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

March 2011

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ASTON UNIVERSITY

The annual conference will be held at Aston again on 22nd June and we are asking for papers from the industry on topics associated with subsidence - soils, investigations, insurance, trees, risk management and so forth.

Please send to cpd-seas@aston.ac.uk, for the attention of Dr Massud Sadeghzadeh at Aston University, or to the clayresearchgroup@gmail.com.

The conference has attracted many major speakers over the years, including Richard Driscoll, Giles Biddle, John Parvin, Robert Sharpe, Gary Strong, Jill Hunt and Nigel Barham etc. It has played host to all sectors of our industry including insurers, arborists, engineers, site investigation companies and geotechnical experts.

Join us at Aston in June.

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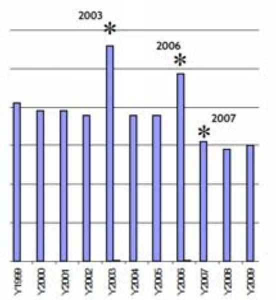
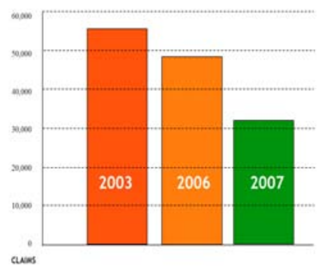
WEATHER PATTERNS & CLAIMS

What weather patterns accompany years with high claims? By building characteristic signatures, can we further refine our understanding of the influence of temperature, rainfall and hours of sunshine?

For this project we have selected 3 years. 2003 with high claim numbers, 2006 with intermediate numbers and compared them with 2007, a year with lower claim numbers. What patterns distinguish one from the other?

Traditionally the industry has used 30 year anomaly Met Office data. The problem is, this data includes all weather patterns – surge and normal – and makes distinguishing a profile far more difficult. We are less interested in whether the year is hotter than the last 30 than how it compares with known event years.





Above are the 3 years that form the subject of our study showing their relative standing. Then we compare the weather profiles with the ground movement data gathered from Aldenham before introducing the Live Tracker.

Live Tracker suggests the following alerts.

1. End of May. SMD for Tile 161, grass cover, Medium AWAC reaches or exceeds 100mm.

2. End of June. Temperature for month reaches 24 °C and rainfall of around 12mm.

3. End of July. Temperatures for month reaches 28 °C and rainfall of around 24mm.

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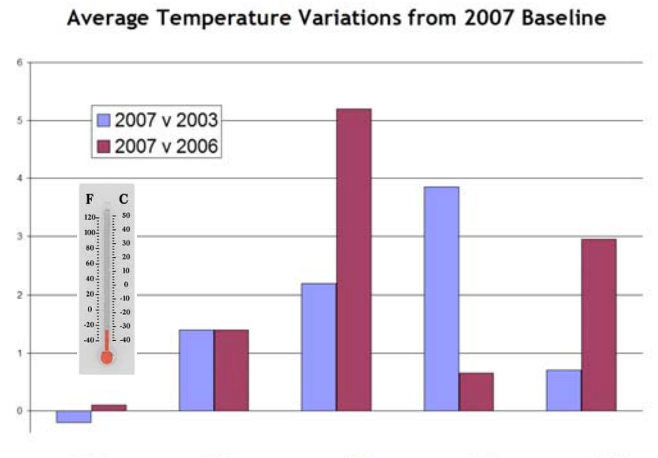
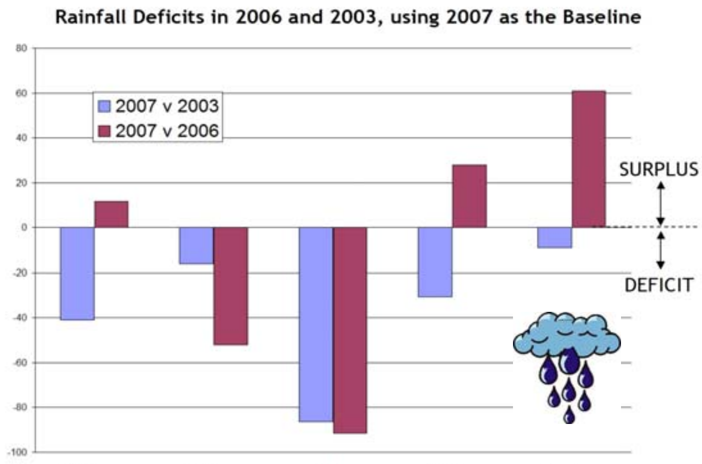
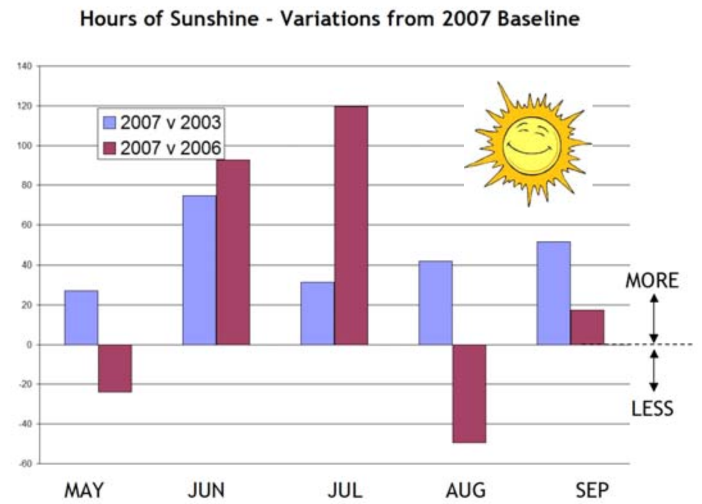
WEATHER ANOMALY DATA







