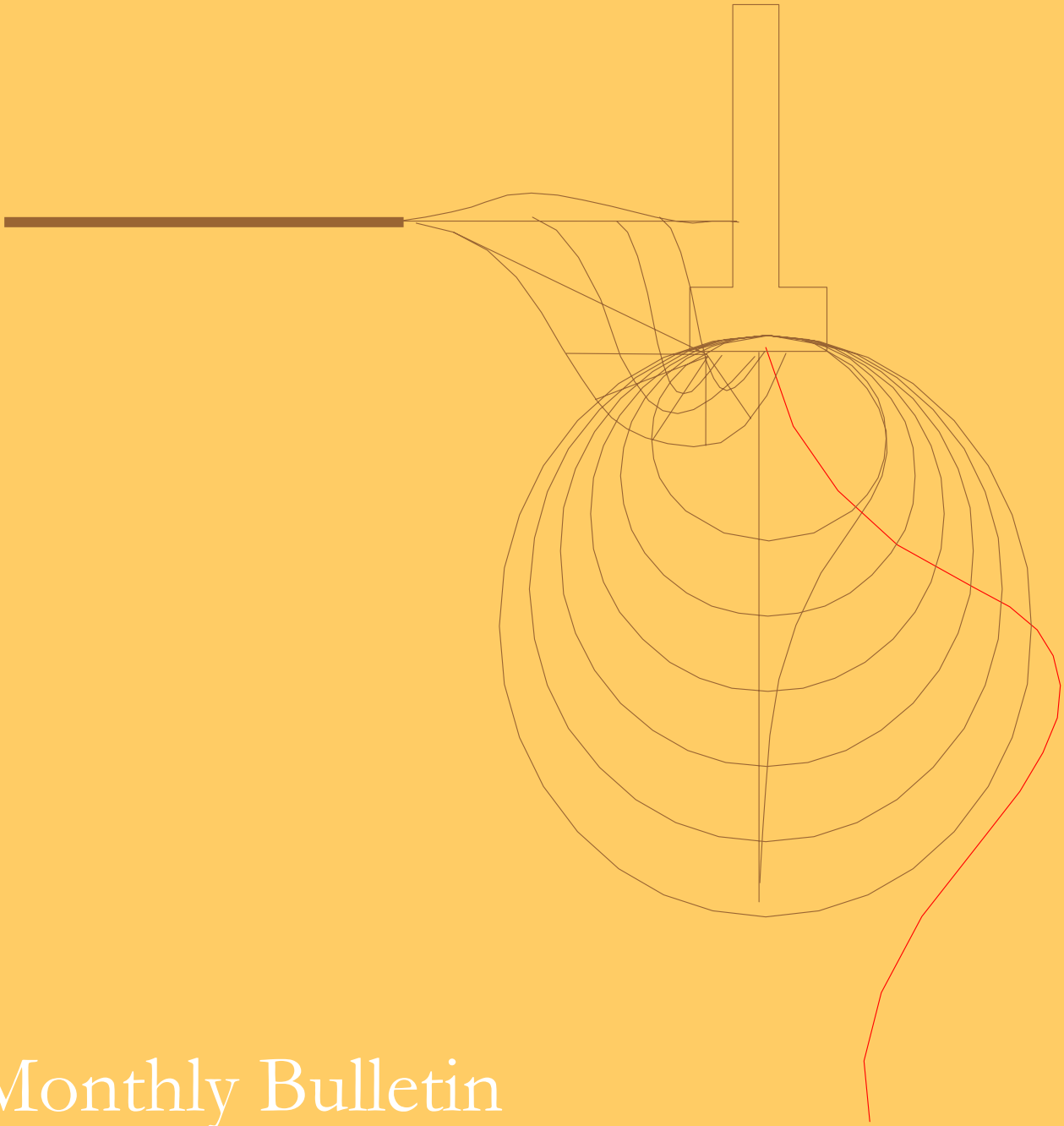
The Clay Research Group



Monthly Bulletin

The Clay Research Group

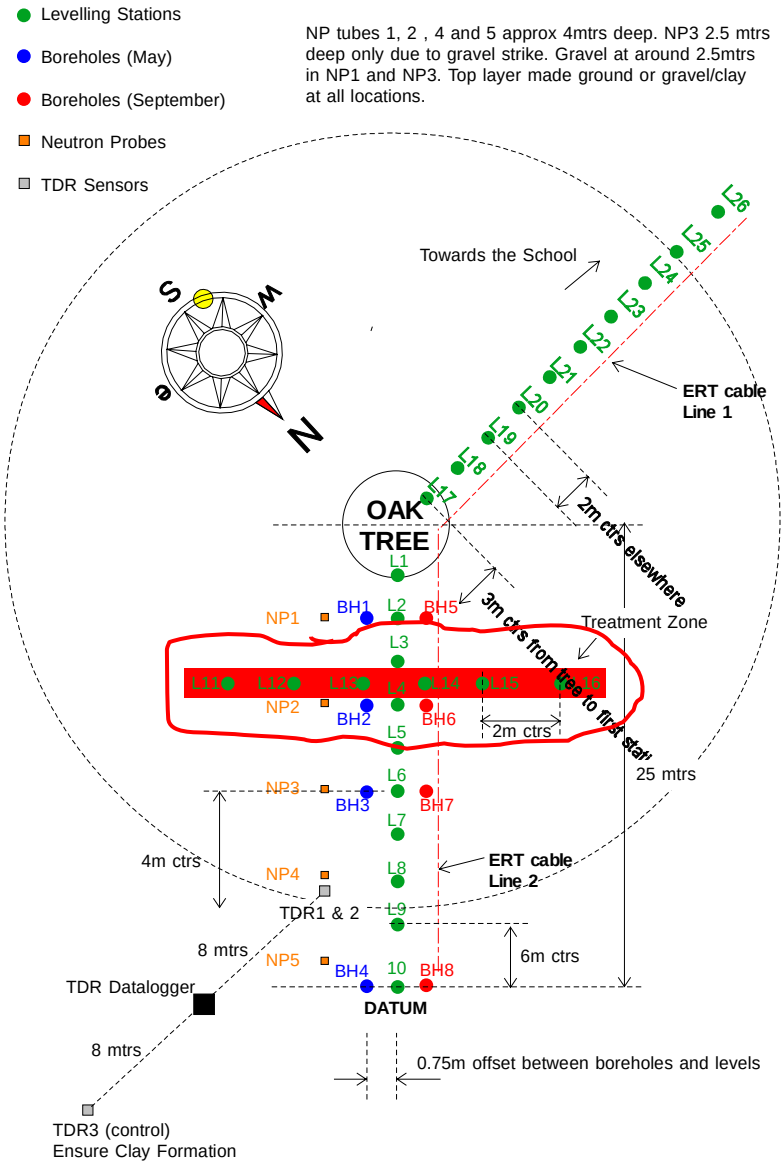
Aldenham SCHOOL Supporting Research

December 2006.

CONTENTS

Treatment Zone - I

We hope to apply several treatments in discrete zones adjoining both the Oak and Willow trees – see red shaded area below - but we have to be careful because of the areas of moisture uptake at the periphery of the root system in both cases.



This may preclude the installation of a root barrier but we may be able to implement electrokinesis, a soil treatment and simple rehydration, or 'watering in'.

Professor Rogers has come up with several suggestions to overcome traditional problems with electrokinesis including the use of carbon rods in place of steel tubes. The objective will be flocculating the clay soil and reducing its hydraulic conductivity, blocking the pores using electrophoresis.

Electrolevels

MAT-LAB Site Investigations and Soil Testing

December 2006.

