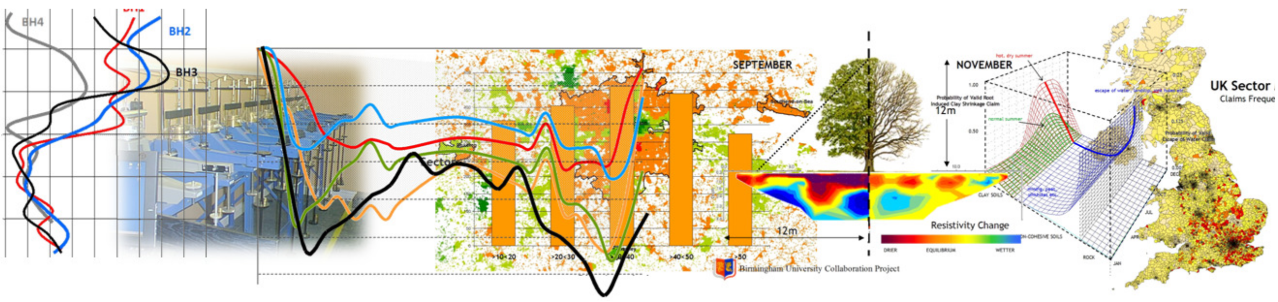
So far, the 2016 profile (blue) is particularly low.

Valid Claims by Cause



In an earlier newsletter (edition 92, January, 2013) 'claims by cause' were analysed for a variety of seasons and years. Over the last few years, clay shrinkage claims have accounted for just over half of the total and escape-of-water claims the balance.

This follows an average year distribution and reflects the heavier than average rainfall.



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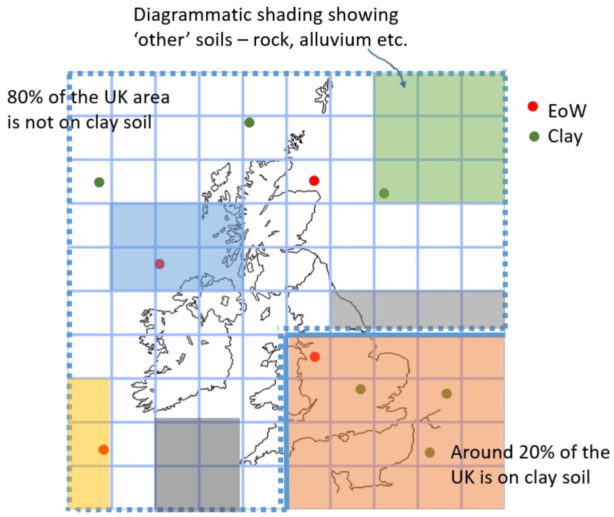
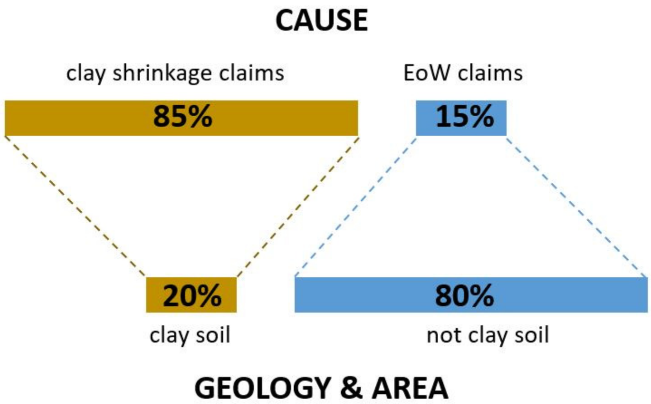
Area Risk of Clay Soil

The increased risk of subsidence posed by clay soils is well known. Around 70% of claims are the result of clay shrinkage – predominantly associated with the root activity of vegetation. The percentage can exceed 80% in hot, dry summers and reduces in years with high rainfall.





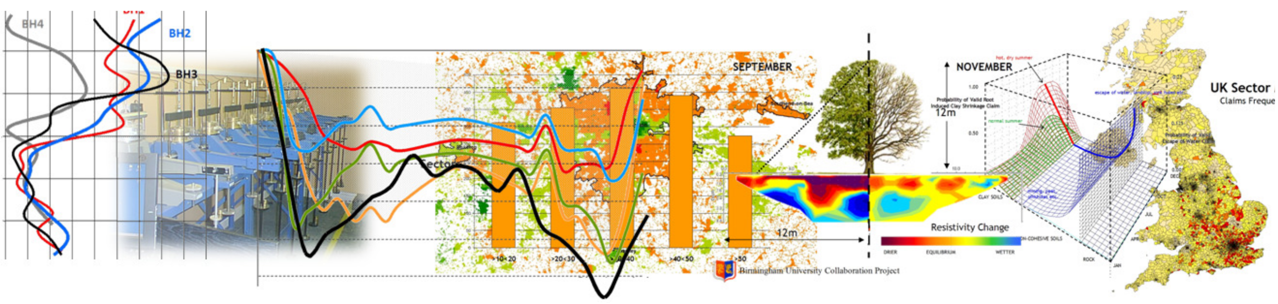
Using a 10 x 10 grid to represent the area of the UK (above) and distributing claims across the 'clay – not clay' geology is an easier way of visualising the real risk posed by clay soils.