Anomaly patterns are plotted, left. Using 2007 as a baseline, we have plotted data for temperature, rainfall and hours of sunshine per month to try to understand the driver(s) behind event years.

Top is the temperature anomaly graph. 2003, with high claim numbers, shows a gradually increasing profile starting in June and continuing through to August.

In contrast, 2006 (a busy year but with fewer claims than 2003) also starts in June, peaking very quickly in July before falling away.

This reflects claim notifications for those periods.

The rainfall deficit mirrors this to an extent, with continued dry weather in 2003 compared with the return to a surplus (when compared with 2007) in August for 2006.

Bottom are the hours of sunshine per month. 2003 values are lower than 2006, but more consistent. 2006 peaked in July and then reduced.

Plotting the years against a 2007 baseline (as opposed to the average for a 30 period as is more commonly done) gives a clearer picture and we can be reasonably sure that future years that follow these pattern will deliver high claim numbers.

It would appear that claims are sensitive to increases in temperature changes of even 2^{o}C, and particularly so when they extend over 3 months. It is interesting to see that the increase in September 2006 did not produce the claims experience of 2003.

The absence of rainfall is a major component. Again 2006 started aggressively, but then faded sharply in August - not forgetting these are not absolute figures, but comparisons with 2007.

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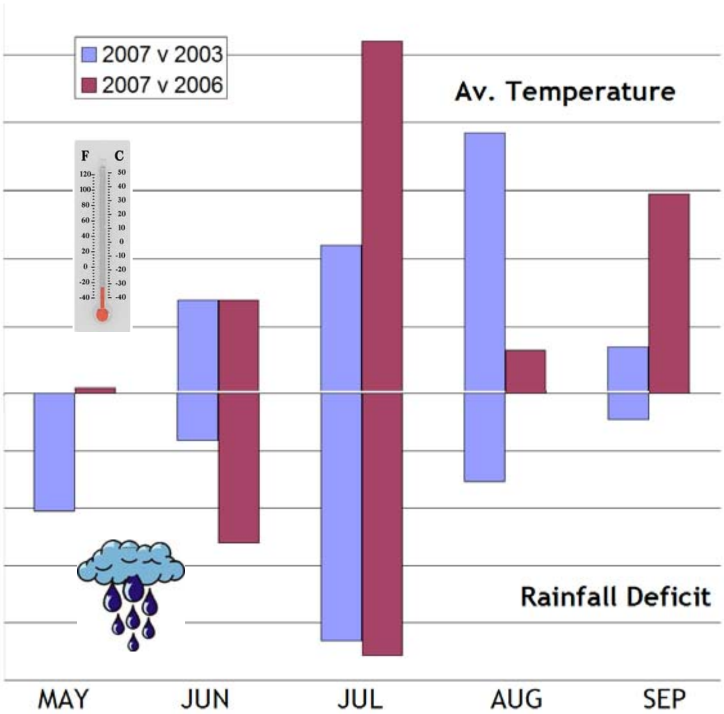


