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 2010

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News Update

The Local Authority Subsidence Day was held in Islington on Monday the 22nd, and was a significant step forward in improving relationships between the various groups involved with domestic subsidence claims.

A joint paper entitled *"What Price Retention? Current Research Relating to Domestic Subsidence in the UK"* co-authored by **Margaret McQueen** from **OCA** and the **Clay Research Group** has been accepted for the forthcoming **Urban Tree Research Conference**, on the 13th and 14th April, 2011.

Margaret McQueen is arranging a meeting in the New Year to discuss another research project combining the Hortlink approach with the Queens Park use of precise levels to improve our understanding of the effect of pruning and crown reduction when used on mature street trees. This is being hosted by Mike Crilly at the offices of Geotechnical Consulting Group in London.

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In the News - ALARM

The Public Risk Management Association, ALARM, has collected data from 16 authorities in the South-East, recording 5,000 subsidence incidents of root induced clay shrinkage over the last five years with an estimated value of around £37m.

ALARM record that this will place significant strain on local authority resources at a time when major savings are required. The Insurance Post reports as follows:-

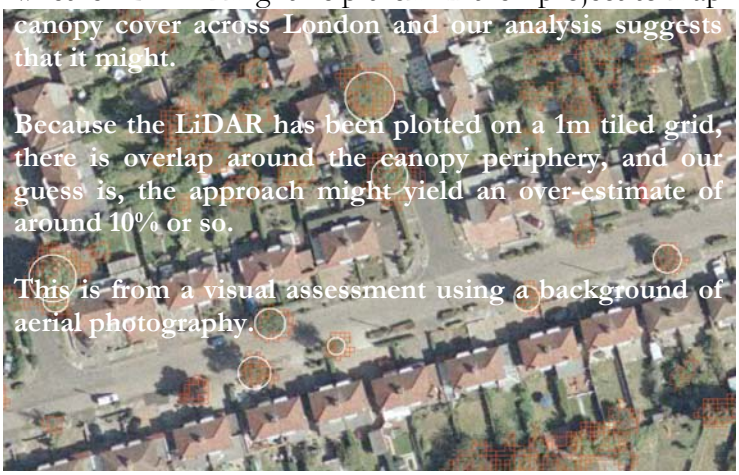
"Alarm said it is assisting its members to highlight these issues with the government, the courts and the public and to draw attention to an imbalance that currently exists in the law applying to such claims against local authorities, in the hope that action will be taken to redress it."

Retaining the tree and underpinning a mid-terrace house could easily reach £60,000 or so for a piling scheme and alternative accommodation. This compares with around £1,000 or so to fell the tree.

The pressure to find an environmentally sustainable solution that will allow trees to be retained whilst providing the homeowner with some security and comfort going forward is increasing.

Canopy Cover & LiDAR

The Urban Greening Division of Transport and Environment, Greater London Authority wondered whether LiDAR might help them in their project to map canopy cover across London and our analysis suggests that it might.



Because the LiDAR has been plotted on a 1m tiled grid, there is overlap around the canopy periphery, and our guess is, the approach might yield an over-estimate of around 10% or so.

This is from a visual assessment using a background of aerial photography.

