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RESEARCH AREAS

Climate Change : Data Analysis : Electrical Resistivity Tomography
Time Domain Reflectometry : BioSciences : Ground Movement
Soil Testing Techniques : Telemetry : Numerical Modelling
Ground Remediation Techniques : Risk Analysis
Mapping : Software Applications
Electrokinesis Osmosis
Intelligent Systems

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Climate : Telemetry : Clay Soil : BioSciences : GIS & Mapping
Risk Analysis : Ground Remediation : Moisture Change
Data Analysis : Numeric Modelling & Simulations : Software

Edition 133

June 2016

The Clay Research Group

CONTENTS

Edition 133, June, 2016

Subsidence Training Day

The Subsidence Forum are arranging a conference at the BRE on the 20th October. Topics include legal updates, Japanese knotweed, satellite mapping and a review of protocols relating to tree nuisance to name but a few.

Program and booking form can be downloaded from our web site or visit www.subsidenceforum.org.uk

Intelligent Systems

Approaching the End Game

Continuing the AI theme, this month we look at individual geological series to ascribe a risk factor related to claim frequency. We see how systems can be used to model the buildings response to its environment, taking into account vulnerability and superimposing the results of monitoring and site investigations.

Next month, exploring how the system can learn from its experience and change its ratings automatically – and intelligently.

Soil Moisture Deficit

Using the SMD to reduce the risk of event years.

How much water is needed to reduce the risk of root induced clay shrinkage claims? Event years – for example, 1990 and 2003 – are characterised by high and persistent SMD values. Normal claim years have a lower value.

What is the difference?

Research Update - Trees

Brief report on papers researching (a) how the diurnal cycle of trees influences their height and (b) how satellite data is being used to estimate the volume of wood in forests.

Climate Change

Update from NASA recording the warmest April in the warmest year – so far. A product of El Niño or a sign of things to come?

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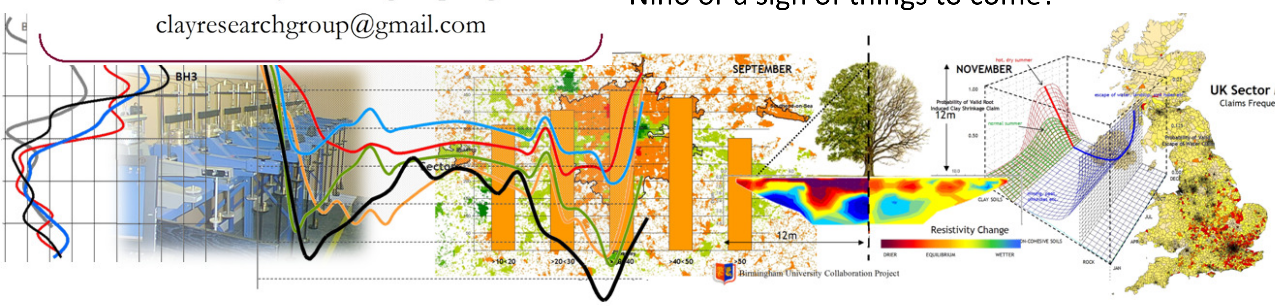

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Risk – Clay-with-Flints series

Last month's edition undertook an analysis of UK soils to deliver a subsidence risk value for each geological series. In this edition we take a closer look at Clay-with-Flints.

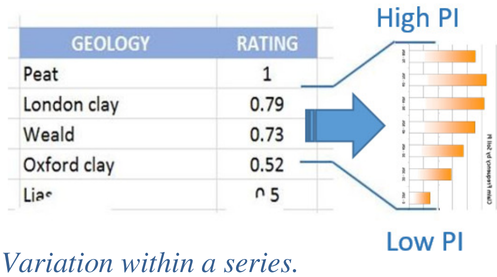
The risk score is derived using a 5-year sample (over 100k claims, including one surge year) to calculate claim frequency. Clay-with-Flints has a score of 0.69, putting it in fourth place just behind the London and Weald series but above the Oxford and Lias.

This exercise also serves to illustrate the variation in risk if house ownership is taken into consideration. The value of 0.69 reflects the score taking into account both private and social housing. This is the basis of the table and reflects how all soils have been calculated.

The value increases to 0.81 if houses in private ownership only are considered.

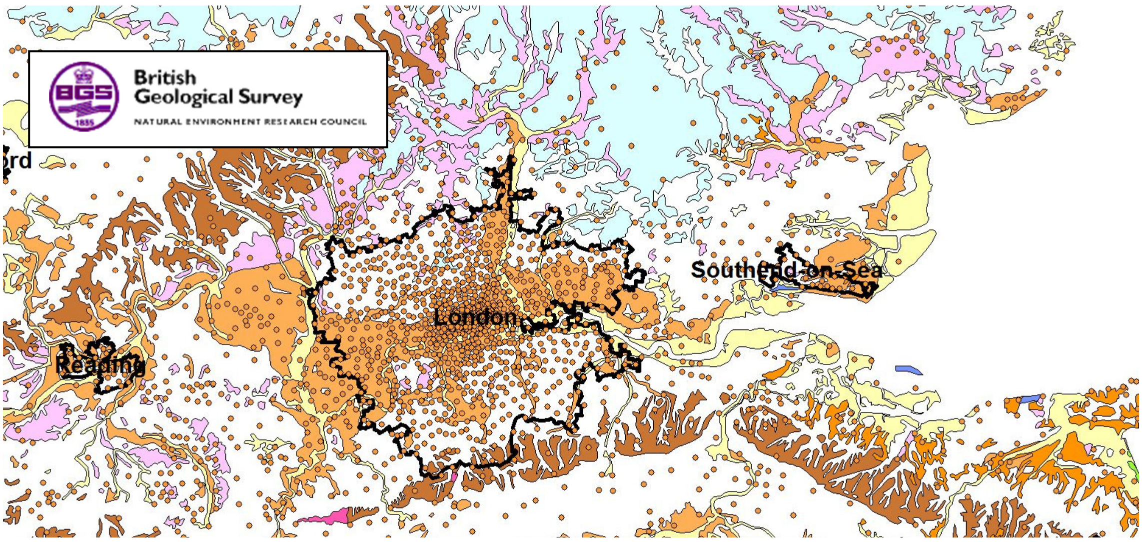
The model can be further refined for clay soils by taking into account the plasticity index. See below.

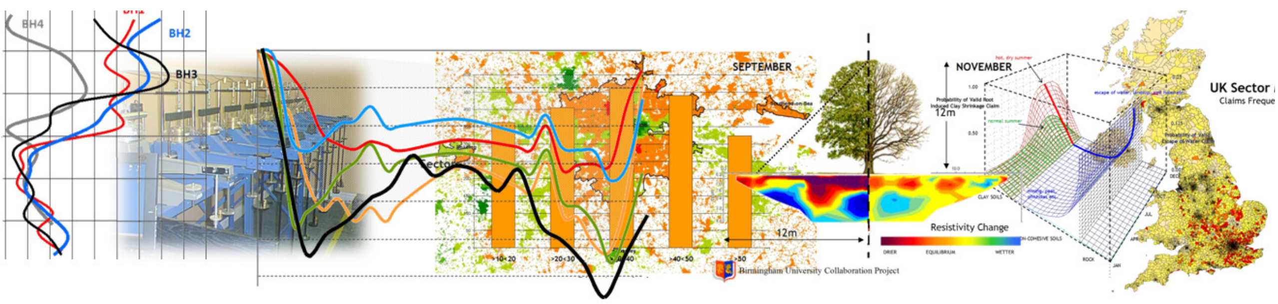
For example, London clay is towards the top of the risk table. Within the series there is variation which can be accounted for as shown.



Variation within a series.

The risk for any clay soil varies within the series as a function of its PI. Using London clay as an example, the higher PI increases the risk to 0.84. the lower PI places the risk somewhere just below the Lias series.





