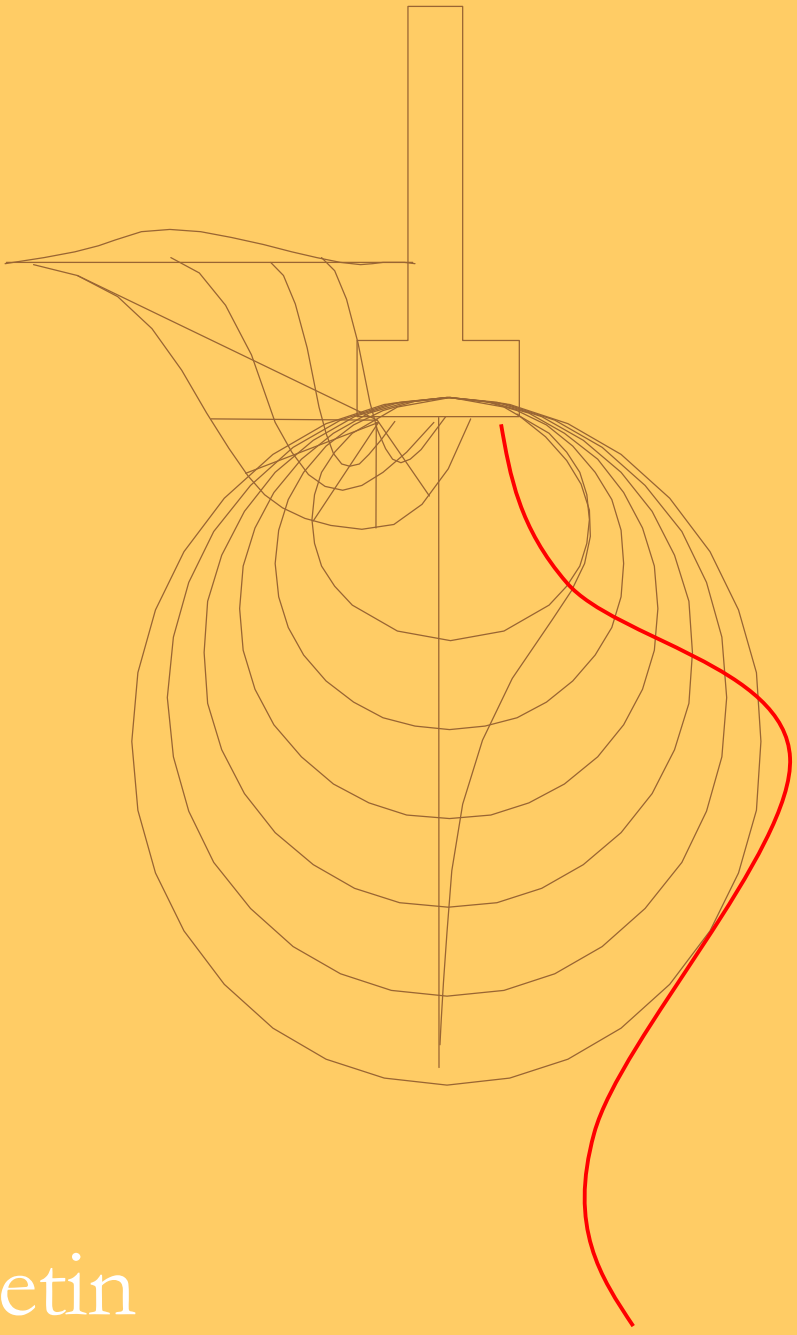
The Clay Research Group



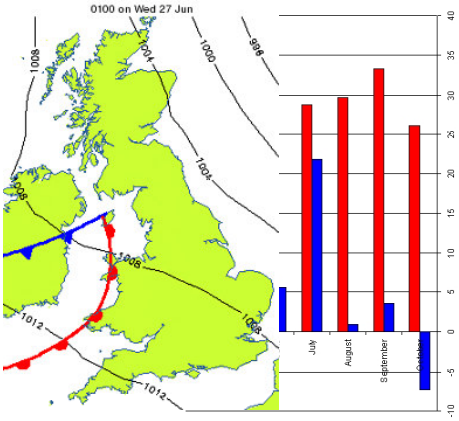
Monthly Bulletin

The Clay Research Group

June 2007

Aldenham SCHOOL

Supporting Research



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The Clay Research Group

www.theclayresearchgroup.org

Climate Change

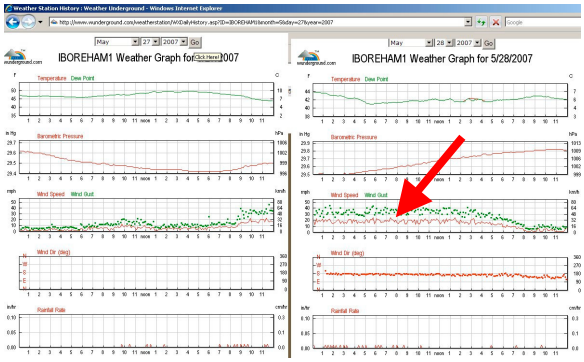
Flooding in many parts of the country and record rainfall merges with the theme of tree water uptake (blue in the graph, left) to provide a glimpse of the complex mechanism that determines so-called 'event years' for insurers. Our research suggests there is a significant water uptake in July and August, tempered by the prevailing climatic conditions of course, and if there is sufficient available water in the soil to meet demand, then the chances of an event year diminish considerably.

This is a particularly relevant finding given our interest in modelling the interaction between climate, soils and vegetation. It also introduces the idea that much of the propensity for ground movement takes place earlier than we had previously thought. See Page 6 for details.

The Aldenham Oak

One of the lower branches snapped off the Oak sometime between the 27 –28th May. Glenda was first on the scene and reported back. We gather that lower branch fall from a mature Oak isn't unusual.

Derek Clark from Southampton University noted the weather data (below) with high winds up to 45 m.p.h. Maybe this was the straw that broke the camel's back.



Our initial fears that we may lose the Oak seem to be unfounded and the program can hopefully continue – as long as everyone taking readings wears protective gear!

The Clay Research Group

Electrolevel Test Rig

To calibrate the electrolevels we use a rig with a 1m long arm, which is raised and lowered onto a 10mm UKAS certified thickness packer.

The objective is to understand the resolution and repeatability over time.