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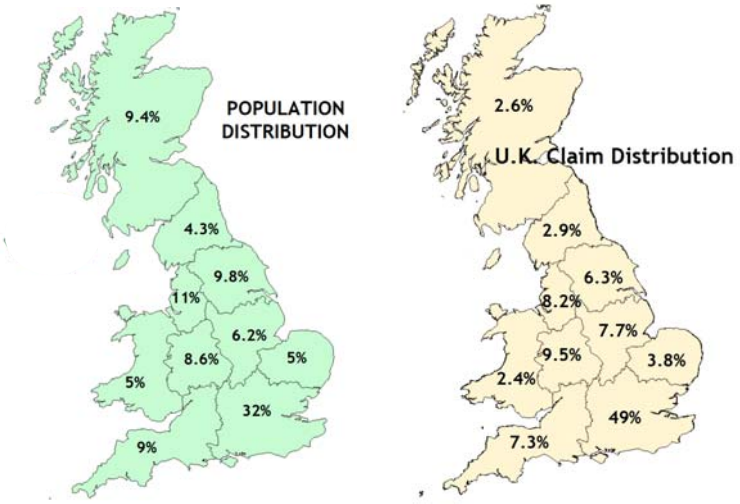
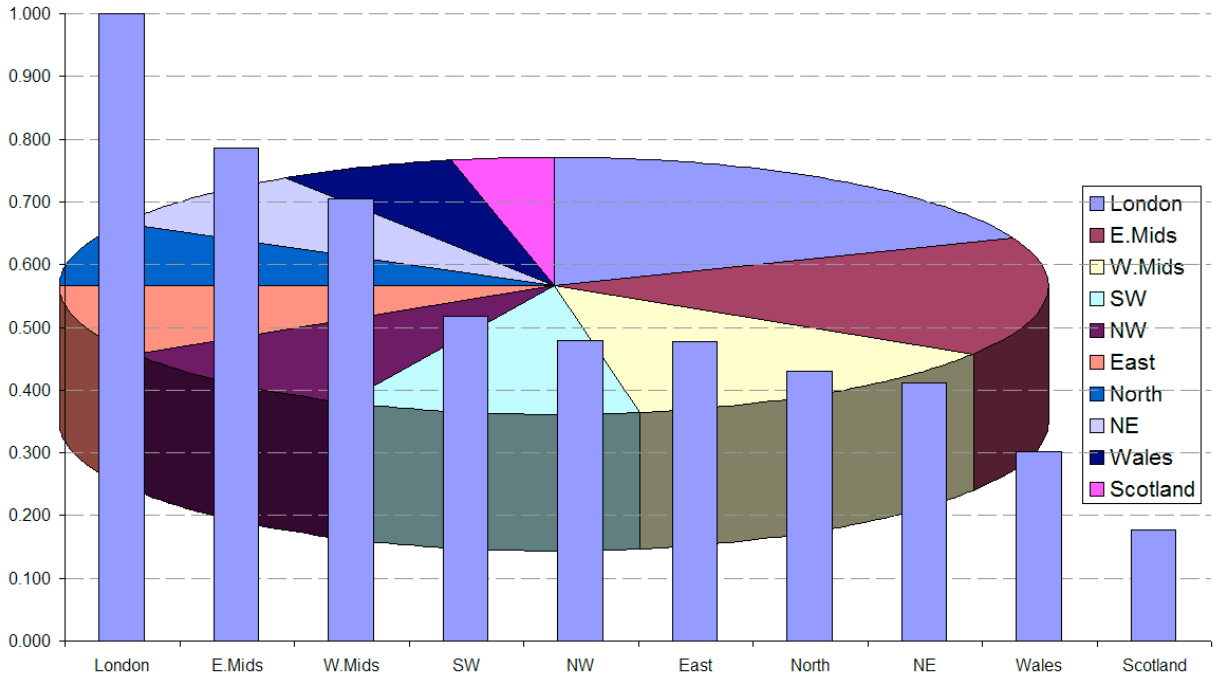
U.K. RISK by REGION



REGION	RISK
S.E.	1.000
E.Mids	0.786
W.Mids	0.705
SW	0.518
NW	0.478
East	0.477
North	0.430
NE	0.411
Wales	0.301
Scotland	0.177

By comparing domestic housing density with claims the relative standing of regions in the UK can be assessed in terms of the risk of subsidence. Scotland and Wales are the safest regions when expressed as frequency, and the South East is the riskiest. East and West Midlands have similar ratings. This data relates to all categories of subsidence – not just root induced clay shrinkage.



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"WHICH TREE, WHERE?"

Tim Freeman, M.D. of GeoServ and former Head of Foundation Research at the BRE has kindly provided a study area to advance our understanding of the risks posed by trees.

When engaged as an Expert Witness on a claim, Tim researched the history of the road as far as possible, finding out whether other houses had been damaged, and if so, when.

