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

November 2008

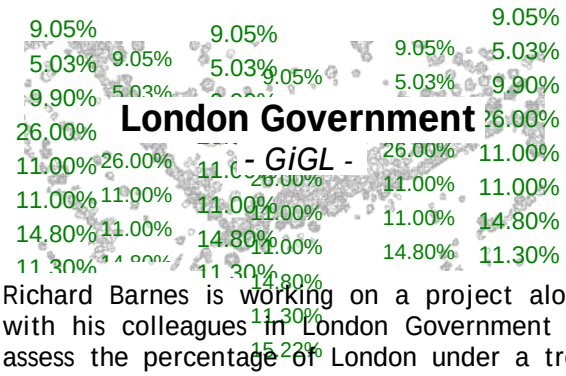
The Clay Research Group

This Edition

We include some personal views relating to the JMP proposals and supporting the topic of a 'see and fix' repair. Our concern is that we risk falling into the trap of delivering 'more of the same', when change might be appropriate.

Newsflash

Dr Allan Tew has been accepted on a Doctor of Engineering course to further his work on building engineering and structural failure. He starts shortly. We hope to share the output of his original research with readers.



Richard Barnes is working on a project along with his colleagues in London Government to assess the percentage of London under a tree canopy. Our initial analysis, using a very small sample, revealed the figure to vary even over a short distance. The study area, just to the West of Hampstead, delivered figures of between 5 – 26%, with an average of 14%.

Initiatives

Congratulations to The Subsidence Forum (and in particular Graeme Phipps) in persisting with their negotiations with Severn Trent to agree a protocol. It has taken a few years of hard work and although not directly connected with clay shrinkage, anything that helps resolve claims quicker and at less cost is to be applauded.

Their work is reported in a recent copy of The Post, along with a commentary on the Joint Mitigation Protocol – an initiative put forward by the LTOA and various bodies including insurers and adjusters to agree procedures for the investigation of root induced clay shrinkage claims.

Cost Benefit of Intervention Technique

- savings and service -

The intervention technique, applied across the industry, could deliver significant benefits estimated to exceed £60m in surge years.

INTERVENTION TECHNIQUE

Industry Claims in Surge	40,000
35% repudiation rate	14,000
Valid claims	26,000
70% of valid claims tree related	18,200
Of which, assume 5% suitable	1,300
Cost of complex 'suitable' claim	£60,000
Cost (with treatment)	£12,000
Saving (per claim)	£48,000
Total Saving	**£62,400,000.00**

These figures take no account of associated benefits including quicker claim settlements, fewer trees removed, fewer houses underpinned (or piled) and improved service delivery amongst them, settling complex claims in six months, rather than 3 years.

The analysis also assumes the technique is restricted to high value claims when in fact it will hopefully be used as a routine, increasing the benefits still further.

Work so far is very promising. If successful it could change the claims process completely, reducing the need for investigations, soils analysis, monitoring and arboricultural reports.

A simple, environmentally sensitive and sustainable solution anticipating Climate Change.

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Filter Paper Test

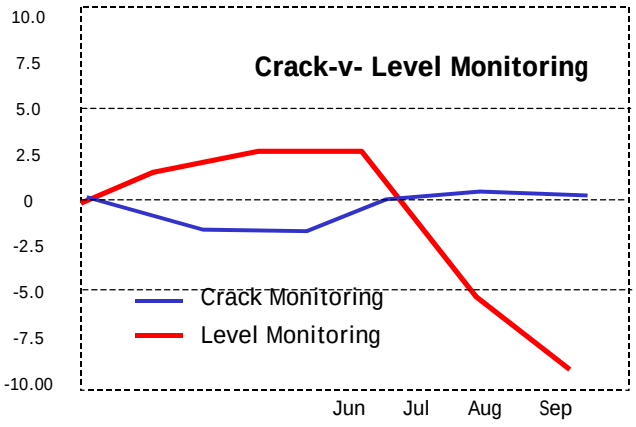
Last month we mentioned the importance of calibrating the filter papers every time a fresh batch is opened, using an identical procedure to that used for the actual testing.

Marinho and Oliveira ("*Filter Paper Method Revisited*", Geotechnical Testing Journal, Vol 29) suggest there is a possibility that salts in either the sample or the filter paper could lead to measurement of osmotic suctions if the contact isn't adequate, explaining the high values we sometimes see.

Researchers suggest applying a 1kPa weight to the paper to ensure full contact with the sample to avoid measuring osmotic suctions and calibrating each new batch.

Crack –v- Level Monitoring

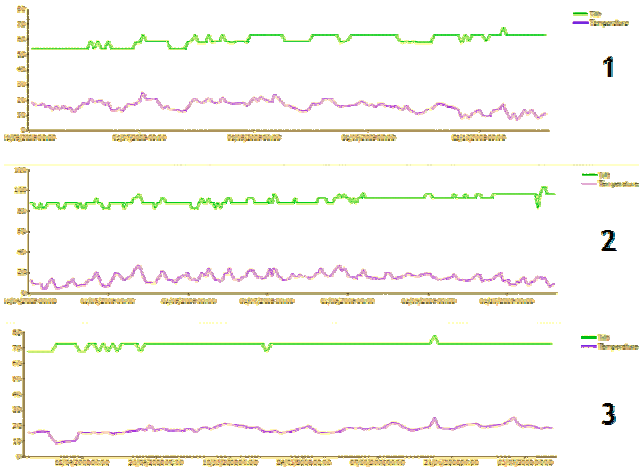
Allan Tew has supplied a neat illustration of the relationship between crack and precise level monitoring – see diagrammatic below. Levels have recorded 10mm of movement, which equates to around 1mm of crack movement.



