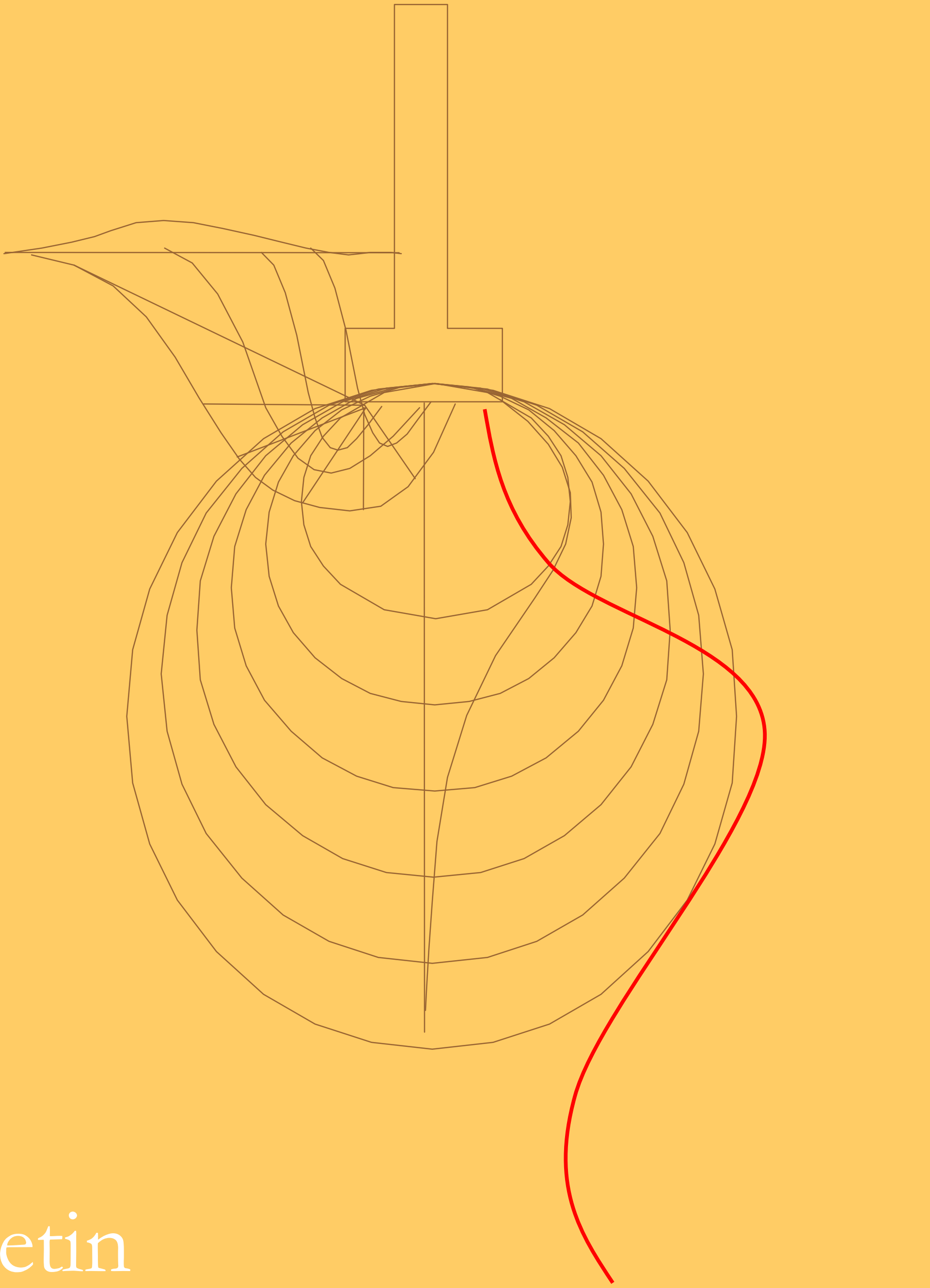
The Clay Research Group



Monthly Bulletin

The Clay Research Group

Aldenham School

Supporting Research

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"DEAR DIARY …"

We met Mott McDonald's team in Croydon and shared details about our respective areas of research at the invitation of James Scott from their Croydon office. We have overlapping interests, both measuring moisture movement below ground in the presence of vegetation and in relation to climate.