The study area comprised 38 houses, of which 9 had a subsidence claim (see red dots) related to root induced clay shrinkage. Nearly 24% of the houses in the road had suffered damage at one time or another and some, more than once.

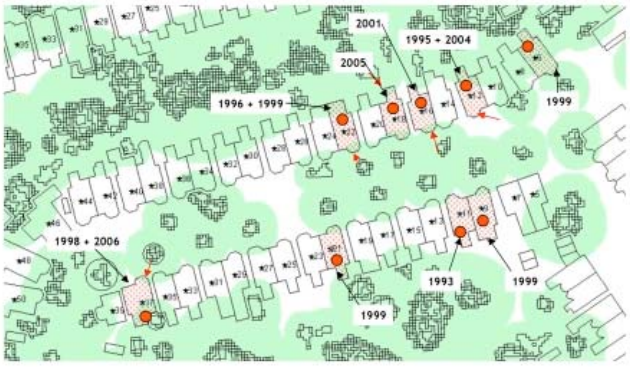
We ran the risk model through various iterations, combining tree height and root overlap to see which combination was most predictive.

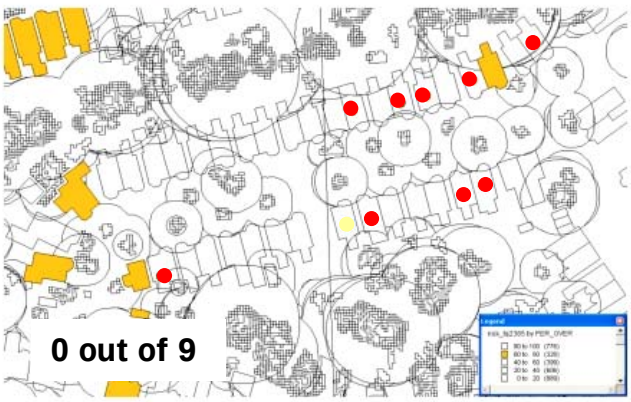
Interestingly and perhaps counter-intuitively, houses with an estimated 100% root overlap suffered far less than those with smaller trees nearby, and root overlap of less than 20%.

The model correctly identified 8 of the 9 houses - an 88% success rate. See third image down. Houses with a low modelled root overlap (indicated by yellow footprint) combined with trees of a certain height (their root zones are shaded green) performed very well and suggest that there are other houses in the vicinity that are vulnerable.

There is no claim to any sort of accuracy. It simply provides a glimpse of broad patterns of risk for this road, and the tree species present.

The majority of trees involved were either Plane or Poplar.





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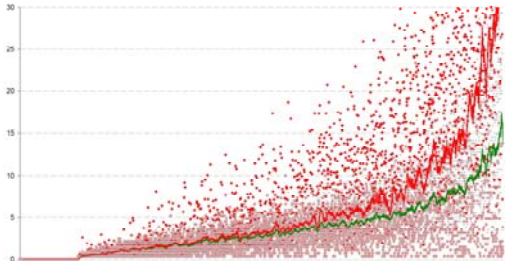
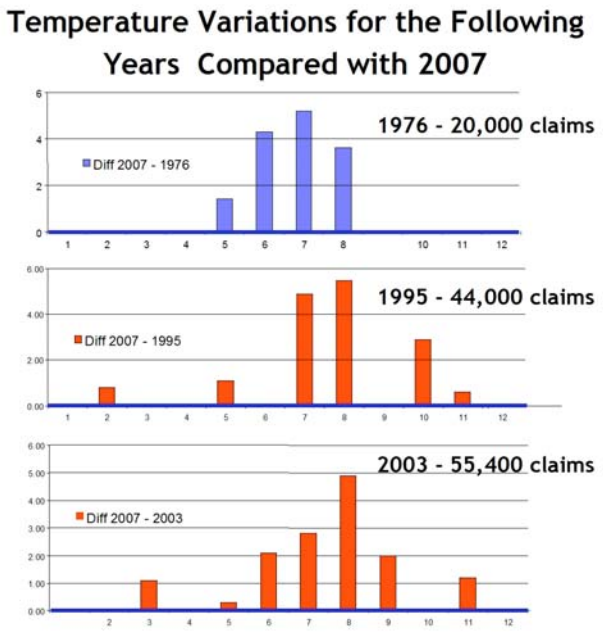
Claims and Climate Change

Claim notifications for normal and event years are plotted below, distributed by postcode. The red line is the claim distribution in a year with 50,000 claims, and the green line the claim distribution for 30,000 claims.