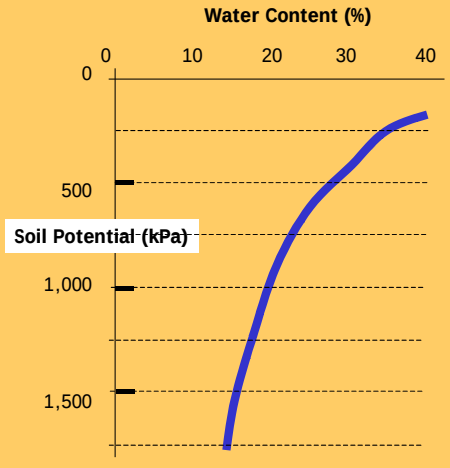
Rehydration

We hope to rehydrate the ground beneath the Oak in the Spring of 2007 to ensure we don't kill the tree off. The Oak is seeking water from the root periphery and we can't 'cut off its supply' without risking serious consequences. The objectives are to:-

1. Determining if the laboratory and modelled estimates of swell are realistic.
2. Improve our understanding the hydraulic conductivity of a desiccated soil.
3. Measure lateral flow via the adjoining precise level stations.
4. See how quickly the rehydrated zone loses water in the following summer.
5. Develop treatments and at the moment these may be precluded by the depletion of the 'free water' zone.

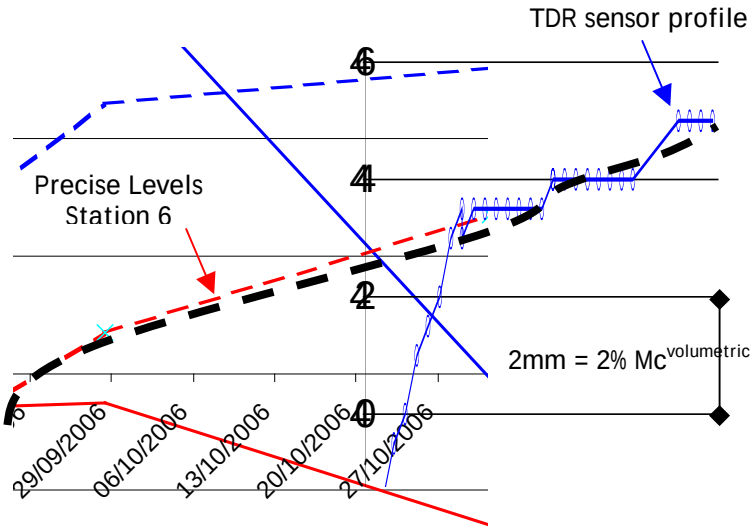
WATER RELEASE CURVE

We mentioned in the last edition the slowing of ground movement as the soil dries and this is plotted as 'the water release curve'. We can see the slope of the line slows with increasing water loss associated with an increase in soil potential.



