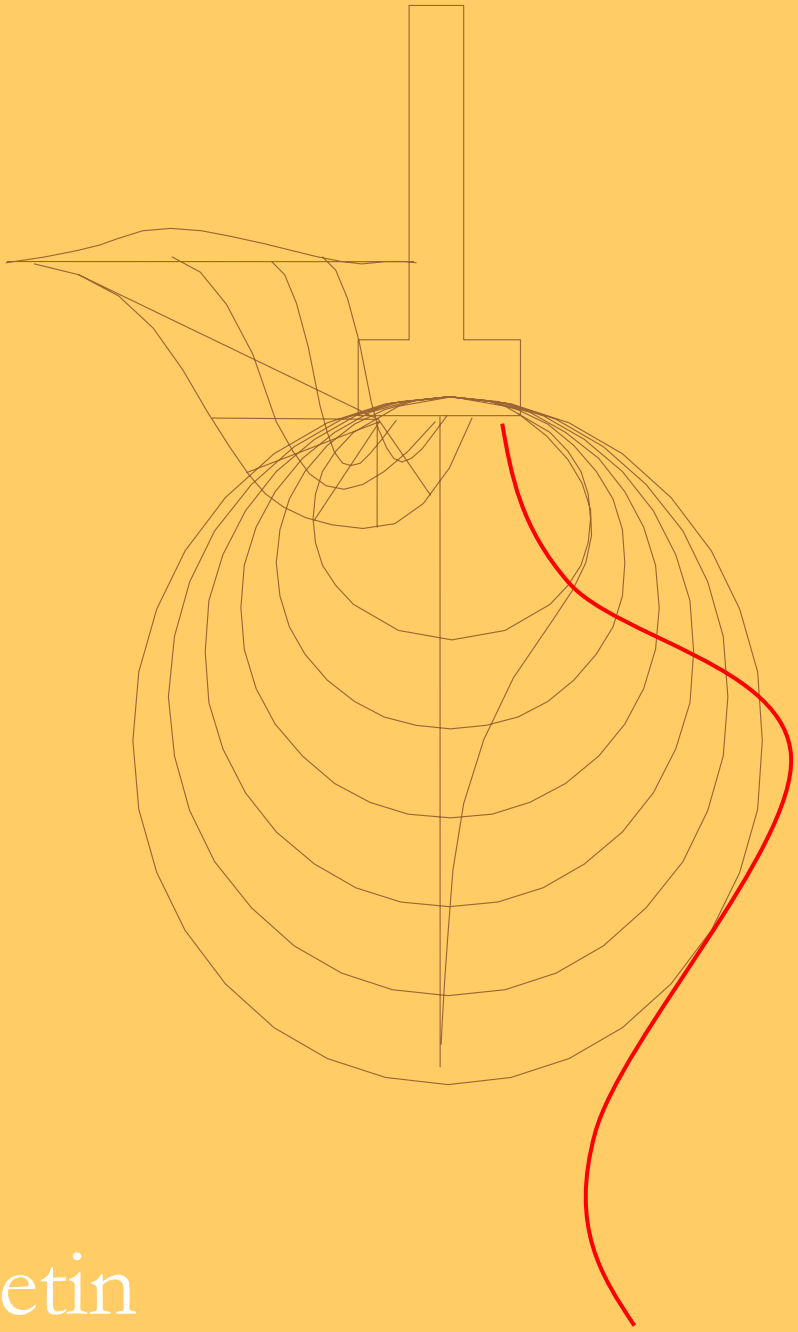
The Clay Research Group

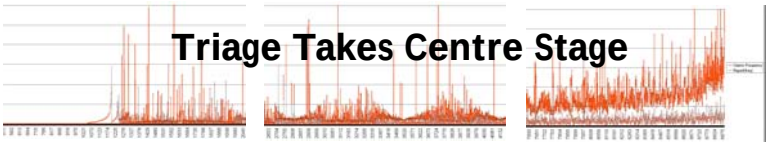


Monthly Bulletin

The Clay Research Group

March 2007

Supporting Research



Continuing the topic of triage (see last months edition), we have presented the data slightly differently above, showing three extracts from the UK sequence. Previous graphs showed how we might anticipate the operating peril. This one assesses the probability of a claim being valid.