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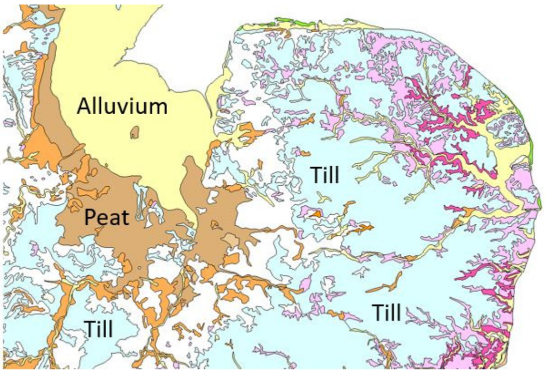
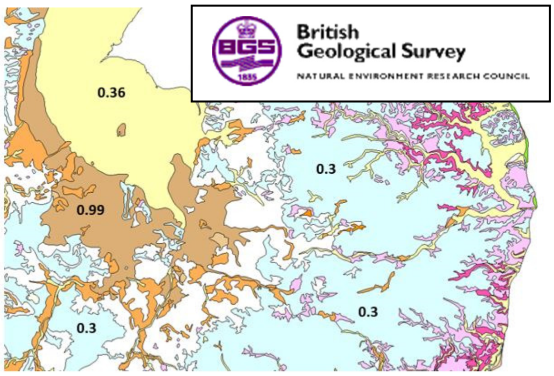
Different Geologies – but the same

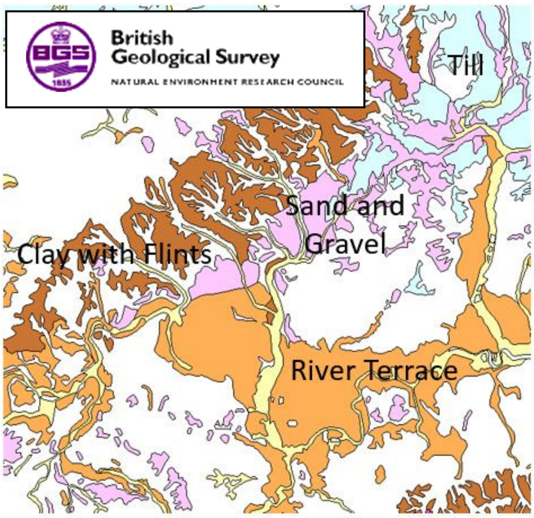
Geologists might prefer the maps on the left (all maps taken from the BGS 625k series), insurers and subsidence engineers might like the alternative view, shown on the right for the drift (top) and solid (bottom) geological series.

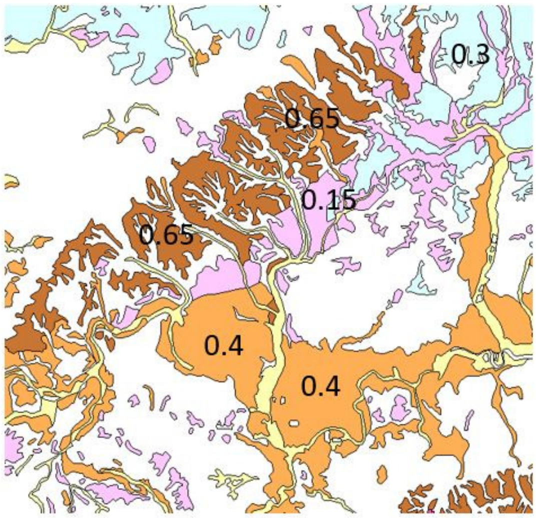
On the left are the names of the various soil types and on the right, their risk rating as outlined in the previous edition, plotted on a scale 0 - 1.

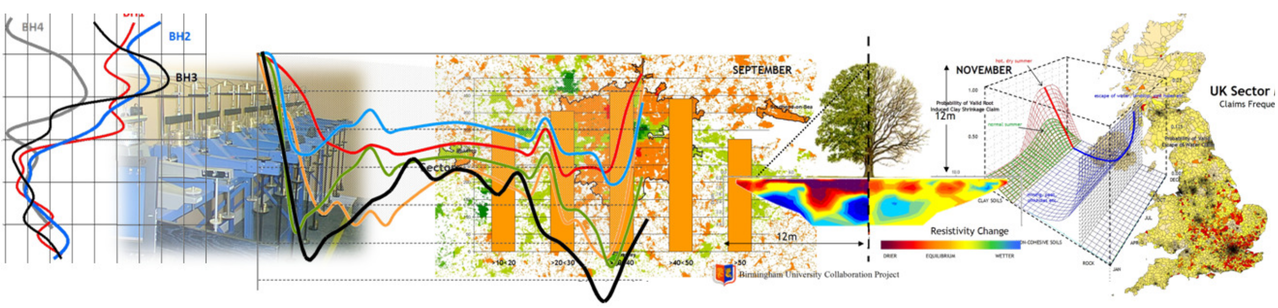




The values aren't on a probability scale where 1 = 'certain to have a claim'. They are rated in a way that can be incorporated into underwriters' existing tables, bearing in mind that subsidence is a relatively small piece of the jigsaw. It can be seen that till for example has a rating of 0.3 and peat (top of the risk table) has a rating of 0.99. Below (solid geology), river terrace is rated at 0.4 and Clay-with-Flints, 0.69.







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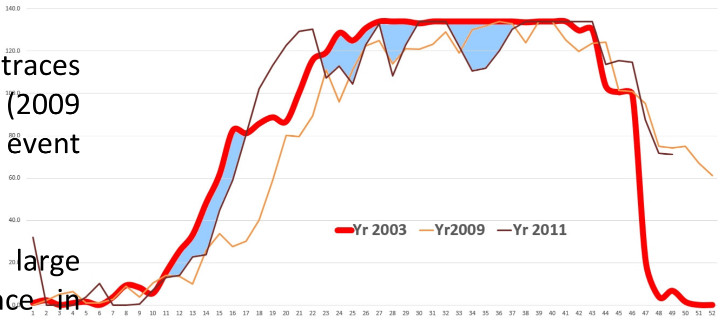
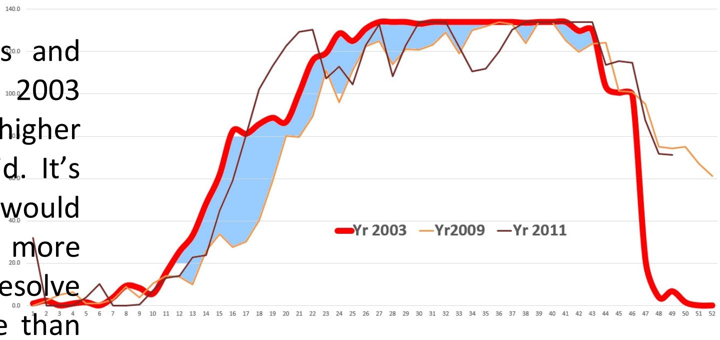
Soil Moisture Deficit
good year -v- bad year



Right, Soil Moisture Deficit traces from two normal claim years (2009 and 2011) compared with an event year – 2003.

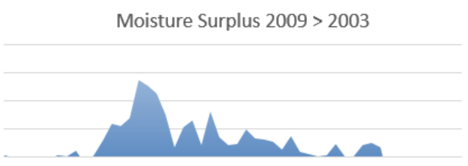
We might expect to see large variations given the difference in claim numbers between them.

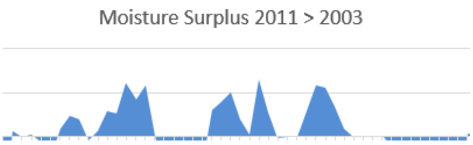


2009 produced 29,700 claims and 2011, 32,000. In contrast, 2003 delivered 55,400 claims with a higher proportion of them being valid. It's also the case that valid claims would have been lengthy and more expensive to investigate and resolve – around 20% more expensive than their escape-of-water counterpart on average.

