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

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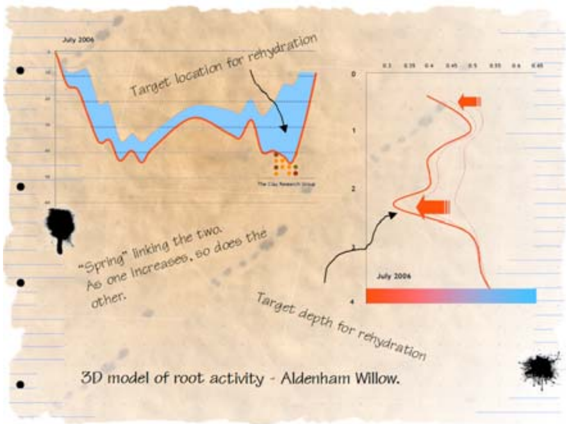
- Intervention and Rehydration
- Trees – Eastcote Data
- Penetrometer – an example
- Shortening Testing Time
- Tree Cluster Graphs
- Tree Roots and Barriers + Weather Patterns

3D Model of Root Activity

A preliminary sketch of how we propose to build a 3D model of moisture abstraction using ground movement and neutron probe data.



Web Ranking

The CRG web site receives around 700 'hits' every month, mainly downloads of the newsletter.

This is an encouraging figure considering the limited audience and far more than we anticipated. Hopefully 2010 will deliver more projects that can be shared with our community and if you have any ideas, please contact us.

Last Decade 'Warmest on Record'

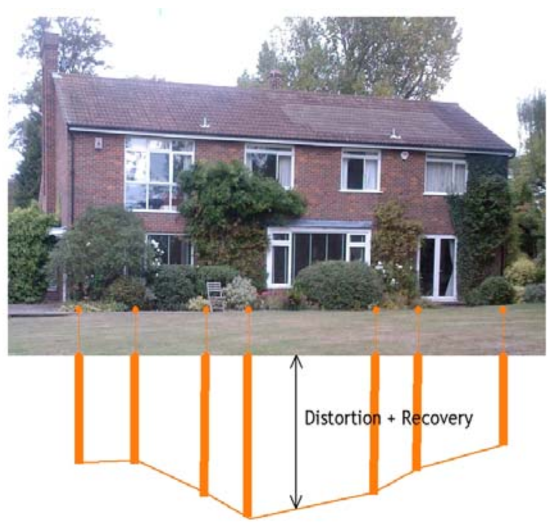
The BBC report. *"The first decade of the 2000s is the warmest on record, a report by the World Meteorological Organisation (WMO) has said.*

New analysis showed that 2009 would almost certainly be the fifth warmest in the 160-year record. The WMO said 2009 was set to be another "top 10" year, with provisional warming of 0.44C (0.79F) above the long-term average of 14.0C (57.2F)."

The Met Office's prediction for 2010 is that it will be amongst the warmest on record.

Soil –v- Precise Levels

A report entitled "Aldenham Investigations" is available for download from the CRG website, comparing the results from a range of soil tests with precise levels.



A variety of trees and shrubs exist within influencing distance of the damaged building and the study compares a range of soil tests (oedometer, suctions, moistures, penetrometers etc) with results obtained from a precise level survey with some interesting results.

Which shrub/tree has caused what movement, and exactly where?

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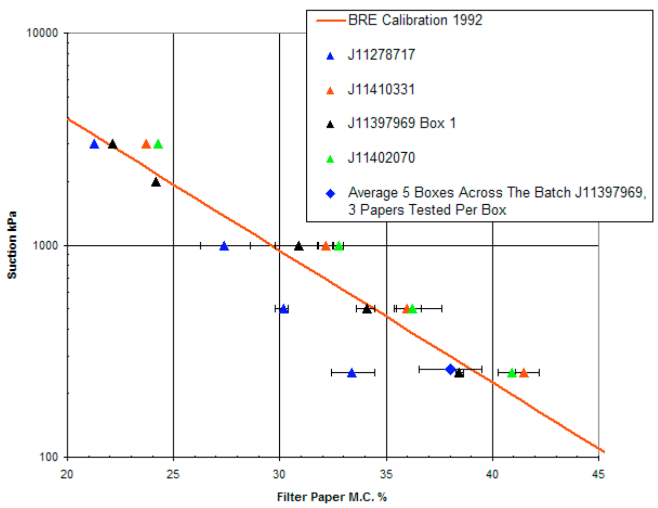
Filter Paper Calibration

Calibration of the Whatman's filter papers prior to testing is essential, as described here by Clive Bennet of MatLab Limited.

