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

August 2009

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CONTENTS

RICS have included the Clay Research Group Newsletter in their E-library, extending the circulation to surveyors and other professionals.

Our thanks to **Gary Strong** for his support over the years both in his 'new' role at RICS, and his previous one running the subsidence team at GAB Robins.

Gary has formed an on-line subsidence discussion group for anyone interested. They should visit the RICS web site for details on how to enrol.

Contact **OCA** for the latest edition of their Climate & Capacity Modelling newsletter.

They provide regular updates analysing data supplied by the Meteorological Office.

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News

Glenda's paper entitled *"Imaging and Monitoring Tree-Induced Subsidence using ER Imaging"* has been published in Near Surface Geophysics, 2009, 191-206.

The paper describes in detail the results of her study at the Aldenham Research Site over a three year term using electrical resistivity to measure moisture change beneath the Oak and Willow, in clay soils.

Extracts from The Post

Jonathan Clark is joining Cunningham Lyndsey following his term at the FSA. Jonathan will be re-joining CL after a term at Crawford and is a widely respected industry figure with extensive experience in a wide range of perils and commercial dealings. Our best wishes in his new role.

Walter Merricks, the Financial Ombudsman, is to step down after 10 years service. "Tough at the top" springs to mind.

The Post Subsidence Conference was well attended this year, with Robert Sharpe , Giles Biddle, Peter Osborne, Jill McLean, Nigel Bareham, Neil Curling, Geoff Ball, Alex Finch, Gary Strong and Richard Rollit in attendance, and a host of other colleagues.

We gather our old friend **Tony Boobier** was delivering a lecture at a recent CILA conference on the benefits of GIS.

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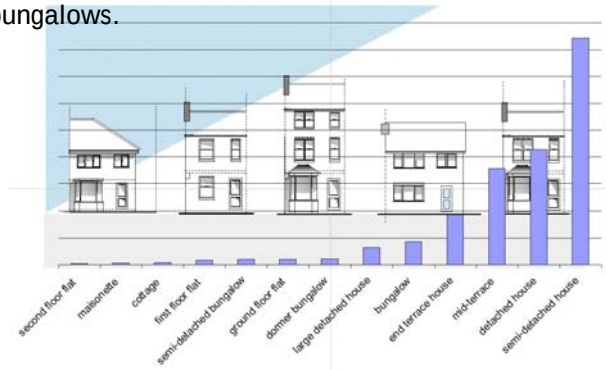
Background Data

In terms of simple numbers – "count of…" – we have reviewed a sample of in excess of 10,000 subsidence claims to understand their characteristics. All data on this page relates to claims notified, rather than frequency.

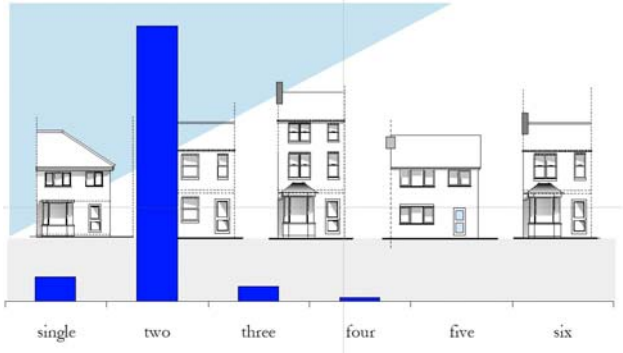
For example, which houses do we visit most often, of what age and style. Where do we find most damage?

Here are some of the findings.

First, house types. It will be no surprise to discover that the semi-detached appears most often, followed by detached, mid-terrace, end-terrace and bungalows.



Then we filtered for the number of storeys and again, no surprises. The two-storey is the most commonly encountered building – by a long way.