To the left we see the postcode sectors with few claims, if any. Centre we see the sectors where the probability is fairly evenly balanced and these usually are a function of the geology – drift deposits of variable composition. However, even in this area we see a high number of clear spikes. The higher the spike, the greater the degree of confidence in the estimate of a valid claim.

To the right we see a marked increase in the probability that a claim is going to be valid.

A pilot version of this web application will soon be available for testing by anyone with an interest in the topic.

CONTENTS

www.theclayresearchgroup.org

Our Carbon Footprint

We were hoping to make much of 'saving the planet' and reducing the CO^2 footprint, but a recent article in the press suggests global warming might be a product of the sun getting hotter, rather than the humble efforts of mankind. We also note the comments from some members of the scientific community who tell us that historically, increases in CO^2 are more often than not related to a decrease in temperature. Anyway, this news hasn't stopped us making much of little.

The introduction of telemetry means fewer visits to site. We will be cutting mileage by at least 50% once the technology is cheap enough to be widely adopted.

Modelling the influence of trees and soils and their response to climate means the number of people interrupting the poor homeowner also reduces – significantly.

In a different vein, we have taken note of the fact that some readers prefer to print off a copy of the newsletter and the coloured banners have been removed to reduce printing costs.

The net saving might not be huge in the scheme of things, but we can claim it delivers the 60% figure the politicians are making much of. Of course, there is a school of thought that suggests felling trees might help as well. A recent article in Nature (see Edition 14) tells us that they are the biggest contributor of methane, producing 40% of total emissions….

The Clay Research Group

London Tree & Woodland Implementation Group

Meeting Hosted by the Forestry Commission

Forestry Commission England

We were invited to meet the members of the above committee on the 2nd March chaired by the BioDiversity Officer, Richard Barnes and held at the Government Office for London.

The invitation stemmed from our newsletter and in particular the frequent references to both data and modelling.

They were interested to learn that we had aerial imagery for 1995, and combined with the LiDAR data from 2005 used by Addressology, they could count the number of trees felled (or planted) in that intervening ten-year period. From this they could determine the loss of amenity and plot the current assets.

They raised concerns surrounding the modelling project and in particular:-

1. Aerial imagery and LiDAR do not identify species, and we all recognise that some trees are more risky than others.

2. The 'notional root zone' cannot hope to take account of specific environmental factors, and this touches on the Esure article in the last edition, where impervious paving can change the direction in which roots grow. They also made reference to the work of Cutler & Richardson, which told us that trees present less of a threat with distance and they felt that practitioners don't take full account of this.

3. The perception that all trees cause damage could blight properties unnecessarily, and cause alarm amongst those living in London,

4. Some attendees wondered if trees did cause damage and questioned the research (by others) suggesting they were involved in 70% of valid claims. It was thought that the tree was an 'easy target' in many cases, and that misdiagnosis was an issue.