From four batches of Whatman grade 42 filter papers it was demonstrated that there was significant variation and only one (batch J11397969) followed the original calibration carried out by the BRE in 1992 and described in BRE IP4/93.



Correlating New Batches of Whatman's Filter Papers with the Original BRE Calibration.

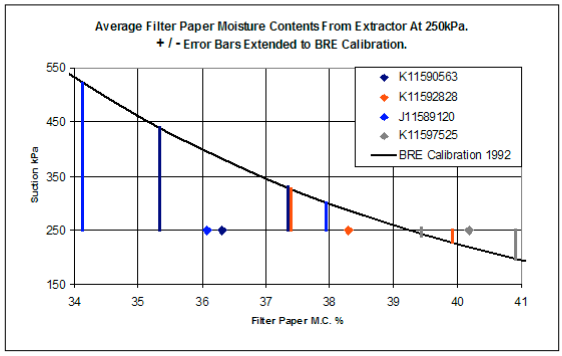
The batches were calibrated using a flexible membrane extractor (as before in 2008) and the initial results are shown below.

The tests were carried out on 9 randomly selected papers from a single box from each of the four batches.

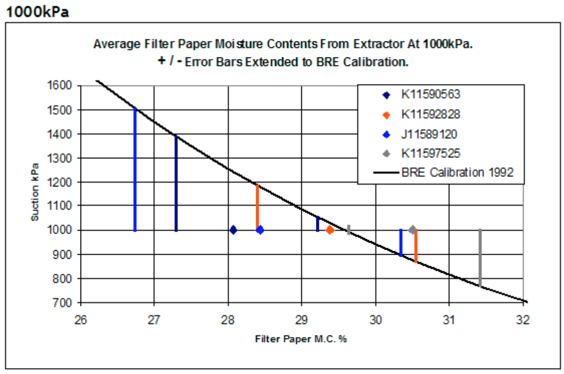
The 36 filter papers selected were tested simultaneously within the extractor at each pressure level.

Variation Across the Filter Papers at each Pressure Level

250kPa



1000kPa



The charts above illustrate the minimum and maximum error bars showing variance from the BRE line.

The chosen test pressures were 250kPa (from experience this is around the most sensitive pressure), 1,000kPa and 1,500kPa (maximum extractor pressure).

The importance of calibration is shown on the 250kPa chart. Batch J11589120 (light blue) has an average M.C. of around 36% with a minimum recorded value of around 34% and a maximum recorded value of around 38% which according to the BRE calibration would have given a suction of anywhere between 300kPa and 520kPa.

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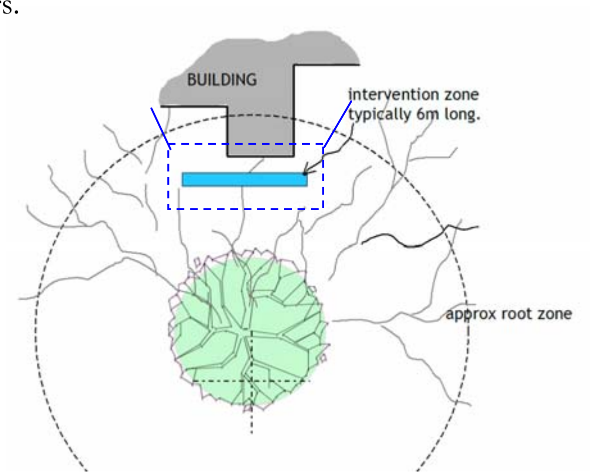
Intervention Update

