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

The Clay Research Group
www.theclayresearchgroup.org

July 2009

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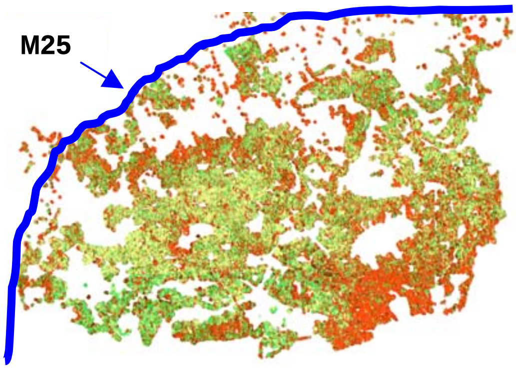
Trees by Height

Below is a thematic map plotting trees-by-height in North West London. The older areas have a high concentration of tall trees as we would expect.

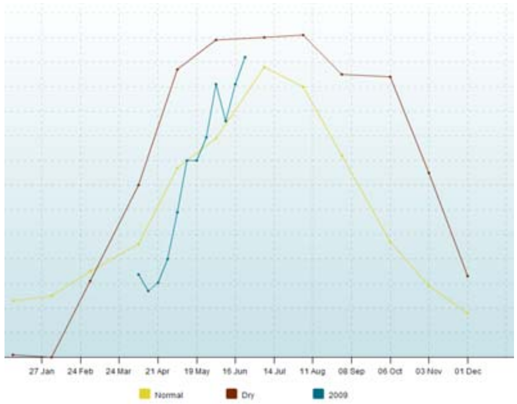


We have no evidence that taller trees present a higher risk – in fact, quite the opposite.

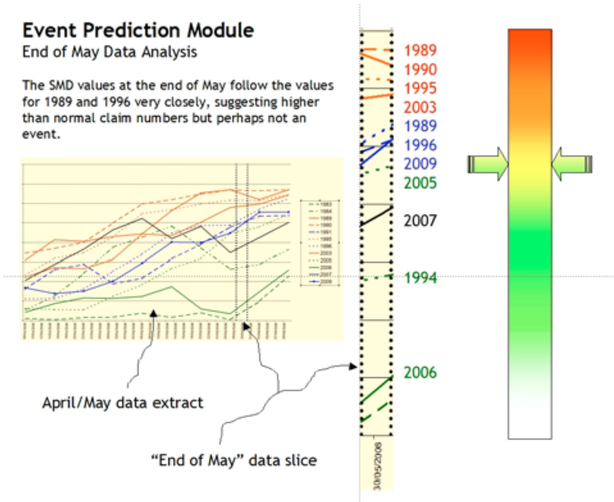
Expressed in terms of claims-by-frequency-of-planting, and ignoring species, trees in the height range 10 – 12mtrs appear to be riskier than trees 20m tall.

Event Prediction

The SMD figures from the Meteorological Office increased significantly for a week towards the end of May, and the slope of the line increased steeply before falling back to follow a signature lying between a normal and an event year – see below. Hotter weather is predicted.



The threat of a full blown event year appears to be balanced precariously with episodes of hot dry weather interspersed with heavy rainfall – 2009 isn't easy to categorise compared with other years.



As we see above, the SMD for 'end of May' are listed above in rank order and 2009 falls directly between 2005 (a normal year) and 1996 – a busier year.