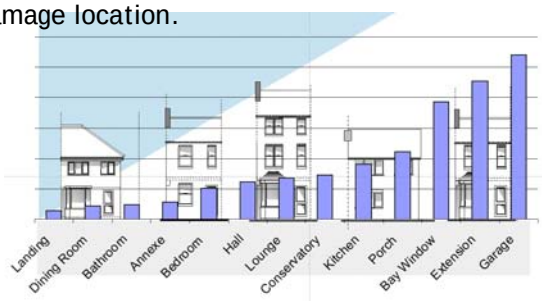


If the two storey, semi-detached house is the property type we encounter most often, which rooms are the riskiest?

It seems that landings, dining rooms, bathrooms, bedrooms, hallways and living rooms are amongst the safest places to be when subsidence strikes.

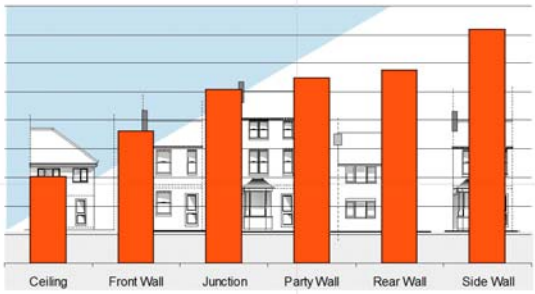
Avoid garages, bay windows, extensions and any 'projecting bits' if possible.

Finally, we filtered on the description of the damage location.



"Side walls" (which includes descriptions like "flank", "gable"…) are riskier than rear walls, are riskier than party walls…

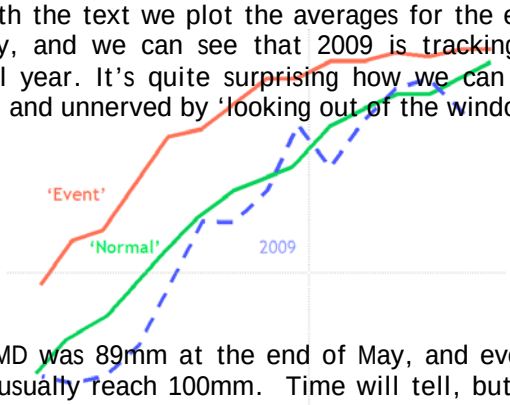
No surprises to the seasoned practitioner, but this review of in excess of 10,000 claims gives an insight to their standing relative to one another. Of course, without frequency data (i.e. how many houses have bay windows, porches, conservatories …) this is of little more than passing interest.



The damage location is perhaps most useful, confirming that extensions, garages, conservatories, porches and bays are 'high risk' - along with side walls.

Event Prediction

Beneath the text we plot the averages for the end of May, and we can see that 2009 is tracking a normal year. It's quite surprising how we can be misled and unnerved by 'looking out of the window'



The SMD was 89mm at the end of May, and event years usually reach 100mm. Time will tell, but at this stage it looks more 'normal' than 'event'.

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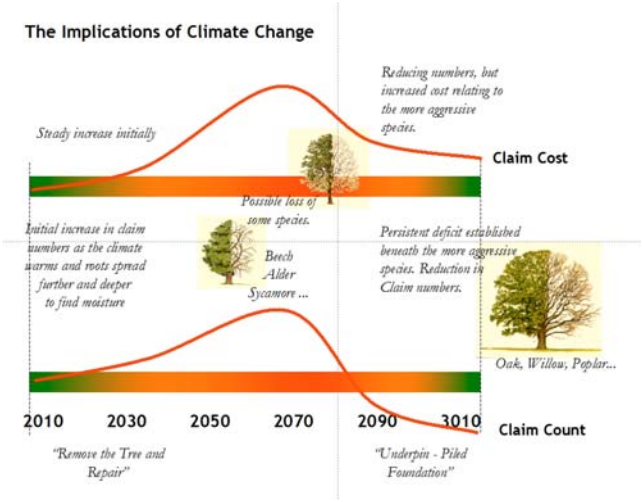
Climate Change - 1

The ABI figures show a gross incurred for subsidence in 2003 (an event year) of £408m compared with a typical annual spend of £200m for 'normal' years. Over a ten year term, and using these figures as a baseline, the spend would be something like £2.4bn, including two event years. If every year does resemble an event year in fifty years time, as predicted, and using the 2003 values x 10 = £4bn, Insurers could double their spend.



