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

December 2009

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CONTENTS

Ground Recovery

Appropriately given the time of year we move our attention from clay shrinkage to recovery associated with trees losing their leaves and rainfall.

We include an extract from the work of Dr Ron Barker at Birmingham University in 2001 showing water movement in a coarse grained sand and gravel soil in the Midlands, following infiltration. We also see how long it takes for the soil to reach equilibrium on drying.

On Page 1 we see moisture development profiles over time, using data gathered by Southampton University using the Neutron Probe.

Next month we hope to produce a review of the work of the CRG over the last three years, outlining individual areas of research and explaining how they fit together, and of course, the objective. What have we delivered and what are our objectives going forward?

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Marishal Thompson
~ sponsorship ~

Marishal Thompson have been supporters of the CRG since its inception and provided funding to purchase and maintain the Aldenham Weather Station.


Press Release

Major Research Breakthrough in tree Related Subsidence!

Marishal Thompson Group

Press Release

Marishal Thompson Group

We were interested to learn of their recent work in developing a technique to distinguish, using anatomical methods, between the roots of Willow and Poplar. Something that has not been possible previously, leading to problems in removing trees, or worse still, removing too many.

Paul Thompson has offered funding to support the work of the Clay Research Group and we are currently looking for a worthwhile project.

All suggestions gratefully received. Ideally this would be a self-contained piece of research, lasting no longer than five years and relating to the interaction between trees and fine-grained soils.

We are in discussions with another commercial party to look at electrokinesis again – the project was shelved last time when we lost our PhD student.

If any University has a PhD project where data gathering of the sort undertaken at Aldenham would supplement research into vegetation, or perhaps the LTOA have a project that is topical, please make contact.

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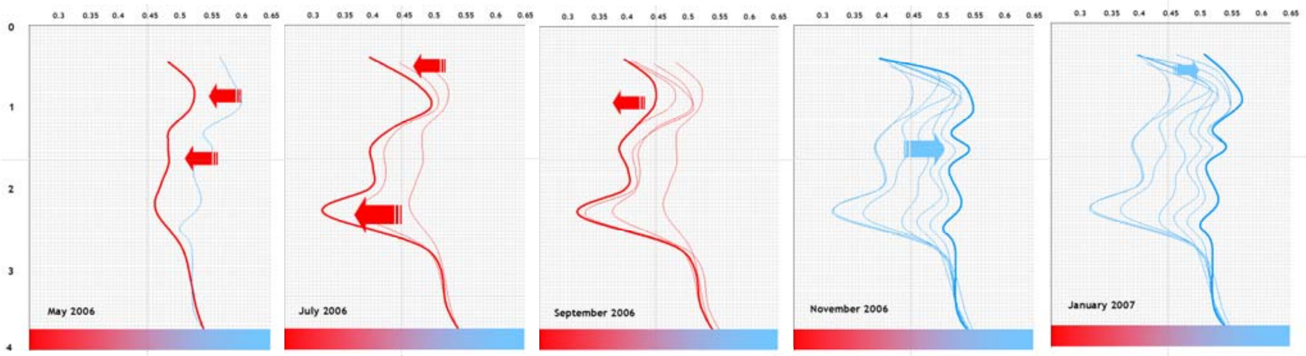
Neutron Probe Moisture Loss Development Profiles

~ Data courtesy Southampton University ~

Using data collected by Southampton we have built moisture loss development profiles for the Aldenham Oak, using readings from Tube 2, which provides the most dramatic example of the changes that take place seasonally. Linked to the information in the previous edition ("Ground Movement Profiles") we have some idea of the dynamics in a 3D form, using information from two levelling arrays, and adding depth data.

Moisture is recorded volumetrically.



