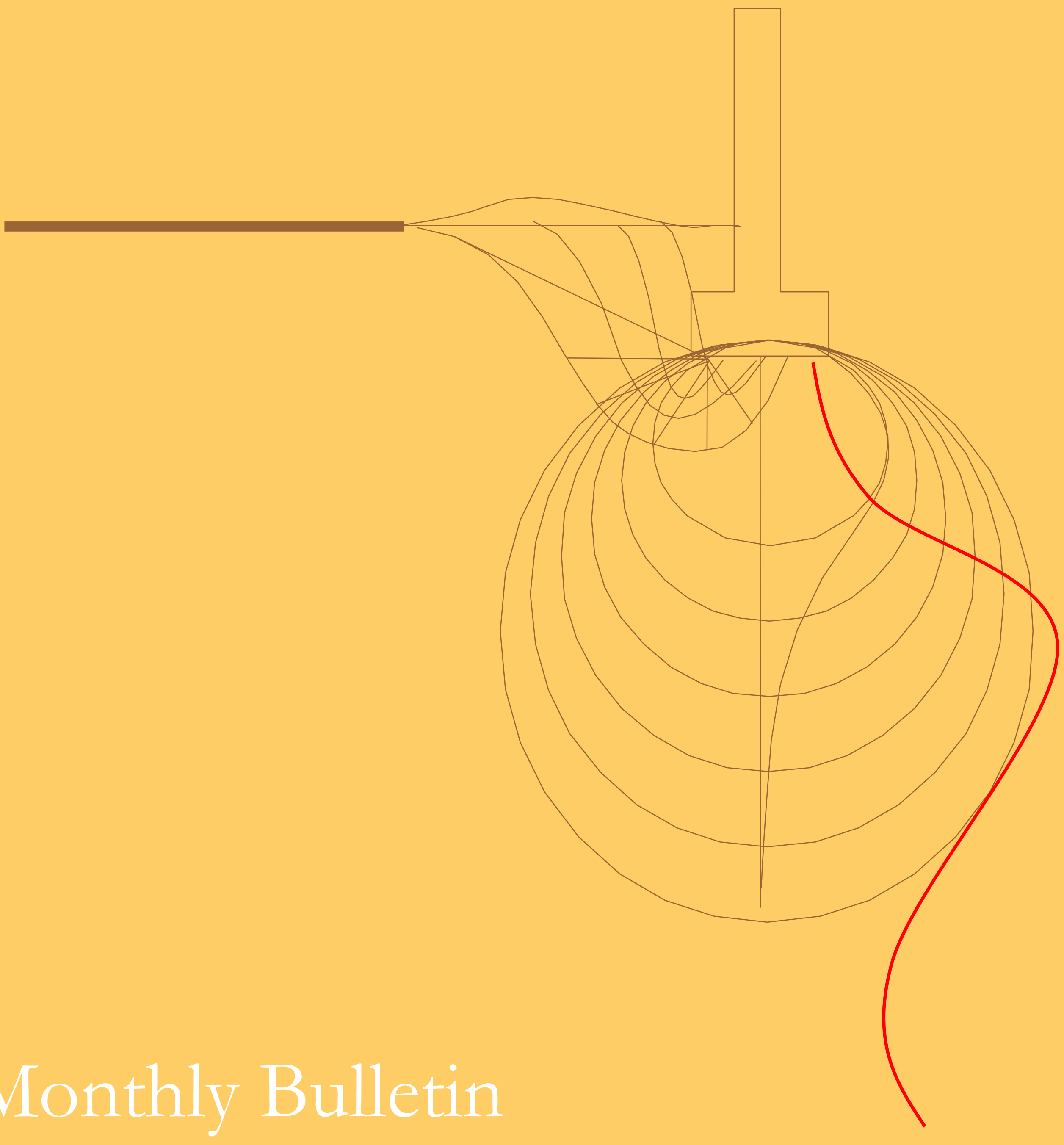
# The Clay Research Group



Monthly Bulletin

The Clay Research Group
January 2007.

Aldenham SCHOOL
Supporting Research

## CONTENTS



# Risk by Borough

A look at the London Boroughs, starting with

## Barnet.

NW11 7 is a high risk postcode sector. Our study includes counting the number of trees, identifying ownership (private or public), counting the number of houses within a notional root zone, plotting the tree heights in 5mtr bands, deriving tree density images, reviewing aerial photographs and claims data to build a frequency table.

We hope it will have relevance to insurers, Local Authority Tree Officers, surveyors, adjusters and engineers.

An obvious application is triage and work has already started on developing a neural imaging program (see Page 3 – "Understanding Complex Patterns") that allows a much wider interpretation of sparse or vague data.

Data is the key to everything we do, and the objective is feeding this back to the suppliers via intelligent applications like VISCAT, OSCAR and the DataReader.