The traces above reveal the differences between those years. It appears that the bouts of intermittent rainfall reduce the risk. The value in the analysis is that the difference can be quantified.

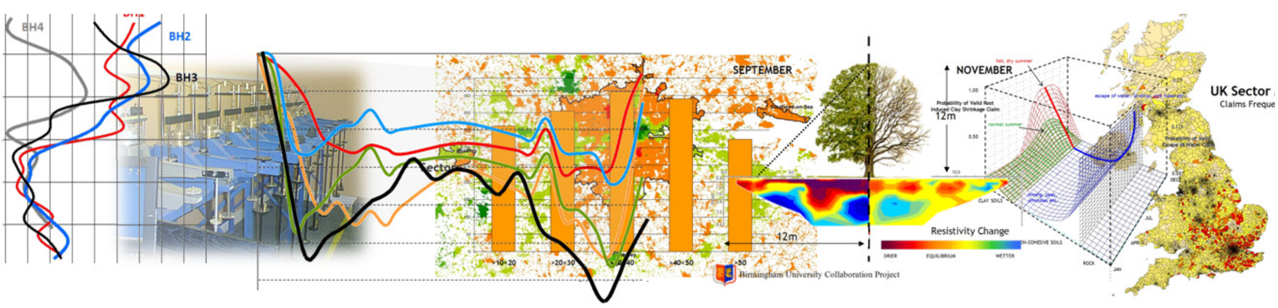
Just how much rain is needed – and perhaps 'when' is as important – to reduce the risk from vegetation?





Rainfall above the 2003 values for the period from weeks 25 to 40 (inclusive) amounted to 146mm in 2009 and 138mm in 2011. 2006 remains an anomaly, producing high claim numbers but with an excess of 272mm – greater than 2009 or 2011.

This period has been chosen to reflect the start of the subsidence season when deciduous trees come into leaf and the end. More detail next month.



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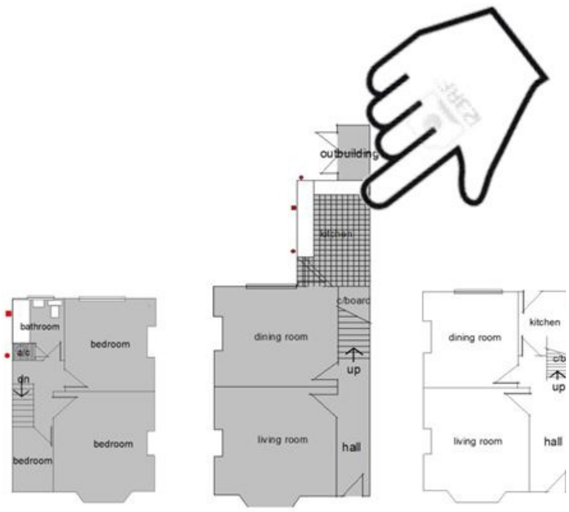
VIRTUAL SYSTEM - REMOTE CLAIMS HANDLING

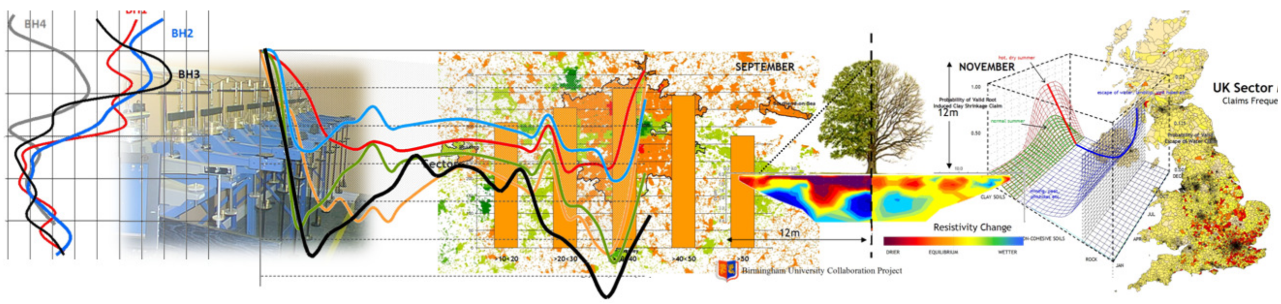
Recent editions have explored how a system that allows homeowners to enter data might look. ‘Click to select’ and ‘drag and drop’ legends that allow users to identify and position vegetation and drains, as well as selecting damage and crack locations for a wide range of standard house types.

This article looks at how the system might model outcomes (likelihood of claim validity, possible cause etc.) based on a range of standard floor plans and vulnerabilities based on analysis of our claims database. “What is the probability of a valid claim if the corner of the building is damaged?”. “What is the soil type?”. “What role do trees/drains have given they are the focal point of movement, given the geology?” approach.

Selecting the property type (see last month’s edition for details) opens a range of options "select room > floor plan > elevations" ... etc.



Floor plan options are based on property type and offer typical layouts reflecting commonly encountered failure mechanisms. At this stage there is no need to be overly concerned about accuracy - we are plotting damage location in relation to environment to see if it matches the characteristic signature of a valid subsidence claim



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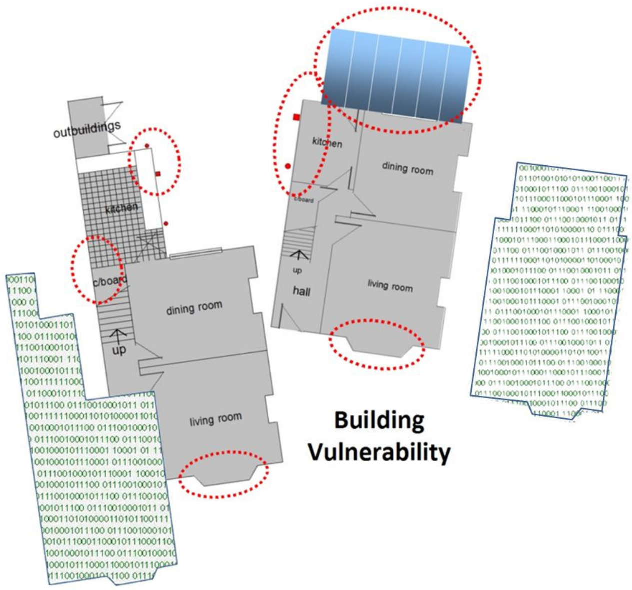


Vulnerable parts of the building are indicated above, with extensions, corners and bay windows rated high risk.

VULNERABILITY MODEL

Houses have areas of vulnerability. Extensions, junctions and corners are top of the list, and floors somewhere near the bottom in terms of risk.

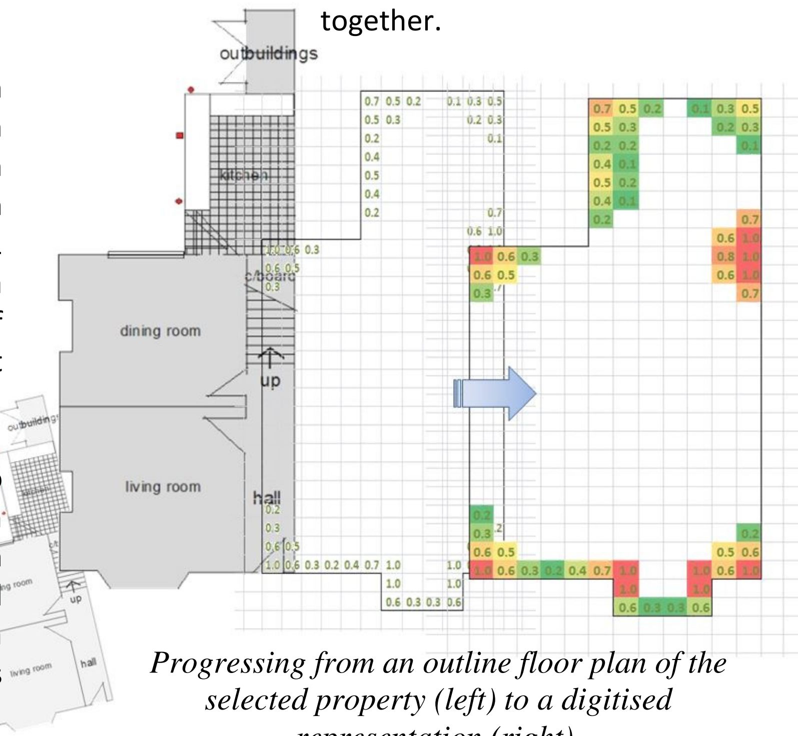
With this in mind, a digital floor plan can be constructed with the vulnerable zones given a higher probability of being linked to a valid claim when combined with a range of possible causes.