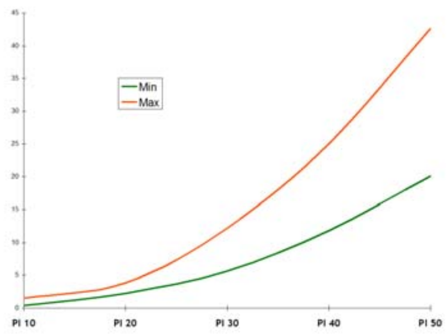
Shallow moisture loss accompanying evaporation can be clearly distinguished from root driven moisture deficit.

Evaporation extends to around 750mm – 1mtr bGL. In contrast, root activity (bearing in mind this study involves a mature tree with a well-established rooting system) peaks at around 2 – 2.5mtrs bGL, and is far more dynamic. Drying extends to a depth of 3mtrs or so and it is interesting to see greater moisture loss with increasing depth as roots extend further afield, and go deeper.

Swell Potential

Does the amount of swell have a linear relationship to the soil PI? For example, will a soil with a PI of 60% swell twice as much as a soil with a PI of 30%?

Expressed as a percentage of the sample volume, swell follows an exponential line as we see right. Taking a mid-range value of swell, soil with a PI of 20% has a percentage swell potential of 3% compared with a value of 15% for soil with a PI of 40% - very approximately and on average.



Potential Expansion (%) by PI
Seed *et al* (1962) "Prediction of Swelling Potential for Compacted Clays" J. Soil. Mechanics, Foundation Division, ASCE

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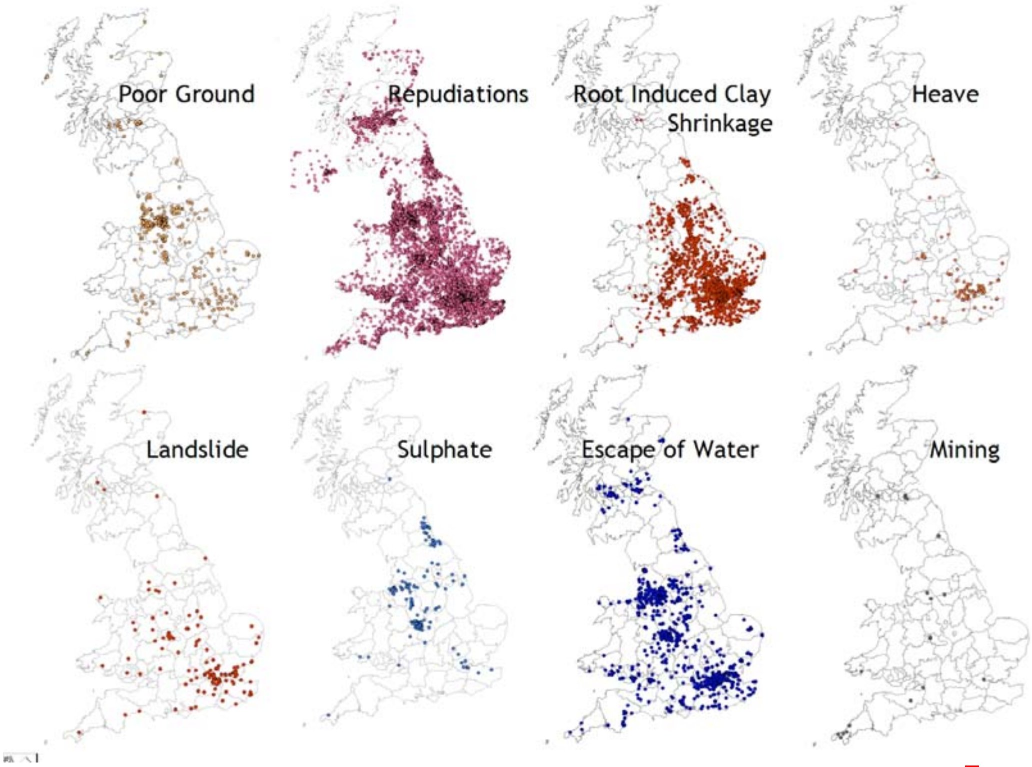
PERIL MAPPING

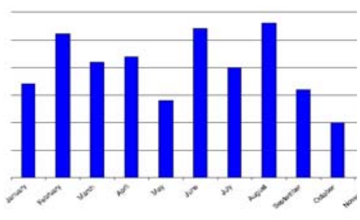
Claim notifications for a range of subsidence related perils are plotted below, revealing some interesting geographic/geological relationships.