This is the baseline graph to develop an understanding of the potential effect of climate change on claim numbers.

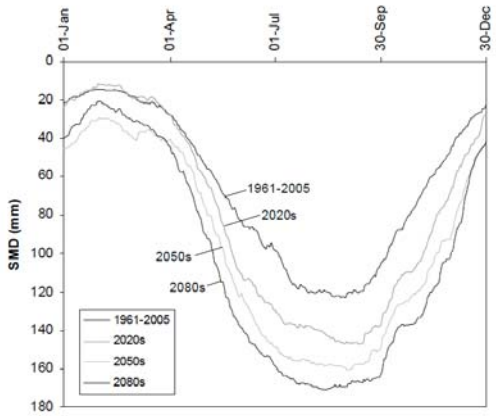


What effect does a temperature increase of a few degrees have on notifications? Below are the differences in temperature between a normal year (2007) and several busy years – 1976, 1995 and 2003.



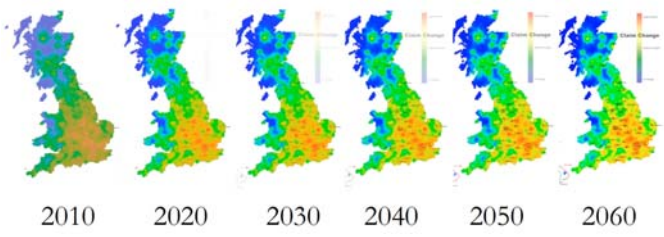
Event years are associated with two or three months with temperatures around 4 degrees C above the 2007 values.

The prediction from the team at Southampton University (see page 6 for extract) of how the SMD may develop through the next 50 years or so is shown below.



Estimates of Soil Moisture Deficit by D. Clarke and J.A. Smethurst. (2010) *"Effects of climate change on cycles of wetting and drying in engineered clay slopes",* v. 43; p. 473-486 published by The Quarterly Journal of Engineering Geology and Hydrogeology

Below is a map of the UK developed by the Clay Research Group taking into account the geology and superimposing climate change onto those areas that will be most effected.



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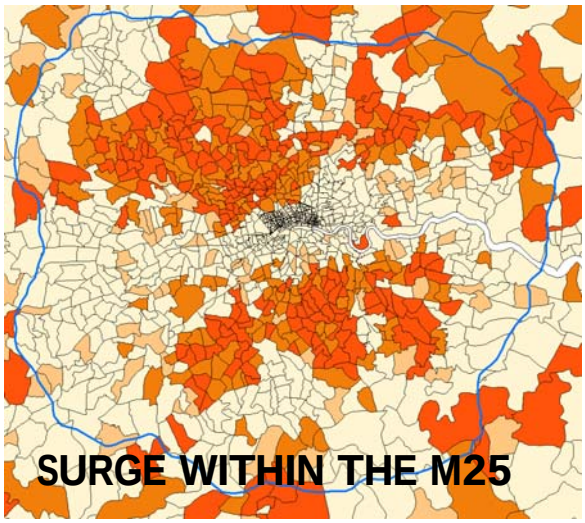
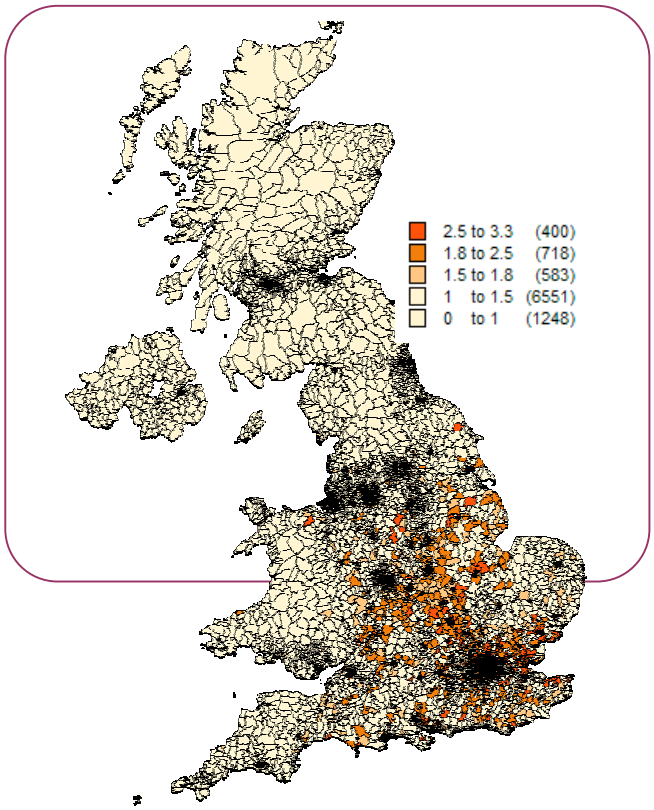
Surge, but Where?