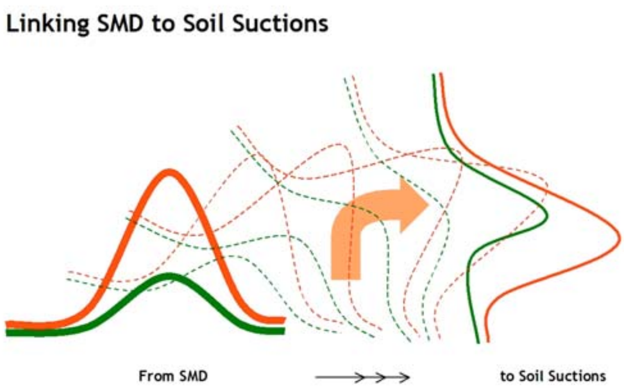
A typical intervention arrangement is shown below, with a harvesting chamber around 6mtrs long by 1m wide and around 1m deep, giving a volume of 6 cu mtrs.



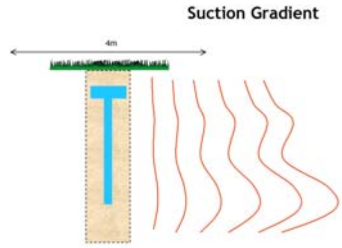
Reflecting on our aims, the treatment zone is almost certainly too small in relation to the root footprint of a mature tree to trigger production of the hormone, Abscisic Acid as part of the Partial Root Drying treatment, which means any benefit is related to local rehydration.

But first, what is the problem we are seeking to resolve? How much water is required to cater for the difference between a normal year, and an event year?

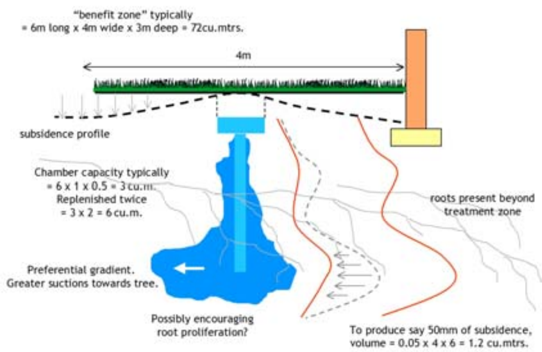
The SMD value for tree cover is around 300mm in a dry year, and 120mm in a normal year. The difference of 180mm probably equates to ground movement of around 180/4 = 45mm. This is our starting point. Can the system deliver sufficient water to replenish this loss in the vicinity of building damage?



Suctions across the root footprint draw moisture to surrounding areas, reducing the effect locally. Movement will be predominantly towards the tree where suctions are higher. Roots also grow across the zone, reaching soil beneath the building. In addition, there are concerns that the treatment might encourage root proliferation.



Increasing the notional zone to say 4mtrs, and assuming the treatment has to satisfy ground subsidence of 50mm for a short duration – a few months – the situation might be as shown below, with the chamber delivering 6 cu.mtrs of water to replace local loss over the treatment zone of 1.2 cu.mtrs.



Dr Allan Tew suggests the deficit can be catered for by harvesting roof water rainfall of say 700mm over half the roof area of a typical house (20^2m, collected by guttering and diverted to the trench via a drainage system with auto-cut off, overflow facility and ventilation) delivers around 14^3mtrs. Adjoining suctions will equilibrate the available moisture over a larger volume.

The bores are designed to retain moisture until a certain suction is established, to reduce the zone over which water can spread, with a consequent reduction in the benefit.