The clay area is to the bottom right hand corner on a grid measuring 4 x 5 = 20%.

Whilst clay shrinkage might produce nearly 3 times the number of claims of 'other soils', that figure increases when we look at the area/claim relationship. Around 20% of the UK is on clay soil, but that 20% can deliver 80% of claims received.

The block diagram above plots the relative risk of 'clay/not clay' soils and it can be seen that taking into account the areas and ignoring for the time being population, clay soil is 20 times riskier than 'other' soils.

The picture can be confusing. On the following page we look at a better way of determining the risk by geological series. By deriving frequencies (number of claims over count of houses) we see the relative risk of each soil type.



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Risk Expressed as Frequency by Geological Series.

The problem with the approach on the previous page is that there may be more claims on a particular geological series simply because there are more houses.

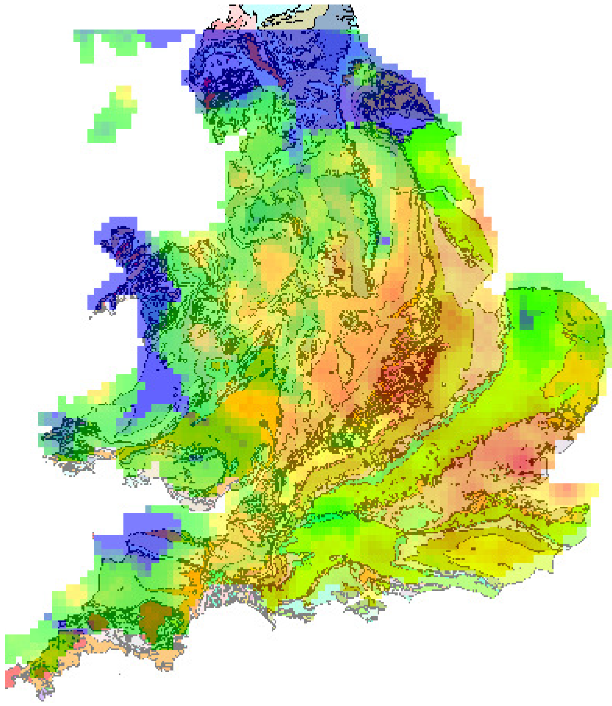
A more accurate picture is obtained by using claim frequency; the number of claims divided by the total housing stock, by geological series.

For this exercise we have added claims data to the OS Open Data postcode points and plotted them onto the 1:625k series BGS maps. This is a coarse analysis but one that provides a starting point for further research.

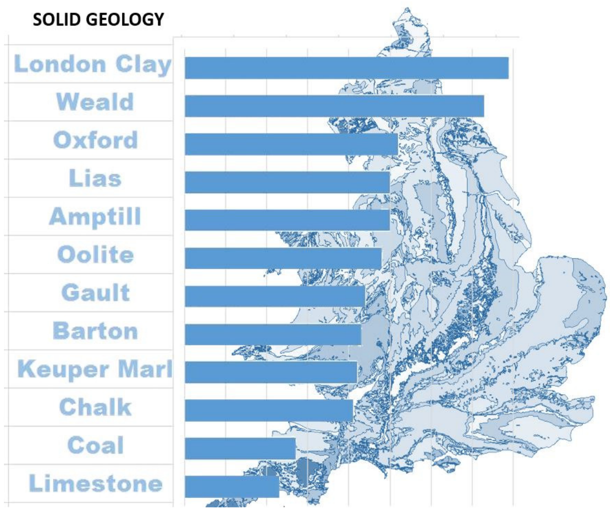
The drawback of this 'macro' approach is that we can't distinguish between shallow, non-shrinkable drift overlying a highly shrinkable series or causation.