When surge strikes, we see increases in what we would regard as busy areas in normal years. The claim numbers increase by 200 – 300% - or more.



Above we have compared the difference between 30,000 claims, and 50,000, colour coding the sectors by the increase in numbers.



Claim Increase by Count at times of Surge

NewScientist

Extract from the web – visit www.newscientist.com

South America's tropical forests flourished when temperatures skyrocketed 56 million years ago. Could this mean that climate change will spare the Amazon? Carlos Jaramillo of the Smithsonian Tropical Research Institute in Balboa, Panama, and colleagues excavated pollen and other plant remains from three sites in Colombia and Venezuela.

Their samples span the Palaeocene-Eocene Thermal Maximum (PETM), when soaring levels of greenhouse gases caused global temperatures to rise by 5 °C in about 10,000 years.

The tropical forests then faced average temperatures up to 34 °C, compared with 27 °C today, yet contrary to expectations the pollens suggest plant diversity increased. Each sample of 150 grains of pollen from the PETM contained an average of 36 species, compared with just 24 species in samples from older, cooler times.

And the rate at which new species formed was significantly higher in the PETM than before it. The trends are puzzling because models predict that the Amazon will burn and be reduced to savannah with future climate change.

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University of Southampton

CLIMATE MODEL

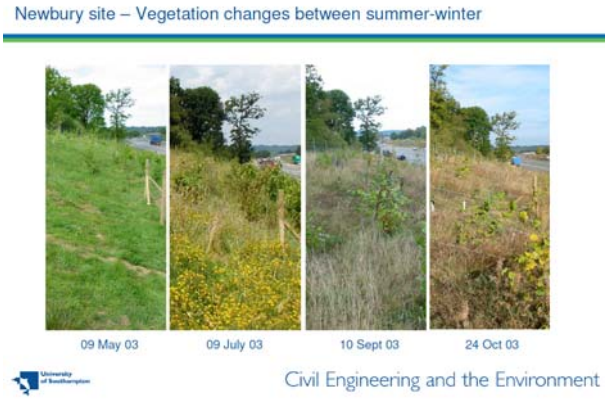
The team from Southampton University have been researching the possible effects of Climate Change across several site – identified as red dots on the map below.

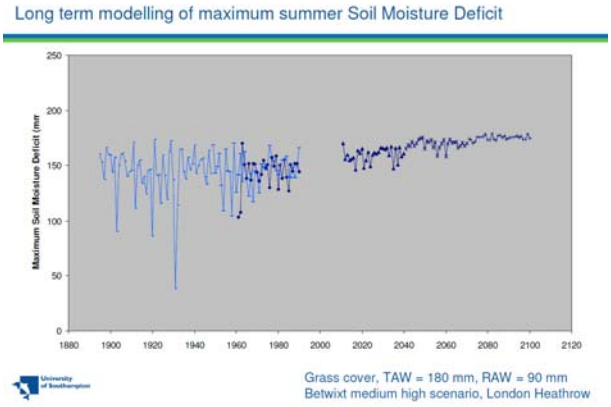
Their output suggests that there will be an increase in the Soil Moisture Deficit over the next 100 years – see extracts from their slide presentation, right.