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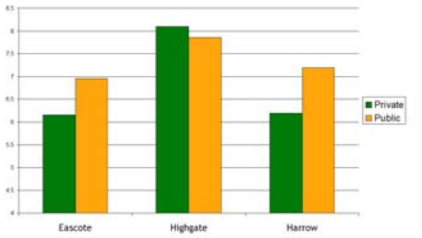
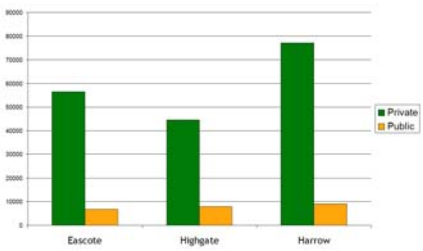
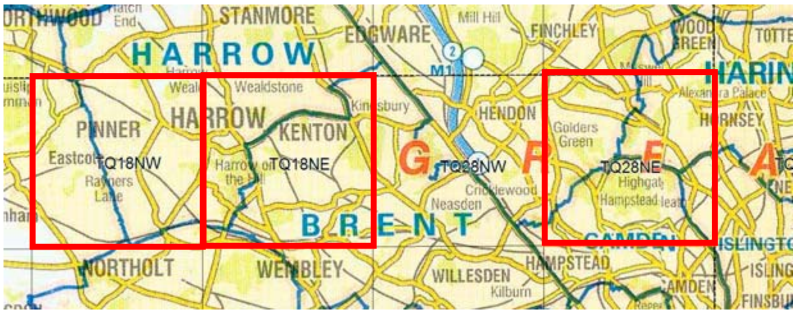