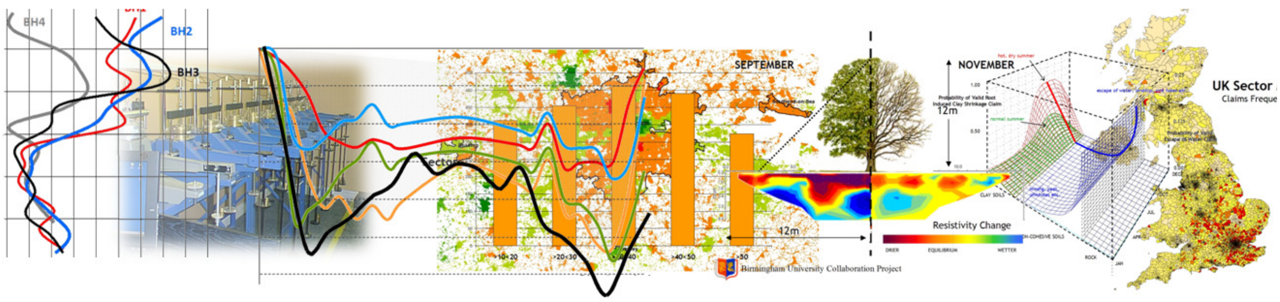
Does the claim result from erosion of the superficial alluvial deposits or is it related to clay shrinkage of the London clay at depth? It 'double counts' in some instances, ascribing risk to both drift and solid geologies. Also, the BGS map used for this exercise is a little coarse and the 1:10k series would be better.

Notwithstanding these issues (both of which could be overcome with more granular data), the risk table is a useful starting point and improves our understanding of the link between claims and geology.



Above, a map merging solid and drift geology (BGS large scale), with claims and housing population to derive a risk value by geological series. Below, soils in rank order with London clay presenting the highest risk when expressed as frequency.

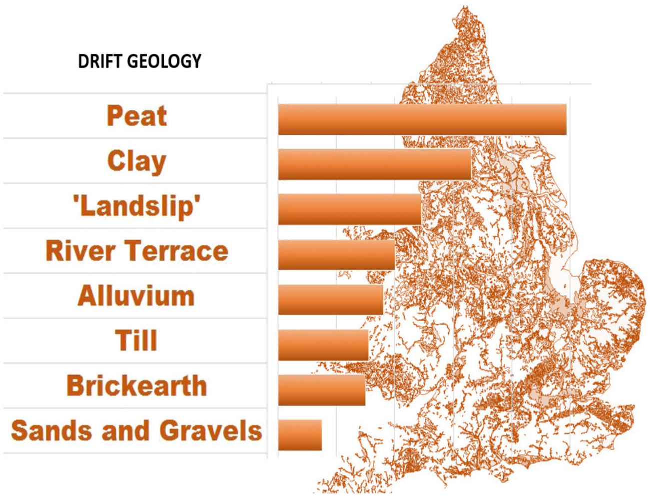




Risk by Drift

Taking account of geology, claims and housing population.

Although there is some overlap between the solid and drift series, the table below provides an improvement on what currently exist in terms of understanding the risk of the later drift deposits.



The risk scores of both series combined are shown on the table, right. The ratings deliver little by way of surprise. Peat is top of the table not just because of its inherent risk but because of the low housing density on this soil. In terms of numbers, peat lies beneath just over 60,000 houses compared with nearly 4 million properties on London clay. Peat is riskier, but delivers far fewer claims than some other soils.

In terms of claim numbers (rather than frequency) London clay is the riskiest soil, followed by Weald, Oxford and Lias clays. Of the drift series, River Terrace and alluvium are just ahead of Till and Brickearth.

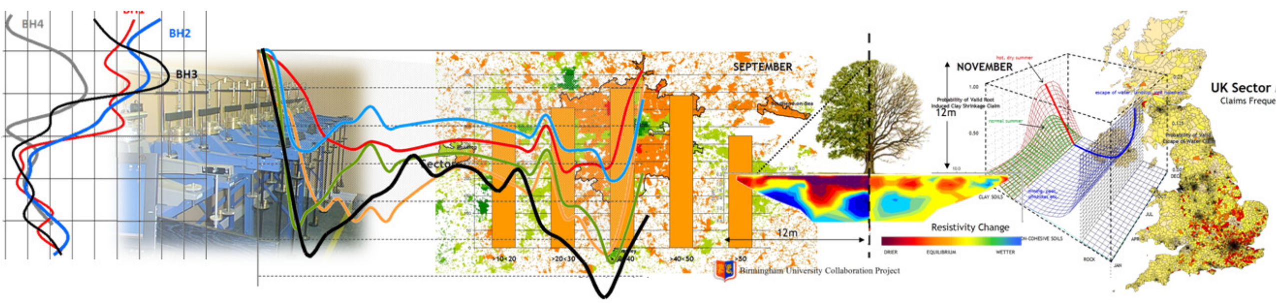
The added value of this analysis is being able to see just how much riskier one soil is when compared with another numerically.