This may be simplistic. We could see a reduction in the number of trees that can survive such dramatic change over a relatively short period of time, although by definition the trees that don't survive will be amongst the less risky.

The more aggressive species (and we have evidence of this at Aldenham beneath the Oak and Willow) will send roots further afield, take water from greater depth, but perversely, cause less ground movement over a wider area as a persistent deficit develops.

Our broad 'guesstimate' is that in fifty years time, claim numbers will probably fall by about 15 – 20%, but the cost of individual claims will rise, and quite possibly double on average taking account of the need to pile damaged houses where trees can't be removed due to the presence of a peristent deficit.

Frequencies will undoubtedly increase in the meantime, although not immediately due to the unsettled weather that experts tell us could continue for the next eight years or so.

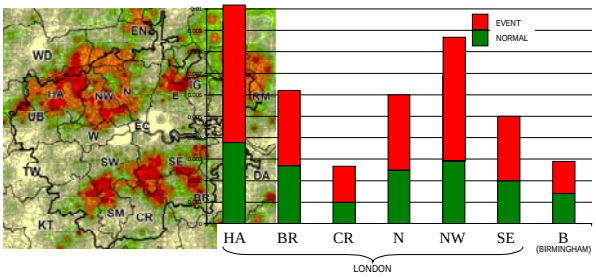
Climate Change - 2

When we talk of claim frequencies we are using averages across the country. So, the fact that a value of say 0.002 in normal years increases to 0.006 in an event year isn't the full story.

The increase is concentrated in parts of the country with shrinkable soils. Around 20% of the postcode sectors in the UK are on shrinkable soils, and of those, probably one-third are classed as low risk – Boulder Clays, Mercia Mudstones etc.

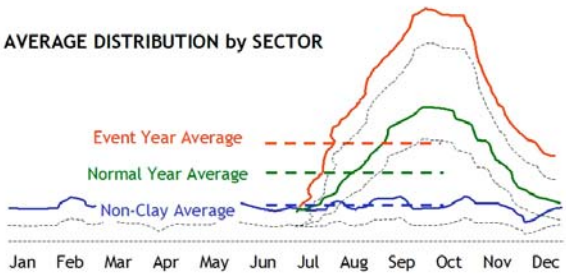
Dry weather event years have a geological imperative, and this would mean that the increase in claims frequencies would be far higher in areas with clay soils, as we see below.

In Birmingham ("B" in the graph below) there will be a modest increase, reflecting the Mercia Mudstone series.



Claim Frequencies by Postcode Area
Comparing Normal and Event Years with Geology

In contrast, areas like Harrow or the NW postcode area may see far greater increases. The industry averages we use don't reflect the operational problem at times of surge.



The above graph illustrates this distribution with non-clay sectors remaining unchanged by season or year, and areas on clay soil suffering most.

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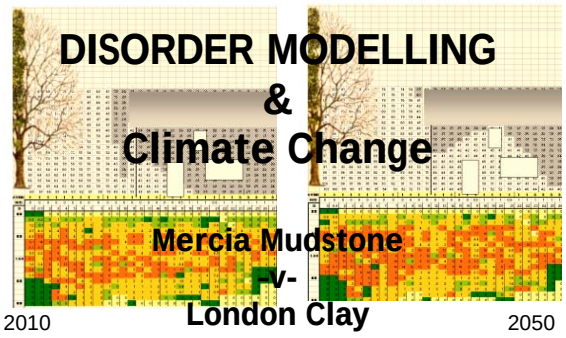
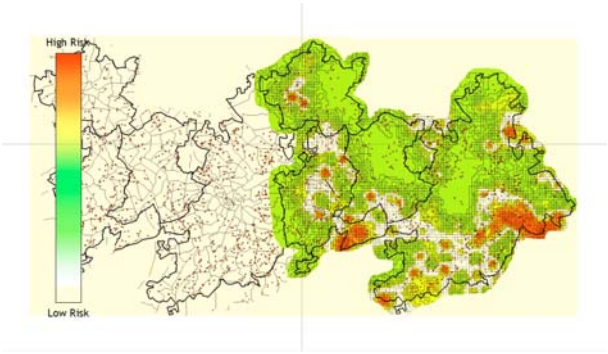


The average P.I. for the Mercia Mudstone will be somewhere around 20 –25%, depending on the smectite content – more to the South East of Birmingham where it might reach 30% or so, and less elsewhere. See map below.