Read-out is via the digital screen attached to the base as we see below and readings are either in degrees or in digital format.

Both then have to be calibrated to provide a 'mm/m' value.

We need to research any hysteresis effect and test for drift.

For example, do we see the same values on recovery as we did when we measured subsidence? If the building doesn't move, do we still record movement?

The work should be concluded by the end of 2007 but the immediate results after deployment of 50 units on actual claims is encouraging.

GRANT APPLICATION

We have an application for funding placed with the INDEX scheme, run by Aston University.

The grant will help towards the cost of developing the disorder model where we sink a series of 'virtual' boreholes and estimate ground movement for a variety of trees and climatic conditions.

TELEMETRY ADOPTION

InFront Innovation already use telemetry on some of their more complex cases and are now looking to purchase more equipment including electrolevels and TDR moisture sensors.

By measuring both movement of the building and soil moisture change they hope to deliver high levels of evidence with data gathered over time – all from their desk.

The cost-benefit analysis has revealed that the adoption of this technology should pay for itself in the first year, but deliver considerable financial and technical benefits going forward.

Crawford

Crawford have recruited Jonathan Gray to take control of their new Telemetry Unit, based in their Nottingham office.

Jon has considerable experience in all fields of monitoring and has fitted most of the new electrolevels himself.

Crawford are taking telemetry seriously and are committed to using it on recovery cases in particular.

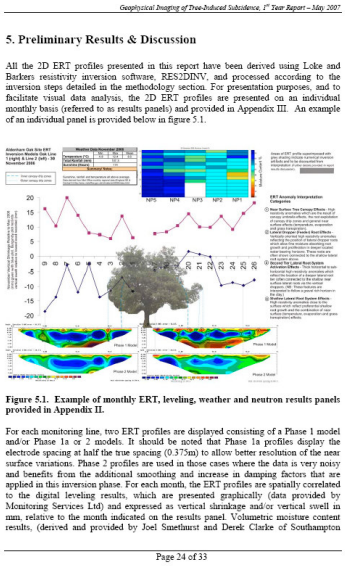
NEW SENSORS

Our suppliers have sourced a cheaper movement sensor, which is currently undergoing tests. If they prove as reliable as the current ones we move a step closer towards making them more accessible to the industry.