For example, London clay is around twice as risky as chalk, and limestone is half as risky as Oolite, most probably due to the confusion introduced by not being able to distinguishing between the drift and solid series.

Risk Table

Geological risk expressed on a normalised scale derived from frequency of claims/housing.

GEOLOGY	RATING
Peat	1
London clay	0.79
Weald	0.73
Oxford clay	0.52
Lias	0.5
Ampthill	0.5
Landslip	0.49
Oolite	0.48
Gault	0.44
Barton	0.43
Keuper marl	0.42
River terrace	0.42
Chalk	0.41
Alluvium	0.36
Till	0.31
Brickearth	0.3
Coal	0.27
Limestone	0.23
Sands and Gravels	0.15



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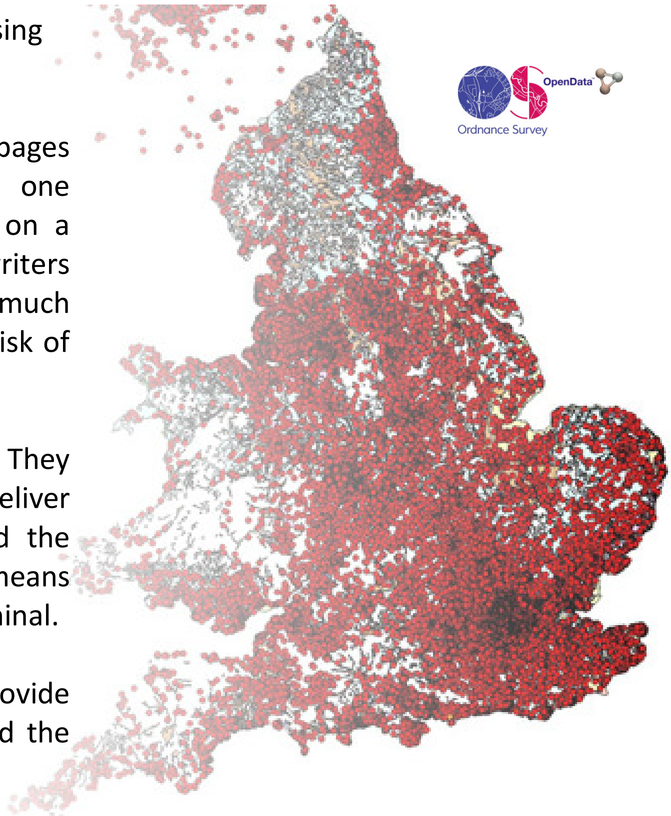
A Value for Every Postcode

Taking account of geology, claims and housing population – in a dot.



The analysis described on the previous pages delivers two outputs. The first (and the one appearing in the table) is the actual risk on a normalised, 0 – 1 scale suitable for underwriters because it uses frequency data. "How much should I charge in this location due to the risk of subsidence?"

Adjusters have a different requirement. They have to worry about numbers. Peat may deliver the highest risk, but far fewer claims and the reduced absence of a seasonal element means that resourcing (in terms of staff) will be nominal.

On the other hand, clay shrinkage claims provide the highest numbers of claims by count and the seasonal element amplifies the risk.

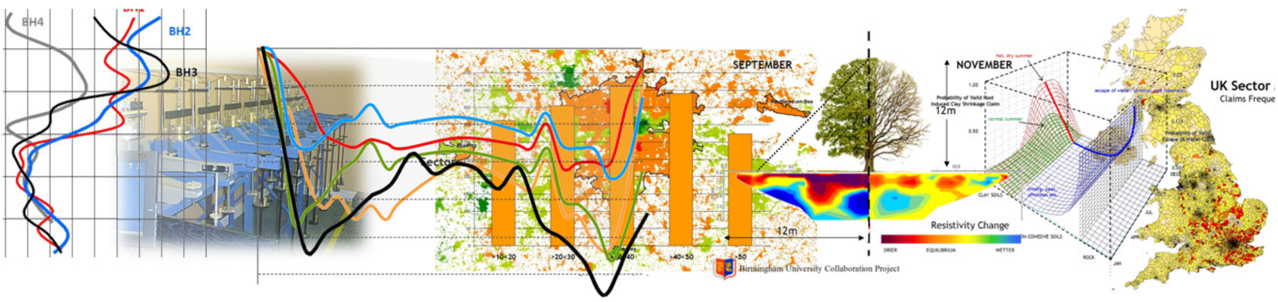
So, for the adjuster, count is more important than frequency. Taking the clay/peat scenario as an example, peat might command a slightly higher premium due to frequency, but the clay belt accounts for over 70% of the valid claims notified and staffing is the driving factor.