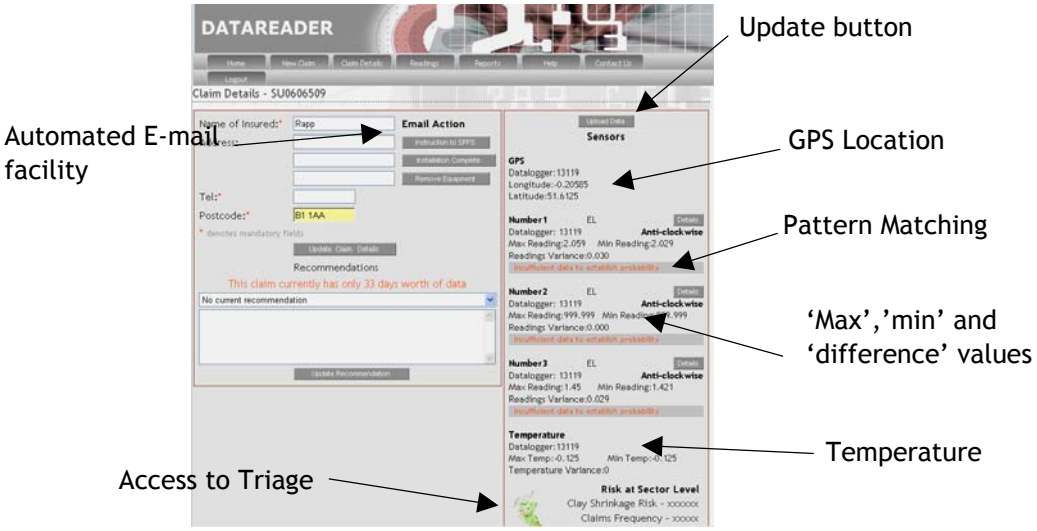
The good news is that we hopefully have the beginnings of a dialog and the best way for us to establish the culpability or otherwise of trees is to carry out research. We would welcome some form of co-operation from the LTO's and would benefit from their knowledge of tree habitat, growth in the urban environment and thoughts on the Esure findings.

By selecting a few cases from each Borough that are the subject of a current claim, and with the help of some enlightened insurers, we could at least help to resolve the technical issues surrounding root induced desiccation, although of course the legal precedent is a separate issue.

The Clay Research Group

DataREADER Update

Some additions to the web based application that helps us understand the data we receive from the telemetry sensors. First, we have added the location of the units using the GPS signal generated from the datalogger. We can plot where the site is and record the position of the dataloggers onto a map of the UK, and start to plot movement with geology to better understand the relevance of the link between them.



The temperature is also recorded, along with the minimum, maximum and 'difference' values. We can see very quickly which parts of the building are moving and which soils are drying more than others.

The pattern matching facility has also been improved. Where we have insufficient data, then no attempt is made to provide advice on correlation. For automated help we suggest that 'sufficient data' is 3 months, but at certain times of the year the engineer can make decisions very quickly in cases of root induced clay shrinkage.

Finally, we have added 'E-mail Action' buttons. The adjuster or engineer can instruct the supplier. The supplier then updates the client once the installation is complete, and automatically advises the telemetry server. On completion of the monitoring, a single press of the button decommissions the unit.

All of the actions are date stamped for audit purposes.

The raw data is available as a download into Excel for analysis and, as before, the user can produce a factual report in HTML or as a .pdf file at the click of a button.

The application goes live at the end of the month and anyone interested in the use of telemetry can have access. Just contact us for further information via the E-mail facility at www.theclayresearchgroup.org.

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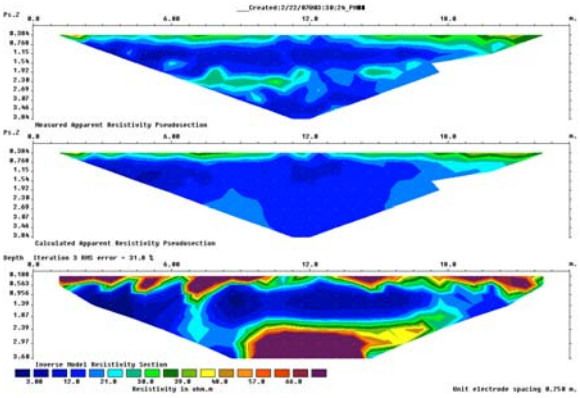
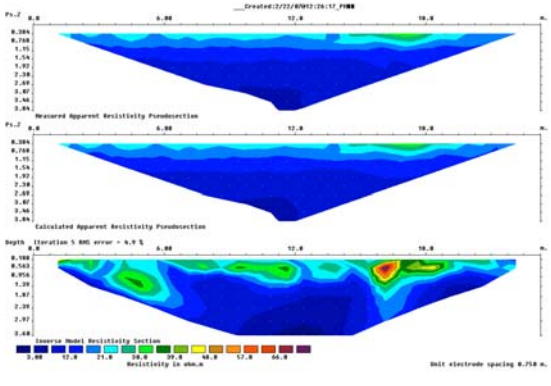
Electrical Resistivity Tomography