ERT Report

Glenda Jones

Glenda has produced her first year report towards her PhD and it is an excellent piece of work, reviewing previous research, recording the methods she has used and drawing some particularly interesting observations.



Geophysical Imaging of Tree-Induced Subsidence, 1st Term Report – May 2007

5. Preliminary Results & Discussion

All the 2D ERT profiles presented in this report have been derived using Loke and Barkers resistivity inversion software, RES2DINV, and processed according to the inversion steps detailed in the methodology section. For presentation purposes, and to facilitate visual data analysis, the 2D ERT profiles are presented on an individual monthly basis (referred to as results panels) and provided in Appendix III. An example of an individual panel is provided below in figure 5.1.

Figure 5.1. Example of monthly ERT, leveling, weather and neutron results panels provided in Appendix II.

For each monitoring line, two ERT profiles are displayed consisting of a Phase 1 model and/or Phase 1a or 2 models. It should be noted that Phase 1a profiles display the electrode spacing at half the true spacing (0.375m) to allow better resolution of the near surface variations. Phase 2 profiles are used in those cases where the data is very noisy and benefits from the additional smoothing and increase in damping factors that are applied in this inversion phase. For each month, the ERT profiles are spatially correlated to the digital leveling results, which are presented graphically (data provided by Monitoring Services Ltd) and expressed as vertical shrinkage and/or vertical swell in mm, relative to the month indicated on the results panel. Volumetric moisture content results, (derived and provided by Joel Smethurst and Derek Clarke of Southampton

Plotting change over time, rather than absolute values, has provided a fascinating glimpse of moisture movement in fine grained soils beneath a mature tree.

The work, funded by InFront Innovation, is amongst the first to map moisture change in London Clay with specific regard to domestic subsidence and ground movement.

IET The Institution of Engineering and Technology

The Clay Research Group were invited to deliver a talk about the new range of telemetry products at a meeting held at The Institute of Engineering Technology in London.

Amongst the guests were Giles Biddle, Nick Deakin (R&SA), Jill McLean (LloydsTSB), Nigel Barham (Cunningham Lindsey) and Robert Sharpe (Crawford).

The Clay Research Group

Funding Needed

We need an 'hours of daylight' sensor to supplement the data we gather from our weather station, and a shuttle to download the data more easily.

We have received the following quotation from Tempcon.

BHW-PC Software and lead	@	£74.00
U-DT-1 Hobo U Shuttle	@	£185.00
Silicone Pyranometer	@	£148.00
Light Sensor Bracket	@	£20.00
Carriage and packing	@	£14.00

The original idea to gather and issue data via the web was confounded because of the wavelength which is approved in the USA, but not for the UK. Hence the need for the shuttle.

This totals £441 + VAT = £518.17 inc.

Financial assistance would be very helpful. Anyone who can help purchases the equipment direct from the supplier, with the delivery as Aldenham – or elsewhere to suit.

CILA + DESICCATION

The Chartered Institute of Adjusters (CILA) commissioned Richard Thomas (RTG Expert Services) and Graham Rex (Cunningham Lindsey) to review the issue of desiccation and they have produced an excellent article.

They explain that desiccation and associated ground movement is a complex relationship that cannot be defined by using a 'one size fits all' formula and go on to explore the importance of a visual assessment combined with movement over time.

Climate Change Impact

Aldenham has proven more challenging than we initially thought but it has delivered significant rewards in terms of the climate change model.

The persistent moisture deficit beneath the Oak was initially considered to be a drawback. We weren't able to measure the change from full winter rehydration to field capacity through to drying in the summer.

The emphasised ground movement towards the root periphery was regarded as unusual and contrary to our current understanding of root activity.

The ground movement was quite small. It was a hot summer in the early months of 2006 at least, but overall movement was less than 40mm.

Roots from both the Oak and Willow extended for considerable distances.