Beneath the maps are the 'date of notification by month' of a selection. There are relatively few landslip claims compared with escape of water and clay shrinkage claims. Clay shrinkage varies by month (and by year – red is the profile in event years) whilst escape of water claims have an irregular profile.

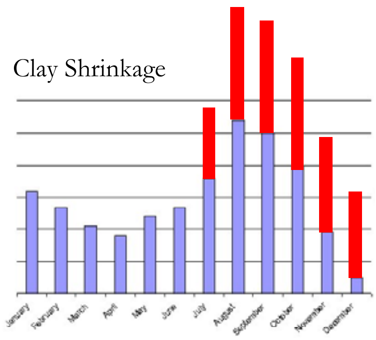


Landslip

Escape of Water



Clay Shrinkage



Mining claims are reducing over time as we might expect, and there are traces of tin mining (south Cornwall), coal (Midlands) chalk and limestone elsewhere. Poor ground appears to be encountered predominantly in the North West, and landslides follow the coast but also we see high numbers on the clay belt where slippages can take place on relatively shallow inclines.

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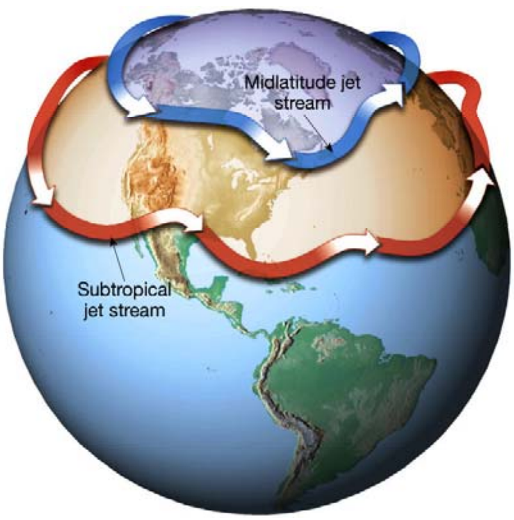
The Jet Stream

The article on climate models and our Event Prediction module in last months edition triggered some response and we came across the image below on the web which illustrates how the Jet Stream works.

It is a current of air travelling at up to 300mph, and effectively separates the warmer air to the south from the cooler air to the north.

If the Jet Stream moves south, the weather becomes cooler. If it moves north, it is warmer. As Richard pointed out, changes in the location of the Jet Stream accounted for the irregular weather patterns in 2009.

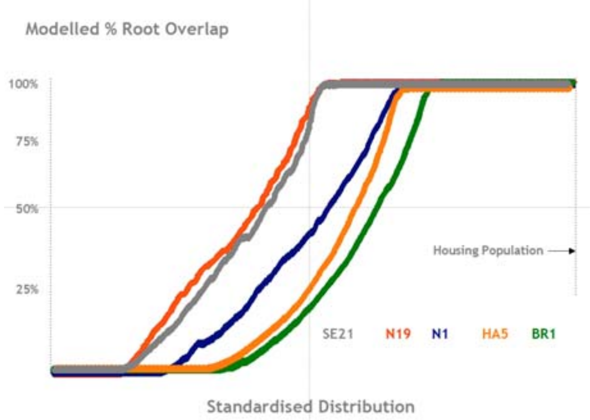
Referring to the article in last month's edition by Richard he explained about the amount of energy required to 'jump the bar' for an event. This is the month the Prediction Model places reliance on using SMD data.



In the last edition we saw how 2009 developed. The SMD was low initially, but rose steeply as it approached this key period. This is the energy cycle – or 'the run-up' as Richard described it.