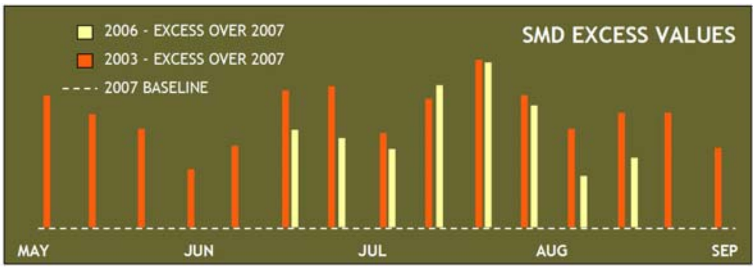
ANOMALY DATA CONSIDERED

The cumulative 'pull' from temperature driven transpiration and the rainfall deficit might simplistically be thought of as inducing tension in the system. Left, the two factors have been stacked one above the other to provide a qualitative illustration of tension.

Below are the SMD values for the same years – again using 2007 as the baseline. The differences between 2003 and 2006 are clear.

The 2003 deficit began early, extended throughout the summer and was still evident in September.

In contrast, the 2006 intermediate year started later, peaked quickly before tailing off.

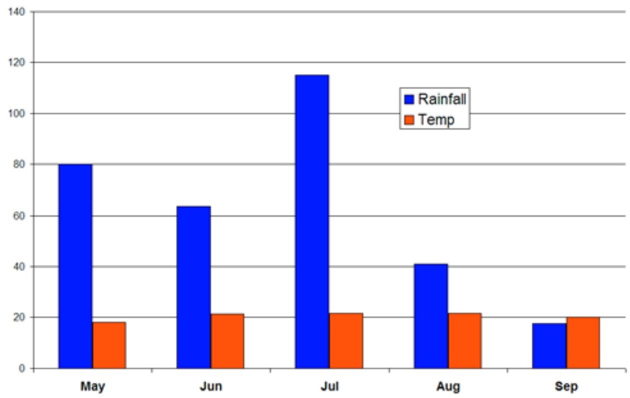


Below are the anomaly envelopes for tension between the temperature and rainfall deficit, as seen in the graphs to the top, left of the page. It seems that the longer the duration, the higher the risk.

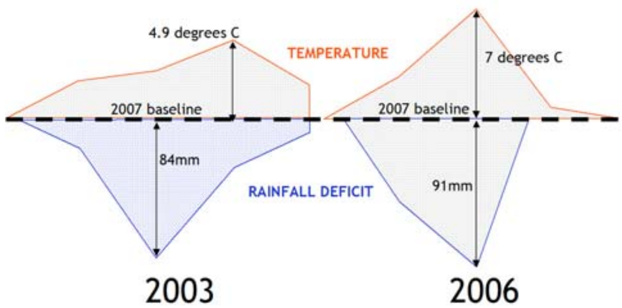
WHAT IS A 'NORMAL YEAR'

From this analysis it would appear that the closer the weather profiles are to 2007, the less likely we are to see high claim numbers.

What did 2007 look like? Here are the average temperature and rainfall values from May to September supplied by the Meteorological Office from their weather station at Heathrow.



ANOMALY ENVELOPES



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WHAT ABOUT OTHER BUSY YEARS?

How do other busy years compare? Do we see similar patterns emerging?

Top right we have the temperature data for 1976, 1990, 1995 and 2003, all plotted against a 2007 baseline to show their relative standing. The patterns reveal that the July and August anomaly distinguishes them from 2007.

The absence of rainfall 'sets the scene' earlier in the year, with differences distinguishable in May.