The previous pages have analysed datasets including BGS maps, claim data (peril and validity) and housing data from the UK Census.

Using a GIS, all of the components have been merged to provide a risk by postcode. An intelligent system would have this as part of its decision making process.

Above, mapping over 100,000 claims onto the BGS drift map to reveal data cover. The analysis can be further refined by taking into account the thickness of drift deposits if required, or information from site investigations undertaken on individual claims where it exists.

Weather and season can also be factored in by adding a weighting for shrinkable clay soils to enhance or dilute their influence. The weighting would be adjusted according to the soil PI.



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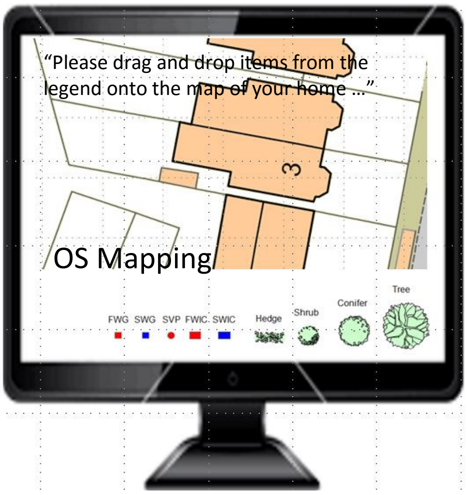
Diagnosing the Cause and Producing the Schedule

The Homeowners Interface

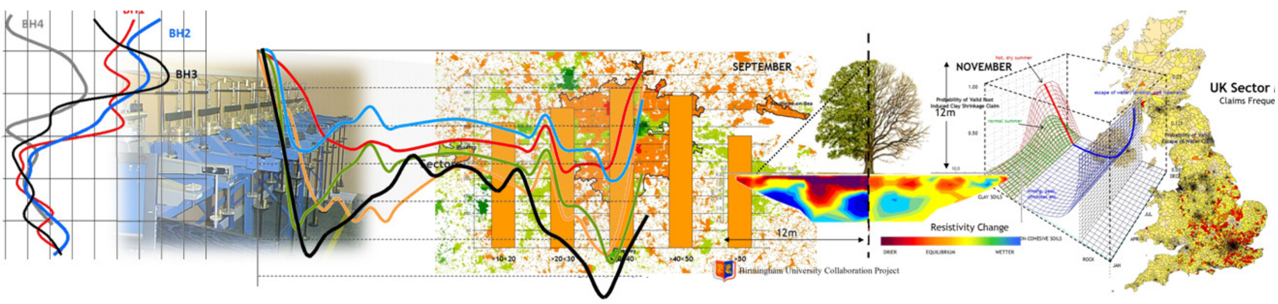
OS maps are central to the digital world. A scaled site map aids identification of the house style particularly if used in conjunction with Google Earth and Street View – see last edition. The number of storeys can be recorded along with the approximate location of vegetation.



The screen available to the homeowner might look like this. A legend containing representations of vegetation and drainage might allow a good number of claims to be directed remotely when used alongside pictures of damage and crack locations seen on other screenshots. A simple 'drag and drop' interface locates drains and vegetation.

As always, geology is central when considering possible causation whether it is being considered by an engineer or the AI application. Knowledge of the underlying soil helps the claims handler ask relevant questions and assists in determining what sort of site investigation might be needed.

In case of potential conflict, the app visits past investigations and the BGS borehole records.



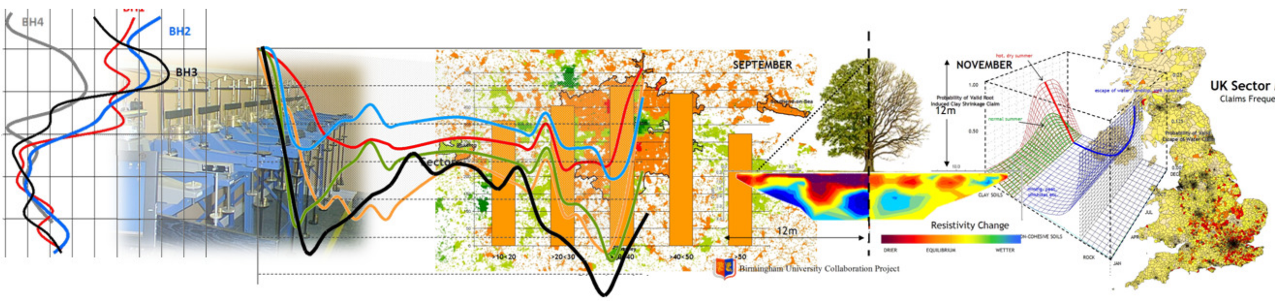
The Building Envelope

Here are some of the screens that would allow both homeowners and engineers to record essential information and enable intelligent decision-making in many cases - and much more. Report production, claim validation and scheduling are all possible.