Sample 'Mean Height of Tree' from 5km Grid

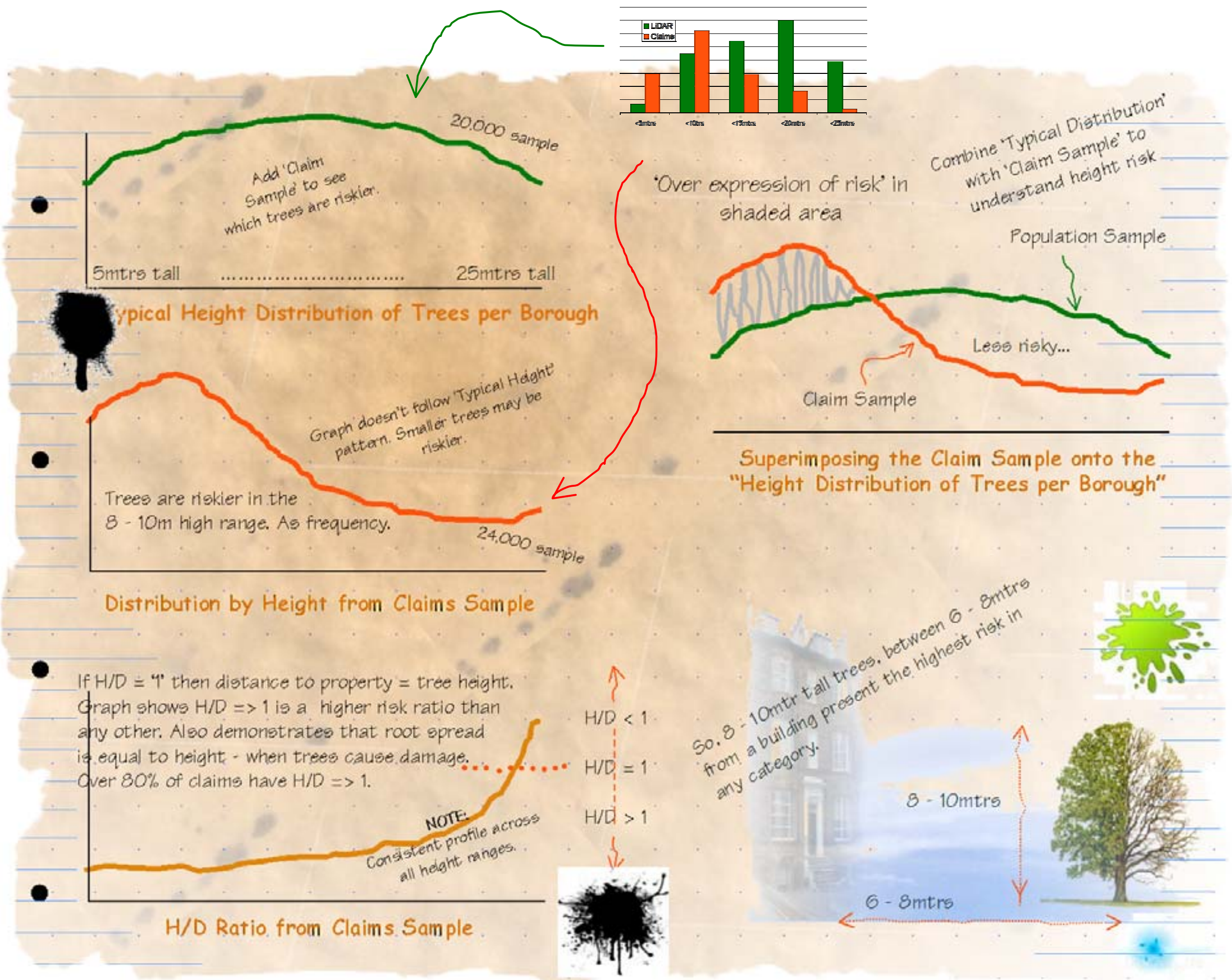


Sample 'Count of Tree' from 5km Grid



The data in the bar charts, left have been derived from an analysis of the three areas above, and include parts of Eascote, Highgate and Harrow. The areas are from a 5km tiled grid, plotting the mean height and count of trees in these tiles.

Below is a sketch illustrating how the risk values have been estimated. Plotting 'tree by height' from a number of locations we have built a normal distribution curve, onto which has been plotted the distribution profile from our claims data.



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Penetrometer

~ On Site Assessment of Desiccation ~

Below are the results from a recent site investigation using a pocket penetrometer and top driven, thin walled window sampler. The technique is described in detail in Pugh et al., (1995) *"A Rapid and Reliable on-site Method of Assessing Desiccation in Clay Soils",* Proceedings of the Institute of Civil and Geotechnical Engineers,113, Jan 25 – 30.

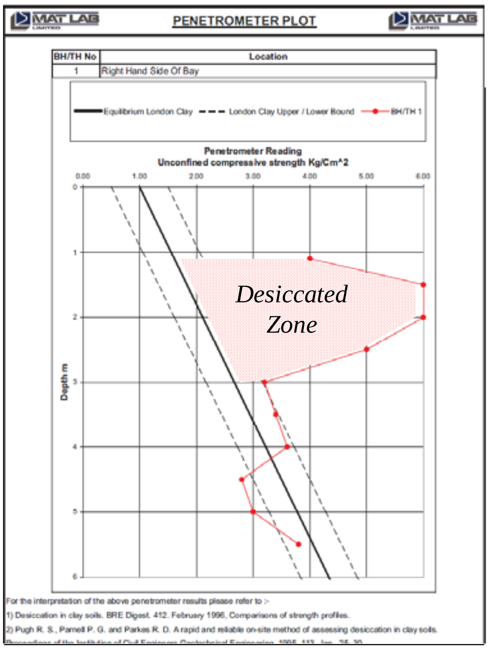
A general review of testing for desiccation in clay soils can be found in B.R.E. Digest 412, published in February, 1996.

Dial penetrometer readings are directly related to the undrained shear strength of the soil and therefore effective stress and pore pressure.

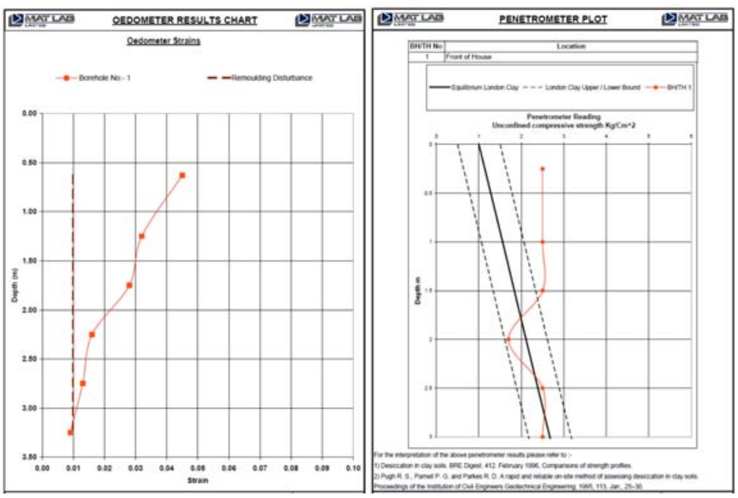
Readings taken from the intact clay lumps between fissures is a good way of assessing the presence (or absence) of desiccation.