Anyone that is interested can draw down 'Barnett Data Sheet' from the web if you would like a copy. www.theclayresearchgroup.org.

## LOOKING BACK ON 2006

2006 was our foundation year. Instruments were set in place to record the daily and monthly lives of the Aldenham Oak and Willow. We watched the ground move – literally – and measured moisture change using a variety of techniques. The combined influences of climate, plant physiology, evapotranspiration and soil mineralogy were recorded using precise levels. Live data was shared with the industry as it was obtained. The Aston Conference saw a real sense of community as we watched the England football team at work.

The output has been prolific. A new geology that directly reflects risk on a 250m tiled grid. A new breed of uncertainty models are coming to the fore. New technology has been validated in the form of electrolevels and TDR moisture sensors. Data is being sent over the web using telemetry. Some of this technology is already deployed, delivering significant benefits to the users.

It has set the pace for 2007 and hopefully, with the help of the existing team and any newcomers, we will see further changes that reduce both the claim spend and life-cycle whilst enhancing the service we deliver.

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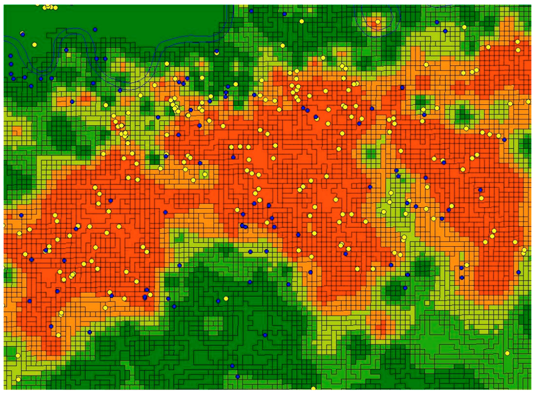
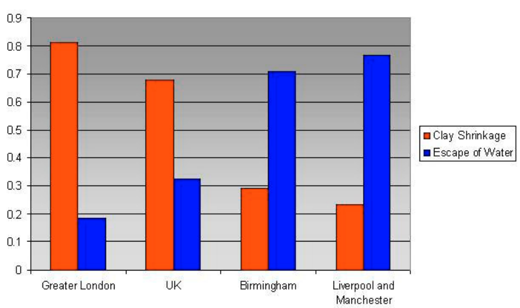
## Probability

Our probability model uses claims data for both underwriting and triage.



The above image sgows how claims are distributed south of the Thames using yellow dots for clay shrinkage, and blue dots for escape of water. We have carried out this analysis this for every major city in the UK.

From this study we derive the probability of a peril occurring. For example, in Birmingham the probability of a claim being due to clay shrinkage is 0.3 and 0.7 for escape of water.




Ascribing these values at sector level requires a lot of information, and the data has to be 'like for like' from a particular period and representative of the industry - if possible.

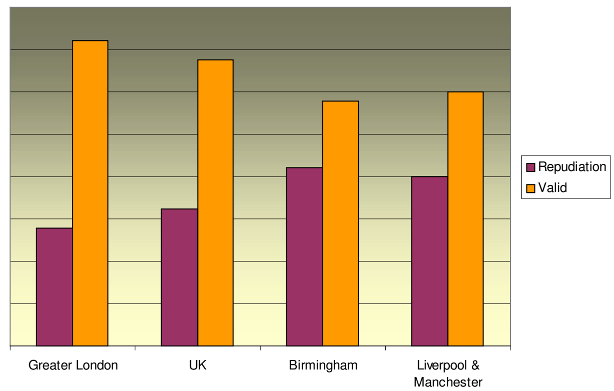
Add loss values per claim for the underwriting model and we have applied some science to a problem that varies not just with location, but also with time.

The winter model won't be the same as the summer one. On Page 5 we add a further dimension by taking into account the age of construction, and explain how we scale the data by postcode sector to build our models.

## Claim Probabilities

Claim data varies by city, district, sector and with time. Repudiations are greater in the winter than the summer, and to compound matters, they vary by year. Long dry summers produce higher valid claim numbers of a particular peril than 'normal' years.

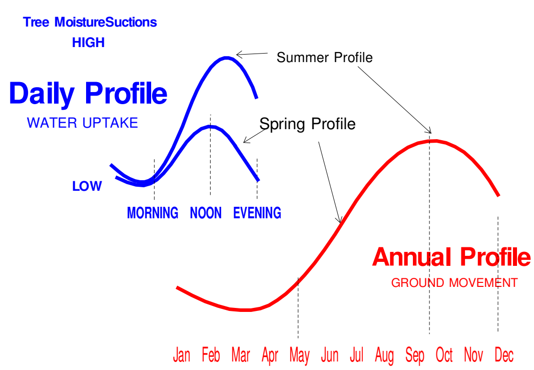
By breaking these elements down and ascribing probabilities to each is part of the risk model.