How do we know? Claim notifications. We can almost infer the smectite concentration of the Mercia Mudstone using claim numbers. High claim numbers on drift suggest that the drift is probably shallow – or has a high clay fraction.



But what difference will the mineralogy make come Climate Change? How will the Mercia Mudstone behave in comparison with the London Clay series?

Enter the Disorder Model. We can compare weather patterns now, with those in 50 years time, by soil type, by tree.

At the top of this column we are carrying out 'what-if' modelling looking at the influence of a 16m high tree (Oak in this instance), 10mtrs away from a property in various situations.

ABA + LTOA?

Dr. Sally Wilkinson from Lancaster University (one of Prof. Bill Wilson's team) mentioned that it might be worth trying a foliar spray to alkalise the leaf apoplast, and reduce the pH locally – where it is most beneficial in terms of enhancing the influence of ABA. Sally mentions using a phosphate buffer of approximately pH 6.6-6.8.

It would need applying regularly – every two or three weeks – but this may be less costly than crown reducing street trees into lollipops over an entire Borough every year. The cost of targeting trees associated with damage to leave others in their natural glory has to be worth trying. Something for the LTOA and an aware insurer to try maybe?

With relatively low frequencies it could work out to be a cheap and environmentally friendly solution.

ABA^{MIMIC} & RECEPTOR

Cutler et al (April 2009) *"Synthetic Chemical Offers Solution for Crops Facing Drought"*, Riverside UC, California, have identified a synthetic chemical that has the potential to be used in a spray to protect crops that are facing drought conditions.

Pyrabactin mimics abscisic acid (ABA) and can be applied by spraying to enhance their protection in times of stress. ABA is a costly, complicated, and light-sensitive molecule that has not found use in agriculture.

The senior author of the study said, *"we found pyrabactin activates some of the ABA receptors in plants and is an excellent mimic of ABA. Moreover, unlike ABA, it is stable and easy to make. It therefore suggests a highly effective chemical strategy for improving plants' ability to survive under low-water conditions, potentially benefiting farmers in drought-prone areas worldwide."*

The researchers also used the pyrabactin molecule to identify an ABA receptor, believed to be the first such receptor to be definitively identified.

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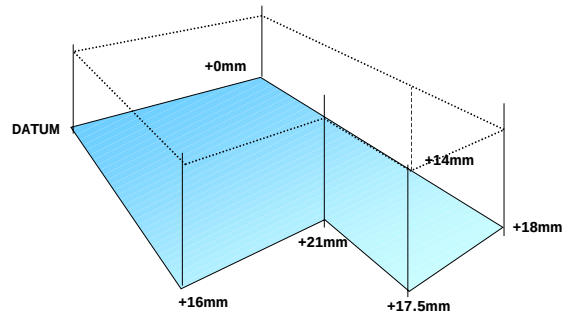
Intervention Technique Update

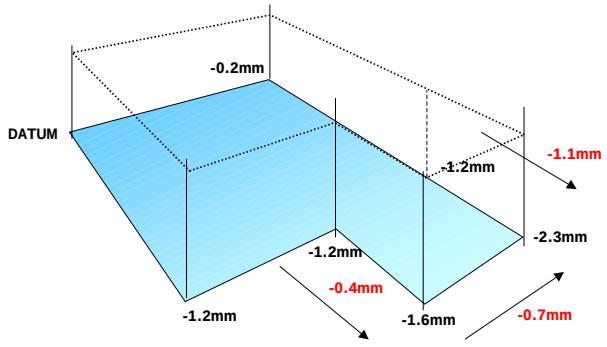
Below is a plot of precise levels taken on the same bed joint, at the end of April – following winter recovery. There are differences of 4mm between stations and the rear wall is reasonably level.