Opening screenshot offering a range of typical house styles. The homeowner/claims handler/engineer simply 'clicks and selects' from the range of options. Over 90% of the claims handled relate to standard styles of property and although there may be small differences (windows, extensions etc.) they rarely alter the outcome.

On selection (in this example a right hand semi-detached house has been chosen), further screens appear revealing associated elevations – see below. A range of typical crack patterns are offered.

The external building envelope showing all three elevations (four if a detached property) appears and users are prompted to select damage patterns from a standard legend - see following page. Coding attaches attributes. In this example, blue cracks are assigned a low probability of subsidence and red a high probability.



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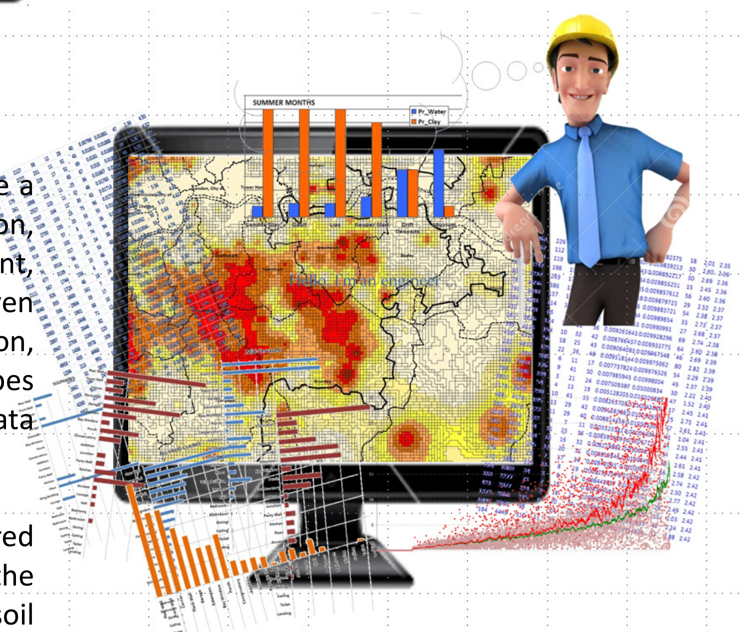
Moving Inside

Most rooms have a door and a window. Ceilings, floors and walls. It is rare that the exact dimensions and layout influence our judgement as to whether the damage is subsidence or not.

Rooms can be represented using a simple envelope of the sort shown left. Ceiling, walls and floor with a legend alongside facilitating 'drag-and-drop' distortions and cracks to be identified in a matter of minutes with a facility to enter notes recording variations. For example, "chimney breast on wall" or "fitted wardrobes on south wall".

The end game is in sight. We have a good idea of the property location, style, immediate environment, nearby vegetation, perhaps even drainage runs, damage location, time of appearance of cracks, slopes and sticking doors from simple data entry text boxes.

The system has already delivered the geology and sometimes even the shrink/swell potential of a clay soil where a record exists from previous investigations in the vicinity. It also knows the weather around the date of notification.



The full story - from our desk. Supplement with pictures and video clips from the homeowner and some probability analysis from the application to deliver high quality service for less, and much faster with a lower carbon footprint.

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"I'm Unique"

Regarding the variations in house style, we like to think our home is unique and of course, it is. The choice we have is to ask the engineer/surveyor/adjuster to draw every one, on every new claim, or invest some time building a library of commonly encountered options, adding to it as new styles are encountered.

Right, we have a range of semi-detached houses with single or two storey bay windows front and rear, gabled or canopy roofs covering the bays, a door in the side and rear walls leading from the kitchen, or a window.

This approach would probably deal with over 60% of the valid claims we encounter.