Bottom left on this page we see how the peril distribution varies, and elsewhere, how the age of house comes into play. Our model takes account of the time of notification by individual peril, likely root spread of certain trees, possible depth of foundation, soil type and the periodic signatures of just about everything.

Data makes experts of us all – until we come to an actual claim of course, when we feel obliged to leave it to people who know what they are doing!

Our point is that the more we share data, the better our understanding. Others may have different datasets that provide different answers in specific locations for good reason. It would be interesting to hear from them. Surely we can't delay our technical progress as an industry simply because of some odd notion that learning from past experience is a bad thing?

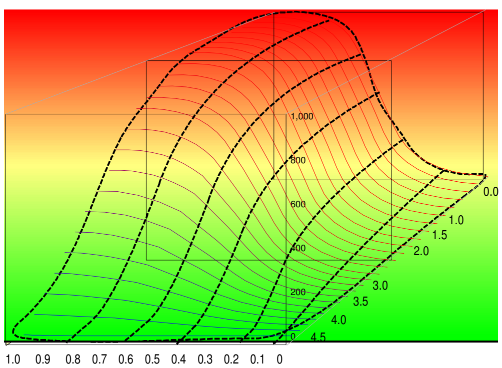



### Patterns within Patterns

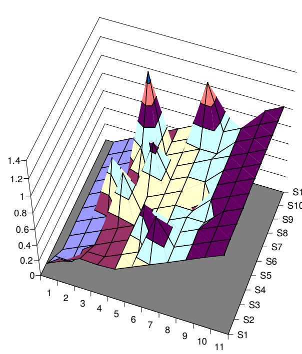
Here we plot the usual periodic signature of ground movement (red) over 12 months. To the left (blue) we see the daily moisture uptake of vegetation. The tree is a pump, working every day exerting ever increasing pressures in response to relative humidity, wind speed, hours of sunshine etc. It drives the ground movement in small incremental steps.

## Understanding Complex Patterns

Over the last 3 years there have been developments in our understanding of how the brain 'makes sense' of complex stimuli and this is relevant to our work. Nicolelis & Ribeiro have shown that the simple linear model of neural activity doesn't cater for the huge complexity of problem solving. Instead, using implants and measuring the activity of individual neurons they suggest a complex array is triggered across the brain, and the suggestion must be that our nervous system 'makes sense' of this 3D array.



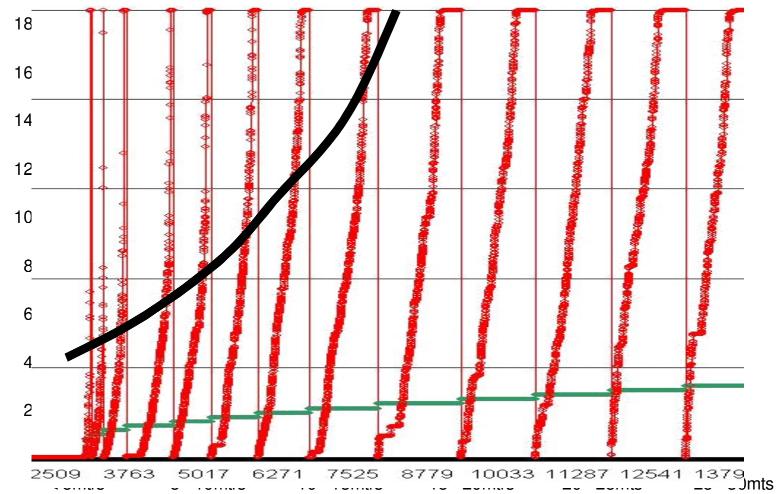

The significance to us is developing a model that can 'understand' the complex interaction of the various elements by pattern matching irregular responses. In short, the pattern doesn't have to be an exact match.




It can be the closest match and dynamically learn from its experience unlike many static, one-dimensional models.

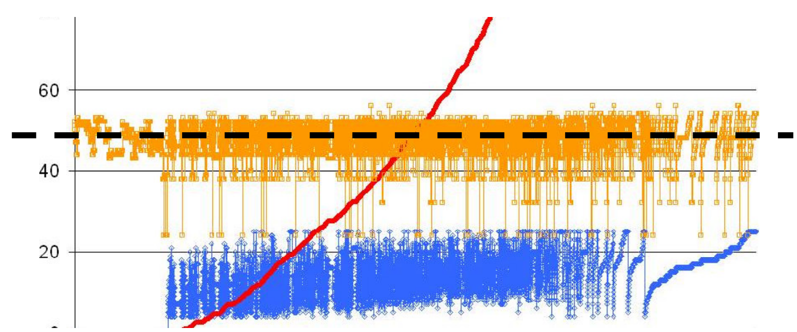
## Which Trees Cause what Damage?