Throughout the summer it remained high, but intermittent periods of rainfall reduced the impact of the high values.

Understanding the Output



The above graph shows the modelled root overlap beneath buildings for a series of Boroughs. If we look at the red line for example (N19), we can see that around 13% of the houses have no estimated root encroachment at all.

Just under 50% of the houses have 100% root encroachment, leaving the balance, 37%, with varying degrees (and a fairly regular distribution) between these two extremes.

Because each area has a different number of houses, we have 'standardised' the distribution, plotting them all along an equal 'x' axis to make comparisons easier. Using this technique we can compare a Borough of 1,500 houses with another having say 2,800 houses.

At the opposite extreme, and possibly safer as a result, is BR1. More houses with no root overlap, and fewer with 100%.

No requirement here for any notion of accuracy, and using the average from each profile allows us to build a 'rank order of risk'. According to the plot, you might anticipate that N12 is riskier – has more claims – than BR1.

Looking at claims data (i.e. not tree data) suggests a frequency (claims / houses) for the sample we hold (not for any particular year) BR1 = 0.0042 and N19 = 0.012. N19 is nearly 3 times riskier. The blue line above (N1) has a 'claim frequency' value of 0.009 looking at the data table. Claim frequencies appear to follow estimated root overlap profiles.

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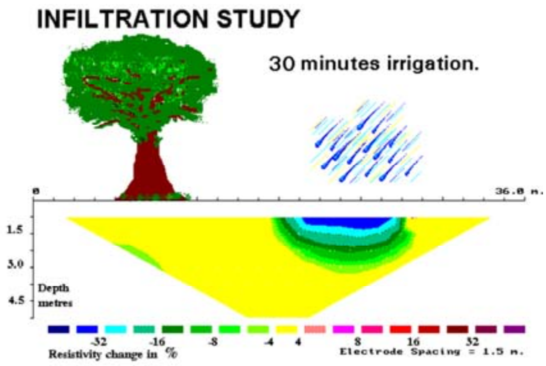
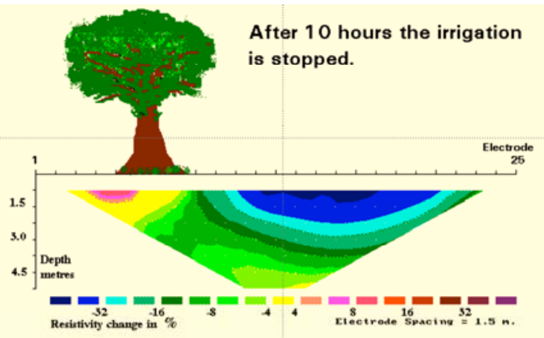
Water Movement in Sands and Gravel

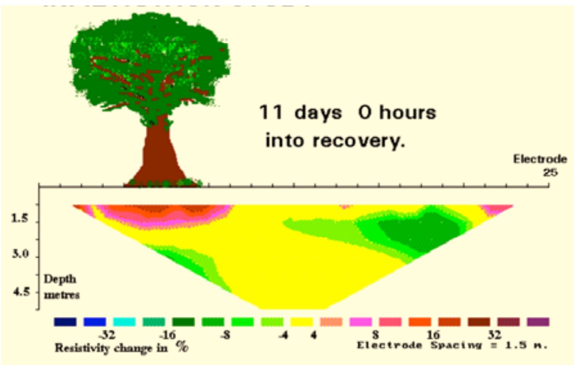
~ Sycamore – Wetting and Drying ~

Dr. Ron Barker from Birmingham University introduced us to Electrical Resistivity Tomography (ERT) around 2004 after carrying out a series of experiments using ERT in his back garden in Birmingham, using the Sycamore tree to see how roots influenced moisture change in sandy, gravely soils, rather than clay.

Below we plot extracts from his presentation to show how quickly water infiltrates into the ground, and how long it takes to restore equilibrium after localised inundation.