Page 11 explores the use of combined probabilities in a little more detail. The digital assessment isn't based on one factor alone, but several acting together.

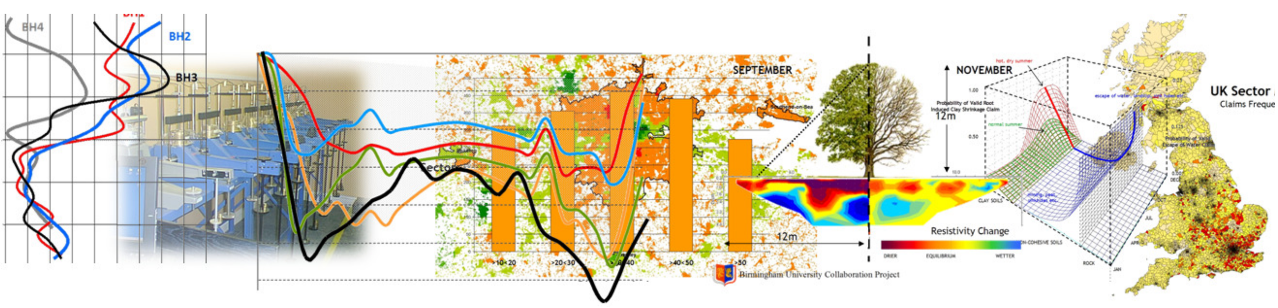
DIGITAL FLOOR PLAN

A diagrammatic illustration of a digital floor plan following selection of an end-terrace. Risk values on a normalised scale of 0 -1 reflect the analysis of a claims database. A score of '1' represents the highest areas of vulnerability.

Floors are rated 0 and so forth, in accordance with the scale described in an earlier edition and following analysis of a subsidence claims database.

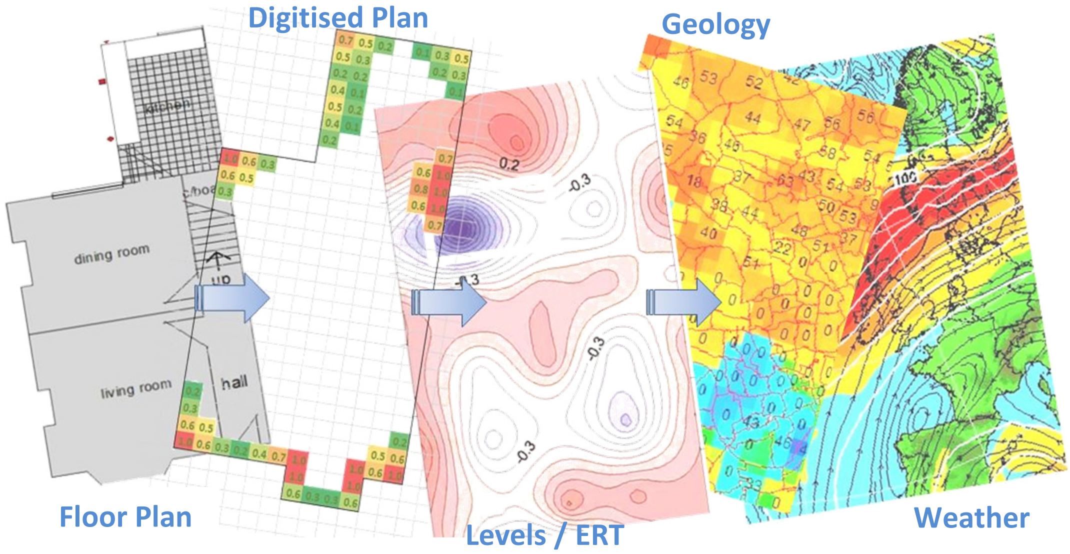


Progressing from an outline floor plan of the selected property (left) to a digitised representation (right).

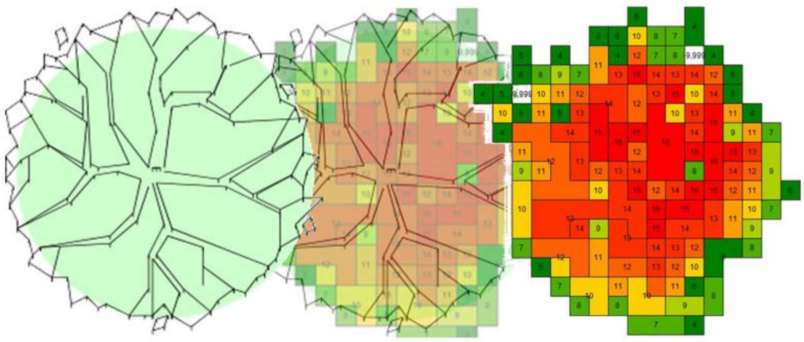


Merging the Elements – Spatial Modelling

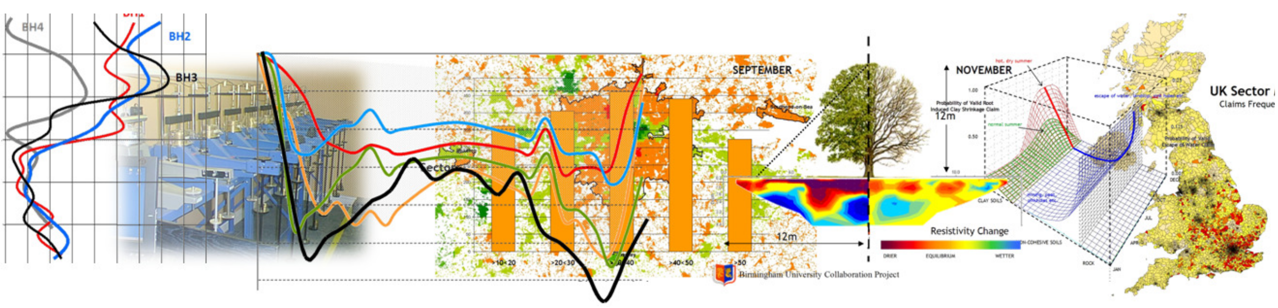
Extending the floor plan and merging with other available datasets including (from the left) a digitised vulnerability model, resistivity (or precise level) map all superimposed onto digitised geology and weather maps.



Below, digitised representations of environmental factors – trees and drains. Trees vary according to species. Root influence zones take account of tree height and distance to building as well as prevailing weather conditions at the time damage appeared.



Each zone has a risk value based on the characteristics derived from a database of over 40,000 records. These are merged with the building vulnerability footprint to build a probability of claim validity and likely cause, as shown on the following page.