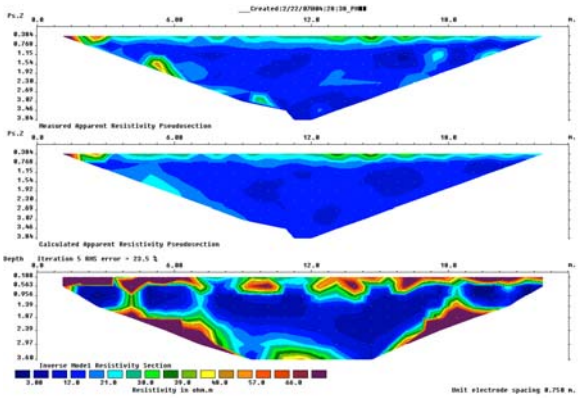
Glenda Jones has provided the following images from the Oak and Willow following her visit to site on the 22nd February 2007. The ground beneath the willow (right) appears to have rehydrated substantially, and over a relatively short period of time. We noted from the SMD data that field capacity was reached in November 2006, and the findings below reflect this.



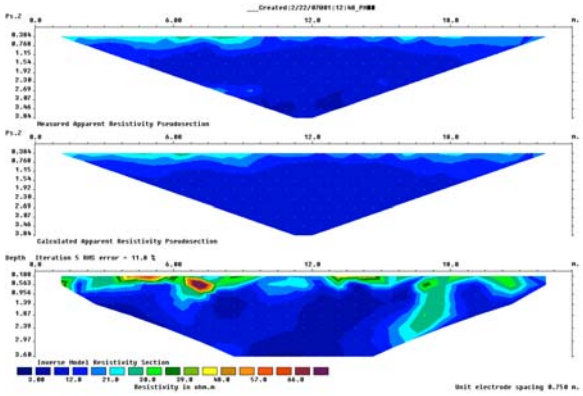
Oak – Line 1 – 22.02.07



Willow – Line 1 – 22.02.07



Oak – Line 2 – 22.02.07



Willow – Line 2 – 22.02.07

To the left we see what appears to be evidence of the persistent moisture deficit beneath the Oak tree, and more noticeable beneath Line 1. This is the cable running towards the school.

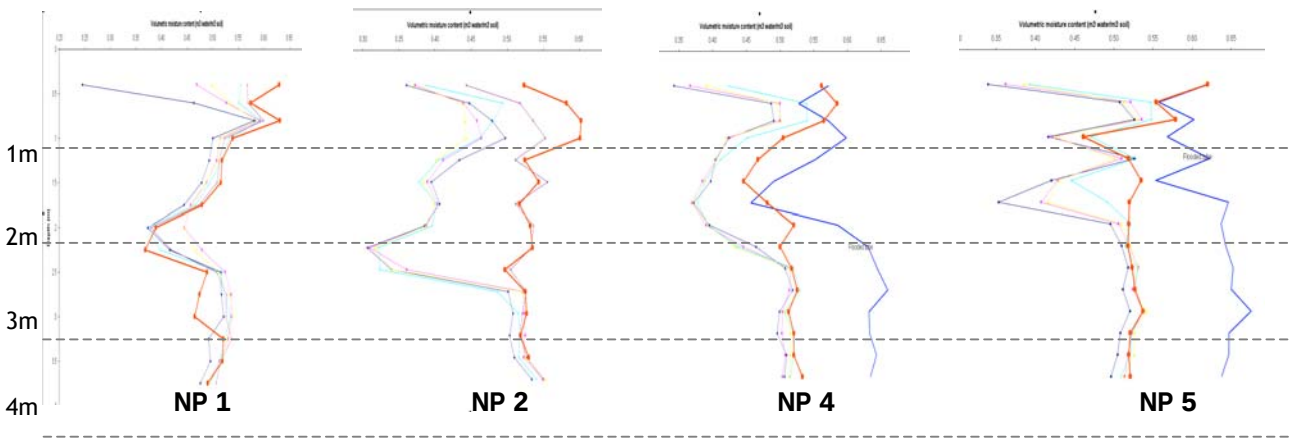
Comparing this image with the results of the precise levels, we see a correlation around levelling stations 20 – 23 with the absence of significant movement, and the presence of desiccation as indicated by the purple zone, although the results do tend to be mixed. Glenda is carrying out some further processing to clarify the zones of high resistivity.