DISTORTION SURVEY - levels taken on same bed joint - 30.04.09



By the end of June 2009, moisture uptake by the tree has produced minor movement (also recorded by the electrolevels – see right) with the largest difference between stations of 1.1mm. See below.

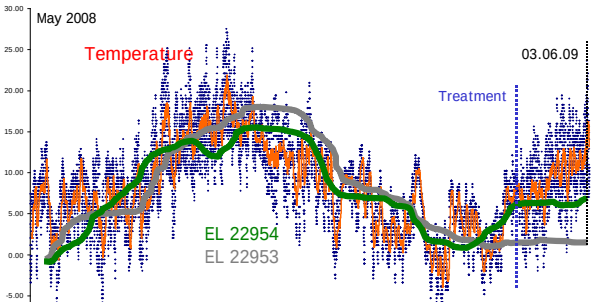
PRECISE LEVEL SURVEY - 26.06.2009 - recording movement from 30.04.09



The movement that has so far taken place delivers a deflection coefficient of 2850/1.1 = 2590.

Using a value of L/360 as the limiting tensile stress beyond which cracks are likely to appear (Burland & Wroth, Skempton et al) produces a value of 2850/360 = 8mm.

The extension is 2.85mtrs deep x 2.6mtrs wide.



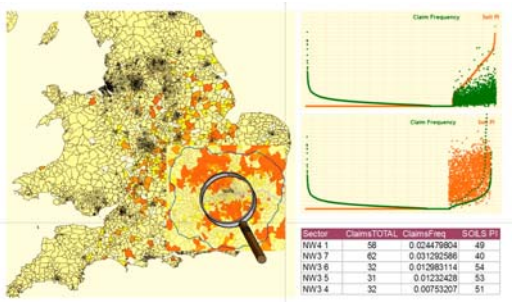
Above is a plot relating temperature to building movement as recorded by the electrolevels and the apparent – yet to be proven – benefit of applying the treatment. Sensor EL 22953 in particular appears to have stabilised.

The Cost to Harrow of Climate Change

Taking Harrow as an example (last months newsletter) we mentioned a claims frequency, taken over a five year term and allowing for the odd event year, of 0.00354 – on average, per annum. This means that for every thousand houses, 3.54 will probably have a subsidence claim notified every year. 35 claims over ten years.

If the average indemnity spend (unfactored and at todays rates) is say £8,000 the total cost over ten years = 35 x £8k = £280,000. That is per 1,000 houses. We don't need to be too accurate, but if there are 170,000 houses in Harrow, that figure becomes £280,000 x 170 = £47m.

Climate Change increases this to £80m because Harrow has lots of trees and a highly shrinkable soil. We know the height of the trees and their growth rate. We could work this into our model quite easily. What do we do then?



Sector	ClaimsTOTAL	ClaimsFreq	SOILS PI
NW4 1	58	0.024478804	49
NW3 7	62	0.031292586	40
NW3 6	32	0.012983114	54
NW3 5	31	0.012324428	53
NW3 4	32	0.00753207	51

Around 20% of the UK postcode sector are on clay. "Elasticity Modelling" applies an increase in frequency by sector as a product of both the soil P.I. and previous claims experience - see graph above.

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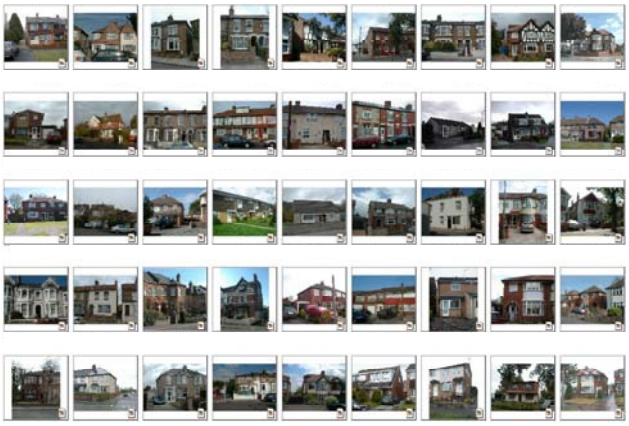
It's all very Complex

Every house is different. No two are similar. Every claim we go to is a surprise.