Our good friend Gary Strong, the subsidence director from GAB Robins, has decided to join the RICS and although we will miss him, our very best wishes.

We can also record the arrival of Harry Milliam. Mom (Becky from RBSI) and Dad (Milliam from Crawford) are doing well. Harry has been made an honorary member of the CRG even thought he is very young.

The Subsidence Forum will be represented at our technical meeting along with Giles Biddle, Neil Curling (HBOS), John Parvin (Zurich), Nick Deakin (R&SA), Richard Rollit (Crawford), Cyril Nazareth (InFront) … and hopefully others. We do need representation from more arborists and geotechnical engineers.

Technical Meeting

Anyone with an interest in the project is welcome to come along to a technical review to discuss our findings in open forum. We are looking for a venue if anyone has any ideas and hopefully we can attract some industry experts (see bottom left).

We will be looking at moisture change in fine grained soils, both in terms of depth and 'by-month' uptake, discussing how we propose to 'switch off' the tree with a view to reducing the life of the claim.

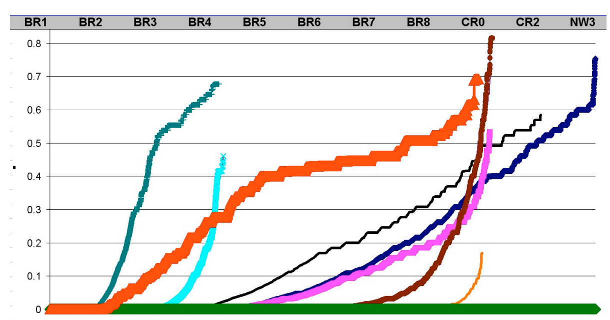
Topics will also include soil testing. Oedometers, filter papers, neutron probes, ERT and TDR sensors. How do they compare and what are the advantages and disadvantages? How we perceive the use of telemetry. What are the issues and how useful is this emerging technology?

Is there a case for the adoption of modelling in certain situations to speed up the process and reduce costs?

Finally and if possible, reach an agreement on direction. How valuable is the project? What has been learnt? Should we change our focus? Can insurers/adjusters help in terms of case studies and the identification of suitable claims?

We are aiming for sometime in late September – if you are interested, contact us at ael@blueyonder.co.uk

Houses at Risk by Postcode



Above we reproduce a graph showing the housing population at risk from root induced clay shrinkage at individual property level for a selection of postcodes. The red line charts the risk in NW3, with lots of properties at high risk. Elsewhere – the orange line at the very end for example – shows just how many houses are at low risk when we use the model in the alternative.

This categorises every single property in the sector.

DataREADER Application

Below we have an example of how the DataREADER application works, sampling data over time, and patching rare data as we see from the red line (Sensor 1) below which was the result of a dropped signal.

To the right of the graph we show the analysis.

Station 1. This has been set up with a clockwise orientation and we see the interpreter scores the correlation between the movement that has taken place and the characteristic signature of root induced clay shrinkage at 97%.

The overall movement is recorded as 'reading variance' = 0.146. We would consider this as being structurally significant because it exceeds the value of 0.1, which we estimate to be the difference between temperature driven and structural movement.

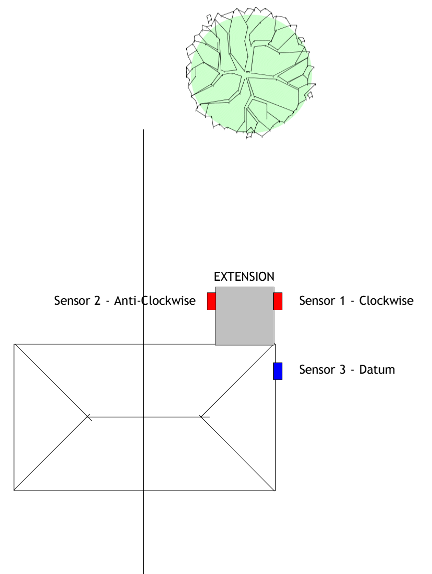
Station 2. This sensor has been set up in the anti-clockwise direction (see sketch – it is on the opposite side of the extension) and we see the probability of it being related to root induced clay shrinkage is 91%. Very similar to Sensor 1 - as might be expected as the two sensors are fitted on opposite walls of a single storey extension.