Using the database of 33,000 trees and a large amount of historic claims data we are plotting the statistical relationships between trees of varying heights against a theoretical root zone to refine our understanding of risk.




The relatively homogenous clay structure North West London is an ideal medium for our study allowing 'like for like' comparisons between sectors – within the usual geological constraints of course.

Below (orange line) we see the variation in the Plasticity Index from the sample, and whilst there is a spread we see a concentration around the 50% line within +/- 4%. The 'noise' reflects the more superficial deposits. As we are dealing with several elements and they include trees, climate and soils, this isn't a huge variation and particularly when you consider the vagaries of the various soil testing methods.




Trees are plotted by height – blue line – and we use these elements in several combinations to establish patterns that might assist us in understanding their combined effect for the construction of our models. The disorder model introduces sufficient uncertainty to simulate bands of silt and sand etc.

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January 2007.

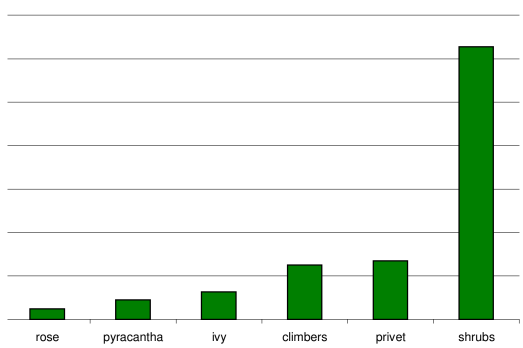
MAT-LAB

Supporting Research

## Shubs

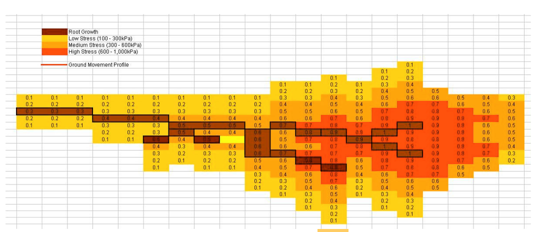
Referring to our tree/claims database of species thought to be the cause of damage, just over 14% (5,121 records) related to shrubs, bushes and hedges.

Small specimens often, with the privet figuring in 675 of cases, and the generic term 'shrub' identified as the cause in 3,135 claims.




## Root Zone Modelling

By measuring the movement of ions through the soil botanists tell us that roots may extract moisture up to 1m from the root tip.

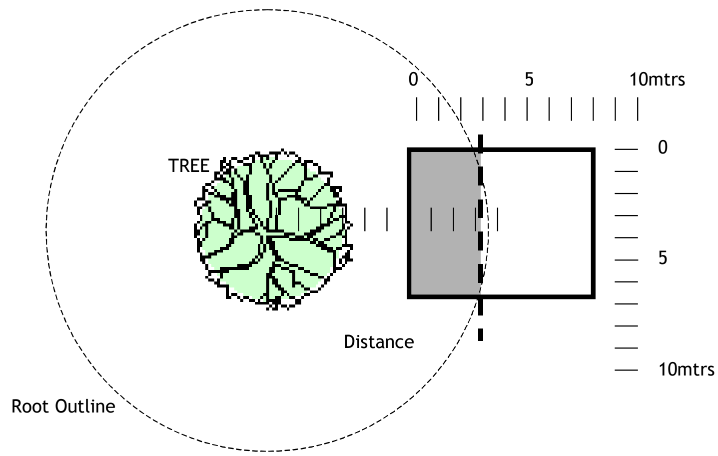


Setting any notion of accuracy aside, this is useful when we try and model their behaviour. Above we show how a root (brown) might influence ground movement by moisture abstraction. The colours show the negative porewater pressures they might exert and it all ties into the uncertainty model we revealed earlier in the year.

As is the case with all of the data we present, it is representative of a particular root from a particular tree in a specific soil at a moment in time, but understanding the mechanisms will help us refine the models we build.

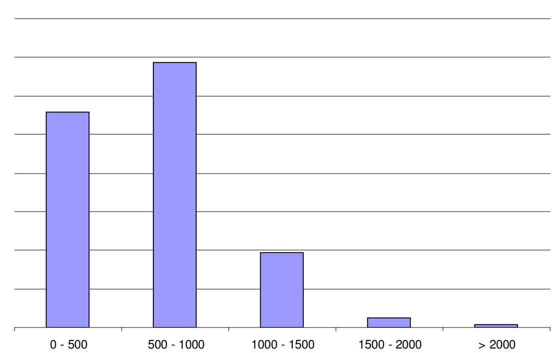
## The(statistical) Danger Zone

Continuing the theme of modelling uncertainty we can say – without knowing anything about trees, soils, climate of engineering – that when the notional tree root zone encroaches beneath the building by a certain amount, with a tree of a certain height nearby on a soil with certain qualities, it poses a particular risk.