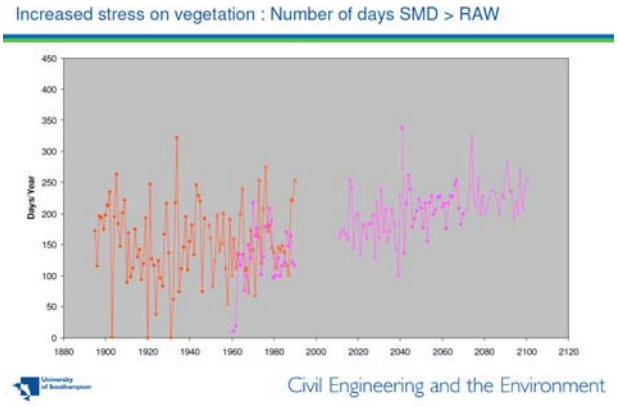
This increase in SMD will have an influence on vegetation – see the bottom slide.

The model has practical implication for insurers. 'Vegetation stress' years will occur more frequently. There will be shorter gaps between events and their recent paper, published in the Quarterly Journal of Engineering Geology and Hydrogeology, D. Clarke and J.A. Smethurst. (2010) *"Effects of climate change on cycles of wetting and drying in engineered clay slopes"*, v. 43; p. 473-486, suggests that *"This demonstrates that a relatively rare event in 1995 (1 in 45 years) will become almost the average year in the 21st century. Similarly, the recent hot dry summer of 2003 that would occur on average once every 8 years in the past is expected to occur 9 years out of every 10 in the future".*

These are trends modelled from sites on clay soils and the work of Southampton is particularly relevant to our industry.







RAW – Readily Available Water
TA – Total Available Water

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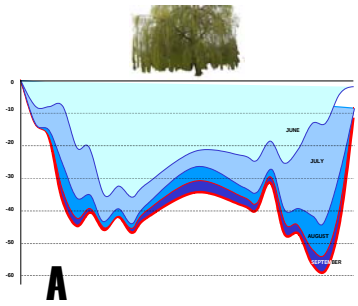
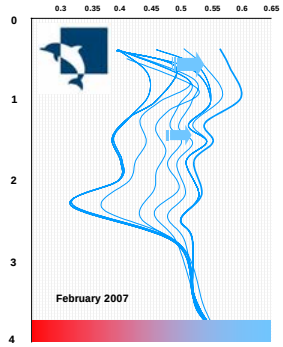
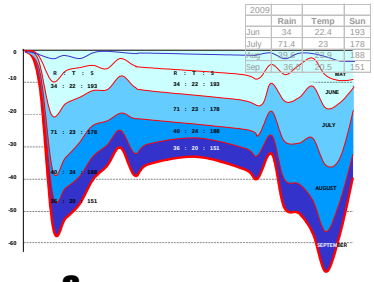


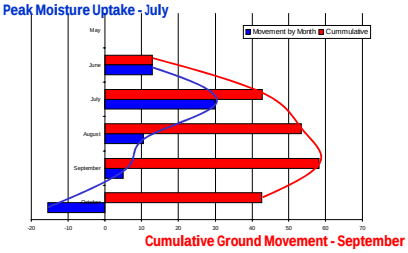
A



B



C



D

What have 5 Years of Research Delivered? Part 1.

Measuring ground movement has provided a shortcut to estimating moisture uptake by month for both the Willow and Oak. Total moisture uptake by the tree is less interesting than the extraction of bound moisture sufficient to cause ground movement and precise levels have delivered a valuable insight – see Figure A.

The heterogeneous nature of the soil and its influence on ground movement has been clearly demonstrated at the site of the Aldenham Oak. The variable mineralogy has resulted in less ground movement than the Willow, not for any physiological reason associated with the tree, but because of the composition of the soil. The sand and gravel content reduced the potential for volume change associated with moisture abstraction.