In fact, the situation replicated the likely conditions that will exist in global warming. The less dangerous species of trees – those unable to generate huge suctions in the soil – will presumably die off first as available water reduces.

The high risk, heavy water demanders – Oaks, poplars and so forth – will survive but in a changed environment. Persistent moisture deficits will become commonplace. As a result their roots will extend further to track down available sources, remote from the canopy.

The outcome for insurers may be perverse and the risk from subsidence may reduce, not increase. If our model is correct, the amplitude of ground movement will be far less, but extending over a much wider area.

So, what does this mean? Initially, we will see an increase in claims as the ground shrinks. This may extend over the next 10 - 20 years or so as event years become more frequent.

This may be followed by the loss of less dangerous species over time combined with the build up of persistent deficiencies beneath the surviving trees – the Oaks etc.

Followed by a period of relative stability.

If we are to retain the low water demand, more vulnerable species, some form of improved water storage/usage is going to be needed. We will have ample water in the winter period but we need to store it, and not allow it to run-off as is currently the position. **If we are to retain our landscape, action is needed now.**

Our research at the CRG is aimed at helping the tee to 'self-medicate' naturally to cope with stress. Local Authorities, Governments and private householders will have to look to introduction of techniques to make better use of the water we have.

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The Clay Research Group BioSciences

ASTON UNIVERSITY BIRMINGHAM

LANCASTER UNIVERSITY

Aston was a great success this year, and even more so when we consider that the annual Subsidence Expo event in London follows closely on the 20th.

The CRG was well represented, outlining the results of our work over the first twelve months and supported by Nigel Cassidy describing methods of seeing the subterranean environment without digging holes or testing soils.

Richard Rollit spoke about how we model soils and described the practical issues related to the new breed of web applications – OSCAR and VISCAT. Addressology went on to explain how they used the output from the research to build their models.

In the afternoon Tim Freeman proposed levelling as a method of gathering evidence for recoveries and he was followed by Paul Leighton, who outlined current case law.

The event was also a success with regard to the attendees it attracted. For the first time we had a mixture of Local Authority Tree Officers, insurers, private practice engineers, investigation contractors, testing laboratories and adjusters.

Question time was very busy as we might expect with the wide ranging interests of the audience.

Aston received a 100% satisfaction with this CPD accredited course from those that attended.

Representatives of the CRG called to see the excellent work being carried out at Lancaster University by Prof. Bill Davies and Dr. Ian Dodd.

Both are leading authorities on plant response to drought stress and Prof. Davies published work includes understanding how the stress hormone acts in response to a combined hydraulic and chemical signal. It can be effective in inducing stomatal closure even in well-watered plants as long as the pH is high enough. His published aim is to …

"increase the efficiency of water use (i.e. reduce transpiration) by allowing maximum photosynthesis under mild environmental conditions and reducing transpiration in stressful conditions."

He re-affirmed the fact that the hormone is effective at promoting stomatal closure but that cell turgor can be maintained. We gather this isn't at all unusual and can be used commercially when plants or small trees are re-potted.

More commonly, a hormonal response is triggered by root drying and we gather it responds to even small changes in soil suctions. Its actions are enhanced by a nitrate deficiency (no doubt related to stress again) but the major significance – as we understand it at least – is the fact it is closely related to the pH in almost every part of the transpiration cycle – the root, xylem and stem.

The site of action is the guard cell apoplast and although the half life can be short, ABA is recirculated via the phloem in some cases and can be drawn into cells – the process is complex – but it can be effluxed back into the apoplast.

The effectiveness can also be influenced by the external climate – the vapour pressure deficit (VPD). Bill Davies also pointed us to a range of anti-transpirants that can be applied directly to the underside of the leaf, quickly, simply and relatively cheaply.

Where does this take us? Understanding the importance of the pH in hormonal regulation – in the xylem in particular - is a huge step forward. Knowing when the tree water uptake is at its peak – based on the work at Aldenham - is very relevant.