It is a statistical problem once we have the data and not in the province of engineers or arborists. This combination helps us to refine our risk model. By inserting the various parameters of individual claims into the system we can make statistically sensible assessments.

## Foundations Depths




Here we have taken a snapshot from a 'valid claim' sample to build a picture of foundation depths in 500mm bands. Not surprisingly we see most 'at risk' foundations are less than 1m deep. As we would expect, there is also a relationship with 'date of construction'.

The Clay Research Group

BRE Data Validation

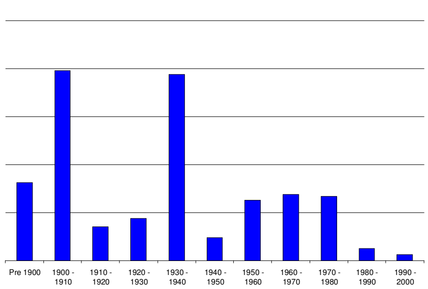
ADDRESSOLOGY Supporting Research

## Help Needed

We need to locate a tree, 7 – 10mtrs in height where we could precise level a series of stations for a term not less than 12 months and preferably longer. The participating party would need to arrange funding for this stand alone project where we would like to set in place ground rods, and take precise level readings every month for the term of the project. This would be ideally suited to the resolution of a complex claim for example with a monitoring budget of say £2,000.

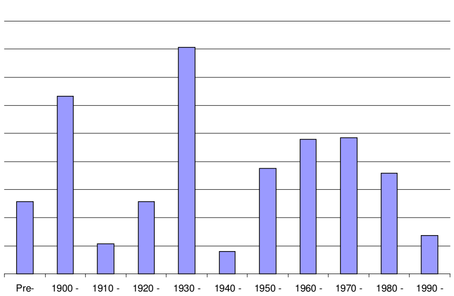
If you have ideas or would like to be part of the development group, please contact us at **ael@blueyonder.co.uk**

### Dangerous Years for Drains




Drainage claim notification ‘by year’ reveals the early part of the 1900’s and the 1930’s to be high risk years.

### And trees …




The pattern for trees is similar, although the risk increases from the mid-1950’s, peaking around 1970/1980 before tailing off.

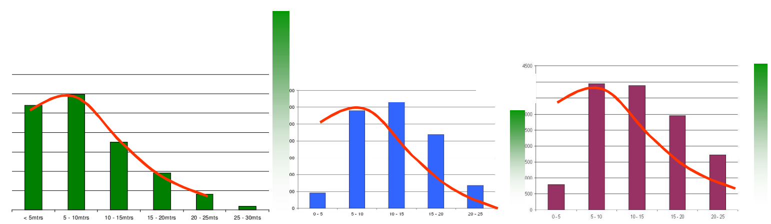
By comparing with the number of houses built in each period we derive a frequency risk value.

## Dangerous Trees

Modelling the danger posed by trees presents innumerable problems. We can’t identify species using LiDAR or aerial photographs, frequency of planting data is hard to obtain and even if we knew both of these, the geology adds yet another variable, setting aside climate.

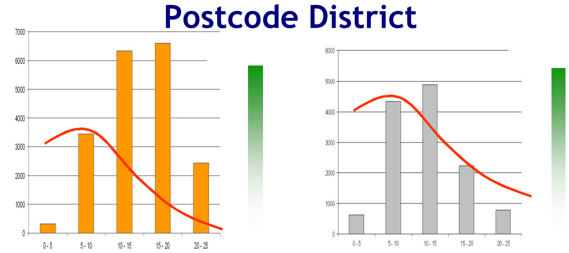
We then need to find out which of the trees are close enough to the building to be significant.

Claims data will include the vagaries of mis-diagnosis from time to time or perhaps recording the tree height/distance incorrectly. Add the fact we live in a dynamic world, where climate and growth interact and change constantly and we have some idea of the complexity.



Actual Claims Data

### Analysis of Tree Height by Postcode District



We doubt will ever be able to anticipate which, out of a row of identical trees, will cause damage in any particular year but this misses the point. We can’t account for how many trees have been felled in a dynamic and changing world, or their health and vigor.

However, stepping back to look at the ‘bigger picture’ does reveal some interesting facts. If we look at claims frequency, claims data and the modelled data at Postcode District level for example, we can see which are riskier than others, how the model rates them and then use variance to derive the real drivers.