The reading variance value here is = 0.141, and again this is indicative of structural movement.

Station 3. This is the datum and has a probability of being related to clay shrinkage of only 19% – no correlation at all. The absence of movement in this location ("main house towards rear") combined with the 'reading variance' value of 0.064 (< 0.1) confirms it is stable when compared with the others.

Root induced movement commenced towards the middle of May as we see from the point of divergence between the plots.

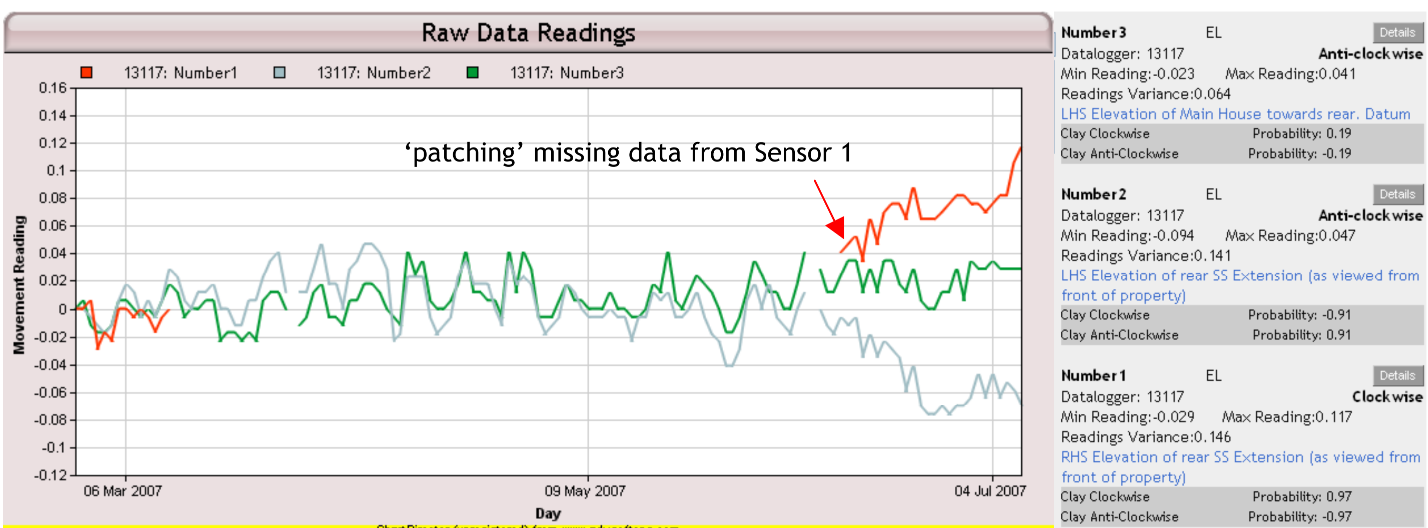
This is a plan of the property showing the location of the sensors and the datum.



The tree along the rear boundary is implicated and the evidence obtained is clear.

There is movement towards the tree of a seasonal nature and of greater amplitude than that recorded by the datum fixed to the side house wall.

The degree of movement is sufficient to cause structural damage.



CRG BioSciences

Root to Shoot Signalling

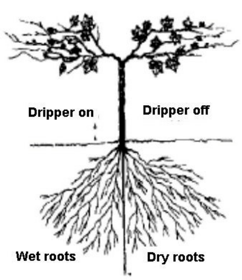
Raising the pH of the water flowing in the xylem is apparently a vital ingredient in extending the life of the hormone that regulates stomatal activity. When the leaf is phosphate deficient the hormone imported via the xylem sap can be degraded very quickly.

This is where buffering the ABA_{xyl} is important to extending the influence and this may be so even in well-watered plants.