Ground Movement & TDR Output

Superimposing the graphs from Page 1 and adjusting their timelines (we only have TDR data from early October) we can see how the moisture rise recorded by the TDR sensor (blue with open circles, to the right of the picture) matches, as closely as one could hope, the ground movement data for Station 6.

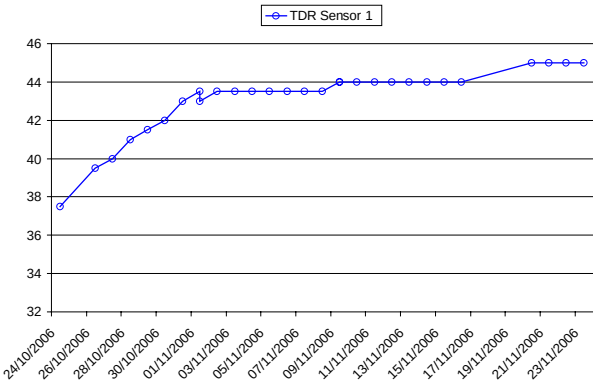


The gradients are very similar (bold black broken line) and the project will be looking at correlations to see if we can 'pattern match' over a season. The slope of the line will of course vary with the soil mineralogy and tree species, height and so forth, although we suspect the profile will be fairly constant as suggested by the work of The Building Research Establishment.

This being the case, it could lead to simplifying the investigation/monitoring operation significantly.

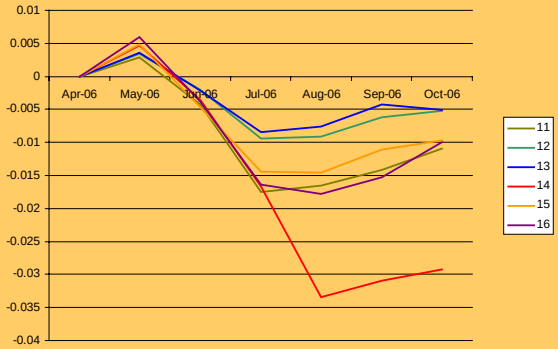
Below we have plotted the results from Sensor 1 of the TDR probes, which seem to be performing well, recording a gradual increase in moistures that correspond to the precise levels. See Page 2 for more detail.

The practical benefit of precise levels is immediately apparent, taking into account the variability of climate and soil by simply recording upward or downward movement. The TDR sensors also appear to be performing well.



Movement over Time Treatment Zone - III

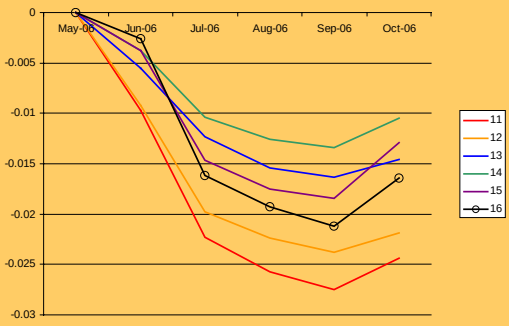
Right we see the movement of the stations over time and below we have plotted movement of the individual stations.



Consistent with the earlier data for the main arrays, we see initial recovery following the winter period and then each of the stations dipping down towards the low point in late August before recovering.

Station 14 exhibits the most movement overall and if we include the 5mm of recovery, the total is nearly 40mm.

We can also see the characteristic pattern of seasonal movement, peaking in early September before recovery commences. This pattern is remarkably consistent, as one might expect, and below we have plotted similar data from the treatment zone of the Willow.



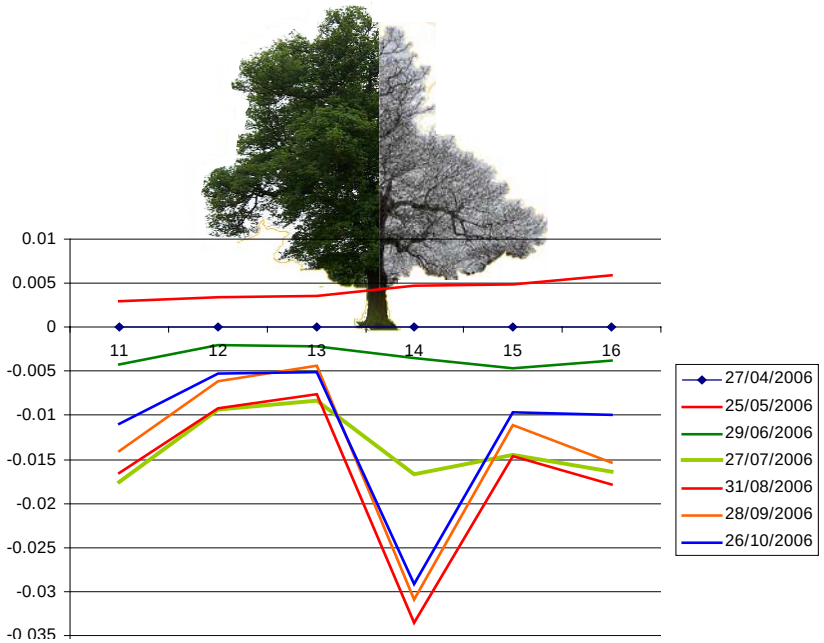
Movement peaked in September, and we are now measuring recovery.