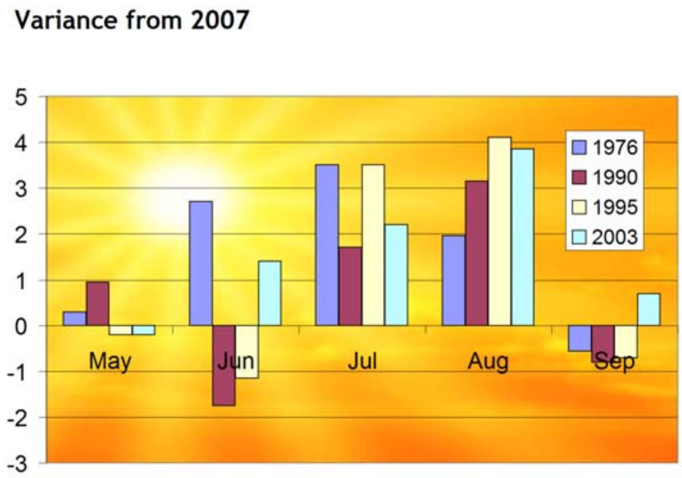
In both examples, we see that by September, variations make little difference. In both of the above cases, the temperature dropped below the 2007 values and the rainfall increased.

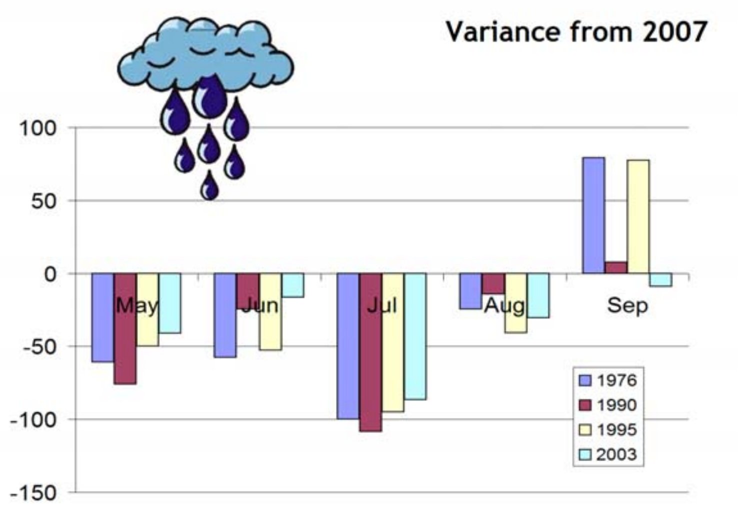
The combined influence of all elements (wind, hours of sunshine, rainfall and temperature) are shown bottom right in the SMD plot (we have no data for 1976).

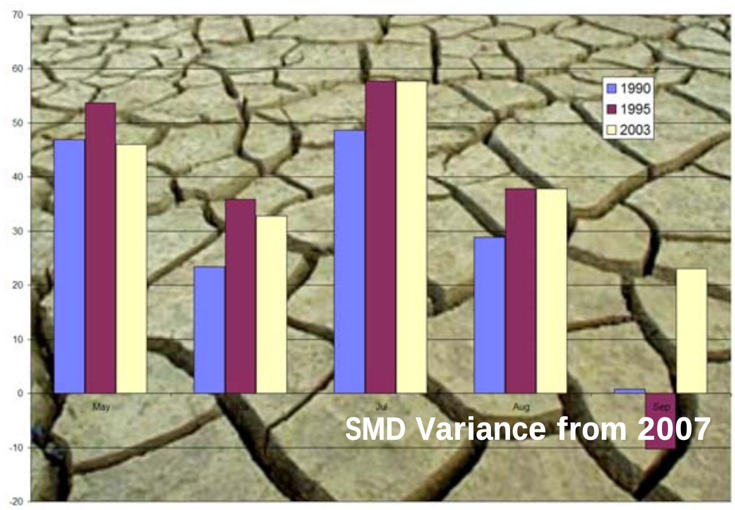
The moisture deficit is clear and constant in all of the years when compared with 2007.

In contrast, the 2003 deficit began early and continued throughout the summer.

Whilst it is obvious that hot years, with low rainfall and higher than average SMD will result in higher claims, but with this information, we can directly relate climate to claim numbers, and track the year as it develops.