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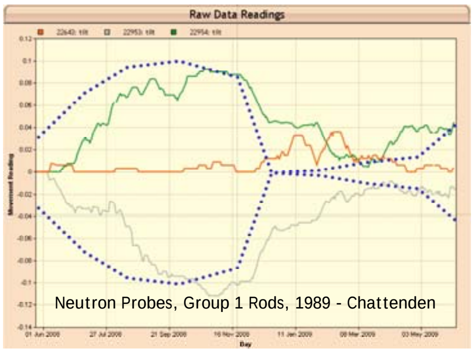
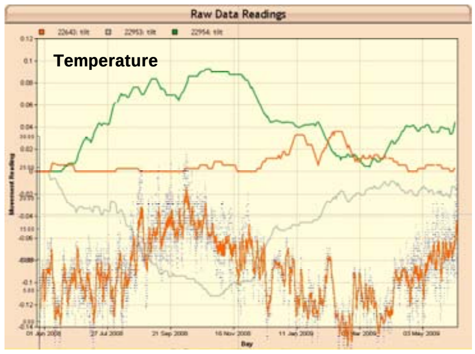
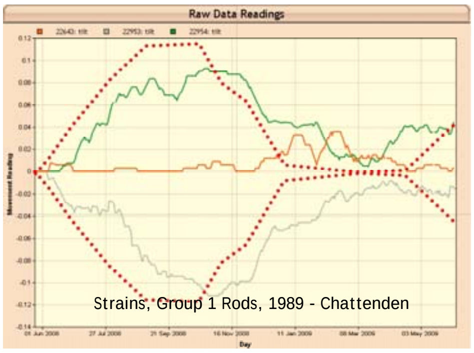
Weather Station -v- EL Graph

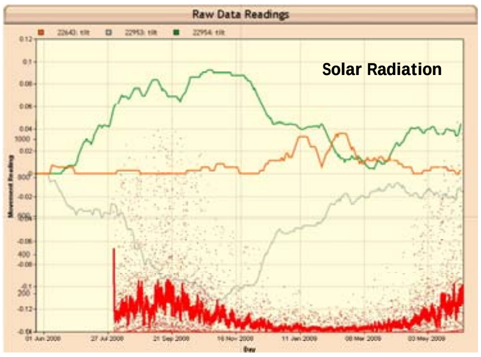
Various graphs have been superimposed onto the electrolevel plot including temperature, rainfall, humidity, solar radiation etc., over a twelve month period, commencing 25th May 2008, to determine which has the highest correlation (and therefore might provide the most powerful influence) driving building movement. In addition we have traced neutron probe and strain data obtained in 1989 by the BRE at their Chattenden site where ground movement was measured over several years and produced bounding envelopes.

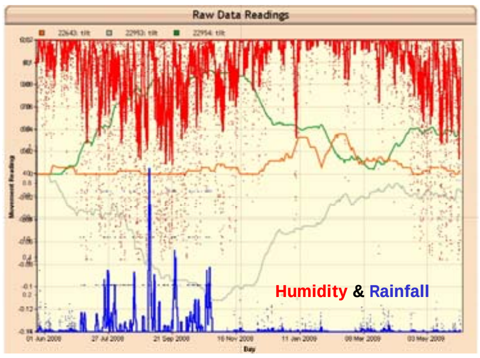
The weather data has been gathered from our station at Aldenham, and the electrolevel plot relates to a building situated in postcode KT, about 20 miles away. Not ideal, but we are looking for trends and relationships and as can be seen on the last page, there does appear to be a general correlation between movement on different sites, even though tree species differ.











The data are not scaled relative to one another to reflect their influence. There has been no attempt to relate quantitative moisture deficits and strains from the Chattended site to the EL plots for example. We are just comparing signatures.

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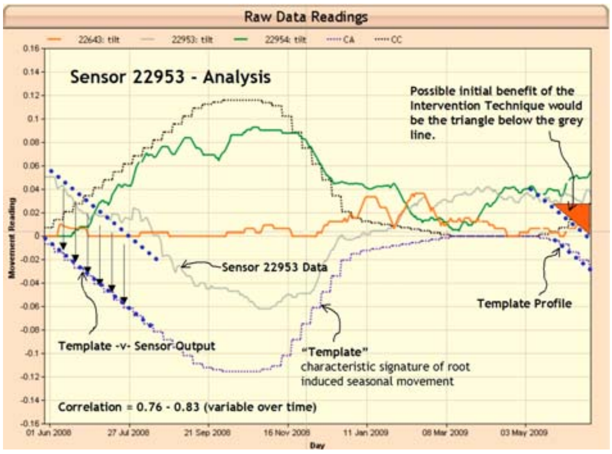
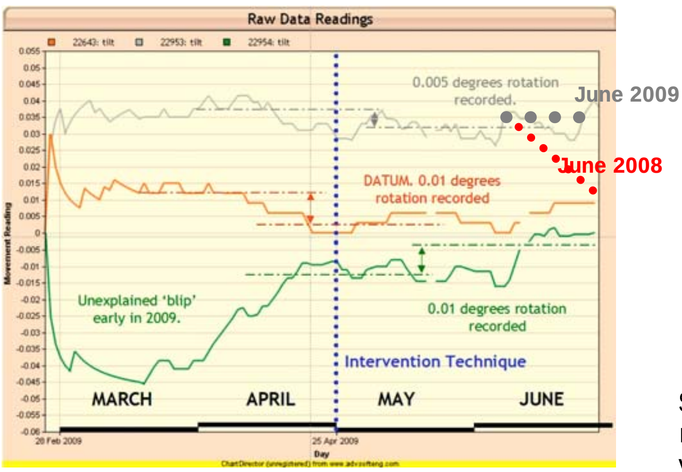
Intervention Update