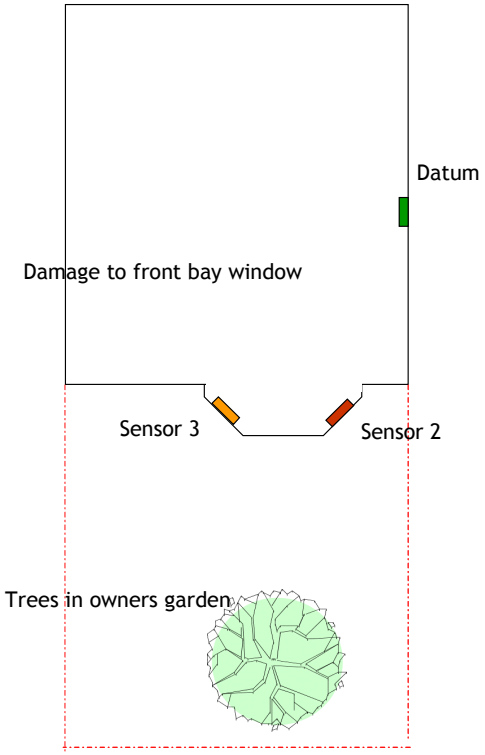
Our work this year – hopefully – may lead us to developing a solution that benefits all parties. The homeowner, the insurer and the Local Authority.

The Clay Research Group

A CASE STUDY

Damage to the front bay window of a mid-terraced dwelling house in London. Plasticity Index around 48%. A selection of trees in the insured's garden. Evidence required of enhanced seasonal movement before homeowner would agree to action being taken.

Electrolevels were fitted in November 2006. One to either side of the bay window and another away from the area of damage, acting as a datum. See sketch below.

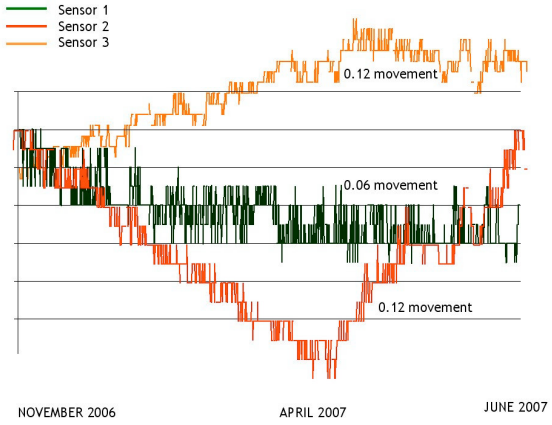


The datum shows movement of 0.07 degrees. In contrast the sensors fitted to the bay window have recorded movement of 0.13 (Sensor 2) and 0.15 (Sensor 3) degrees.

There has been twice as much rotational movement where there are trees than where there are not. Further, there is a characteristic periodic signature recorded by both Sensor 2 & 3. The ones fitted to the bay window. The pattern does not match that of the datum, so not only do we see seasonal movement, we are able to discern one pattern from another.

We can see one side of the bay (Sensor 3) moved a little later than the other. The one that moved first (Sensor 2) is providing evidence that the soil beneath this wall is drying at a faster rate.

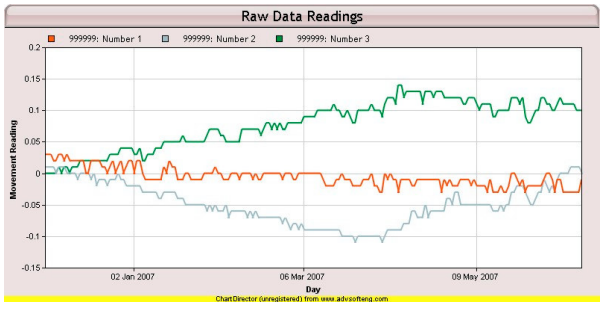
The values suggest that rotation of 0.1 degrees or more is possibly the level that could cause cracking to a domestic structure. Diurnal movement varies between 0.01 and 0.02 degrees.



Because we are measuring flexure directly, we have an opportunity of making comparisons with the work of Burland & Wroth and others. It is widely recognised that crack monitoring is of limited use and whilst precise levels measure vertical movement, electrolevels measure how the masonry bends and the amount of flexure needed to exceed the limiting tensile stresses within the wall.

Gathering data of this sort over the next few years will help us understand the vulnerability of different house types as we build a library of case studies.