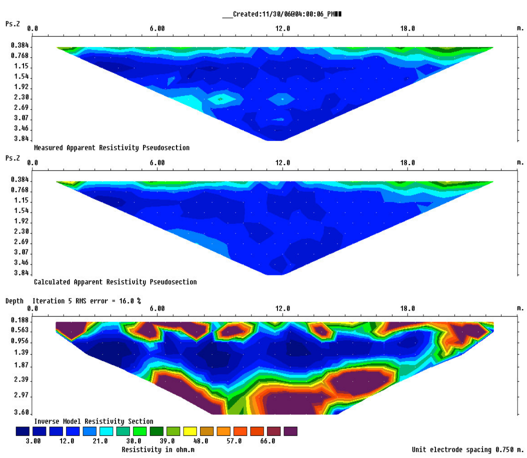
Our rank order of risk using frequency data sees N3 topping the league (at district level), with NW11 a close second followed by NW10 in third place.

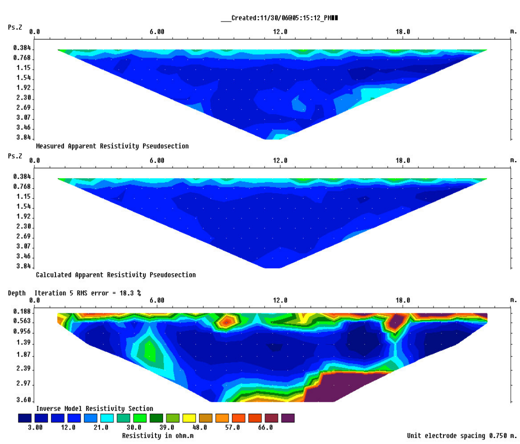
Trees in the range 5 – 10mtrs are often high risk, and this relates to frequency of planting. The highest risk **district** (not sector), NW3 bucks the trend completely, as we can see on Page 8.

KEELE UNIVERSITY

## ERT Imaging

Here are the latest images from the Oak at Aldenham, courtesy of Glenda Jones at Keele University. Top we have Line 1 and below are the readings from Line 2.





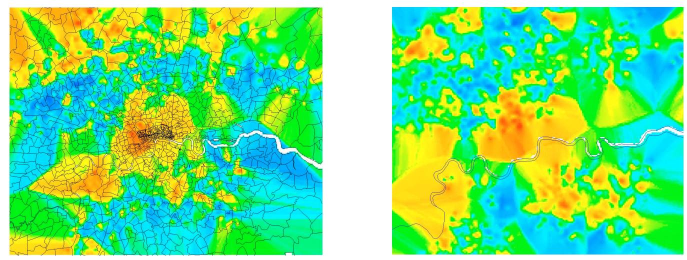
Electrical resistivity measures moisture flow through the soil and our interest at Aldenham is to see how the technique works in fine grained soils and over time.

Glenda is compiling the data she has acquired over the last 8 months or so and we hope to provide a summary in the next three or four months.

This work builds on the previous work of Dr Ron Barker at Birmingham University.

## Tree Density

Below we thematically plot the trees within the M25 by height. The picture shows private trees (left) and public trees (right).

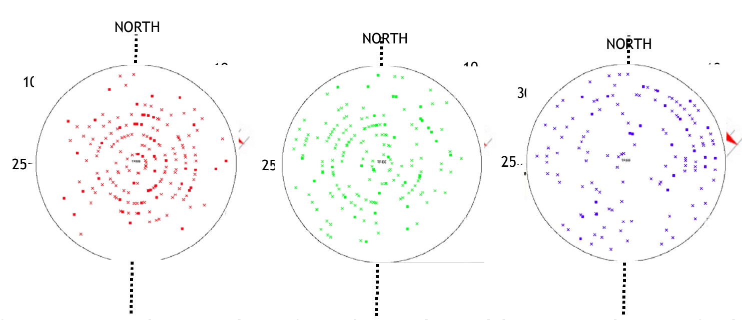


We can see the relationship between tree density and risk, which is reinforced when we add the geology. Blue areas show the shorter trees, green intermediate and red represents the taller trees. We have taken averages from the themed cell size to produce this high level image.

## Jon Heuch's Radar Imagery

Jon carried out a radar imaging survey a few months ago and has been using interpretative software to determine root density at depth.

Below we have superimposed the precise level data to establish if there is a link between roots in any particular layer and movement. That is to say, referencing the two sections, do we see areas of root that might correspond to the activity measured when comparing the two sections. Do we see more roots to the periphery of level Stations 10 than Stations leading from the tree to No 25 for example? If, so, at what depth?