In well watered plants the xylem sap (and the apoplastic pH) are relatively acidic and the hormone is partitioned into the leaf symplast. By raising the pH by even one unit (making it less acidic - relatively) improves movement into the apoplast and then into the guard cells. We understand that a change in ABA concentration of around 10nM is enough to limit leaf growth.

It is also likely that a rise in acidity associated with drying stress means the ABA is more likely to be taken away from the site of action (the guard cell apoplast) in the phloem, re-circulated back to the root.

The pH of the system is therefore an important element in ensuring the effectiveness and duration of the hormone in regulation of stomatal activity.



Recent work has highlighted the value of Partial Root Drying (PRD) treatment. Shrubs have been cultivated with half of the root system in dry pots, and the other half in well watered pots. The result is an increase in ABA production, with an increase its effectiveness.

We assume the droughted roots produce more ABA, allowing the water from the other roots to conduct them in a more concentrated form to the leaf. If this is so, dealing with trees in event years delivers some hope.

In dry weather the roots of trees are already replicating one system, and some localised rehydration would stimulate stomatal closure – or so we assume.

Interestingly the water potential within the plant remains the same using this technique which suggests its health and vigour remain.

Unfortunately significant genotypic differences in stomatal sensitivity to non-hydraulic signalling between six deciduous tree species have been recorded in a study, just to make life even more complicated.

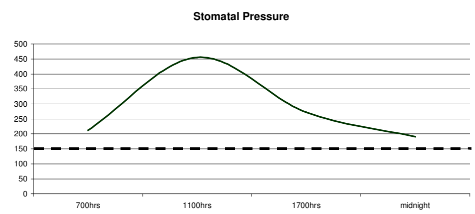
What works with one species might not with another.

PRD - Extract

Professor Davies

"Partial Root Drying (PRD) is a way of manipulating water use and crop growth without genetic manipulation".

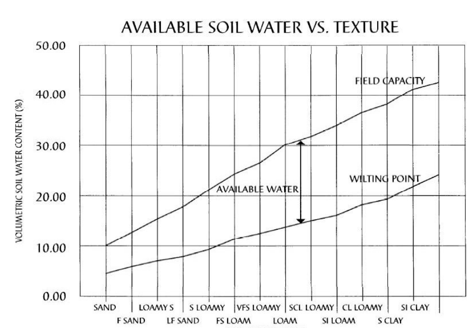
The Lancaster group first experimented with apple trees, watering half the roots whilst leaving the other half to dry out.



The table above from some earlier work (by others) shows the osmotic pressure measured at different times of day in typical guard cells. The osmotic pressure within the other cells of the lower epidermis remained constant at 150 lb/in^2.

When the osmotic pressure of the guard cells became greater than that of the surrounding cells, the stomata opened. In the evening, when the osmotic pressure of the guard cells dropped to nearly that of the surrounding cells, the stomata closed.

Below we see the available water for a variety of soils as the difference between field capacity and the wilting point. Clay holds more moisture and we can see similar values at Aldenham.



Moisture Uptake by Month, by Station

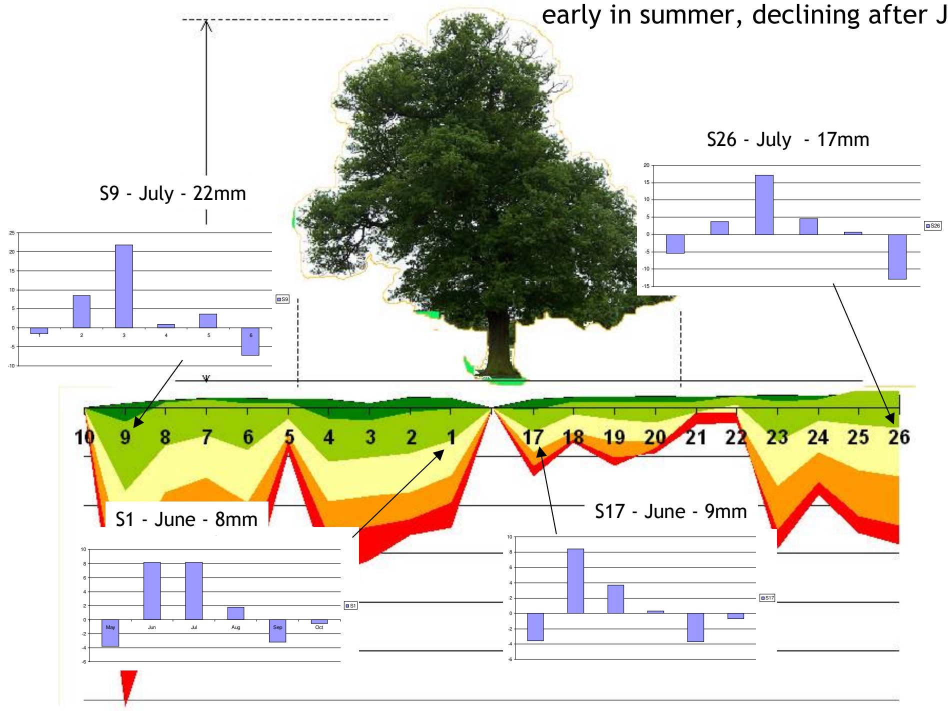
Plotting the moisture uptake for the Oak tree by levelling station, by month, suggests that the tree begins taking water earlier in zones of higher desiccation than elsewhere.