The Clay Research Group

NEUTRON PROBE VALUES

Readings taken 28th February 2007

The latest readings from the neutron probes (heavy red line) provided by Joel Smethurst from Southampton University, reveal the influence of heavy rainfall in February. We see the soil is gradually rehydrating and particularly at Station NP2 where it would appear we have almost reached field capacity. In the summer months the moisture content was around 30% at 2.25mtrs bGL, and in February they were slightly in excess of 50%. A moisture gain of 20% over a short period of time.



For reference purposes, Station NP 1 is nearest to the tree and NP 5 furthest away. We have omitted the readings from NP 3 due to the variable geology (gravel, sands and clay) and the relatively shallow depth of the bore.

NP 1, nearest to the tree, shows no recovery at 2.25mtrs bGL which appears to confirm the persistent moisture deficit that we know exists.

At all other stations – and particularly NP 2 - we see recovery is taking place at mid-depth with the values converging at around 3mtrs. The moisture content at the point of convergence is around 50%, as predicted by Joel but this will depend on the mineralogy.

NP 4 and NP 5 tubes were flooded in January following the heavy rainfall as can be seen by the blue line to the extreme right of each plot. The red line reveals a return to more sensible values in February.

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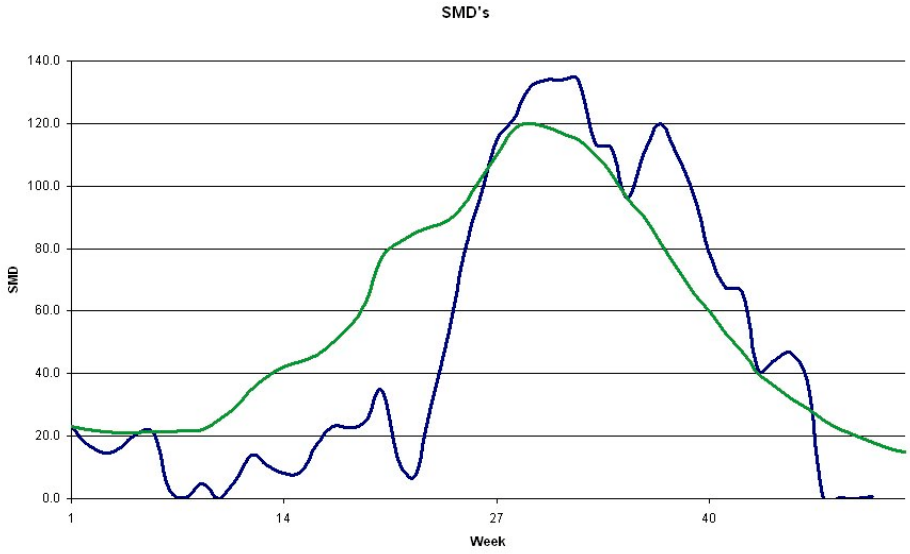
SOIL MOISTURE DEFICIT

2006 – A Defining Year



2006 was a busy year but not a surge and it provided some useful information.

'Normal' years follow a periodic signature characterised approximately by the green line on the graph above. Our view has always been that we calculate the difference between the maximum and minimum values at the beginning of the year (from January to May inclusive), and then factor in the SMD at the end of May. This has served us well for the last 16 years, correctly predicting the outcome in terms of claims.