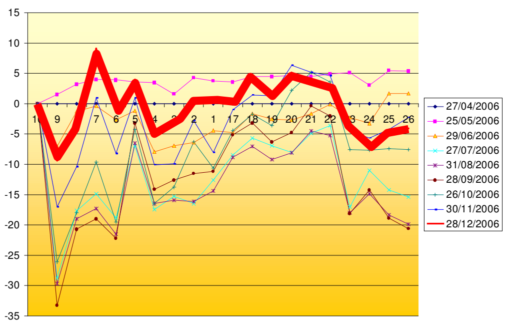



Of course, such a study is fraught with problems not least of which is the subjective visual assessment and the absence of levelling data around the entire periphery of the tree and of root data at depths greater than 450mm.

However, we are defining the areas where more research is needed and building a 3D visualisation of the root zone is amongst them.

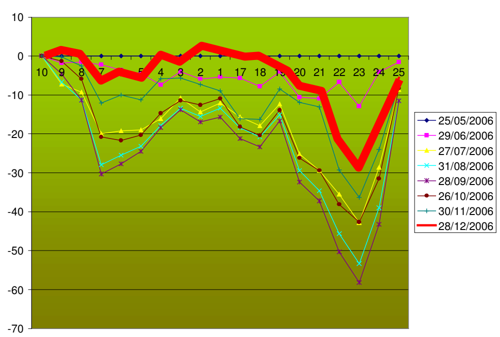
## Precise Levels December 2006

The December levels show fairly rapid recovery for both trees, with several stations already above the highest point recorded last May 2006 due to recent rainfall.




**OAK**

The latest readings are plotted as a bold red line and we are surprised at the rapid recovery given the presence of a persistent deficiency. We had anticipated that it might take longer.




**WILLOW**

If the rainfall continues we might be able to realise the estimates of swell although it is doubtful we will see full recovery from one wet season.

The plots have been consistent relative to one another month by month and variations from station to station show the irregular nature of the combined elements over short distances. The stations are at 2mtr intervals.

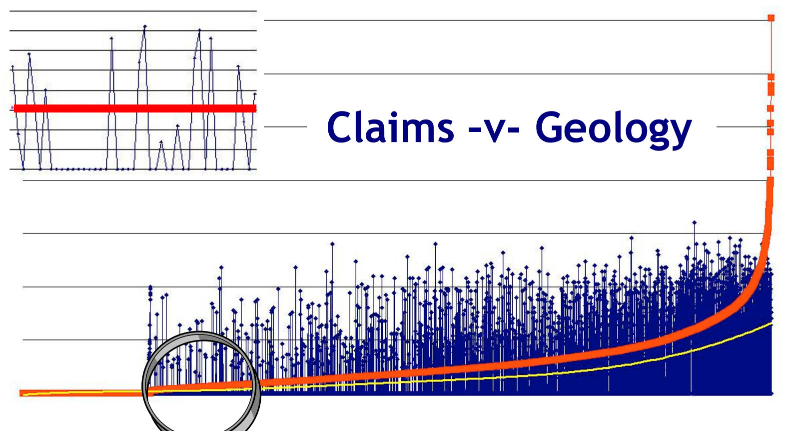
In both cases, the tree is situated between stations 1 and 17, and Station 10 (to the extreme left in both cases) is the datum.

## Rare Data –v- Long Numbers

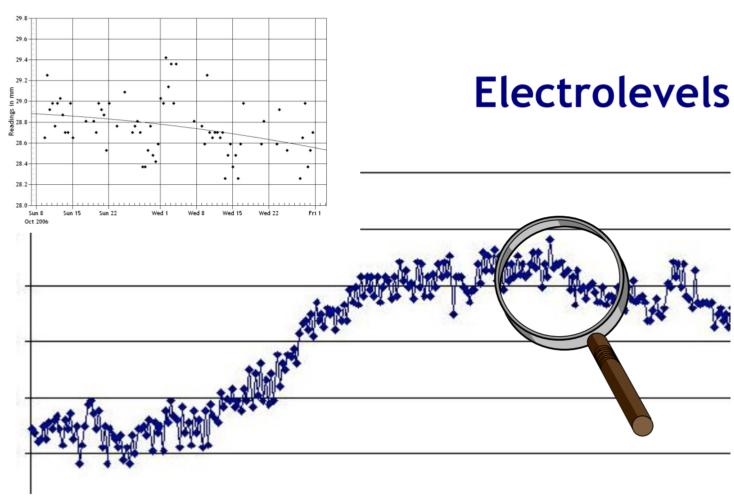
Below (top) we see postcode sector claims frequency and soil index properties plotted together with the two sets of data reconciled by amending the 'y' axis. The blue line shows the scatter of the P.I. against claims (red line). The yellow line is the polynomial of the soils data and we can see that it follows the claims plot very closely.

The apparent degree of scatter of the soils is related to the scale of the 'y' axis. The blue line plots frequency (values of 0.002…) against soils with average index property of 50%.

In summary, we do see a good correlation between postcode sector claims frequency and soil index properties.