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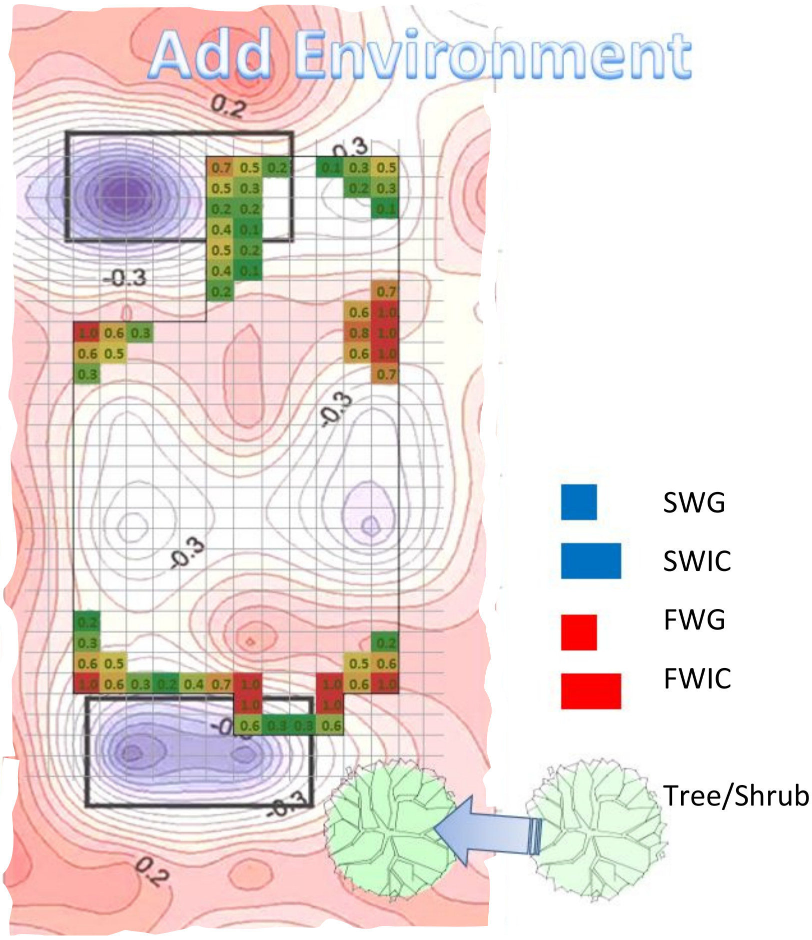
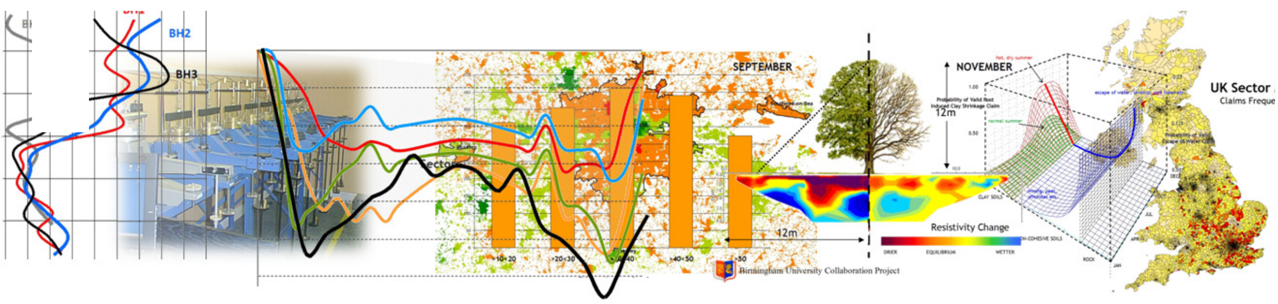
Taking Account of Environmental Influences

'Drag and drop' screens (see below) combine possible influencing factors. All of the plans align and account can be taken of the structure and environment. The system automatically attributes values to each element and calculates the probability of claim validity and causation.



In the above sketch, the digital building vulnerability model has been superimposed onto an image of the resistivity map (taken by Keele from the EKO research at Aldenham) to illustrate how a range of data can be incorporated. The legend includes typical drainage connections and vegetation.



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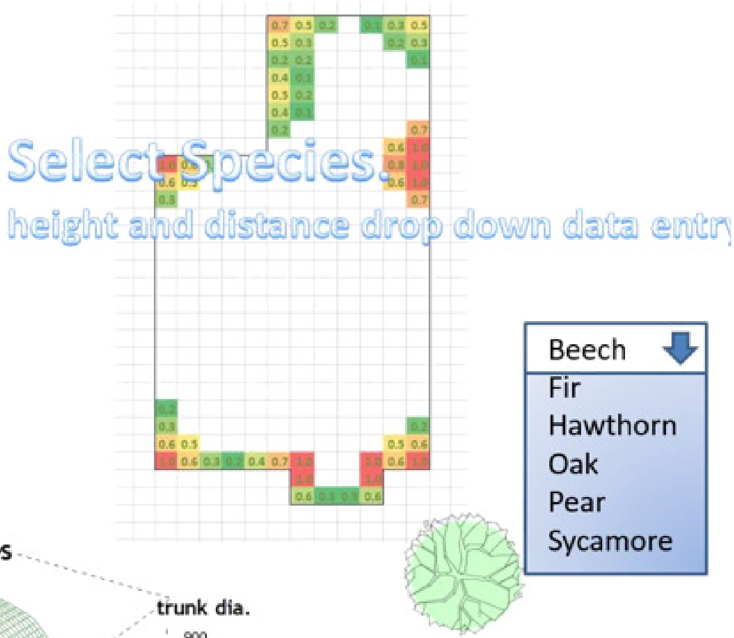
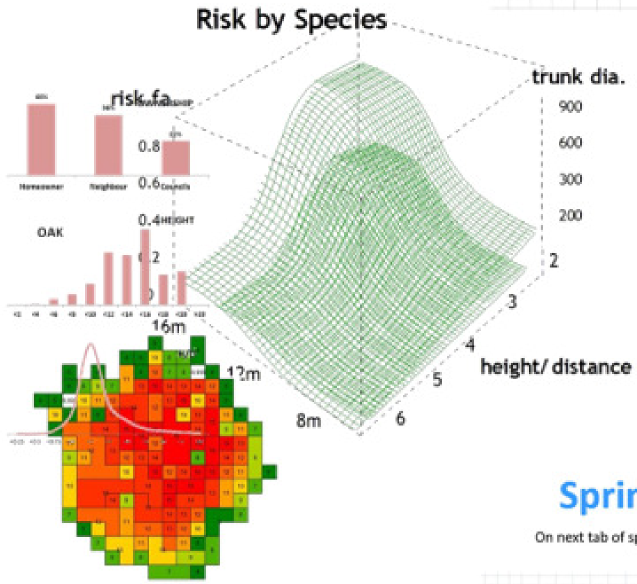
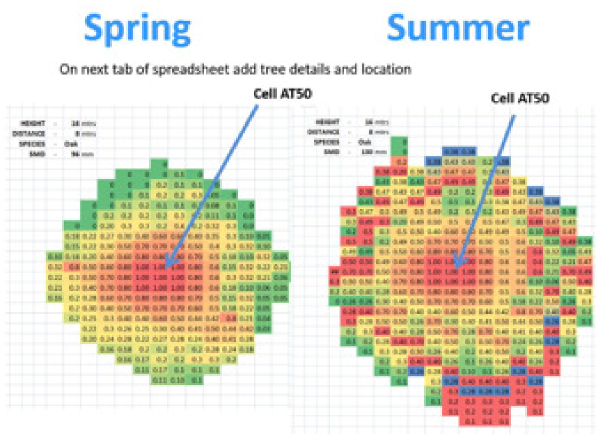
Tree Risk

The vegetation 'drag and drop' option shown on the previous page triggers a drop down menu to select species and metrics. The risk posed by each species is calculated as shown below, using a database of past claims and replacing 'in my experience' with a factual output based on objective analysis.