Levels are far more accurate than crack monitoring when measuring foundation movement and provide compelling evidence when trying to determine causation. The information is also far more useful when trying to persuade a Third Party to remove vegetation.

Monitoring

Crawford have provided extracts from the output of their new electrolevels and their web application plots rotation (green) and temperature (blue) over various date ranges.



Examples 1 & 2 both show seasonal movement evidenced by clockwise rotation and unrelated to temperature change.

In both cases, movement continues in the same direction even when temperature rises and falls.

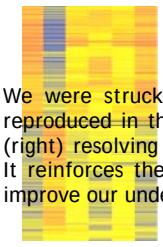
Example 3 reveals that the building is stable, with no rotational movement even though the temperature fluctuates.

Decisions can be made with three months of data in these examples, and reinforced over time at minimal cost.

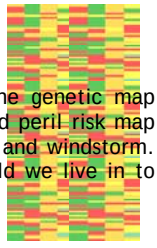
The CRG DataREADER web based application amplifies the signal and analyses the profiles carrying out fuzzy matching, supplying a confidence estimate to ensure the decisions are statistically significant.

The Same

- but different -



We were struck by the resemblance between the genetic map reproduced in the last Issue, and our colour coded peril risk map (right) resolving subsidence, flood, theft, COMAH and windstorm. It reinforces the importance of mapping the world we live in to improve our understanding. See below.



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CRG Data Handling

Tree Height as Risk

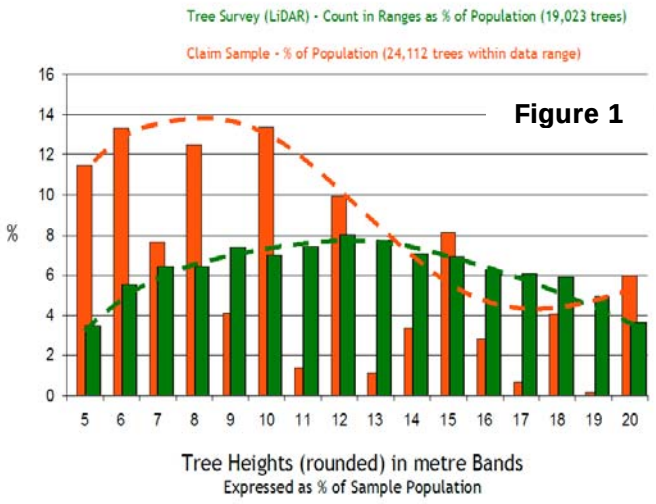
Understanding frequency when looking at the count of claims against the tree population is important in our understanding of risk.

We have taken a random sample of 19,023 measured trees from OS Tile TQ28 and sorted them into 1m height bands. The resulting distribution is shown below.

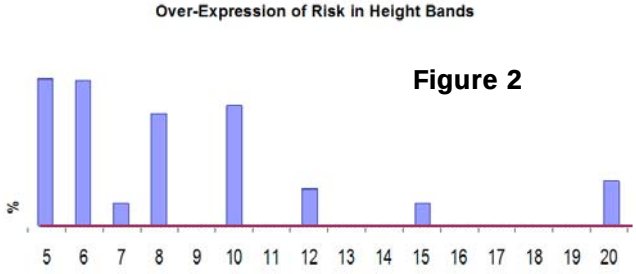
The survey excludes 'remote-from-building' (parkland) planting in order to try and achieve a like-for-like comparison with our claims database.

To ensure the two samples (claims and surveyed) are similar (excluding species) we have limited the analysis to trees in the range 5 – 20mtrs. The final extract from the claims database amounted to 24,112 records.

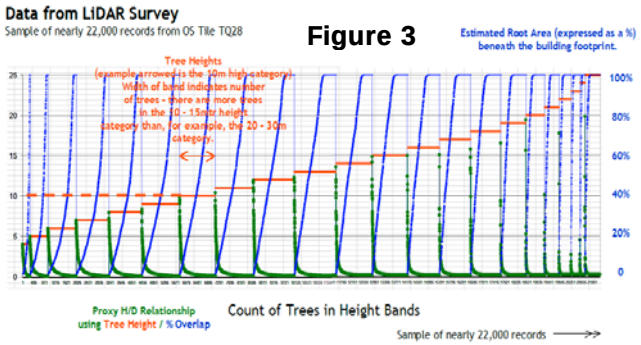
The results were standardised and the figures expressed as percentages for comparison purposes. See Figure 1 below.



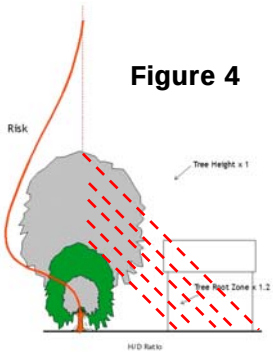
We can see an over-expression of risk in trees between 5 - 12mtrs tall – Figure 2, below – compared with older, taller, mature trees even when taking into account frequency. This is an area where the arboricultural specialist's input would be welcome, and in particular the work outlined by Marishal Thompson, which might be available towards the middle or late 2009.