The plot from sensor 22953 has been flat-lining since treatment was applied and sampling the data at the end of May (see image at the bottom of this column) suggests the technique may have delivered some benefit, although it is far too early to say with any confidence.



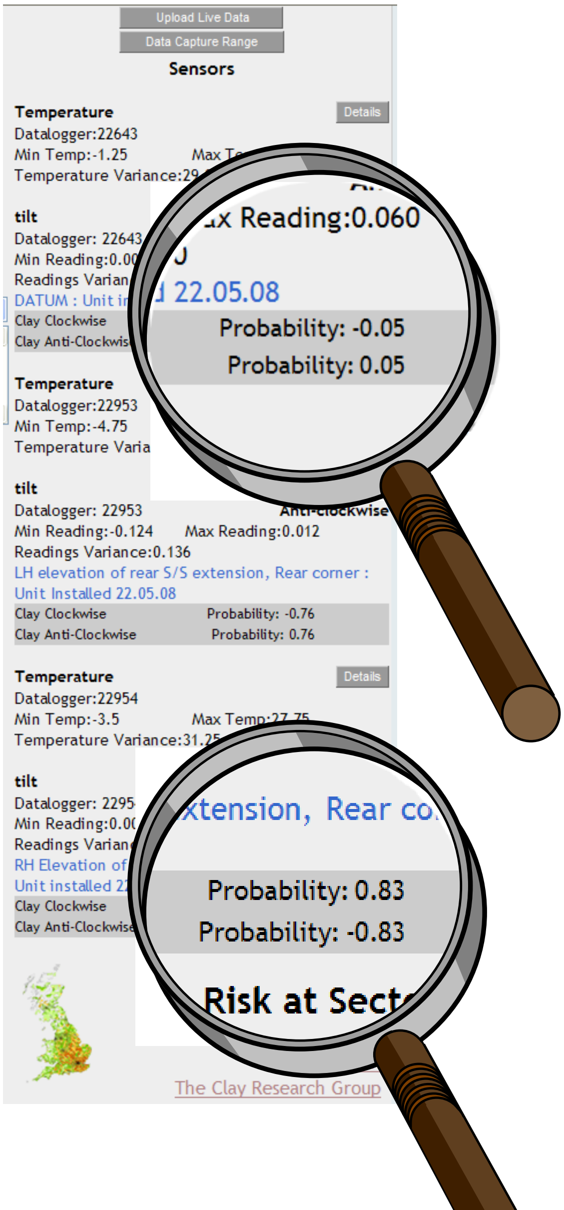
Sensor 22953 (grey line) is delivering the more consistent signal (the green plot suggested subsidence commencing in early March, which can't be root induced). Comparing the output with the characteristic signature of root induced clay shrinkage (above) we see (right hand side of plot) that there is initial cause for some cautious optimism, but we will see through June and July.



The treatment method will be reviewed taking into account our findings throughout 2009. The objective is to reduce the amplitude of movement, even though 2009 looks like being a drier year than 2008.

Electrolevel Update

Understanding the output of the electrolevels isn't always straightforward. Below we have the screen print of the Intervention site sensors.



Sensors 22953 and 22954 (the lower two of the readings) show probabilities of 0.78 (max variance 0.124 degrees) and 0.83 (max variance 0.1 degrees) that the pattern of movement is due to root induced clay shrinkage. Anything above 0.7 has a very high confidence. In contrast, the datum has a probability of 0.05 with a max variance of 0.06 degrees.