At Stations S1 and S17 – the ones closest to the tree and according to both the site investigations and levels the area where there is a persistent deficiency, we see moisture uptake starts in June and July.

Not only do we see the onset of water uptake starting early in the year, but also the decline, which we imagine must be triggered by the soil moisture retention curve which in turns, initiates the ABA cycle.

We can see both S1 and S17 becoming negative a month earlier. S1 – in an area of ‘middling deficit’ takes a mid-path between the extremes.

Whatever the explanation, we appear to have evidence that the Aldenham Oak takes most water early in summer, declining after July.



Due no doubt to the lack of available moisture, movement at these stations is 8 – 9mm only.

To the root periphery and where there is more available moisture, the uptake starts a little later in July and we see ground movement between 17 – 22mm.

The data seem to suggest the tree detects a deficit and starts to seek moisture earlier in these locations. Where there is available water, it starts a little later.

The intermediate station (S1) falls between the extremes.

Applying a soil treatment in July – and for a short term and over a limited area of the root zone – could solve the problems we experience in August, September and October.

These observations suggest the root system is very sensitive to drought stress indeed. Far more sensitive than we might have previously thought.

This work is shedding more light on what is – apparently – an amazingly complex series of linked events.

MAT-LAB

Soil Testing

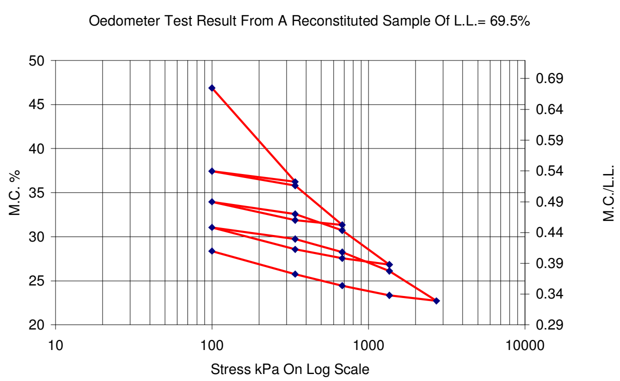
MatLab Research Program

Clive Bennett has been using the oedometer to compress samples to simulate their stress history, reproducing the influence of glaciation and overburden pressures.

He writes …

“Below we see the results from an oedometer test carried out on a sample taken from postcode KT3 4 with a LL of 69.5%.

The sample was consolidated in stages from the LL down to a maximum stress of 2720 kPa before being allowed to swell back to 100kPa through the previous loading stages from each maximum loading stage.

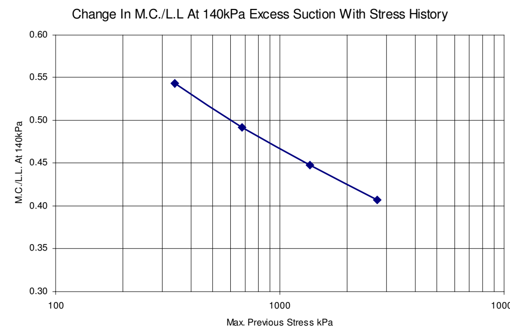


The virgin compression line can be clearly seen with the branching unloading and reloading lines. This is not representative of its undisturbed natural state but it does show the general signature of the consolidation process.