However, we were less clear about the influence of the slope of the line from winter to summer. Were event years influenced by (a) the incline of the line or (b) the eventual deficit? For example would a steeply sloping line, a little later (as happened in July 2006 – the blue line in the above graph) be an over-riding factor? Steeply sloping lines indicate huge amounts of energy being expended and last year seemed to suggest that the same energy over time is more dangerous, than a short (although large) burst even though it may have the same SMD value. To put it another way, it takes time to move the ground by an amount sufficient to cause damage.

The data from 2005 and 2006 suggest an answer. If we are correct then it would seem that the original algorithm is substantially correct, and as one would expect an extreme weather condition – the steep rise in 2006, only influences it. It doesn't determine whether the year will be an event.

Every year we learn something new by studying the weather patterns and by building a series of signatures we hope to improve our understanding of the interaction between climate and ground movement. 2005 and 2006 fit a particular pattern, and both involved increases in claim numbers, but they weren't surges.

The Clay Research Group

DISTRIBUTION of CLAY SOILS in the UK

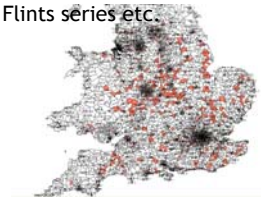
Our analysis of the site investigation data we hold suggests that just over 2,000 postcode sectors have a geology sufficient to allow meaningful testing using the filter paper technique or the oedometer – a slightly different criteria to the more formal 'drift or solid' description that we are used to, but more significant from a claims perspective. More important still, they record values at a level below ground where there is root activity. We can estimate the depth of any drift deposits.

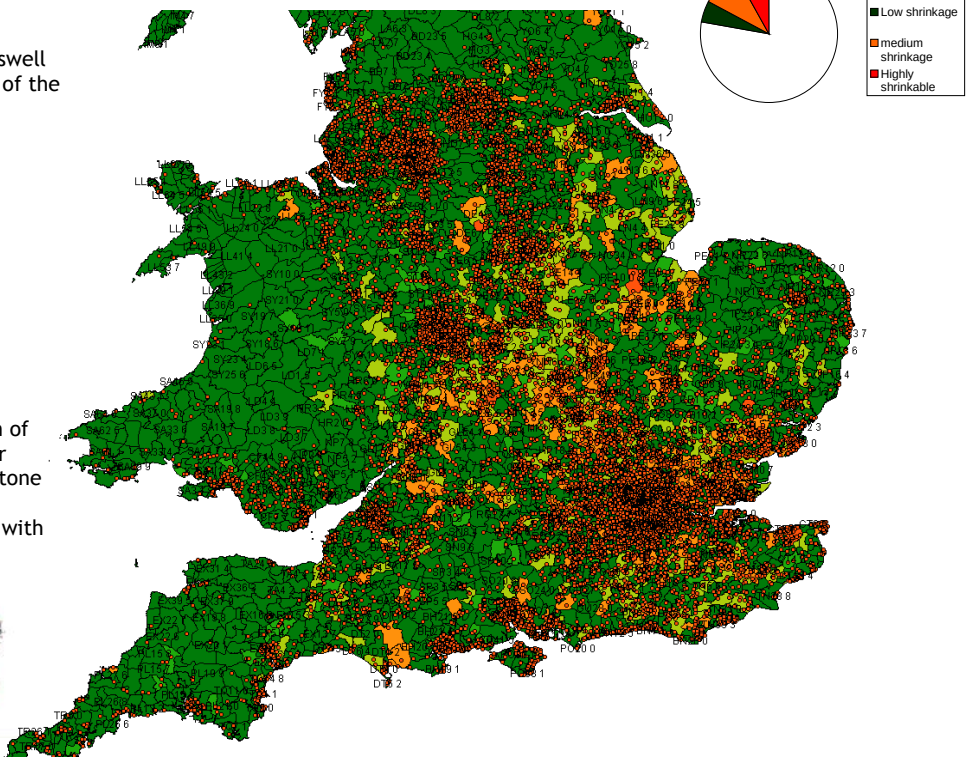
Of these sectors, 446 have a Plasticity Index of between 1 – 20%, falling into the 'low shrink/swell' category. 789 have index properties between 20 and 40% (medium shrinkage) and 708 have index properties between 40 – 60% (highly shrinkable).