We assume this increase in risk is associated with higher water demand at this stage of growth, although we do not have species data.



The LiDAR tree survey data (provided by Innovation Group and plotted above - Figure 3) helps to understand the relationship between the height, 'distance from building' and the H/D ratio, all of which are plotted. The remarkably regular signature provides a characteristic profile shared by all height bands, but in slightly differing proportions. By plotting the height data differently we see the survey tree count rising towards the centre of the range (as Figure 1) and the root overlap (using percentage overlap as a proxy for distance) being fairly consistent for all height ranges. The green dots represent the H/D ratio. All height ranges share similar profiles due to the limitations of the 'y' scale.



We do wonder if the "distance to building" value is a poor measure for risk modelling – nearly all of the trees in Figure 4 could have caused damage, and yet all share the value 'D'.

The distance to crack propagation would be far more useful when determining the root zones of trees – in our view.

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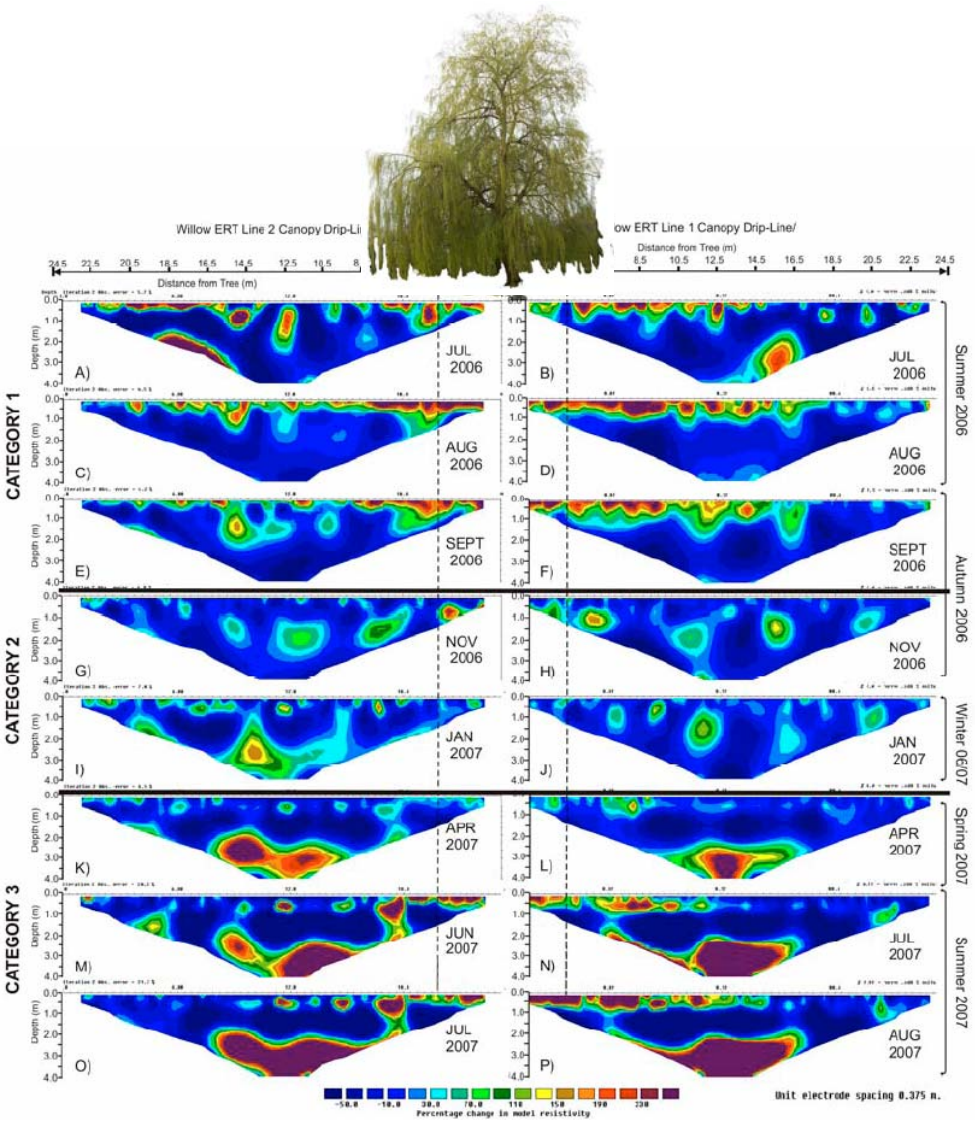
KEELE UNIVERSITY

Electrical Resistivity Tomography – Aldenham Willow

Below we reproduce one of the images from Glenda Jones PhD research project at Keele University, plotting resistivity changes over time, for Lines 1 & 2 at the site of the Aldenham Willow. See issue 37 for further details. The images illustrate moisture change seasonally in fine-grained soils and this is probably one of the most comprehensive studies of this sort in the UK.



It is interesting to compare the drier zones at depth (towards the root periphery) with the areas of maximum ground movement and also the build up of apparent desiccation at depth in the summer months.