The dial gauge is calibrated to read in kg/m^2. To convert to kPa, the value is multiplied by 100. A value of 5 kg/m^2 is approximately equivalent to 500kPa.

The benefits are clear. An on-site assessment of desiccation that appears to be robust, tried and tested over many years.



The results can be used by themselves, or as a filter to determine whether samples should be laboratory tested. Often both time and money are wasted testing soils that are not desiccated.



Left, oedometer and penetrometer tests reveal similar profiles. Above, readings are taken at 250mm ctrs from intact 'clumps' of clay soil using the penetrometer.

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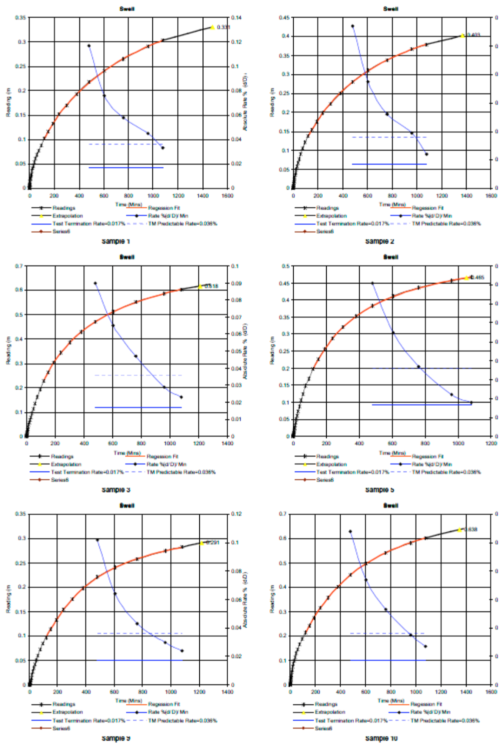
Shortened Test Cycle

- predictive model –



Predictive swell rates have been developed to safely shorten the test cycle when using the oedometer, as we see above.

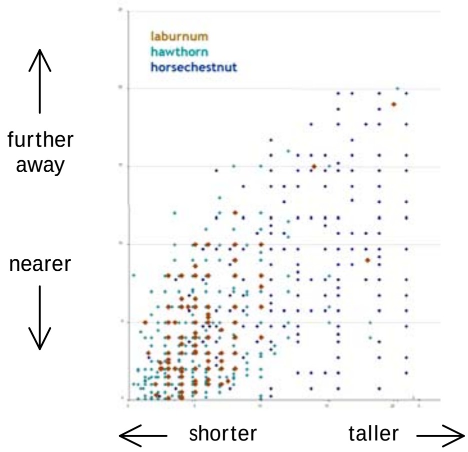
Using consolidation theory and applying linear regression analysis, MatLab build 'best fit' predictive curves to estimate total swell when the curve reaches a certain position.

Typically, 16 hours, variable with the soil index properties.

The benefit is the speed of testing, gathering good quality evidence quickly.

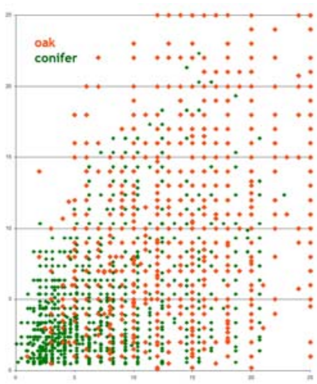
Distribution by Height and Distance

The cluster plots below illustrate distribution by species, taking account of tree height and distance from the damaged building.



A low density population reflecting the relative risk of the species and probably the planting frequency. Most cluster diagrams confirm the increased risk from trees less than 10mtrs tall, and closer to the building than their height.

Increased density and clustering in the mid-height : distance range.



The most obvious difference between species. Conifers are grouped together in the 'shorter and nearer' category whilst the Oak has a much wider distribution with taller trees, further away.