64 postcode sectors have a plasticity index greater than 60%.

Distribution of the shrink/swell clays more representative of the solid geology.

Plotting the likely location of the 'variable deposits', for example, the Mercia Mudstone series with a covering of Boulder Clay and the Clay with Flints series etc.





Here we have plotted valid claims from a large sample (around 80,000) to illustrate the significance of the geology. Low shrinkage clay soils are shaded dark green. The lighter shades of green, orange and red show the highly shrinkable soils as defined above.

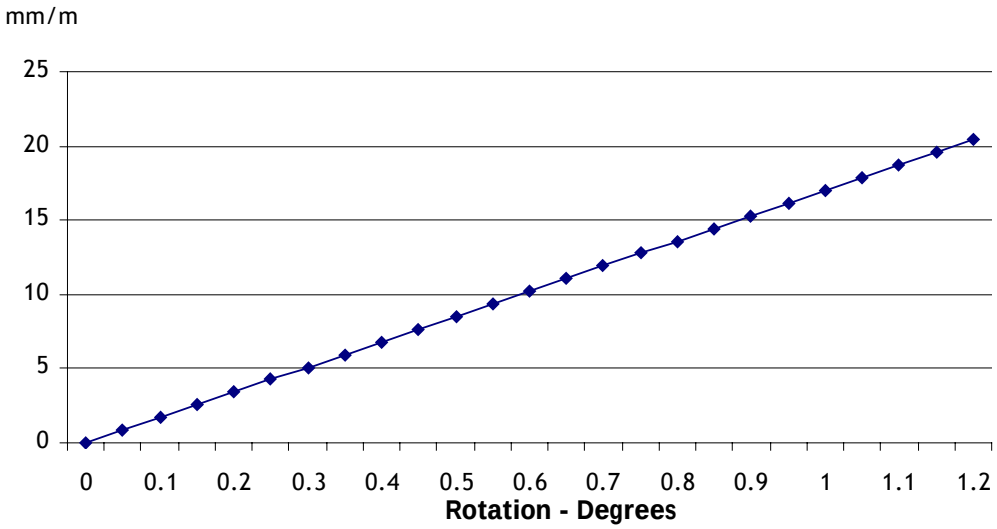
The significance of using actual claims data and real site investigations, with samples taken from a depth that is relevant to vegetation, is easily understood in the context of a triage application.

The Clay Research Group

ELECTROLEVELS – DATA OUTPUT CALIBRATION

Data from electrolevels, transmitted to the user via the web using telemetry, allows us to detect movement quickly. More quickly than crack monitoring and precise levels. Instead of taking readings every two or three months, we measure change (or the absence of) daily.

One of the hurdles in the adoption of this new technology is relating rotation to the more tradition crack width monitoring or precise levels. The brand of electrolevel we have selected has a resolution of 0.001 degrees and to provide some idea of just how sensitive the sensors are, this equates to approximately 0.017mm of vertical movement. We have carried out calibration tests to assess the relationship between rotation and vertical movement over a limited range (20mm). The test comprised fitting a sensor to a 1m long rigid steel cage and raising and lowering it over a known height using steel blocks of certified thickness.



For practical purposes and to exclude minor movements that are encountered on clay soils, but do not result in damage, we suggest a value of 0.01 degrees (that is, 0.17mm of vertical movement over 1m) is regarded as the onset of anything 'significant'. The interpretation would be a difference between the datum and the 'active' station, and should not be regarded as an absolute measure of movement from one sensor alone.