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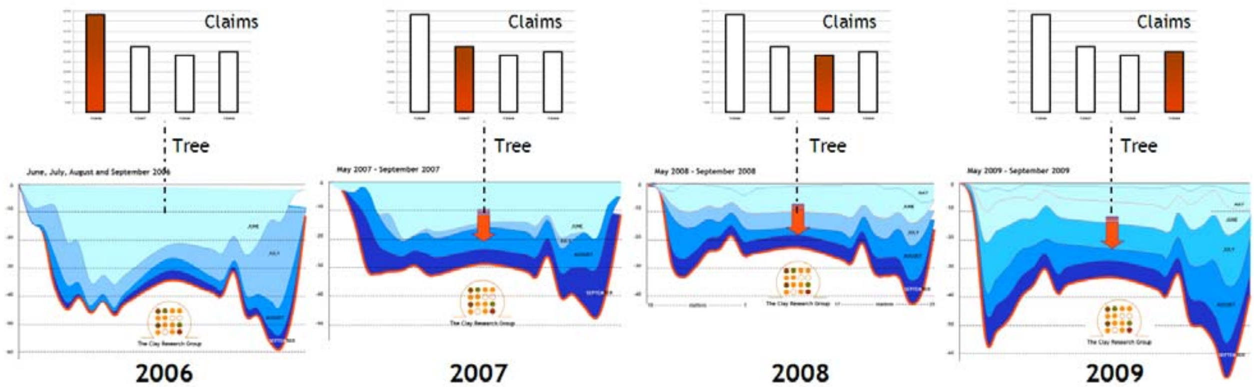
'By month' ground movement (subsidence) at the site of the Willow describing the difference between an intermediate year (2006) and a wetter year (2007).

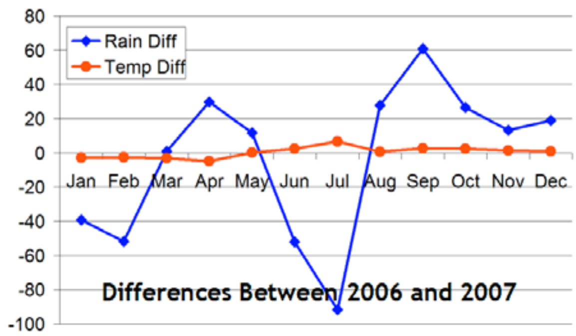
The temperature in June 2006 was 2.5 °C higher than 2007, and rainfall was 52mm lower. This divergence increased in July with an increased temperature of 6.8 °C and reduced rainfall of 90mm.



Ground Movement Profiles, by Month, at Site of Aldenham Willow

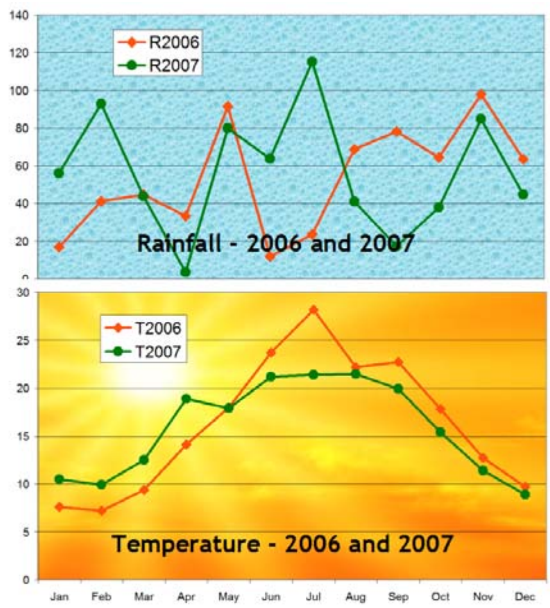
The charts reveal increased activity at the root periphery associated with moisture uptake and a regular signature across the footprint in both wet and dry years, which continued through 2008 and 2009.

Most of the movement in the intermediate year (2006) had taken place by the end of June, and although the total movement by September was greater than 2007, subsidence in August and September was quite small.



The above chart shows the weather differences that produced this movement.

The reversal in August explains the small amount of ground movement recorded.



The above charts plot the actual values for comparison purposes. It can be seen that June and July were critical months in 2006.