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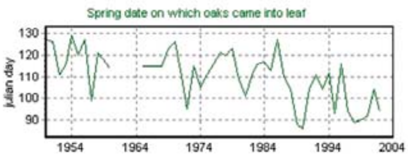
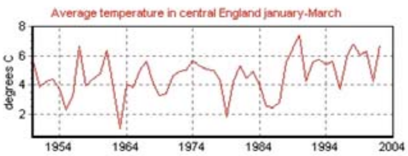
Coming into Leaf

Work by Sparks and others suggests that a 1°C increase in temperature is associated with a 7 day advancement in leafing. In short, warmer weather leads to trees coming into leaf earlier.

The paper publishes a graph of the relationship over time. See below.





The figures suggest that Oaks for example are coming into leaf almost a month earlier over the last 50 years.

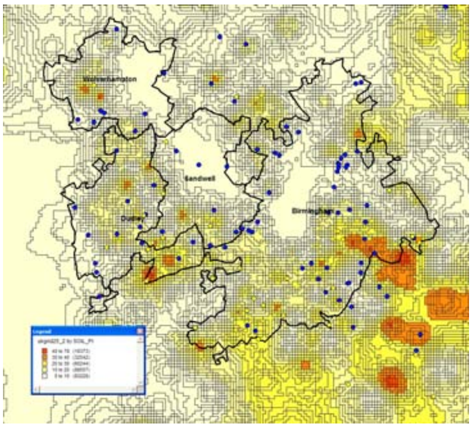
Source: TH Sparks, Institute of Terrestrial Ecology, Monks Wood, Abbots Ripton, Huntingdon, Cambridgeshire PE17 2LS; courtesy of Mrs J Combes, Ashtead, Surrey

Sightings of trees of varying species coming into leaf across the UK are logged on www.naturescalendar.org.uk/ - select "Results"

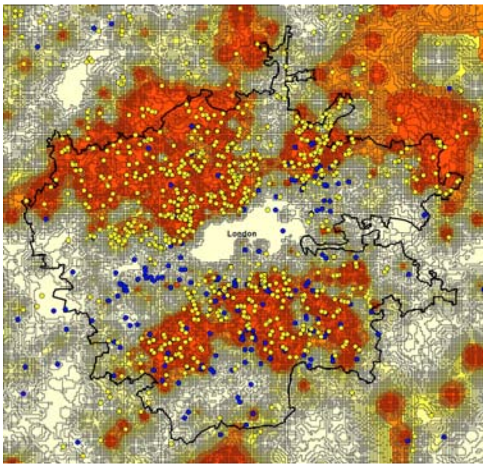
This well constructed site shows a peak in reports for the Ash coming into leaf around the 25th May and for the pedunculate Oak, 19th May. The data are mapped.

Escape of Water

We have been studying an extract of claims to see if there are any particular indicators (at the point of claim notification) that would help us distinguish clay shrinkage claims from damage caused by water escaping from drains.



For example, would the area of damage include more kitchens and bathrooms? Is there a particular age of house?



The only link that we could find was a geological one – using our soils map 'in the alternative' provided a far better indication of the peril than any individual item of data. Above we have thematically mapped soils PI in the ranges 0-10, 10-20, 20-30, 30-40 and > 40. Yellow dots are clay shrinkage, blue dots are water claims.

The breakdown for the above cities (London and Birmingham) appear on the following page.

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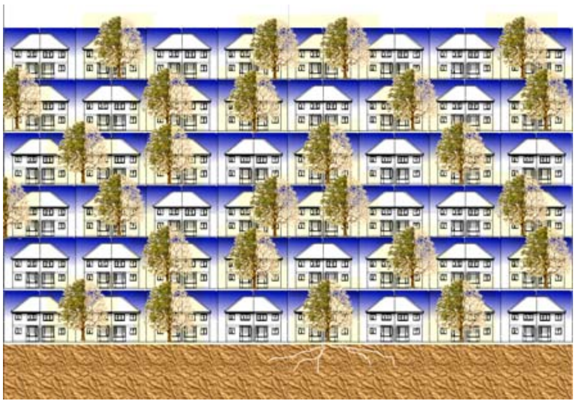
Risk

There are 96 houses in this picture, and 25.5 trees. A not untypical sample from an area like Harrow. Using the figures from the previous page, we might expect 0.00354 x 96 houses to be damaged. That is one-third of one of the houses we see. Of course, time doesn't stand still, and over say 10 years, just over three of the houses will be damaged. But which?