This plot is known as the soils intrinsic properties having been totally remoulded for the preparation of the LL test.

It can be seen that with different stress histories and corresponding OCR’s the values for M.C./L.L. at an excess suction of 100kPa and an overburden pressure of 40kPa (replicating desiccation) varies anywhere between 0.41 to 0.54”.

The results of the tests from Aldenham should be available in the next edition of the newsletter and it will be interesting to compare profiles with the earlier data from May 2006.

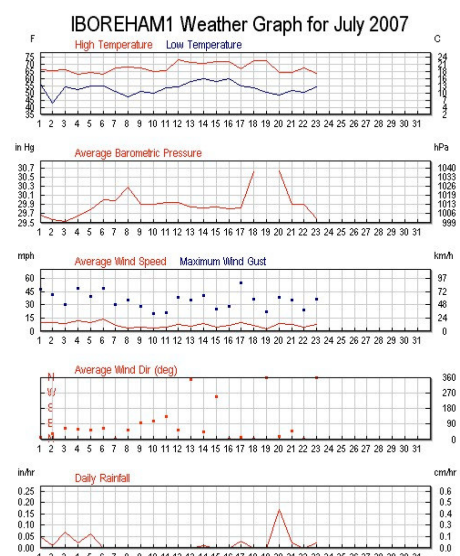


Clive Bennett

Clive is the Managing Director of MatLab Laboratories. They undertake soil testing and research for a number of adjusters and engineers in the subsidence industry. MatLab are sponsors of The Clay Research Group, funding site investigation, soil testing and the installation of levelling stations as well as undertaking research into ground treatment.

Rainfall

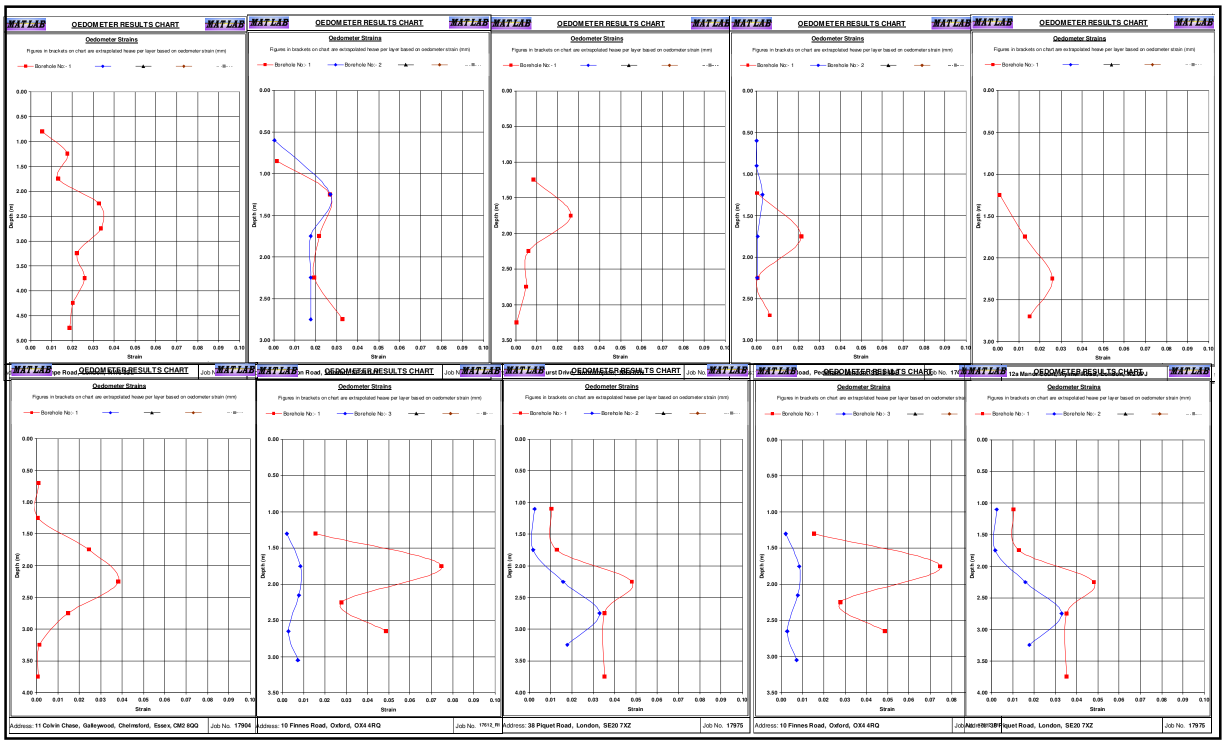
2007 has been an exceptionally wet year and yet we see the ground profile subsiding around the perimeter of the Oak and Willow.