We can see in this example that one sensor is recording anti-clockwise movement and the other, clockwise movement as they are fixed to opposing faces of the bay. This is useful when understanding the DataREADER output.



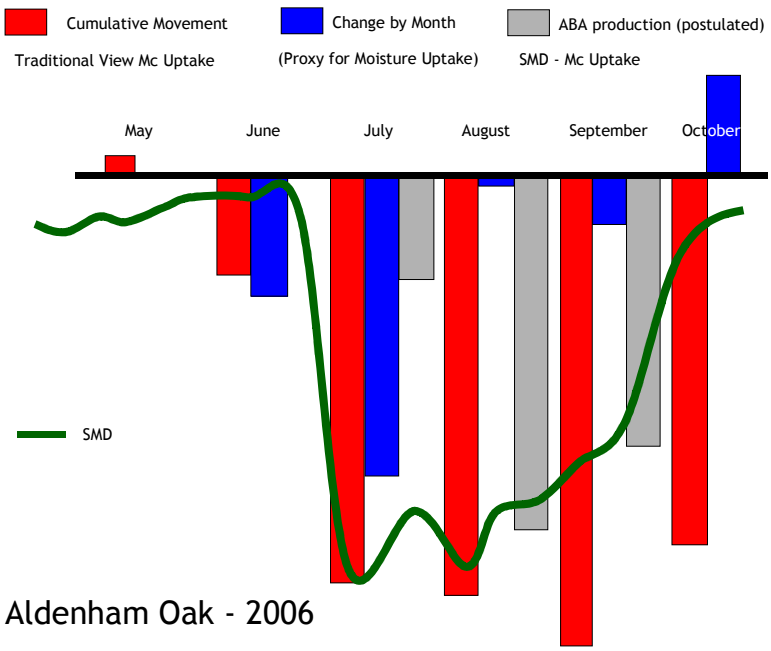
DataREADER suggests an 80% probability that movement reflects root induced clay shrinkage for the 'active sensors' and 45% for the datum. Generally any value less than 70% would be classed as unreliable.

The Clay Research Group

A DEVELOPING VIEW OF MOISTURE UPTAKE

Below is the graph of 'cumulative ground movement' and 'movement by month'. We have reproduced this before, but it is worthy of further exploration because we think it changes the way we should be looking at how trees take up moisture and possibly the influence of the stress hormone, Abscisic Acid. For the illustration it helps to assume the climate is reasonably static in the summer. Clearly it isn't. We see showers and fluctuations by the day, but it will help us to understand the basis of the model and weather can be factored in later.

The red bar graph shows our current view of the subsidence world. Ground movement increases month by month, peaking in September or October. The blue bar chart, recording the difference by month, shows the qualitative influence of the tree, which we regard as a proxy for moisture uptake.



Aldenham Oak - 2006

Evaporation forms part of this value, but this is a minor part of the 'moisture loss' equation. The relationship between moisture uptake and ground movement is complex because it isn't linear and varies with the mineralogy of the clay, the health of the tree and climate. We have already examined the water release curve. To simplify matters we can discount the soil mineralogy and health of the tree as the above levels have been taken from one station and share common characteristics.

Using the 'difference' values we can see the tree is taking most of the moisture from the ground early on in the summer, between late June and July. Most of the readily available water that would lead to ground movement at least. If the climate remains fairly stable (taking the values of the SMD in July and August as an example), the limiting factor that might cause the tree to take less moisture from the ground is the soil suction. If the suctions reach 1,500kPa, then we know the tree would have to close down because it can't overcome the water retention properties of the soil. We also know that the production of ABA is very sensitive to even small changes in soil suctions at lower values. The hormone will take effect well before the wilting point is reached, whilst retaining cell turgor.

Understanding this, we may infer that the production of ABA can be very crudely estimated (in broad qualitative form as least – the scales of the various items aren't the same) as the difference between the moisture uptake and the climatic condition – the green SMD plot. It will be a dynamic relationship, changing by the day.

The upper limiting factor – the point at which the relationship would fail – has to be when the wilting point has been reached in which case ground movement would cease under the control of ABA alone and climate would have little influence.