Our model points to a particular age of house as being more vulnerable than another. It suggests trees of a certain height, and distance away from the house of a certain age, present a higher risk. The presence of a shrinkable soil – the more shrinkable the better – is self-evidently involved somewhere, as is the climate, but getting back to the point in question, which houses will be damaged in the next ten years? Can we point them out?

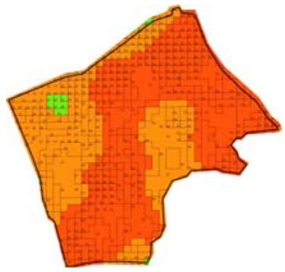


No we can't. Can an arborist, or a geotechnical expert? No, they can't either. None of us can predict with any degree of confidence which trees will cause what damage, where, or when. If this was a picture that painted a thousand houses, we would only see 35 subsidence damaged houses in 10 years, assuming a 5 year return period for event years.

We imagine this is the risk posed by a variety of perils, and is the nature of insurance. Smoking causes deaths to a small number of people, but it increases their risk nonetheless. Cars of a certain make, model, combined with a certain age of driver of a particular sex increases risk. Trees are no different. We don't know which tree will cause what damage, and when, but they do increase the risk.

Harrow Study Area

Harrow has a fairly uniform geology as we see below. The soil PI is in the region of between 40 – 55%, typical for London Clay, with much lower values to the western boundary.



It has a claims frequency of around 0.00354, comparable with Islington at 0.0038. The distribution of claims is spread evenly around the Borough of Harrow as we might expect given the soil profile.

The difference is, in Islington the frequency increases significantly to the North West, reaching a value in excess of 0.005, revealing the problem with current boundary definitions.

The 250m tiled grid allows maximum definition at a sensible resolution when dealing with geology.

By Peril

Referring back to the study on the previous page, the probability of a claim being due to Escape of Water in Birmingham is around 68%, and in London that value falls to 20%, reflecting the geology.

The probability of a claim being due to root induced clay shrinkage is therefore only 32% in Birmingham, but that concentration is heavily skewed towards the clay series. Elsewhere (where the soil PI proeprties are much lower), we anticipate low order damage associated with the presence of Boulder Clay or the outcropping Mercia Mudstones.

In London, the split between the perils is clear. Lots of blue dots (EoW) around the Thames and to the South where we have variable geology, and high probabilities to the North West, reflecting the more homogenous composition.

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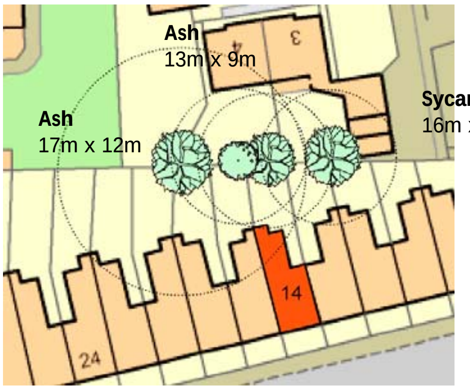
Hampstead

In 2003 (an event year) a site was identified in North London to test the first release of electrolevels. It shared many features with our current project.