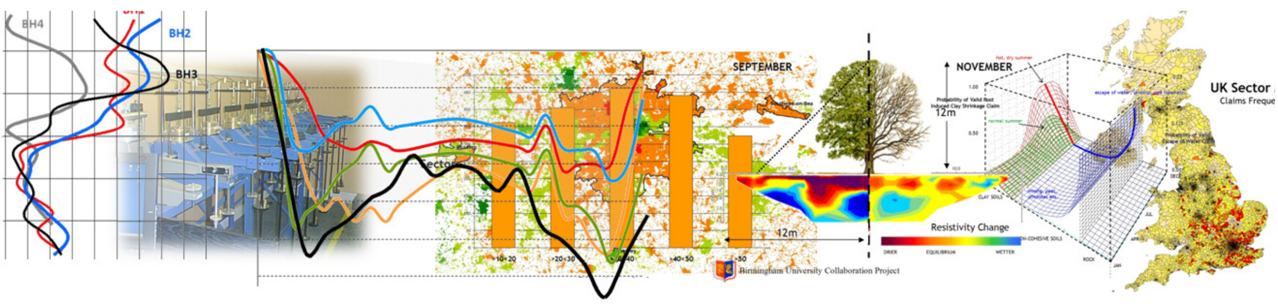
Automated Schedule Production

Previous pages describe the system outline. Cracks have been recorded along with their location.

The next step is automating the preparation of the repair schedule with a table of rates.

Using the typical semi-detached house as an example we have a good idea of the dimensions. "Rake out and re-point crack in masonry to side elevation … 2.5 l.m. = £xx.xx".

Again, this doesn't need to be accurate. It serves as an audit check when the contractor visits site.



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Modelling the Input

The screens so far allow the selection and identification of the property. We have some idea - not a measured survey exactly but probably sufficient for our needs - of damage location and patterns of distress.

Using 'click to select' and 'drag and drop' is a rapid way of entering data onto the system. Much of the work may have already been done by the IT literate homeowner using some simple screens.

More importantly we have sufficient data in most cases to (a) produce a report, (b) assess claim validity, (c) identify causation and (d) produce a schedule.

Benefits for the homeowner using the system are not having to take time off work where claim validity can be assessed and most important, to take part in the process and understand the logic trail. They have objective data from the BGS relating to the soil beneath their home and from adjuster's/insurer's records, the most likely peril and outcome.

All in a matter of half an hour or so.

Of course a site visit may still be needed. When monitoring, site investigations and/or arboricultural advice are required, all can be directed from the desk. Asking for any of these would be a simple matter of plotting areas of interest onto the OS map and issuing to the expert and homeowner.

The advantage here is that the expert making the visit will have all of the above information to hand. It's 'reverse engineering' the approach allowing the engineer to make a decision with all of the evidence available to them.

In the background, the AI system is running, considering the peril for any previous claims in the area and findings. Is this an area where vegetation/clay produce many/few claims that have been valid/declined?

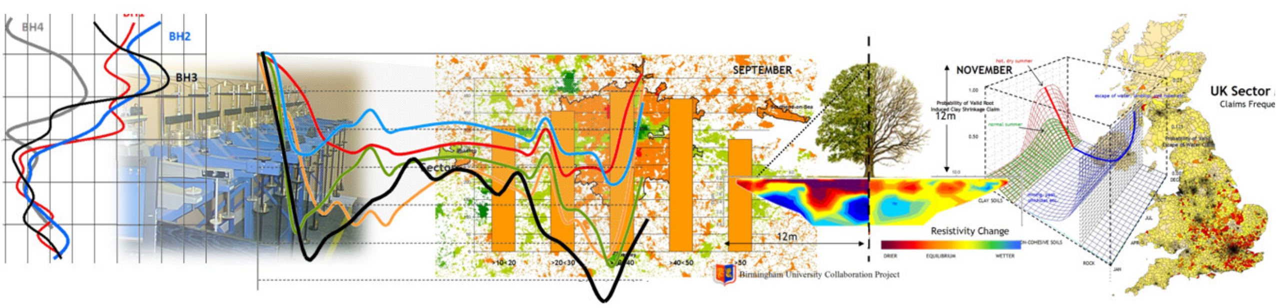
What is the profile? How about the age of the property? Older is riskier as we know.

NEXT MONTH

In the June edition we consider how a floor plan might be constructed to take account of 'live' data – monitoring, soil results and arborists advice. Monitoring patterns can be interrogated fairly easily in the sense of recognising seasonal movement or ongoing subsidence – or stability – but how does the system place them in relation to drains, trees etc.?

By adding layers of data onto a floor plan and ascribing risk to each element in relation to the range of likely causes on a spatial model adds further value to the model.

We consider how the geology risk data earlier in this newsletter can be further refined and the values ascribed to individual series incorporated into such a model.