On the following page we reproduce our own 'ground movement by month' data which we use to estimate (crudely) moisture uptake by the Willow in a very dry summer.

Glenda is currently working on her final report and we hope to publish extracts shortly.

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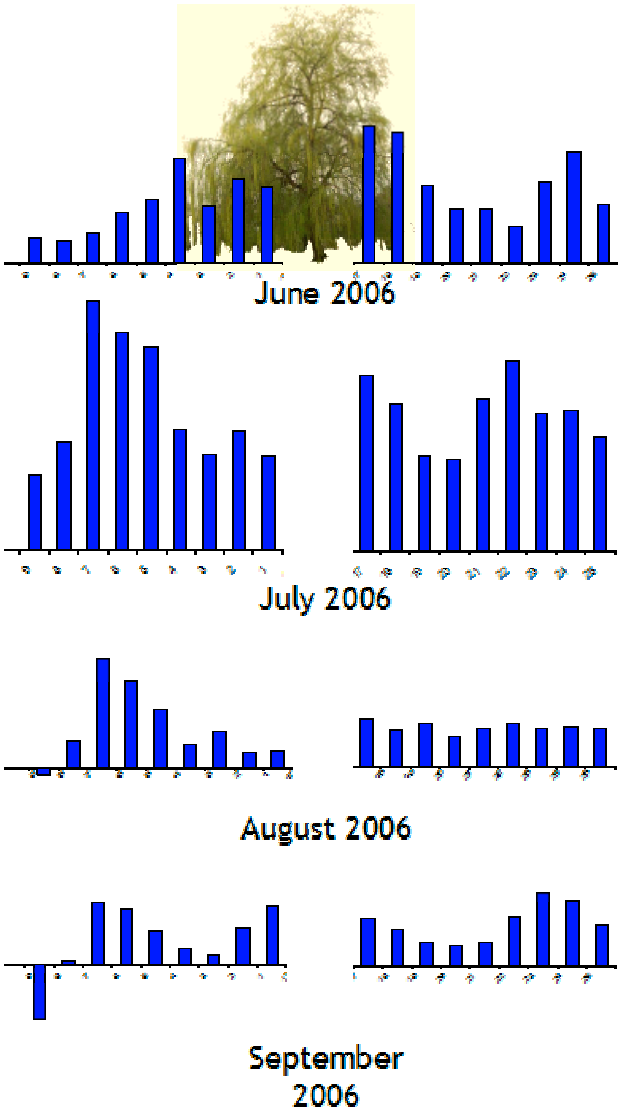
Water Uptake by Tree by Month, by Station, across the Root Zone

The 'tree moisture uptake' values across the root zone of the Aldenham Willow (using the 2006 'difference by month' ground movement as a proxy measure) reveals the following patterns across the levelling stations from June to September.



JUNE
Maximum uptake beneath the canopy following a persistent deficit carried over from the proceeding winter months. The soil was already desiccated and roots were abstracting moisture from the dry zones. The suggestion might be that uptake is governed by stress - or is it simply measurable because elsewhere the roots have access to 'free', unbound, water.

JULY
A more even distribution of uptake possibly as the soil reaches a similar state of dryness across the root footprint (suggesting the movement above may have been related to uptake of the 'free' water?) but with sufficient moisture available to allow stomatal activity to continue as normal.

AUGUST
The moisture uptake of the tree diminishes rapidly, with a sharp reduction in moisture uptake even though it was a dry month. This no doubt reflects the higher suctions needed to draw up bound water but may also be evidence that the tree is 'switching off' in terms of transpiration and we can infer that stoma open less, and for shorter periods of time, to conserve water.

SEPTEMBER
Continued low levels of moisture abstraction even though the weather remained dry and at one station we see reversal – soil rehydration. The tree is controlling transpiration using stomatal regulation.

2006 was an unusual year, starting off with a low SMD which rose very quickly in July and continued to be dry until quite late. The tree appears to respond quickly to dryness, possibly as a defence mechanism, taking water as it presents itself. The complication lies is the fact that once any 'free' water has been absorbed (that is, water held in micro-fissures between the cohesive soil, and not bound at a molecular level), any abstraction will result in ground movement, so the roots might be taking water, initially at least, with no movement being recorded. Also, soil water retention properties across the root zone will vary with the soil structure.