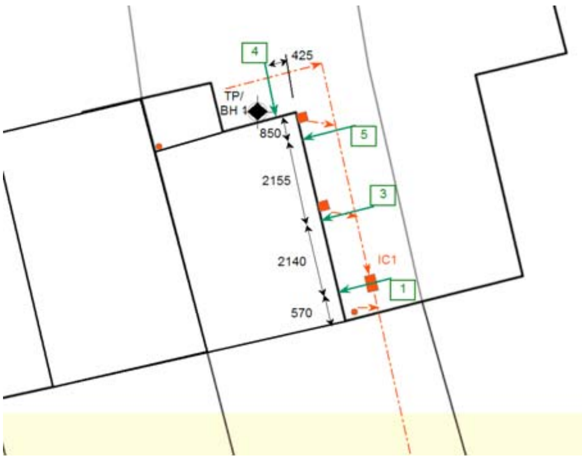


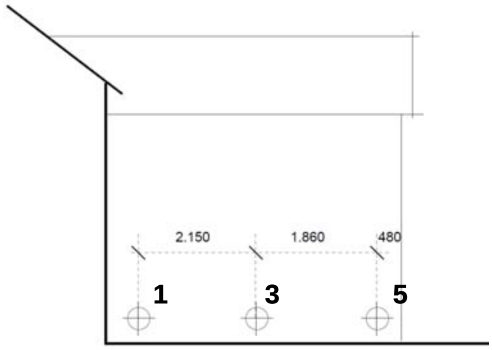
There were trees of similar proportions, species, height and distance. The soil P.I. was around 45%.

TABLE 1 **TREE DETAILS**

Tree No.	Species	Age Cat	Age Class	Approx. Height (m)	Dia. (cm)	Crown Spread (m)	Condition	Growth Potential	Dist. to Building (m)
T1	Ash *Fraxinus spp.*	1	E/M	*13.0	*29	*6.0	Fair	High	*9.0
Description	No evidence of recent management.								
T2	Sycamore *Acer pseudoplatanus*	1	M	*16.0	M/S *68	*11.0	Fair	Medium	*12.0
Description	No evidence of recent management.								
T3	Ash *Fraxinus spp.*	1	M	*17.0	M/S *50	*10.0	Fair	Medium	*12.0
Description	No evidence of recent management.								

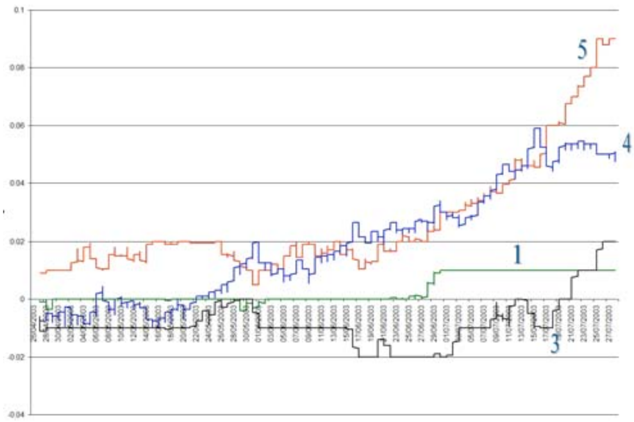
4 No. electrolevels were installed and the output is shown in the adjoining column. The sensors were distributed as below.





Sensor 4 (fitted to the rear wall, just around the corner from Sensor 5) started moving first, towards the Sycamore, around the 18 – 20th May, 2003.

Sensor 5 followed around 1month later, commencing around the 20th June. Sensors 1 & 3 followed later in the month.



The amplitude of movement also varied. Sensors 4 & 5 rotated by about 0.09 degrees. Sensors 1 & 3, less at around 0.02 degrees but with a variable signature.

Interestingly, Sensor 4 recorded movement much earlier (22nd May) than Sensor 5 (29th June) even though they were fitted only metres from one another. Does this suggest the Sycamore came into leaf earlier than the Ash?

Does the amplitude of movement (Sensor 5 rotated more than Sensor 4) suggest the Ash is the more aggressive species?

As the circumstances are not dissimilar to our Intervention study, is it the case we will see movement commencing towards the end of June?