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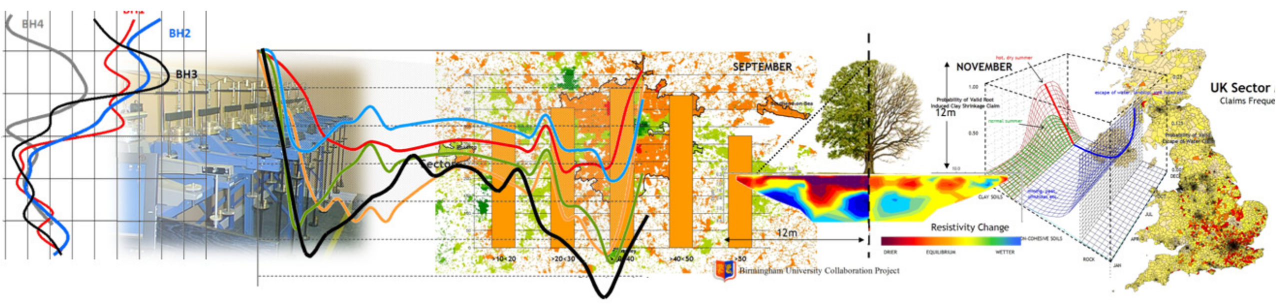
A Dynamic World

The beautiful image of the world, left, mapping ocean currents and temperatures around the globe. Reds and pinks represent warmer and blues and greens colder. It's easy to see the strong lateral flow of the Pacific and compare it with the chaos of the Atlantic.

Right, a 300m long, 1.2m wide fissure that has developed along the Jurassic coastline. This is a picture taken with a drone of the Bowleaze Cove slip in Weymouth, Dorset. Apparently tons of soil dropped away in a very short time.

Turbulent times ahead. Much like the last 5 billion years.

A 6m deep hole (left) appeared in a main roadway in Sheffield, thought to be related to old mineworkings in the area. Right, a 40m deep sink hole that appeared in a B&B car park in north Staffordshire has been repaired at a cost of more than £2m. Picture shows backfilling underway.



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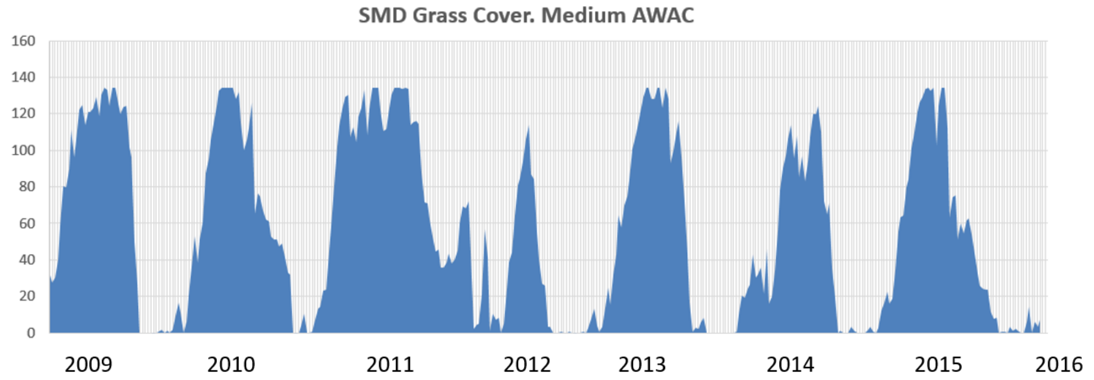
Soil Moisture Deficit over Recent Years

Below, an area graph showing the soil moisture deficit over recent years, commencing in 2009. 2011 produced the largest deficit and 2012 the smallest. Claims followed these profiles with 2011 delivering 32k and 2012, just under 23k.



Area graph showing the SMD between 2009 – 2016. The main difference between an event and a normal year appears to be intermittent rainfall as we shall see in next month's edition.

In the News – Trees and Weather

- A Plymouth man has been fined £30,000 for destroying ten protected ash and bay trees at a beauty spot on land near Hooe Lake, situated along the South West coastal path. Mr Stevens told the court he wasn't aware the City Council said the trees were protected under planning regulations which had been in place since May 1994.

- The Woodland Trust have plans for a massive tree planting program – 64m trees are to be planted across the UK, starting in Suffolk. Of the total, 15m trees will be planted in and around towns and cities, starting in Durham. 20m will revive the country's hedges and farmland.

- NOAA report that March 2016 had an average global temperature of 12.7^{o}C and marks a period of warmer weather that started in May 2015. The March value was 1.22^{o}C above the 20th century average – most likely associated with the El Niño. NOAA climate scientist Jessica Blunden says the 11 months in a row smashes a run of 10 set in 1944.