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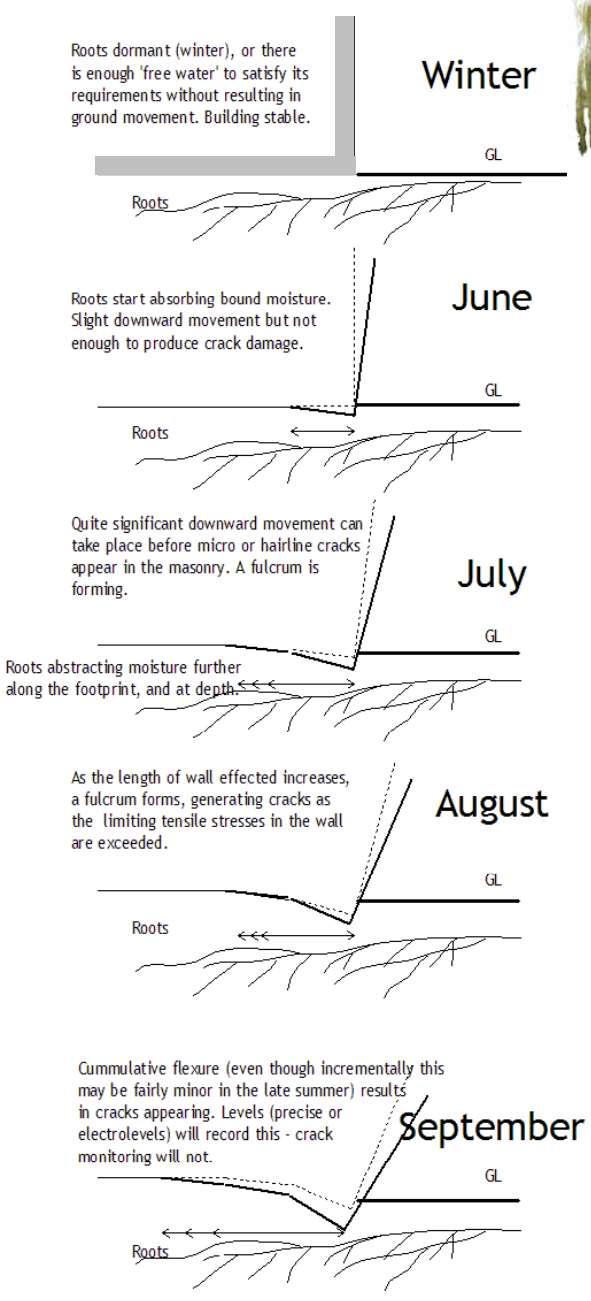
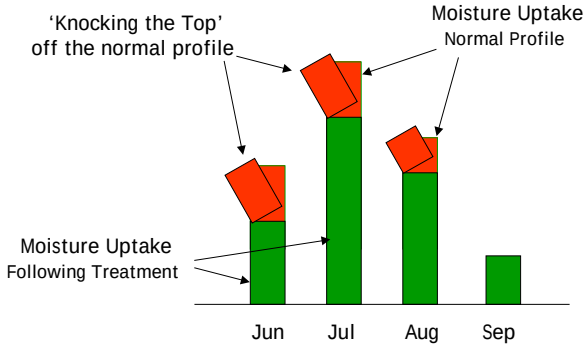
Building Movement

Gathering data to improve our understanding of how buildings move in response to root induced clay shrinkage is essential and here we illustrate the findings relating to flexure (left) taken from our electrolevel survey and combine it with the moisture abstraction data from the previous page.



Even though the 'by month ground movement' plot reveals more movement in the early summer, damage is often notified a month or two later (August and September) suggesting that domestic buildings are able to withstand quite significant flexure, and sometimes it is fairly minor incremental movement that 'tips the balance', resulting in cracking.

For the intervention technique to be successful, we don't have to satisfy the entire needs of the tree, or close the stoma all through the summer, but 'knock the top off' the water demand and reduce stomatal activity. See below.



More important, it may be that we can reduce (or satisfy) the water demand early in the year, which may seem perverse when traditional thinking has been directed towards watering in the summer, as the cracks appeared.

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A New Approach?

Traditionally adjusters have been tasked with issuing their report to insurers in around ten days and appending a Preliminary Advice putting forward some idea of the Reserve insurers should maintain - the cost of repairs.

At some stage afterwards, depending on whether they are working under what is known as Delegated Authority, and maybe the type of claim, they may instruct soil testing, arborists reports and monitoring.

In surge, the results from the further investigations can take 3 months to obtain.

How do we improve on this? Is there an alternative that might allow Tree Officers and Insurers to work together, protecting both the tree and the homeowners interests?

What would happen if we applied the level of evidence required by the Courts, but added some science using the range of models we have described elsewhere?

1. Does the damage described fall within the root zone?
2. Is the PI 40% or more?
3. Did the damage appear in the summer?
4. Is the pattern of damage indicative of root induced clay shrinkage?

Fortunately the industry has lots of data about climate, soils trees – which cause what damage, and when.

It becomes a statistical exercise, using individual skills on complex claims, where they are most needed. It resolves surge.

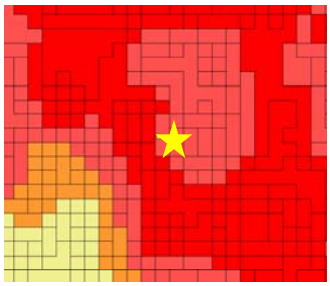
We have used several examples in the past to illustrate our suggestion for a new approach, and below we see a typical situation in London, SE25, dealt with from our desk.

The modelled root zone suggests that the pavement tree is the most likely cause of damage when root zones are plotted.

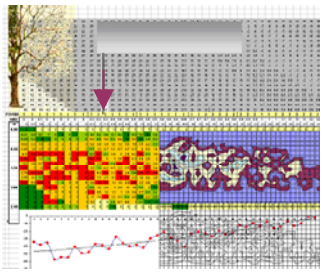
There are several trees in the vicinity of the building, and using the model we can identify which is most likely to be the cause of damage to the bay window by plotting statistically derived root zones.