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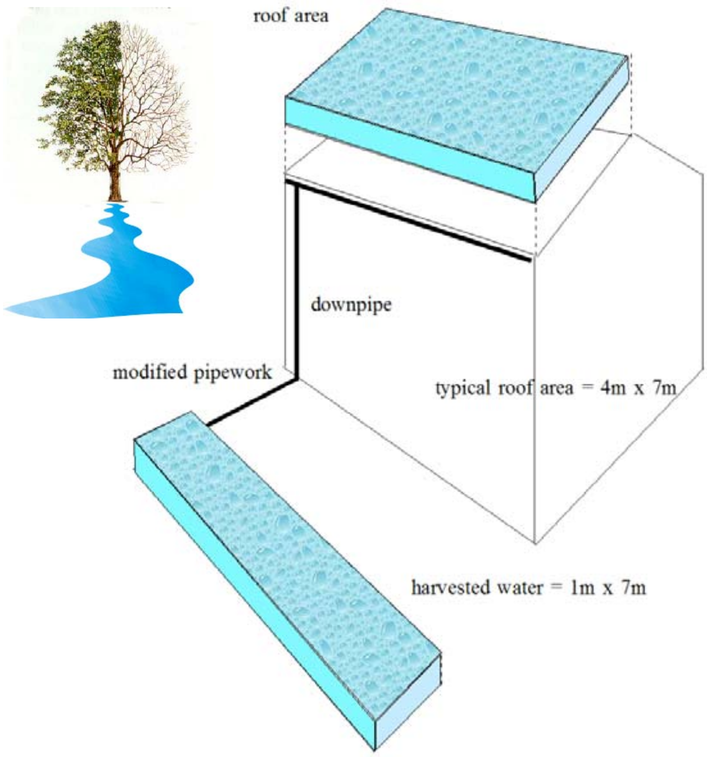
Rehydration



Unfortunately, the interaction is far complex than we have suggested. This model doesn't take account of root proliferation, or water lost via suctions to adjoining soil zones.

Both will reduce the efficiency of the approach.

On the other hand, the figures are for extreme years, and the localised watering-in will hopefully trigger Partial Root Drying (or in our case, partial root wetting) with an increase in the production and influence of Abscisic Acid (ABA). The 'root to shoot' signalling hormone that reduces transpiration.

It may also reduce the potential for roots to extend beneath the building when an ample supply is available elsewhere.

A simplistic way of looking at harvesting is to compare rainfall between a wet year with a low claim count, and an event year.

The water deficit is the amount we would require – the rainfall needed – to reduce the risk from root induced clay shrinkage.

For this exercise, we have taken two extreme years. 2007 was particularly wet, with low claim numbers, and 2003 was dry, with high claim numbers.

Restricting our analysis to the months that matter – from May when the tree comes into leaf through to August - delivers the following figures.

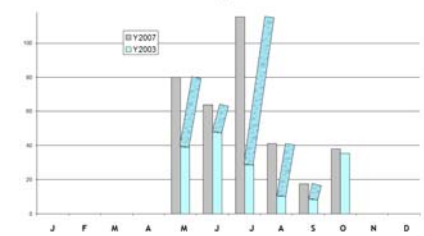
	2003	2007	Deficit
May	39.1	80	-40.9
Jun	47.6	63.8	-16.2
Jul	28.8	115	-86.2
Aug	10.4	41	-30.6

Throughout the month of May for example, rainfall in 2003 was 40.9mm less (at the Heathrow weather station) than 2007.

Taking an average roof area of 7m wide by say 4m, the area of rainfall collected would be 4 times that of a 1m wide harvesting chamber of a similar length.

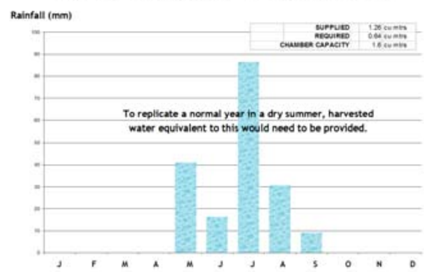
In summary, and very simplistically, we have increased rainfall by a factor of 4 in the treatment area. We have made 2003 replicate 2007 in the vicinity of damage.

Water Required to Emulate a Normal Year in a Dry Summer



The technique does not rely on satisfying the water uptake of the tree. It has to satisfy the localised moisture deficit in the soil and that will be the difference between a dry and normal year.