Treatment Zone – II - Oak

A treatment zone was established at a point distant from the Oak equal to a line where a property is likely to be situated which we estimated to be around 7mtrs. In fact, this may be a little closer than usual but the logic was that if we could apply a treatment at this distance, it would work for most of the cases of root induced clay shrinkage that we come across.

Below we have plotted the precise level stations running along this line – Stations 11 to 16 inclusive – together with their orientation, with Station 11 to the left as you look from the datum towards the tree from Station 10. See Page 1 for layout.

We see that in May the ground rose just prior to the tree coming into leaf, and then subsided (in respect of the initial reading) by about 35mm on 31st August 2006 at Station 14. There is a significant variation across the line as can be seen below. Stations 12 and 13 appear to have moved no more than 10mm taking into account the initial rise.



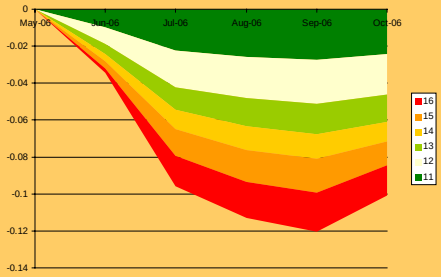
The differences we record across the site are most likely due to the soil variability and the influence of the persistent moisture deficit.

Our objective in 2007 is to apply ground treatment and initially at least, this may take the form of simple rehydration. This technique has been used successfully in the past, and the study will seek to measure the time and the volume of water required to rehydrate the soil.

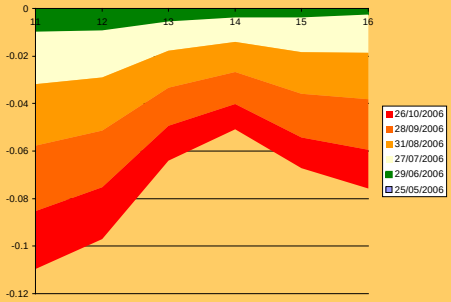
Recognising that this is rarely a lasting solution, we will be looking at (a) electrokinesis which may change the soil structure, hydraulic conductivity and the shrink swell characteristics and (b) chemical treatment, using naturally occurring chemicals again with a view to altering the soil structure.

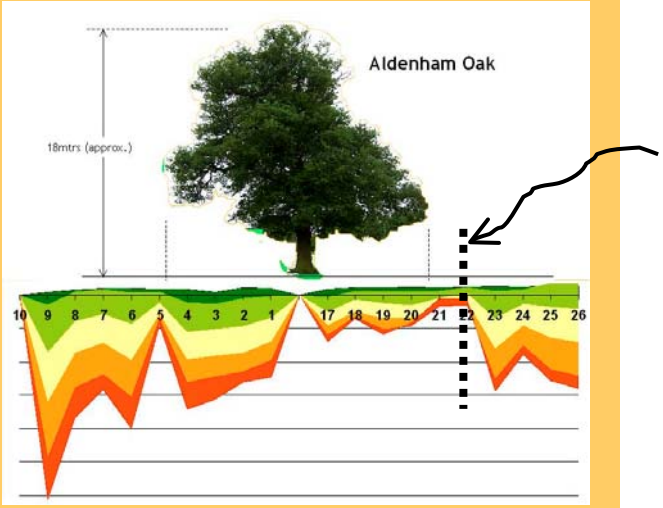
Data Presentation

Below we see the same data across the treatment zone levelling stations using different plotting techniques, with the Oak above the Willow.



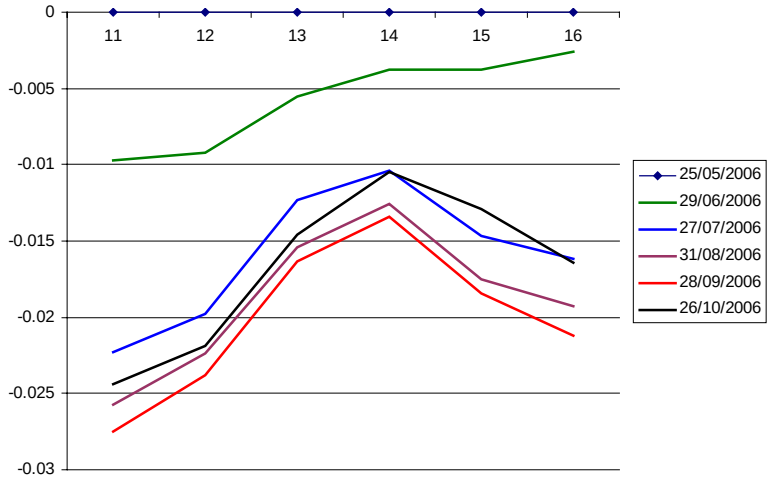
Part of our aim is to look at data afresh and the visual presentation sometimes throws new light on old problems. Or so we hope.