'Background noise' - movement associated with changes in temperature, vibration and signal fluctuations – seems to be in the order of +/- 0.002. After repeat cycling we recorded a 0.009 degree of drift when sensors were returned to their original position. Setting the 'significance' value at 0.01 degrees seems to be appropriate, but again it is the difference between stations that should be regarded as the determining factor.

Above we have the calibration chart showing the relationship between 'mm/m' (y – axis) and rotation (expressed in degrees on the x – axis). There isn't a direct correlation of course, but within our requirements over the anticipated movement range this will suffice.

It is going to be the relative amplitude of movement between the datum and the 'active' sensor that is the determining factor and these guidelines are just that - guidelines. The engineer has to take care in using this method. Building rarely move uniformly. They often flex when they subside and the movement isn't always linear which makes direct comparison difficult, but absolutes are less important than detecting movement.

The Clay Research Group

Hormonal Control of Transpiration

Direct intervention to introduce transpiration change by the regulation of stomatal activity using naturally occurring hormones is complex as we might expect. The half-life of commercially available hormones is 8 hours. The effect of direct injection is probably no more than 24 hours as we see noted in the paper below.

Our findings at Aldenham suggest that a small reduction in transpiration over a short period might be the difference between 'normal' ground movement, and volume change that results in damage but 24 hours is unlikely to be enough.

Drought stress induces change in the plant physiology that lasts over a period of time and to replicate this we would have to introduce a 'drip feed' methodology. This would be practically feasible, but costly and there would be problems implementing it in cases involving Third Party trees. However, it could offer a solution that means retaining valuable street trees and would be worth exploring if we could persuade some of the London Borough's to co-operate.

For the moment we are concentrating on site treatments that trigger the production of beneficial hormones naturally. Getting the tree to 'self-medicate' has lots of advantages not least of which is that hopefully a 'one-off' treatment might resolve the problem in the longer term and it may be possible to apply without recourse to neighbours or Third Party owners.

Below we reproduce an extract from a recent paper exploring the topic.

Alternation of wet and dry sides during partial root-zone drying irrigation alters root-to-shoot signalling of abscisic acid

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Abstract

Partial rootzone drying (PRD) is an irrigation technique where water is distributed unevenly to the root system such that part is irrigated while the remainder is allowed to dry the soil. Tomato (*Lycopersicon esculentum* Mill.) plants were grown with their roots in two soil columns to compare the physiological consequences of alternation of wet and dry columns during PRD irrigation (alternate PRD, PRD-A) with retention of the same wet and dry columns (fixed PRD, PRD-F). When PRD plants received 50% less water than well-watered (WW) plants, xylem ABA concentration ([X-ABA]) increased and stomatal conductance decreased relative to WW plants. Although both sets of PRD plants received the same amount of water, [X-ABA] of PRD-A plants increased up to 2-fold above that of PRD-F plants, which further decreased stomatal conductance. Differences in [X-ABA] were detected within an hour of alternation, but did not persist beyond the photoperiod of alternation. [X-ABA] increased linearly as whole-pot soil water content (θ_{pot}) and leaf water potential (Ψ_{leaf}) declined, but the difference in [X-ABA] between the two sets of PRD plants was not due to differences in either θ_{pot} or Ψ_{leaf}. In PRD-F plants, the unwatered part of the root system contributes proportionally less to the transpiration stream as the soil progressively dries (Yao *et al.* 2001, *Plant, Cell & Environment* **24**, 227–235). In PRD-A plants, we hypothesise that re-watering the dry part of the root system allows these roots to contribute proportionally more to total sap flux, thus liberating a pulse of ABA to the transpiration stream as the root ABA pool accumulated during soil drying is depleted. Since the enhancement of [X-ABA] caused by PRD-A increased as θ_{pot} and Ψ_{leaf} declined, an optimal frequency of alternation to maximise the cumulative physiological effects of this ABA pulse must consider possible negative impacts of leaf water deficit as soil water status declines.