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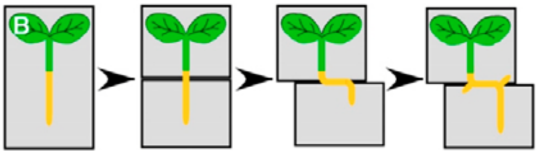
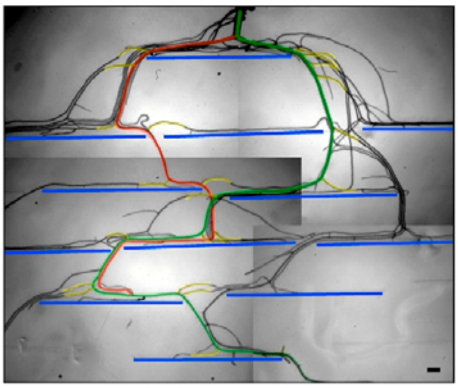
Roots and Barriers

Richter et al, (2009) *"Mechanical Stimuli Modulate Lateral Root Organogenesis"* Plant Physiology, Vol. 151, pp. 1855–1866, illustrates that physical bending of the root promoted new lateral root growth on the convex side of the bend. Illustrations from their paper are included below.



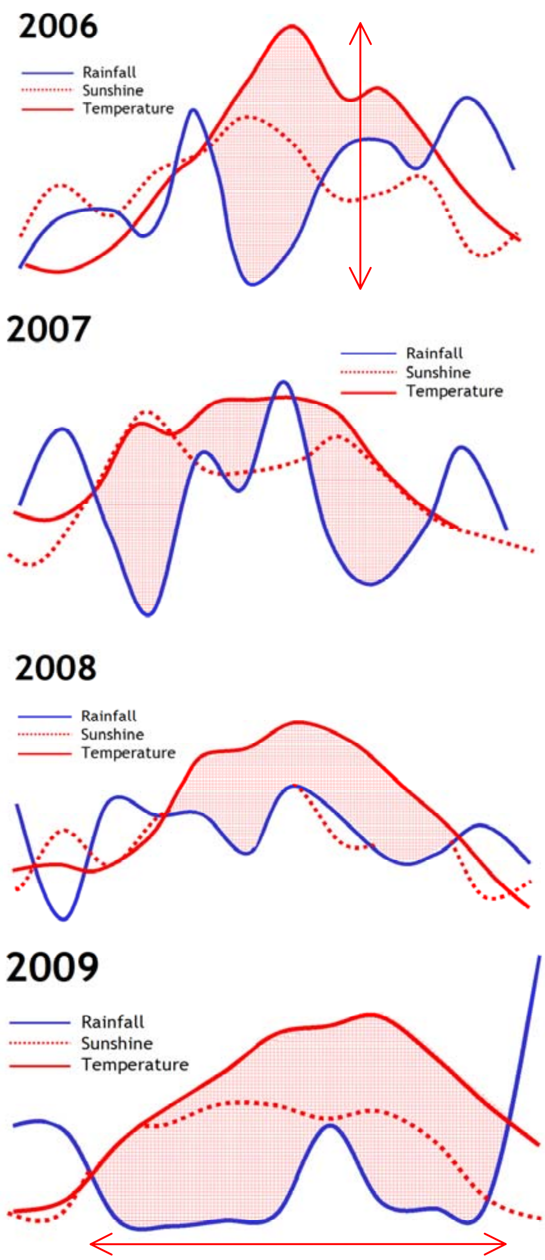
The study used Arabidopsis and not trees of course, but this provides a glimpse of the ability of plants to adapt quickly to their environment. The study may throw some light on how roots respond to increases in soil density resulting from desiccation (i.e. root proliferation) or when they meet obstructions.

Their experiment is shown below. It's likely that tree roots have a similar response when they meet root barriers.



Artificial root barriers were formed by slides (blue) to induce bending. Primary root growth is coloured green, the initial bend-induced growth is red, and subsequent growth, yellow.

Met Office Data Review



Monthly temperature (red), rainfall (blue) and 'hours of sunshine' data supplied by the Met Office illustrate differences between busy claim years (2006 and 2009) and normal years (2007 and 2008). The red shading illustrates the 'tension zone', - the envelope of difference between temperature and rainfall - showing the link between climate and claims. The trigger can be either the maximum difference at any point (2006), or the duration of the difference (2009) and timing of 'peak tension' is clearly an important factor.