Treatment Zone – IV - Willow

Perversely, we see the Willow assuming a different profile, with the outer stations (11, 12 and 16) moving most. We missed the initial reading in April. From May onwards the line has been subsiding with maximum movement of around 25mm at Station 11.



The central station, 14, has moved less – 15mm or so.

This exercise shows the considerable variation across the site. These stations are 2m apart and the irregular profiles are seen along Stations 10 to 25 for both trees.

ROOT BARRIERS

It was always our plan to install a root barrier and use precise levels to determine the benefit. If the barrier was successful, the ground on the far side of the barrier would no doubt swell on recovery if it was doing its job.

We hoped to supplement this with the ERT imaging of moisture movement, removing the need for testing soils etc.

This was raised by Gary Strong at his last visit, but we have some problems at Aldenham, not least of which is the fact the Oak sits between two football pitches! That aside, our concern is that by cutting through the roots, we could kill the tree.

Because of the persistent deficiency moisture is being taken up at the root periphery. Cut through the roots in this instance, and we could damage the tree. See left.

Characterisation of Seasonal Movement

We make much of this pattern, and it is central to our project. The original work was produced at the Building Research Establishment over many years by Ward, Mike Crilly, Tim Freeman and Richard Driscoll. Giles Biddle has done valuable work in this area over many years.

Here we reproduce an extract of the BRE work from data gathered at Chattenden plotting strains, neutron probe moisture content and ground movement over one of the driest and busiest years in terms of claim notifications.

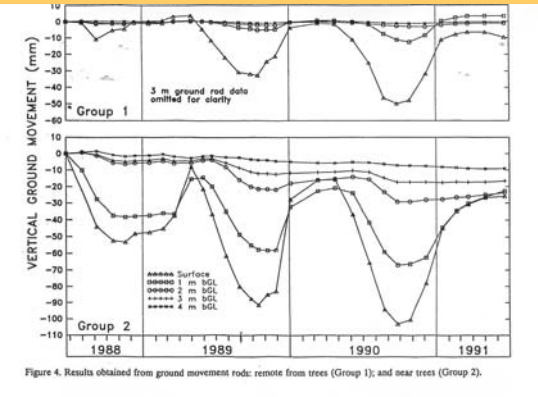


Figure 4. Results obtained from ground movement rods: remote from trees (Group 1); and near trees (Group 2).

We were hoping to pick up the threads by continuing to gather data at Chattenden, but the MoD lease is about to expire.

Our aim is to show how important and consistent this profile is using another site with different trees.

The amplitude of the curves will reduce in wetter years, in soils with as lower shrink swell potential and trees of lower water demand, but the profile remains reasonably constant.

The periodic signature appears across everything we do – ground movement, moisture change, water uptake, claim notifications and SMD etc.

It also forms the engine of the various models we are building and the fact that their importance was recognised by the BRE over 15 years ago reflects their pre-eminence in our work.

Visitors

We had several guests on site when we last met and Aldenham laid on a buffet lunch in their honour.

From the left we have Dimitrious (Mott MacDonald), Richard Rollit (Crawford), Professor Chris Rogers (Birmingham University), Gary Strong (GAB Robins), Glenda Jones (Keele), Robert Sharpe (Crawford), Cyril Nazareth (InFront), John Peterson (Foundation Piling) and Neil Curling (HBOS). We were joined by Dr David Boardman (Birmingham University) and Joel Smethurst (Southampton).

Chris Rogers and David Boardman are looking at electrokinesis and will be putting some proposals forward shortly. Mott MacDonald are working on a Network Rail project and they are interested in slope stability and sensors.

Tim Freeman was hoping to join us, but the date clashed with his scheduled return to his home in Ireland. Better luck next time we hope.

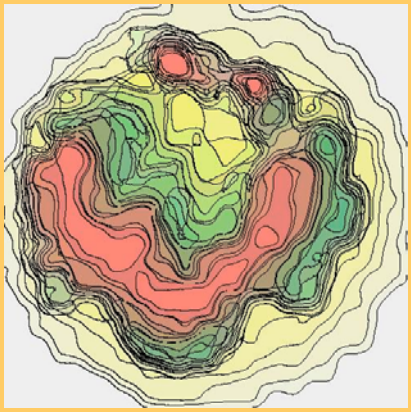
Together with late arrivals we managed an attendance of nearly 20 people. Please phone Cyril if you would like to come along at some future date.