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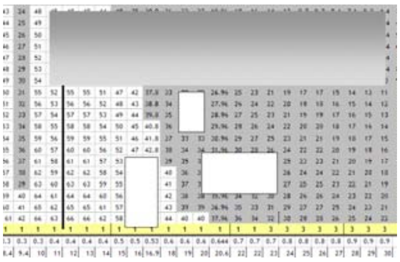
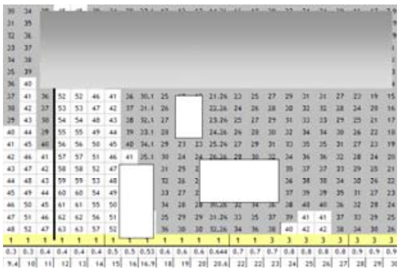
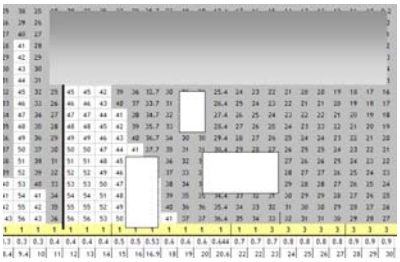
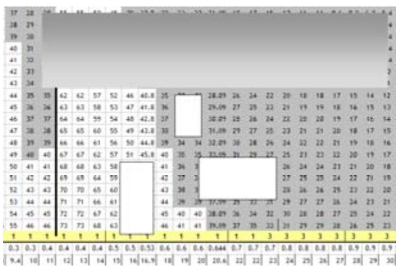
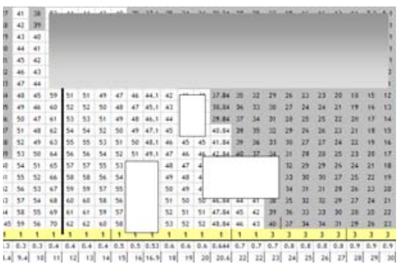
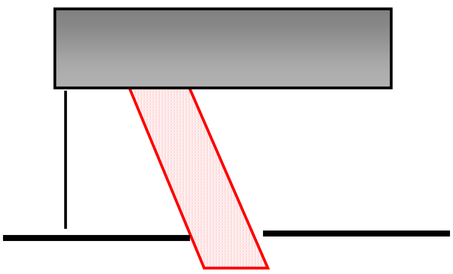










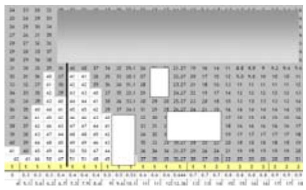


Disorder

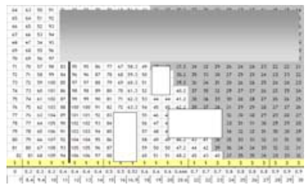
Climate, variable soil properties, building vulnerability, and tree physiology all conspire to bring a degree of chance to the topic we are researching, and hence the term, "Disorder Modelling".

From this apparently random mixture is a semblance of chaotic order, and the random nature is – if we are to believe recent research into neurology – absolutely fine. It is what makes things work.

Apparently our brain doesn't function in a linear fashion when problem solving. It literally 'throws all of the cards up in the air", and as they land, the pattern that emerges can deliver solutions. Going to bed "to sleep on it", might not be a bad idea apparently.



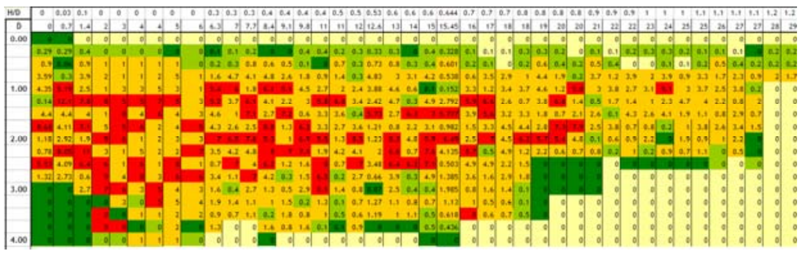
56% P.I. - Ash



56% P.I. - Oak

Left we show how our model iterates several hundred times a minute to build random patterns that take account of the above disorder to build probability patterns. They have an empirical basis as we have used claims data and actual results to provide bounding envelopes.

Root Zone



"Looking OK", is fine in such cases. The example we have modelled here is a 16m Oak tree, 9mtrs away from a building on a soil with a Plasticity Index of 45%. The likely stress zone is shaded in red at the bottom of the array.

This is where the model predicts that cracks might develop. The initial probability of the tree causing damage is very low – 0.00354 in Harrow – but when it does, we can use probability theory to assess the likelihood of the tree being the cause.