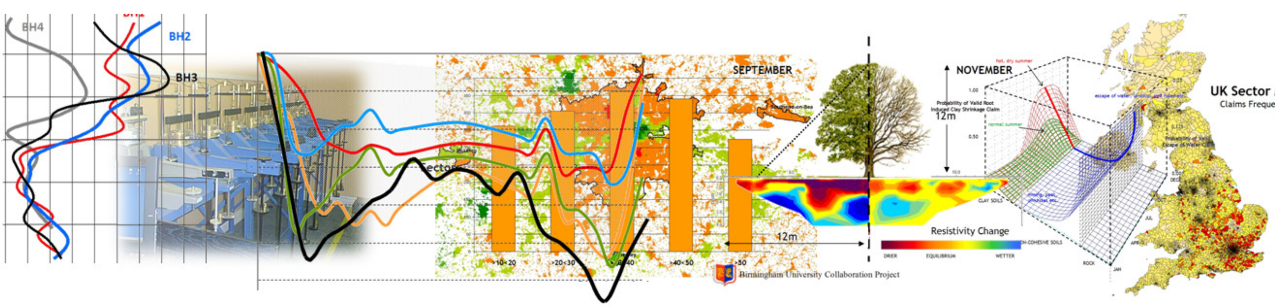




Tree ownership, height, distance and risk value are all available from the underlying database and can be upgraded by the system using the Sigmoid learning curve (see next month's edition) as times change.



The root zone will vary by species, metrics and season. Simulations are easy. "What would have happened in November, 2006" for example would retrieve weather conditions at that time and amend the output by modifying tree height. Links to risk model on following page.



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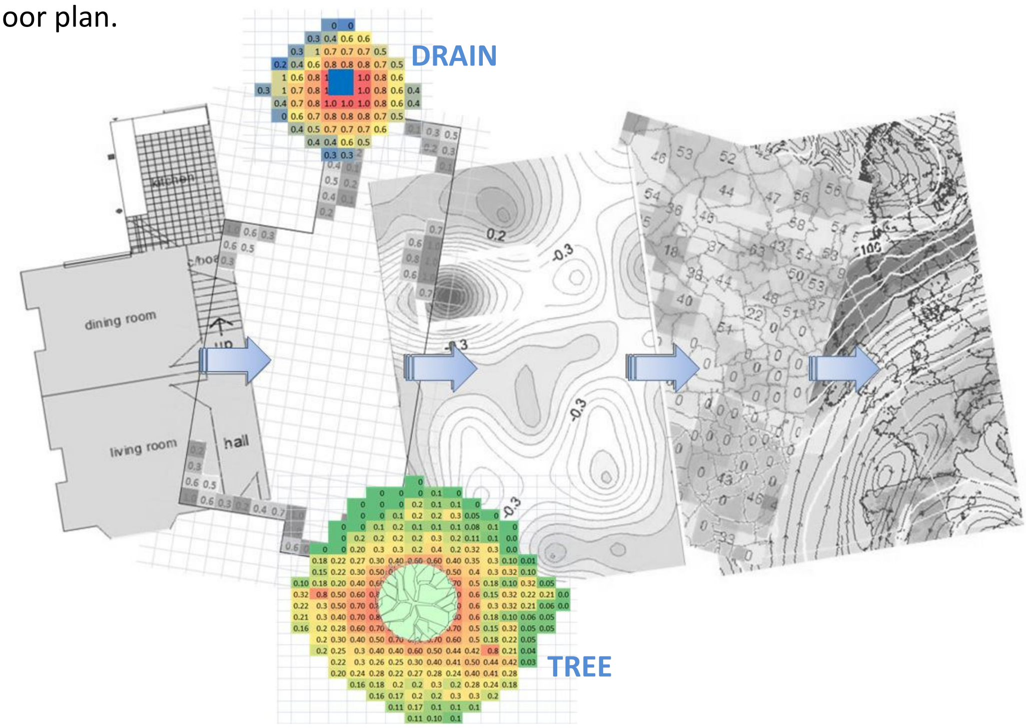
Towards the End Game

By combining the various elements, we can calculate the probability that a crack in a certain location may be related to a particular environmental factor given the geology and weather.

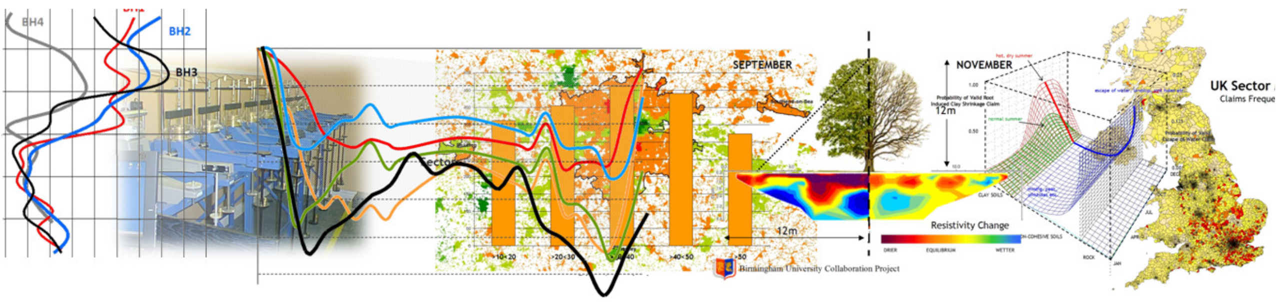
Below the influence zones of nearby drains and trees superimposed onto the floor plan.



The influence zones of both will be a function of the underlying geology. Drains will have an increased zone of influence the less cohesive the soil. Tree risk zones will be influenced by both soil shrinkability and weather.

The results of site investigations and monitoring can be added as the claim progresses. The coincidence of elements with damage is a determining factor as illustrated on the following page.

Articles on risk by geological series in this and the previous edition provide data used in the 'cause and validity' assessment application.



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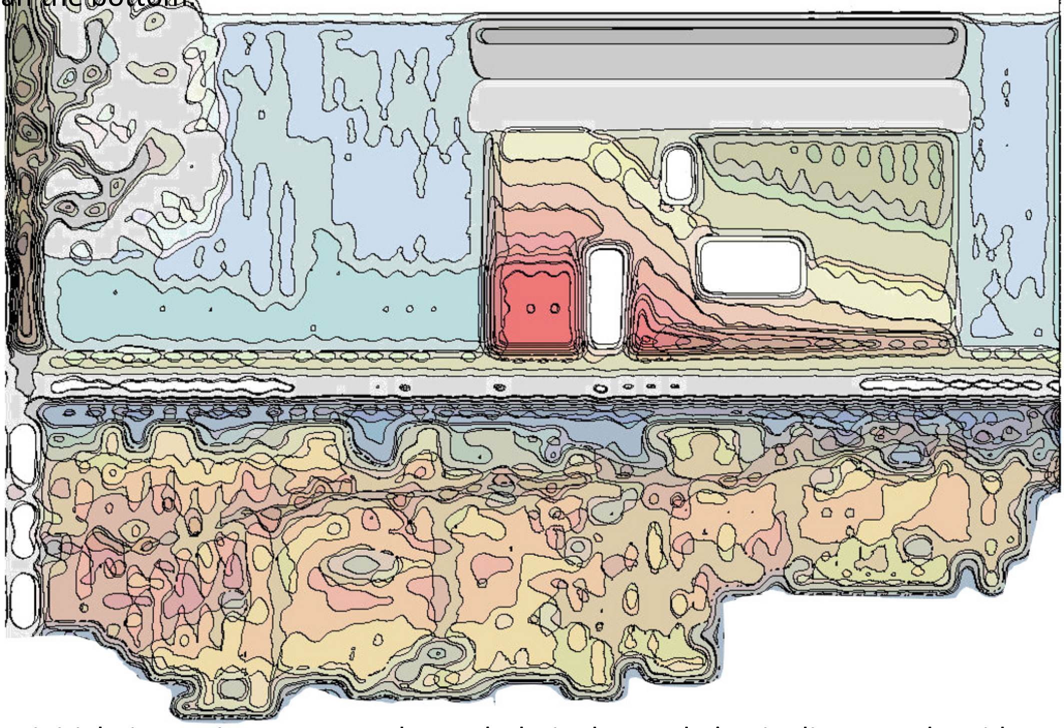
Towards the End Game – Combined Probabilities