Nigel 'sick note' Cassidy

Poor Nigel has a history of back problems, and they came to a head recently when one of his discs collapsed and he was rushed to hospital. He is off for 6 weeks, leaving the rest of us (Glenda in particular) doing all of the hard work.

Let's hope he makes up the time when he gets back.

Root Zone Stress



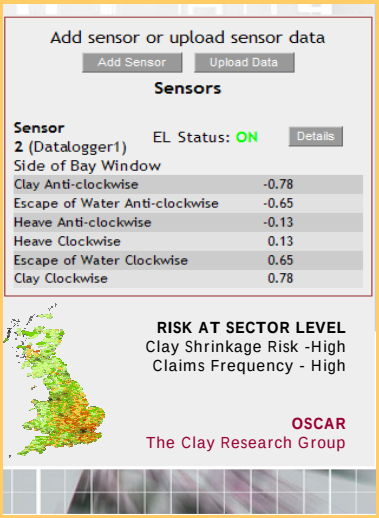
If we plot the stress zones within the area of root activity for winter and summer conditions, it will change with time as we might expect. It is also likely to change with location, as we see from the sections, right.

Above we have a virtual plot of stress showing its random nature which varies with the soil mineralogy and root activity.

It supports the view that tree roots 'take water as they find it', to misquote legal text.

Risk Modelling

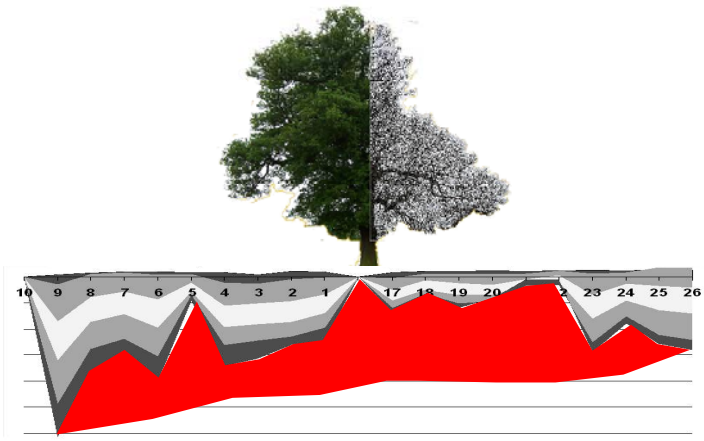
You will already have seen our risk model in various guises, and we have bolted it onto the DataReader application to assist our members.



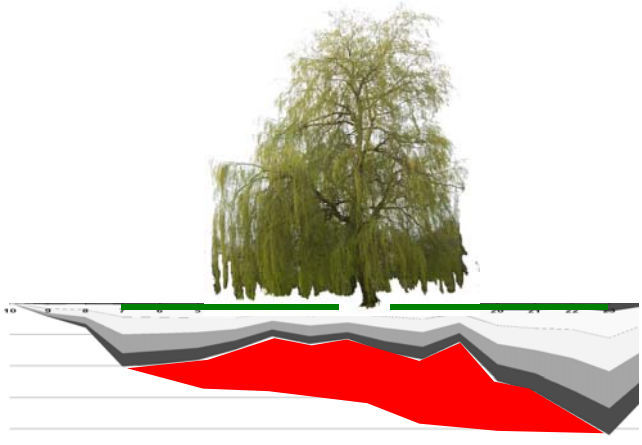
Enter the postcode and assess its risk in terms of claims frequency and soil P.I. – access OSCAR, or visit us at The Clay Research Group.

Persistent Deficiencies

Mapping the apparent persistent moisture deficit produces the following images. Because of the variable geology we can't be sure the red zone is entirely dry clay. For example, we know from our investigations and sinking the holes for the neutron probe tubes that the absence of movement in the area around Stations 5 and 6 is due to the presence of gravel deposits.



Elsewhere, at Station 1 - 4 and 17 - 20 we may be seeing the dry area associated with the protection afforded by the tree canopy when in leaf, but this is almost certainly secondary to the gradual drying effect of the tree over many years.

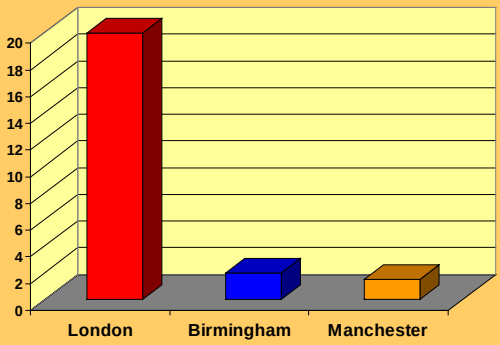


The depth of root activity is exaggerated and we have used precise levels as a proxy for soil testing by increasing the movement profile to coincide with the depth of desiccation for illustration purposes. The soils data reveals the influence of the tree roots extends to around 4mtrs.