In this case, the tree height has been measured, and it's distance from the building recorded using a GIS system and LiDAR.

We then refer to our database of past soils investigations and retrieve the PI.



Insert the data into our numeric model to estimate ground movement and the influence of tree roots.



Produce the geotechnical assessment and the arboricultural report ready to take with you when you carry out your inspection, amending them as needed when you return to the office.

What have we done? Resolved 80% of standard issues relating to the most typical claim we face, and resolved surge at the same time. We have unblocked the supply chain, leaving them free to do something, rather than report on it. See over.

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The Joint Mitigation Protocol (JMP)

THE GOOD

Working together is the only way to resolve differences between the various parties and this is recognised in the Joint Mitigation Protocol. Instead of going to Court, insurers, adjusters, arborists and Council Tree Officers are talking to each other.

THE BAD

Doing 'more of the same' – more tests, monitoring etc. – compounds the old problems and particularly in surge. Investigation not undertaken until November or December to prove desiccation waste time and money. Soils results are so often flawed and fuel debate. It is a costly process.

THE UGLY

It is likely we will be spending more money, gathering ever more evidence of a generally poor quality, over a longer period of time, fuelling the debate rather than resolving it.

Months (or years) pass by and when claims eventually arrive at the doorstep of the Court the latest judgements seem to be based on the balance of probability. That is, "Tree + Clay Soil + Damage in Summer = Liability".

The JMP are effectively suggesting gathering a level of evidence that far exceeds that required at Law. It isn't – in our view – a commercially sustainable solution.

We can resolve disputes very quickly, and for far less than the cost of undertaking endless – and often flawed - investigations. We could actually fix the property instead of talking about it.

We support the JMP but would like to see any agreement shorten the life of the claim, retain the tree where possible, and arrange for it (the tree) to be removed quickly where not.

We would like the JMP make life easier, not more complex. The inevitable outcome will be that insurers will be driven to spend so much money on investigations they will have little option but to pursue a recovery, and the JMP will have driven a level of evidence far in excess of the Courts requirements, leading to an increase in success for insurers.

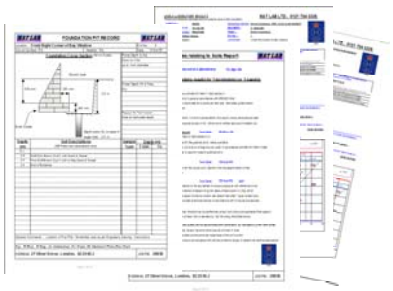
Not the outcome we are all aiming for.

If the proposals on the previous page are adopted then the JMP could move forward very quickly, and at little cost.

More trees would be retained, costs would be reduced and claims resolved far quicker.

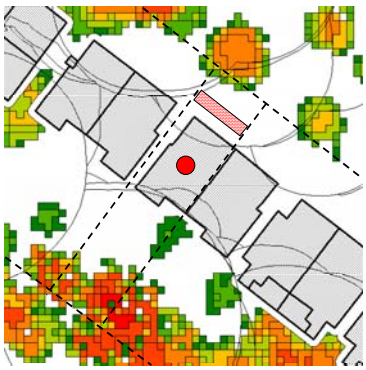
The key is the Intervention Technique which is already being tested on several sites. On the previous page and below is an example of a claim we have recently been involved with.

The claim was investigated thoroughly using a traditional approach before being passed to Cyril Nazareth for review.



The investigations suggested up to 30mm of potential recovery. The disorder model produced the same figure. One took four weeks, the other ten minutes.

Instead of retrieving roots for identification and worrying if they are dead or alive using a starch test, and then puzzling over the relevance, we might install the intervention technique instead, and retain the tree.



The cost of saving the tree here amounts to around £2,500. No investigations, no reports – we just do it. It's cheaper.

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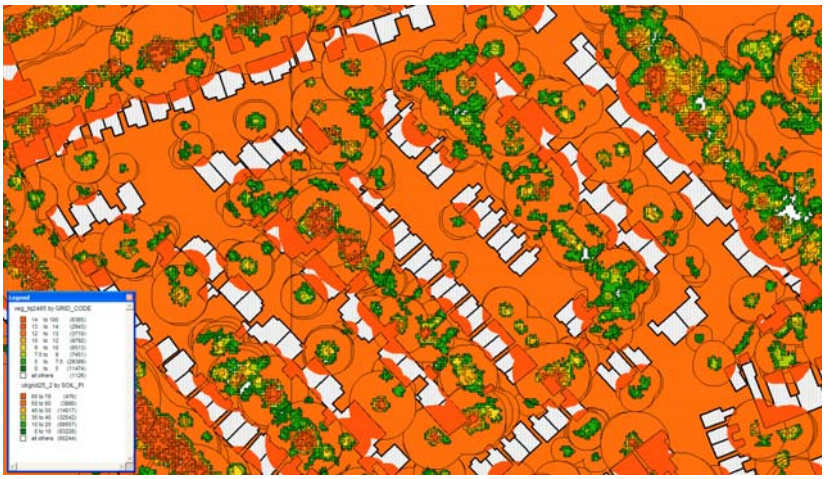
North London Claims

Our latest study area (below) shows the tree canopy shaded by height, the estimated root zones and the overlap of the root zone beneath the adjoining buildings.