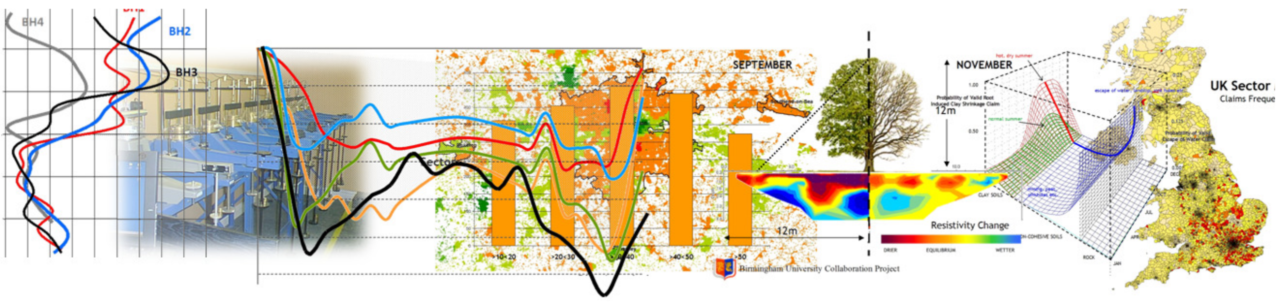
Each element in isolation adds little. The claim isn't valid simply because the house is 90 years old and older houses are riskier. The oak isn't the cause simply because it is high risk and nearby. The application uses the same deductive approach as the engineer and relies on a combination of probabilities. A diagonal crack in the side wall of a house may for example be seen as clear evidence that the nearby tree is the cause. The crack has a diagonal aspect and 'points' to the tree. It is wider at the top than the bottom.



The initial view gains support when a hole is dug and clay is discovered. Evidence in support increases if the clay is desiccated and there are roots beneath the area of damage. Perhaps the H/D ratio is 2? Did the damage appear following a particularly dry summer? Do the cracks close in the winter?

The engineers' deductive approach combines a range of probabilities, ascribing a weighting to each. The system can do this in many instances by combining the various probabilities to deliver a score that takes account of all elements. Geology, weather, building layout, tree species and metrics, spatial distribution and so forth.

The next step is, can we convert the homeowner into a subsidence engineer using the screens described?



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Towards the End Game

The system outlined here is a step ahead of what can be achieved using data alone and requires a means of modelling building outlines and spatial relationships.

When a tree is selected from the legend and 'dragged and dropped' into place, with species and height entered in drop down boxes in earlier screens, the relationship between modelled root influence and building vulnerability takes place.

Similarly, drains and their likely zone of influence, taking into account the soil type. Perhaps small zones for clay soils and a wider circle of influence for non-cohesive soils.

There is a better than 50% chance of the claim being valid if the corner or an extension is damaged. Environmental influencing zones introduce the value of combined probabilities.

As the name suggests, combined probabilities allow for logic paths like "hot, dry summer, highly plastic clay soil, vulnerable part of building damaged within zone of influence of high risk tree species therefore probability of valid claim = > 0.84".

This could trigger actions. For example, if the tree is in the neighbour's ownership then "instruct site investigations". If it is in the ownership of the Council, "instruct SI, precise levels and arboricultural report".

Assessment by the engineer of photographs supplied by the homeowner or at some later date by the SI contractor could resolve the claim. It isn't difficult to distinguish between fresh and old cracks and their pattern is a good indicator of causation with the above information to hand.

What are the objectives?

1. Empowering homeowners who feel confident using IT systems by providing an alternative pathway to progress their claim – something supported by the FCA.

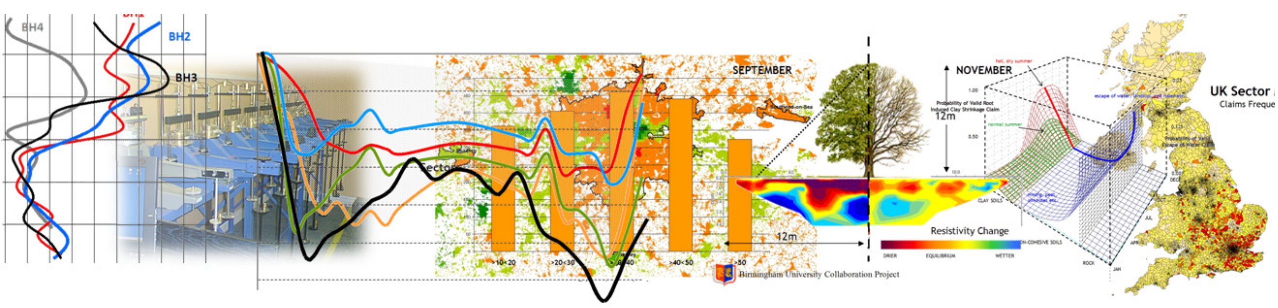
2. The conclusion – whether the claim is valid or not, and if it is valid, what is the most likely cause – is far more likely to be accepted by the homeowner having dealt with it themselves.

3. The claim is likely to be resolved quicker and quite possibly at a significant saving.

4. There is a traceable logic path.

5. Disputes around TP trees may be resolved as the system gains acceptance.

6. The approach goes some way to reducing the impact of surge bearing in mind the increase in claims is almost entirely related to root induced clay shrinkage problems.



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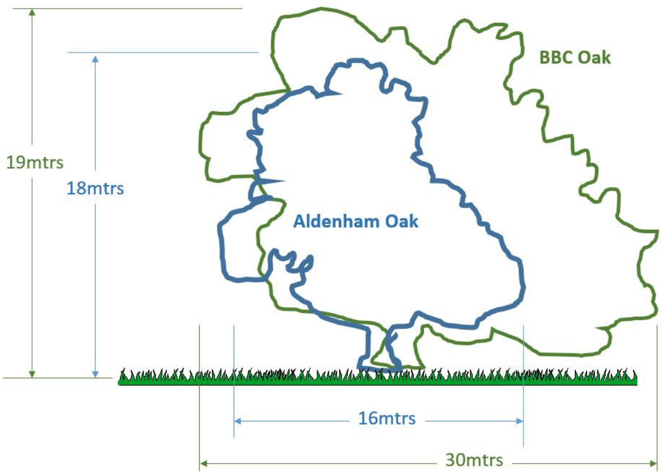
Aldenham v BBC Oak

How does the Aldenham oak compare with the one featured in the BBC repeat showing of "The Oak Tree: Nature's Greatest Survivor"?

Approximate proportions shown right (not to scale).



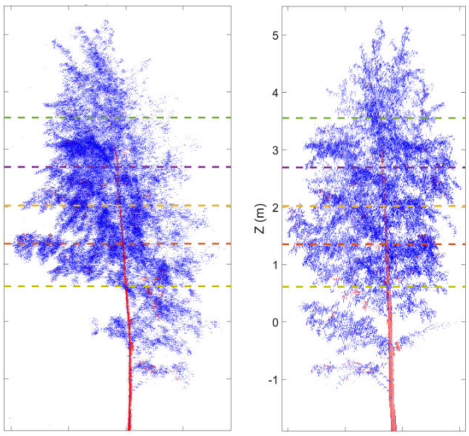


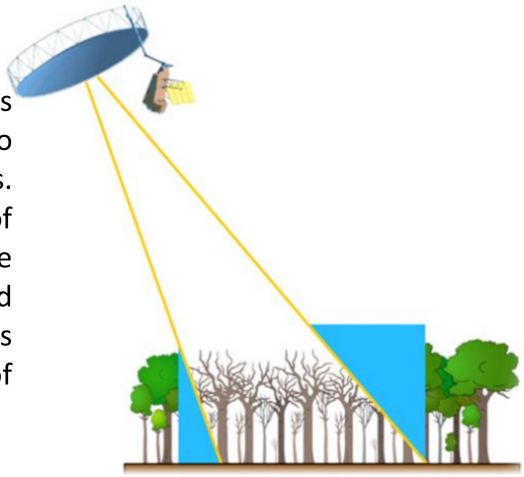
Image courtesy of Vienna University of Technology, TU Vienn

Eetu Puttonen from the Finnish Geospatial Research Institute explained, "Our results show that the whole tree droops during night which can be seen as position change in leaves and branches. The changes are not too large, only up to 10 cm for trees with a height of about 5 meters, but they were systematic and well within the accuracy of our instruments."