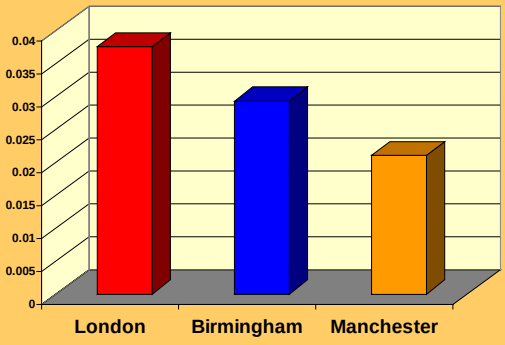
RISK

The top bar chart shows just how risky London is. Looking at simple 'count of claims' it is far ahead of its nearest rival, Birmingham and we estimate from our data that 20% of valid claims fall within the M25.

Birmingham accounts for just under 3%, and Manchester is around 1.5%.



However, if we look at frequency, the picture changes quite dramatically. London is still ahead with a frequency of around 0.037, Birmingham next with 0.029 and Manchester third with 0.021.



Using count, London is 13 times riskier than London. Using frequency, it is just under twice as risky.

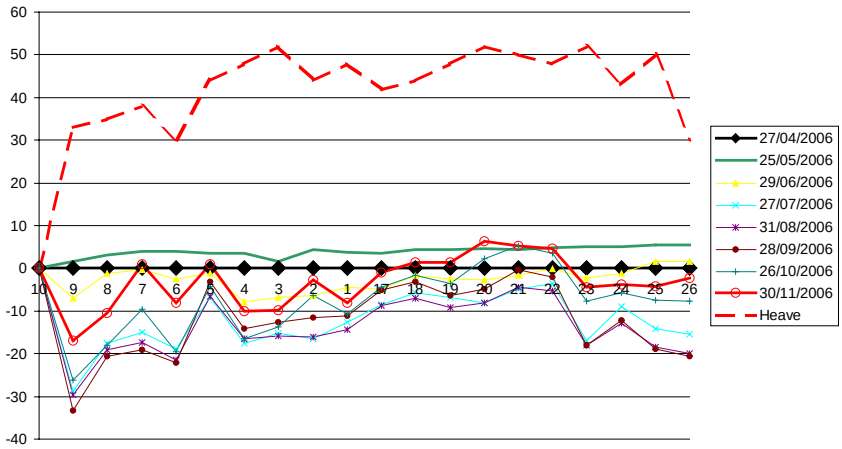
2006

We have been gratified by the considerable interest shown by insurers, adjusters and suppliers over recent months. There is a willingness to embrace the new technologies that we are validating at Aldenham and particularly data gathering using a range of sensors and telemetry.

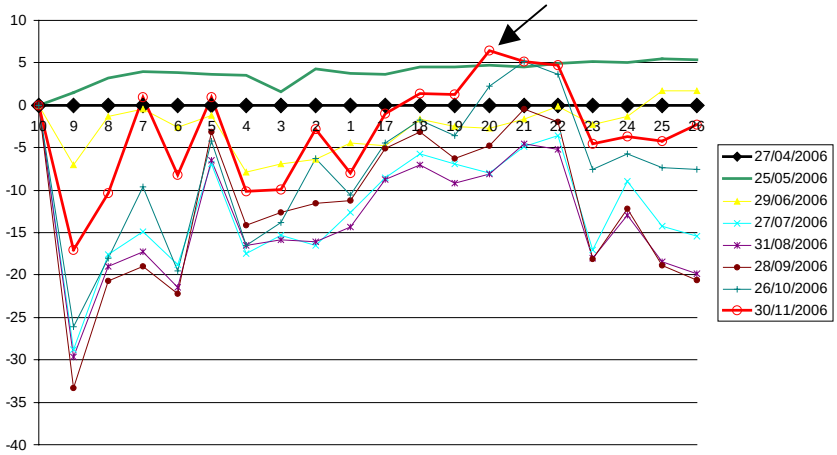
2006 saw the site at Aldenham being instrumented. We have already gathered some fascinating data and improved our understanding of how moisture flows through a clay soil.

Precise Levels

Precise levelling has been by far the most useful tool for mapping ground movement in relation to moisture change and by inference root activity and desiccation. Below we have plotted the estimate of swell (top, broken red line) if the soil beneath the tree is rehydrated.



Water will be will be applied to the ground (a simple sprinkler and hosepipe used intermittently) from December through to late April and we will benefit from seeing the correlation between the laboratory estimates of recovery, and what actually happens.



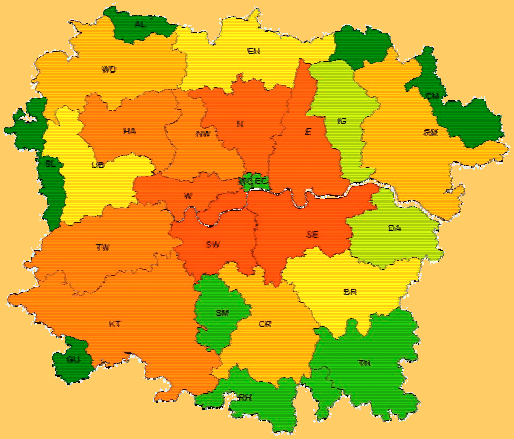
Above we see the results for the end of November. The green line is the high point from May, and the red line is the November reading. We see that at Stations 20 and 21 recovery has already 'lifted' the ground to a point higher than it was in May by nearly 2mm.