All are plotted onto our unique 250m tiled grid showing the shrink/swell properties from previous site investigations over many years.

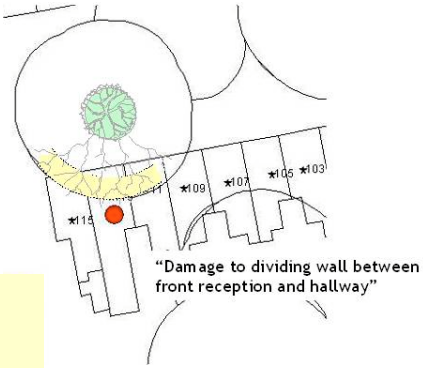
It is immediately evident that – in the study area at least – very few houses fall outside the root zone.

The implication might be that we would expect more claims in any year than we receive. Nearly all of the houses appear to be at risk.

Below is the answer. Many of the properties are at risk, but they don't exhibit movement at the same time. Subsidence is something that happens over time, and it isn't the case that we can't model the risk – rather we have a problem understanding when it will manifest itself.

Left we have a typical distribution of claims (red dots - 8 in this image) from North London in a twelve month period. Over the last 30 years (and ignoring variance by area and surge) we might expect to see 8 x 30 = 240 claims.

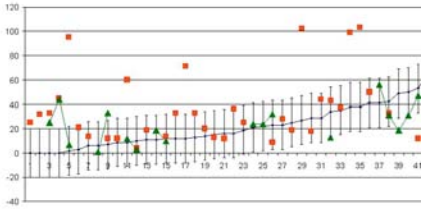
How have we estimated root zones? The answer is, we have used several approaches, and the first involves plotting carefully claims where we have detailed investigations and outcomes.



Above is an example of using the 'distance to the fulcrum of movement', rather than 'distance to building', and it illustrates the benefit when building a model.

The second is a statistical evaluation, and this is where species-specific measures have been incorporated. For example, our analysis suggests that the roots of the Ash have a statistical relation to the norm of 1.2, and the Oak might be 1.8, but could reach 2 or more in a very hot summer. Each value is climate dependent and variable.

Our analysis has helped to develop an understanding of the ground movement associated with each tree type, using a variety of measures. Precise level data was preferred, supplement by estimates of swell and finally crack measures where nothing else was available.



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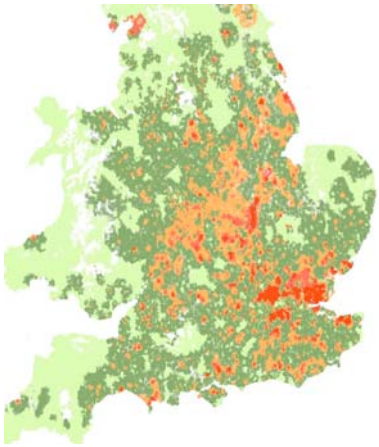
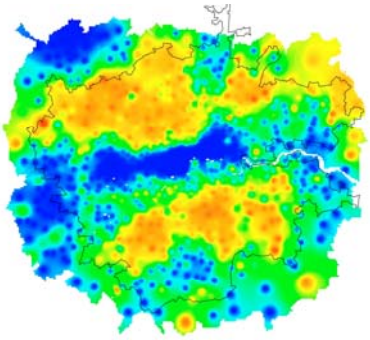
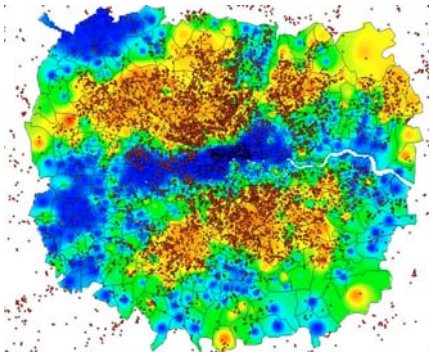


The Underlying Risk Maps

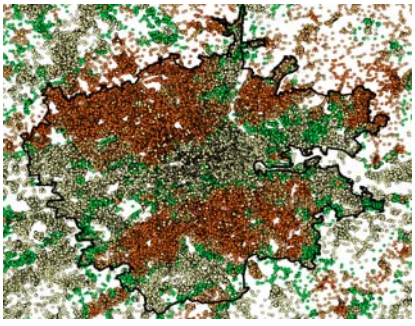
We use a variety of maps to understand the relationship between claims, geology and trees and some are reproduced below.



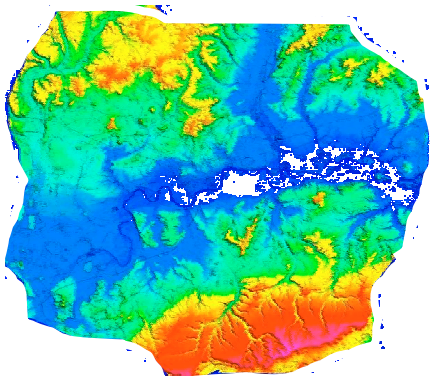
First (above showing London extract) is the geological map using actual investigations .