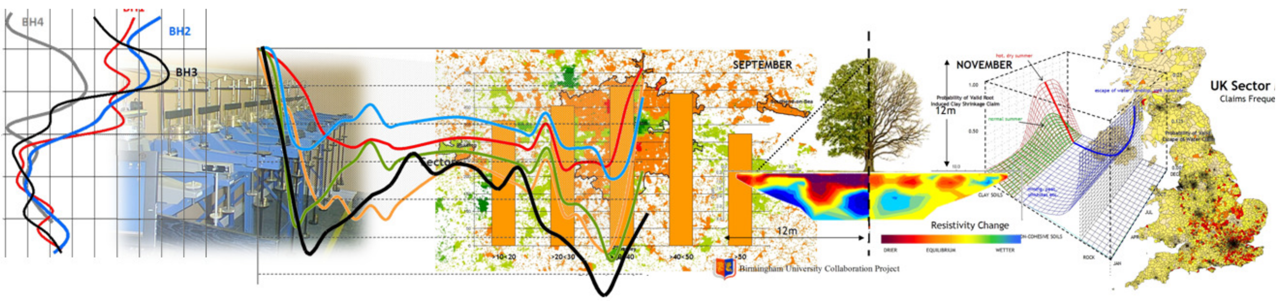
Perhaps not a surprise given the reduction in pressure within the cell due to a decrease in transpiration through the night, but another insight into the life of trees.

Weighing the Wood

As part of the European Space Agency's research program, a satellite is being built to measure various environmental elements. Amongst its capabilities is the measurement of wood mass in forests by 'seeing through' the canopy to assess the trunk proportions and mass of branches etc. The Biomass mission's novel space radar will make 3D maps of forests, updated every six months.



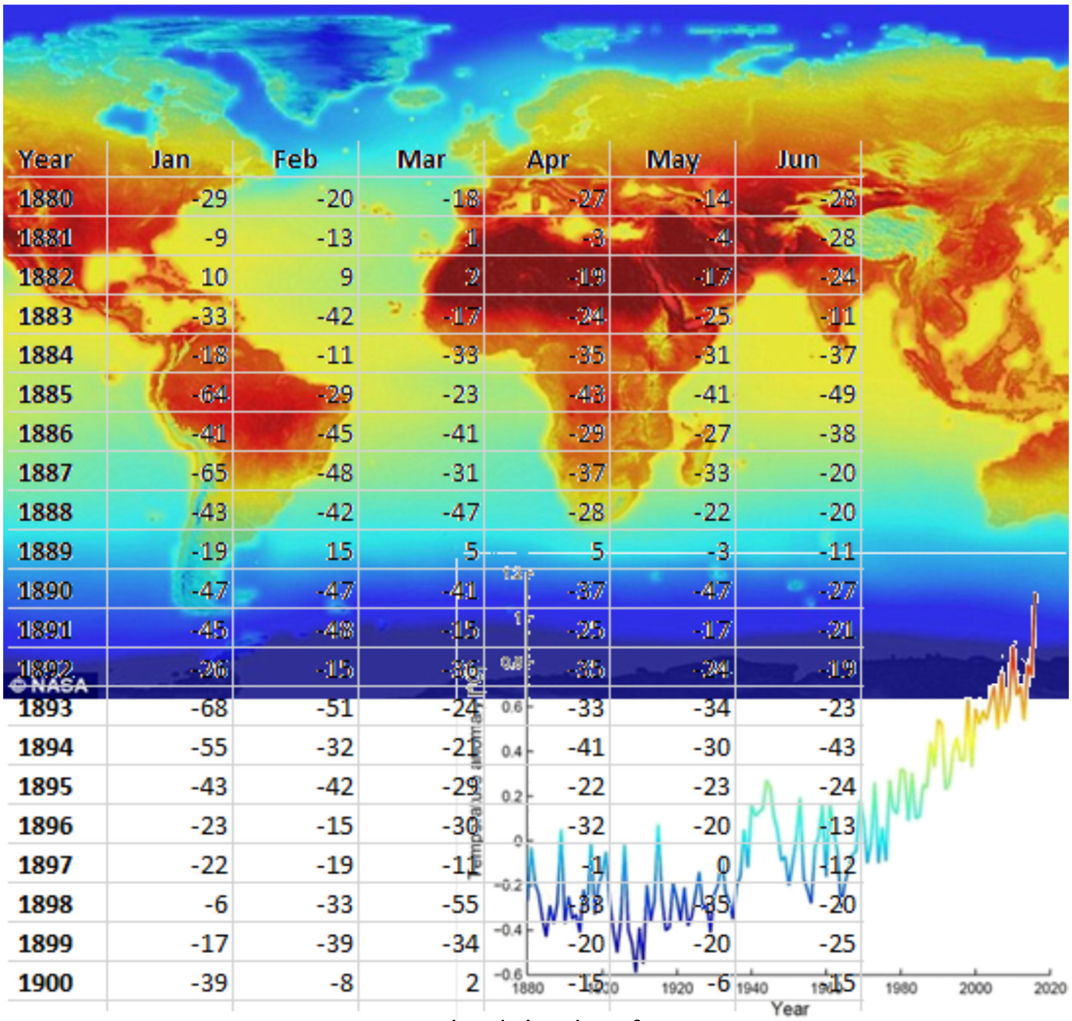
http://www.bbc.co.uk/news/science-environment-36195562



Climate Update - Warmest April. Warmest Year?

Satellite global climate data from NASA reveals that April was 1.11°C above the 30-year average covering the period, 1951 – 1980. This follows a developing trend as shown by the graphed data below. 2015 was confirmed by NASA as the warmest on record.

The record warm spell follows in the wake of an El Niño event, warming the southern Pacific and influencing weather systems around the world.



Year	Jan	Feb	Mar	Apr	May	Jun
1880	-29	-20	-18	-27	-14	-28
1881	-9	-13	1	-3	-4	-28
1882	10	9	2	-19	-17	-24
1883	-33	-42	-17	-24	-25	-11
1884	-18	-11	-33	-35	-31	-37
1885	-64	-29	-23	-43	-41	-49
1886	-41	-45	-41	-29	-27	-38
1887	-65	-48	-31	-37	-33	-20
1888	-43	-42	-47	-28	-22	-20
1889	-19	15	5	5	-3	-11
1890	-47	-47	-41	-37	-47	-27
1891	-45	-48	-15	-25	-17	-21
1892	-26	-15	-36	-35	-24	-19
1893	-68	-51	-24	-33	-34	-23
1894	-55	-32	-21	-41	-30	-43
1895	-43	-42	-29	-22	-23	-24
1896	-23	-15	-30	-32	-20	-13
1897	-22	-19	-11	-1	0	-12
1898	-6	-33	-55	-33	-35	-20
1899	-17	-39	-34	-20	-20	-25
1900	-39	-8	2	-15	-6	-15

Download the data from: -

http://data.giss.nasa.gov/gistemp/tabledata_v3/GLB.Ts+dSST.txt