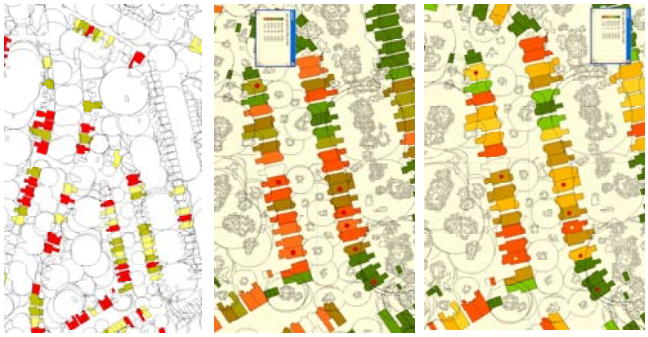
From a distance one might be forgiven for wondering what that difference is.



Collecting and analysing a lot of data might change our opinion. We might end up with some odd shaped boxes. Some with bits that stick out, and others that are taller, but in the scheme of things, we wonder how different these houses are.

Does it come down to their age? Differing depths of foundations?

And should we talk of vulnerability in terms not of where the windows and doors are, but where the root overlap is?

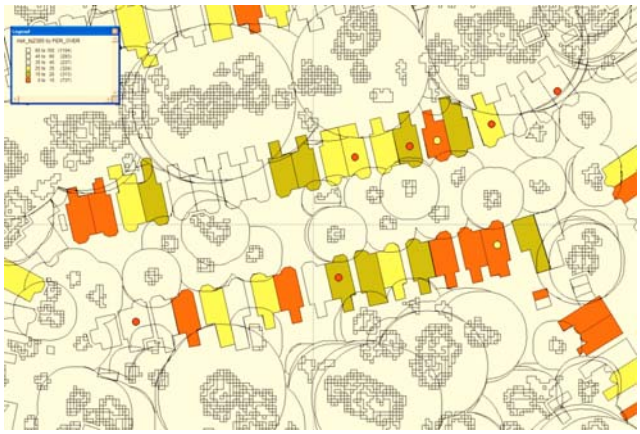


The image above distinguishes between similar houses, with similar trees, or varying height and species nearby.

To the left we see how many of the houses are rated high risk using our model. Not as many as we might of thought.

Iterating by estimated root zone we can filter to detect a more sensible level of risk. The images to the right show how differing estimates of root overlap can be a distinguishing feature.

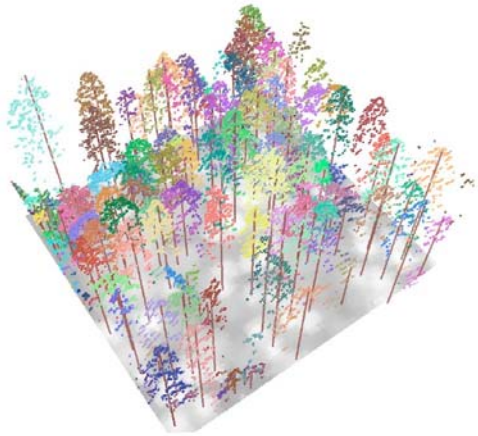
Below we have taken a well researched street and logged the houses with claims, deriving a correlation with root overlap and claims experience. The model has a 75% 'hit rate'.



No doubt this will increase over time as new claims are notified, even ignoring climate change.

Risk by Species

Scientists are using LiDaR to identify tree species remotely. They characterise standard trees, taking crown shape, volume, height and so forth, and compare the output gathered from surveys when the trees are both in and out of leaf.



See *"Individual Tree Species Identification using LiDaR Derived Crown Structure and Intensity Data"*, by Sooyoung Kim, University of Washington PhD thesis, 2007 and other published works.