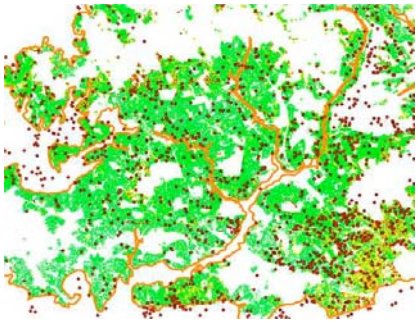
Superimposing claims (red dots) on the first map reveals the relationship between claims and geology. Below, we have attributed a risk to each postcode, and every property based on distribution and geological contouring.



InfoTerra have produced a digitial terrain model which has a remarkable likeness to our geological map (even apart from the colours used) following depositional contours with the chalk series and drift deposits standing out from the flatter profile of the London Clay series.

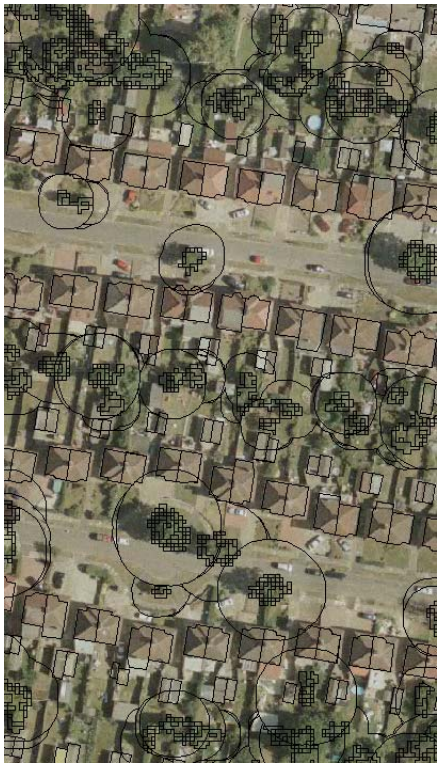


Below we have added trees to the map of North London, and the red dots reveal their relationship to claims.



Then we have the statistical models that are derived from the raw data where we ask, 'is there a robust relationship between the various indicators', and if so, what is their hierarchy? For example, which is the more important between geology and climate, and geology and trees etc., and what sort of weighting should be applied taking account of the variability within each sub-set?

Finally, the model has to provide some idea of relative risk across the UK - a value of "0.37" for example, relating to HA5 5SN, would be meaningless without some sort of scale. It also has to provide a risk at address level as we see below (house by house).



The LiDAR data was superimposed onto aerial imagery to ensure the outlines coincided with trees canopies, and then over the OS maps to take account of recent extensions.

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'More of the Same' -v- Common Sense

- a very personal view -

Engineers, arborists and geologists sometimes resist the idea that their experience can be mathematically modelled. It might even appear offensive.

'Every claim/soil/tree is different' is the view, and of course, we agree. They are.

However, stepping back from individual cases we have to ask how the following example might be handled, and how approaches differ – if in fact they do.

Looking at the picture, the practitioner might ask "can your model tell me which of the trees in this street-scene will cause damage?" We would have to admit that no, it can't.

Reversing the question – can the practitioner tell us which tree will cause damage? Of course, the answer would have to be the same. No, they can't.

What we might all agree is that each of the trees presents a risk, and it may only be a question of time.

Now, this leads us further. When one of the houses is damaged, the arborist arrives at site, estimates the height of the tree, its distance from the building. They will identify the age, species and health, looking for signs of disease etc.

They don't then report that 'there are several trees in the road, of the same species and proportions, and as other houses appear undamaged, we can discount the tree as the cause of damage". Of course not.

The geologist doesn't discover clay beneath the house and express surprise. Not if has dealt with a few claims in the area. Or, to put it another way, not if he is experienced. If they dug a hole outside one of the adjoining, undamaged houses would the soil be desiccated? We imagine so.

Of course, we could always monitor the buildings. Those that are damaged, and others that aren't.

Imagine finding the same amount of movement whether the house was damaged, or not. It could get very confusing and until we start examining houses that aren't damaged, we will never know.

To complicate matters, we are told that the Courts are moving towards a 'balance of probability' determination in several recent instances.

In this situation, the evidence might simply record the area of damage, the presence of a tree, damage to the building where the two adjoin, combined with clay soil and dry weather.

No wonder the Tree Officers are worried. The reaction – entirely laudable in defence of the poor tree – is to set up the JMP and require quite astonishing levels of evidence. Soils tested in various ways, supplemented by monitoring.

If there is a genuine wish to reach an amicable, industry-wide solution, why aren't we adopting a more sensible approach? Instead of asking for 'more of the same' (see Page 8), we could model the risk as the damage appears.

Of course, we have foreseeability and the very real worry is that we might blight all of the trees in London that are near houses.

But claims are only a concern to everyone because of the cost of repairs. What would happen if we reached an agreement that could be objectively entered into, that protected all parties?

What would happen if we removed the commercial blight of subsidence by adopting a 'see and fix' approach?

Instead of adding to the costs, and delaying the repair, can we agree a new way forward?

If we understand things correctly, the JMP 'requirements' will lead to insurers spending around £2,000 for investigations, soil tests, monitoring and reports. The homeowner will have to wait at least 12 months before any agreement is reached – if it is.

A virtual assessment followed by the intervention technique would cost around £2,500 and could be completed within a few months, ready for repair, keeping the tree.