Dr. Ron Barker applied water to an area of the ground in the vicinity of a mature and pollarded Sycamore in his rear garden and measured infiltration rates over time using ERT.

Watering continued for 10 hours and from the second image down it can be seen how water percolates through the sand and gravel strata.

For the next 11 days, he recorded the drying process. There was no intermediate rainfall.

The saturated zone diminishes gradually, leaving a small trace (green shading) to the bottom right of the picture.

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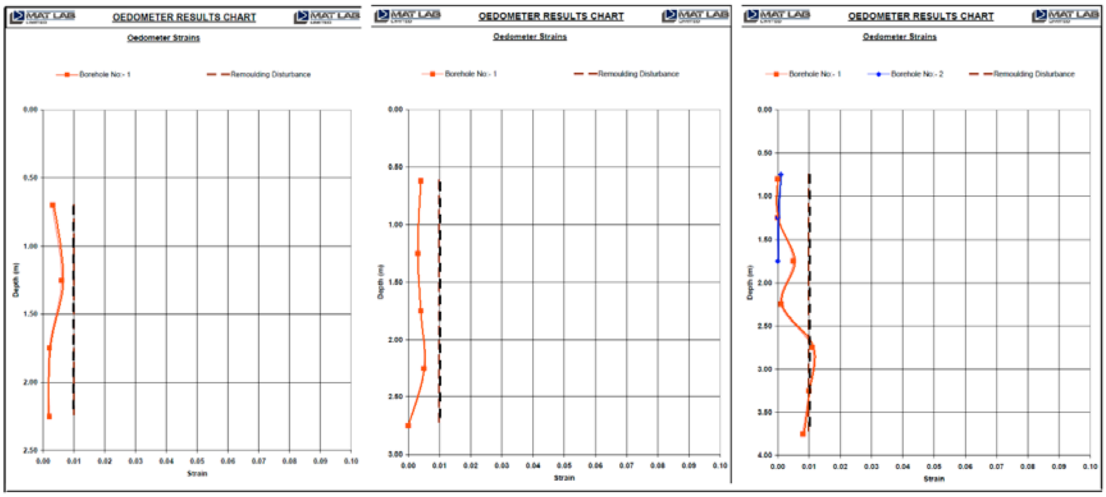
"Tree not Involved"

~ Examples from Recent Investigations ~

Tree Officers are sometimes sceptical when they see soil results, and perhaps rightly so. They all seem to show desiccation. Are all of the houses in London sitting on a desiccated soil? Is it just because it is summer? Are the tests robust, or biased in favour of the insurer?



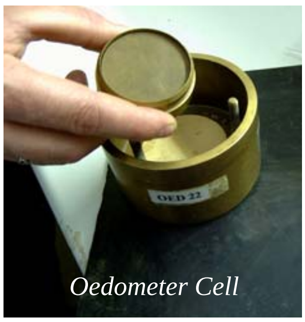
The results of several investigations, undertaken in October 2009, where oedometer testing of disturbed samples reveals the soils to be at their equilibrium level – i.e., there is no evidence of root induced desiccation. The red line plots the strains, and the vertical black, broken line represents the limit where strains are the product of sample disturbance.

A quick review of samples retrieved in October 2009 show cases that won't reach the Council – hopefully – because the results show the soil to be at equilibrium condition, even when there are trees nearby. One of the examples was taken from North London.

Clearly not all clay soils in the vicinity of trees are desiccated. Using the oedometer on disturbed samples doesn't always produce strains, and even when it does, ignoring values to the left of 0.01 seems to account for them.

The measurement of swell using the oedometer is consistently delivering reliable data, even though the test uses disturbed samples. As we see from the results above, swell isn't inevitable provided the samples are consolidated to their in-situ stress in accordance with the UKAS approved test procedure.

Benefits include a quicker (typically 48 hours), and in some cases, a more reliable result than other tests. Next month we compare the results with penetrometers and other tests undertaken at Aldenham.



Oedometer Cell