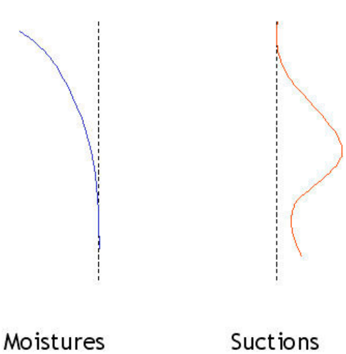
The Borehamwood weather data suggests why this might be so - see above. The rainfall is plotted along the bottom line of the above picture and we see it has been relatively dry at Aldenham - apart from a downpour around the 20th.

THE ZONE OF ROOT ACTIVITY

The suggestion that roots extract moisture from around 2mtrs below ground – and not from the surface downwards – appears to be reinforced by many of the soil test results and particularly when we use the filter paper suction test, or the oedometer.



Above we have reproduced a selection of profiles from different locations showing the characteristic suction bulge anywhere between 1.5 and 3mtrs below ground. This pattern isn't at all unusual – in fact it is commonplace.



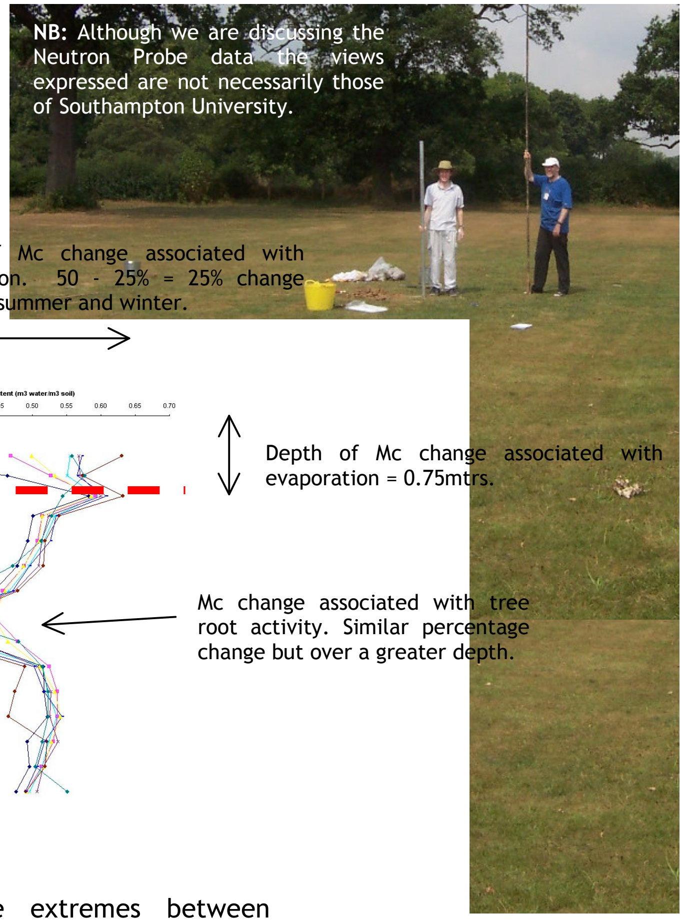
The traditional view (as far as we are aware) is that trees take moisture 'top down' and this is the plot we often see when using moisture content profiles.

Suctions and strains tell a different story.

Botanists that we have met take the view plants and trees take moisture in the form of the blue line but that isn't borne out by experience.