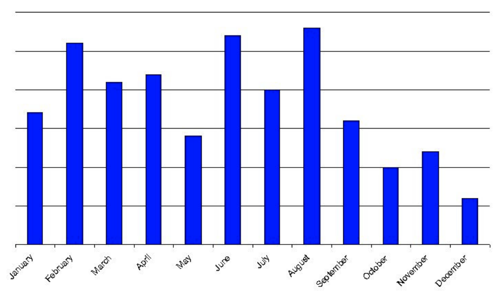

This scatter can be initially confusing. When we have little data, the spread suggests there is no pattern and this is where we agree with Martin Culshaw from the BGS who says that sometimes we have to 'stand back' to see the bigger picture.



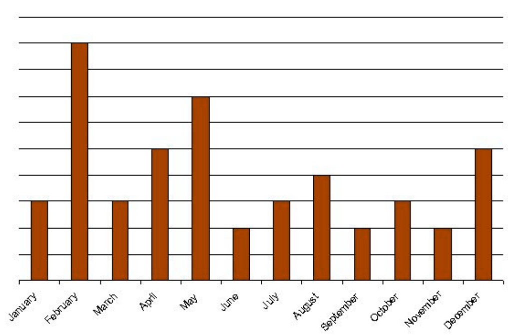

Above we see a similar problem. A small extract (insert, top left) doesn't tell the story. Sometimes our data gains value over time and by amending the scale.

## Time of Notification

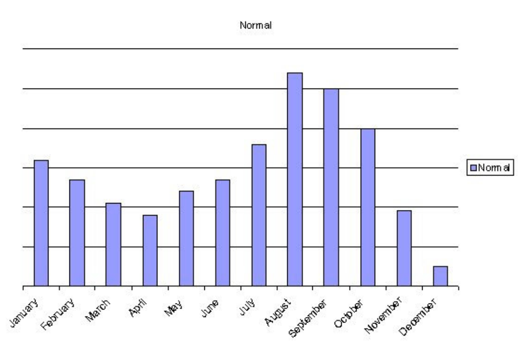
Here we see perils by date of notification. As is the case with all such samples, it has to be viewed a little tongue in cheek. Many times the homeowner's date of notification doesn't correspond to the date the damage was noticed or when it occurred, but nonetheless, it provides a glimpse into trends surrounding clay shrinkage, escaper of water and landslip perils.




**Escape of Water**
No obvious seasonal pattern with claims notified sporadically throughout the year.



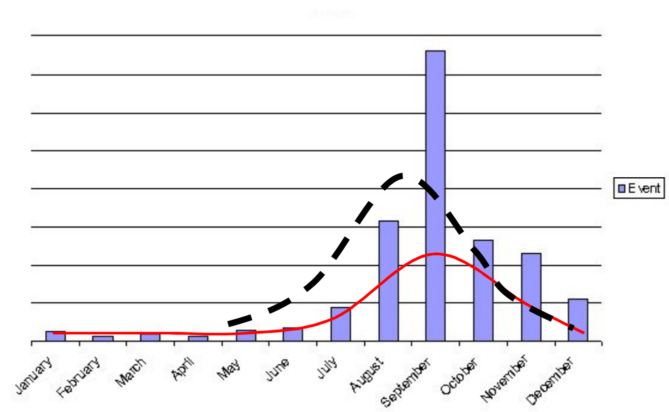

**Landslip**
Typically associated with wetter weather in the winter and heavy rainfall we can see peaks in January, May and December.



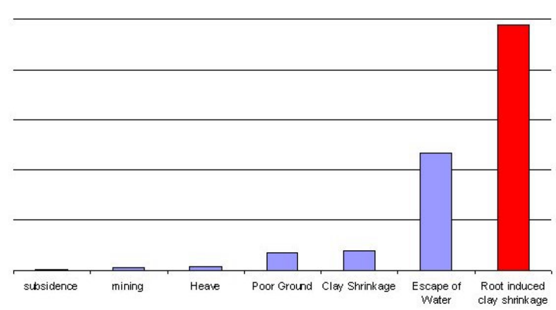

**Clay Shrinkage**
The classic clay shrinkage curve for a normal year. The starting point to the left of the plot is determined by weather in the preceding year.

## Claims Data

Below we see claim notifications in a 'normal year' as a red line, superimposed onto the volumes we receive in an event year. 2006 was not an event, but it was busy and the line fell somewhere between the two plots – black broken line – starting a little earlier as we saw from the data at Aldenham but then falling away quickly.




Plotting 'claims by peril' for an average year we see that root induced clay shrinkage heads the table as expected, followed by escape of water claims, clay shrinkage (no vegetation identified) and then poor ground.




'Historic movement' leads the way for repudiations. Old movement that shows no sign of progression. This is followed by 'shrinkage', settlement, poor construction, thermal movement and roof spread etc.