Difference in Rainfall between 2007 & 2003



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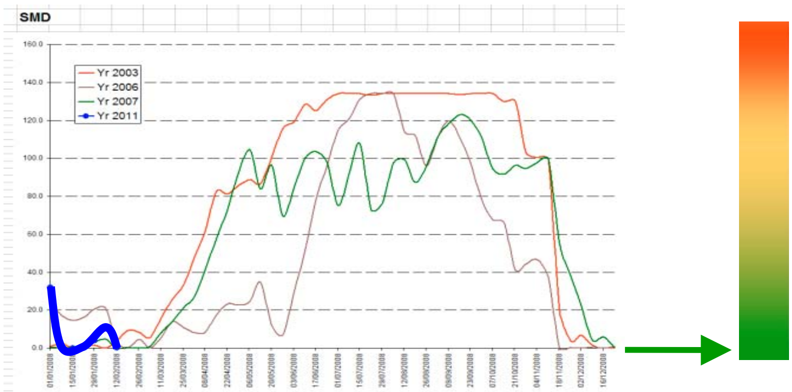
LIVE TRACKER

We are introducing a Live Tracker to monitor the elements described in this study. The Tracker will compare the developing profile through 2011 (blue) with a normal year (2007 represented as a green line on each graph), an intermediate year (2006 - brown) and a busy year (2003 – red). So far, 2011 has a lower SMD, higher rainfall and lower temperatures than 2007, suggesting it will be a normal year although this will not be meaningful until May at the very earliest.

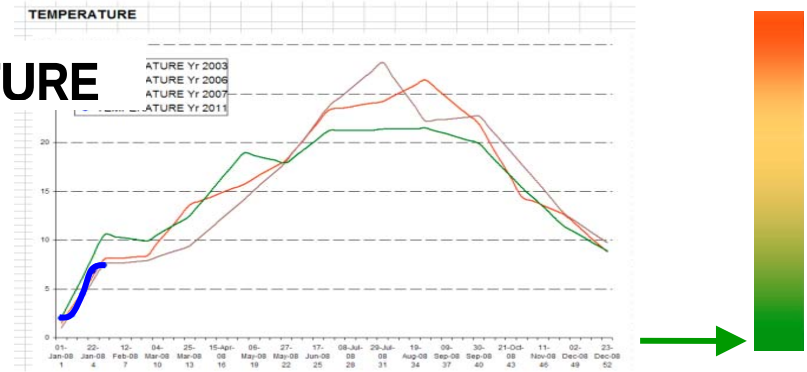
The indications are that the earliest warning is when the SMD for grass cover on tile 161 reaches or exceeds a value of 100mm at the end of May, and when temperatures reach 24 °C in June and 28 °C in July and Rainfall for June is in the order of 12mm and for July, 24mm only.

SMD



RAINFALL

TEMPERATURE



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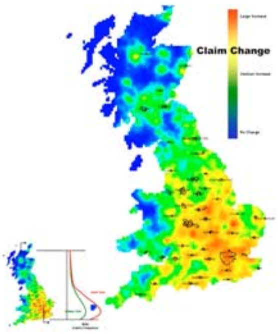

B

C

D

What have 5 Years of Research Delivered?   Part 4.

Data Analysis. How many of what type, where and when? Claims by cause, the style of house plus the location of damage. Implicated trees – species, height and distance plus soil type and weather. Date of notification, by peril, by depth of foundation by crack width. Recording data, storing it and retrieval for analysis using a variety of techniques.

Triage, the Disorder Model, OSCAR and VISCAT all run off empirical claims data.

Climate modelling and 'what if' simulations based on geology and modelling weather patterns related to previous years. What would a temperature increase of 1 °C mean?

Several 'alerts' have been identified the first of which (SMD values) appears in May. Temperature and rainfall follow through June and July. A tension envelope identifies the qualitative roles of temperature and rainfall.

In addition, the objective has been to share findings and develop a sense of community, respecting commercial sensitivities. We have welcomed many parties to the site at Aldenham, including the climate group from Zurich, along with John Parvin, members of the LTOA, together with Jim Smith and Peter Osborne.

Other visitors have included Robert Sharpe, Gary Strong, Neil Curling, Tim Freeman and groups of academics.

We have spoken at numerous meeting of professionals to discuss developments, including CILA, The Subsidence Forum, various claims handling practices, The Post, Aston University etc.

Our newsletter is distributed monthly and numerous articles have appeared in trade press and papers over the last five years.

In addition, we have welcomed members to undertake their own research and also to contribute to projects that deliver benefit to improve our understanding of the interaction between climate, trees and fine grained soils.