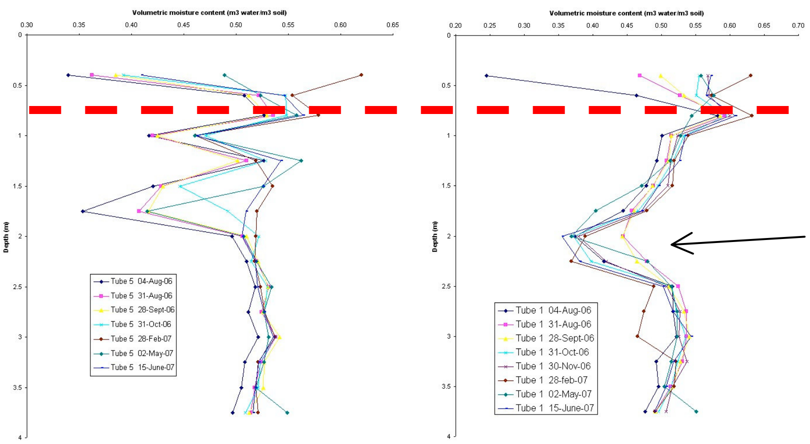
Hopefully someone amongst our readers will shed some light on this.

The Neutron Probe data has provided some valuable information about how trees take up moisture, but also how evaporation alone is limited to the upper 750mm or so. See the images from NP1 (nearest the tree) and NP 5 (furthest away) below.



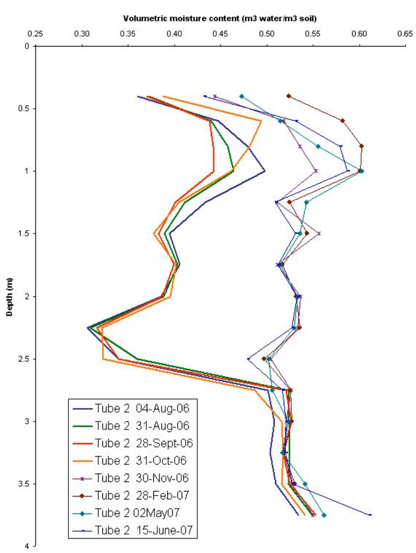
NB: Although we are discussing the Neutron Probe data the views expressed are not necessarily those of Southampton University.

Range of Mc change associated with evaporation. 50 - 25% = 25% change between summer and winter.



Depth of Mc change associated with evaporation = 0.75mtrs.

Mc change associated with tree root activity. Similar percentage change but over a greater depth.



NP 2

Readings from August 2006 through to June 2007. Note the seasonal extremes and the relative stability throughout the summer months.

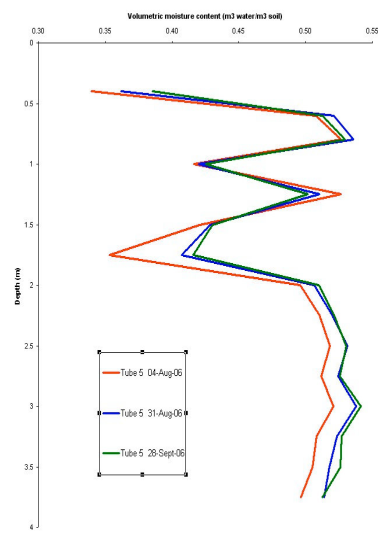
Left we see the extremes between summer and winter as plotted from data derived from NP 2.

As suggested earlier, there isn't a huge difference between the summer months. Water appears to be extracted fairly early in the year and then the change by month is quite small, which coincides with the precise level readings.

In this location the moisture deficit reaches 20% and extends down to 2.75m bGL.

Right we plot the data from NP 5 which tells a similar story. Moisture deficits actually start to decrease in this location and the depth rules out rehydration directly due to rainfall because we don't see any change at shallow depths.

The suggestion must be (we assume?) the soils are trying to equilibrate from adjoining areas. We know that NP 3 has gravel banding for example.



NP 5

Change between August and September 2006. Although the depth rules out rainfall we may be seeing equilibration between adjoining areas if the tree has been 'switched off' by hormonal influence.