November SMD data suggests notional recovery (using the Penman Monteith equation) has already taken place with deficits at zero.

Hopefully we will assist the Oak tree in its search for moisture in 2007, and measure just how quickly it loses it in the summer months following watering-in.

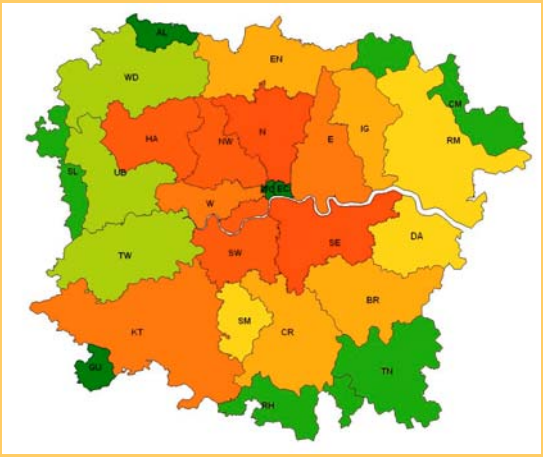
Risk by Area

Using a GIS we have plotted the population density by postcode area (top) and we can see that N, E, W, SE and SW are the most densely populated.



POPULATION by AREA

Looking at the frequency of claims per population we see a slightly different picture, although there are similarities.



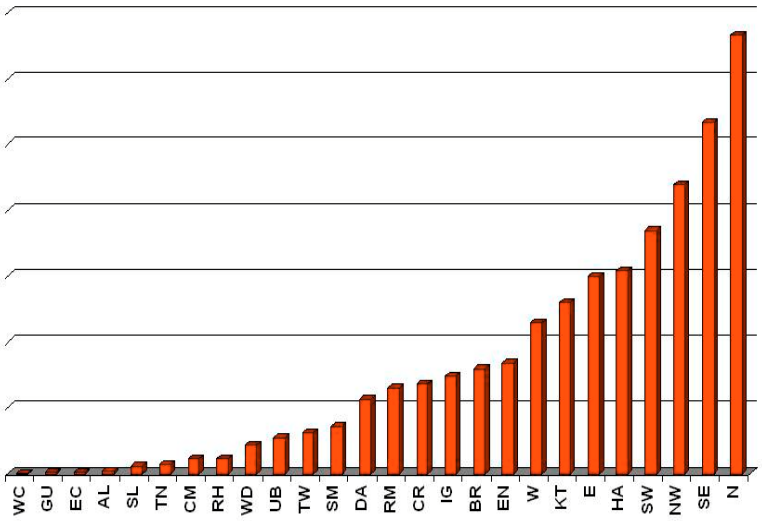
CLAIM FREQUENCY

There are significant variations within areas. Islington for example has highly shrinkable clay soils to the North West, and less shrinkable soils to the South East, where the risk is less.

Risk follows geology very closely as we have seen in previous editions.

LONDON RISK

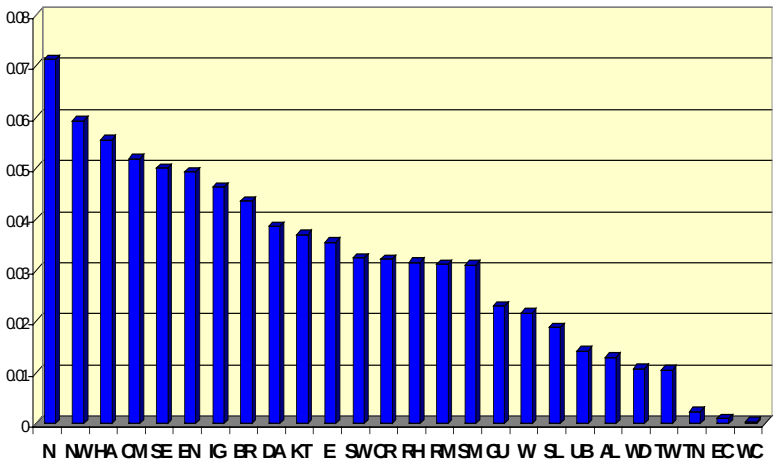
Below we see the London Postcode Areas listed in rank order of claim count and not surprisingly we see the 'N' area as top of the league, followed closely by SE, NW, HA and E.



COUNT OF CLAIMS BY AREA

When we look at the same sample as frequency data, we see the risks are very similar, with N, NW and HA in the top three, but with CM moving up the league, followed by SE.

The average frequency is 0.0312 (variable with number of claims in sample and over time) and we can see just how risky the N area is, at around 0.07. This pattern seems to be reflected in most of the data we see although there will be fluctuations based on portfolio, sample size and exposure.



FREQUENCY DATA