Why is this of interest? If we are seeking to reduce moisture loss – or replace/reduce it using a system of harvesting chambers - a good starting place is to understand the volumes involved.

If we are going to apply a treatment, where should it go? Neutron probe data gathered by Southampton University has given us an appreciation of the depth (Figure B) from which moisture is abstracted.

The traditional view has been 'drying from top down'. In fact, drying typically takes place at a depth of around 2mtrs – for mature trees. The more direct the application of water to the drying zone, the quicker it will take effect.

'By month' data (Figure D) has allowed us to correlate ground movement with changes in temperature and SMD values to assist in understanding which components exert the greatest influence (Figure C).

The interaction is both complex and chaotic. The SMD is a gradual drying process interrupted from time to time by rainfall. Generally – apart from odd fluctuations – it develops slowly over days and months, whereas stomatal opening and closing has a diurnal cycle, varying by the hour, and differing each day depending on sunshine, wind and relative humidity etc. Soil suctions – once established at a level of say 300kPa or more - take time to dissipate.

An appreciation of the various elements will help to develop a technique that may allow us to retain the tree.

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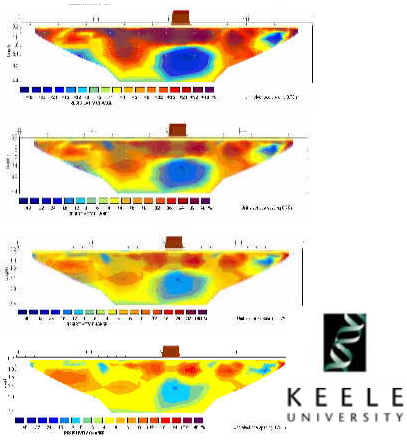
What have 5 Years of Research Delivered? Part 1.

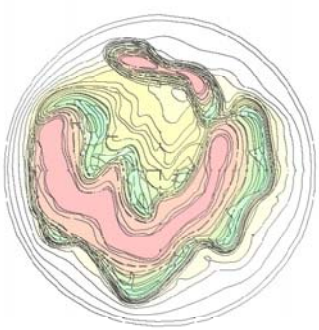


E

We have a clear picture of root elongation and moisture uptake at the periphery of two mature trees following soil drying closer to the trunk. Ground movement at the root periphery explains some odd patterns of damage that have been seen from time to time.

The images have been helpful to illustrate the findings, and change over time is better understood as a result of this work.

Electrical Resistivity Tomography (Figure E) has provided images of moisture change beneath both trees over time. It isn't a uniform process and we might understand why boreholes sunk only a few feet apart might yield differing results. Homogenous clay soils will of course equilibrate over a short period of time, but soil mineralogy can interfere with this.

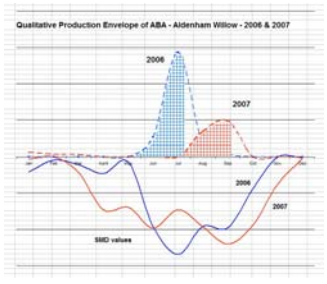


F

Root stresses have been modelled on plan – (Figure F) the irregular nature of the drying – a function of tree root health, moisture availability in the soil and soil mineralogy – made clearer.

The 'high water demand' classification of the Willow and Oak have been reinforced, each influencing the ground for a distance in excess of the tree height, and the vigorous nature of moisture abstraction at the root periphery.

Understanding moisture uptake over time has helped us to develop a very crude qualitative model of ABA production (Figure G), and played an important part in developing the ground treatment techniques that are currently being tested.



G

Away from our own work, a team working with Prof. Bill Davies has suggested - for crop growth at least – that a system of Partial Root Drying and increasing the pH of xylem water can enhance the effect of ABA in the leaf apoplast.

All of the above has been used as background data to develop the current work on ground treatment. Without it, we would have been unable to build a numeric model. Having some notion of water loss, by month, across the root footprint and at a certain depth under particular weather conditions has been essential.