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

January 2012

The Clay Research Group

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Issue 80, January, 2012

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2011 ON REFLECTION

2011 has seen progress on the topic of drought response of plants and trees, building on the identification of the ERECTA gene back in 2005, and followed by the identification of specific receptors for the hormone in 2006. See Pages 9 & 10 for information.

The CRG have concentrated on developing the Intervention Technique in an attempt to retain trees wherever possible. We now have over 30 installations, many of which are being actively monitored to assess the efficacy over time.

Studies of several London Boroughs have been published in 2011, along with a more general assessment of Welwyn & Hatfield in this edition.

Climate continues to be challenging, with reports of the UK having the second warmest year in history. We also see warnings of a return to an ice age and threats of drought being reported alongside one another.

This month we look at risk of subsidence more generally, with examples of distribution by district and dates of notification. What is the probability of a claim from Cardiff being valid when compared with, say, London*? Are summer claims more likely to be valid, and if so, by how much and by what peril?

We also take a look at the 'other' perils. Those involving escapes of water (EoW) from drains and water services. Some postcode sectors have as many EoW claims as others have clay shrinkage claims, but where are they?

**Probability of claims being valid = 0.72 for London and 0.44 for Cardiff, variable by month, year and climate.*

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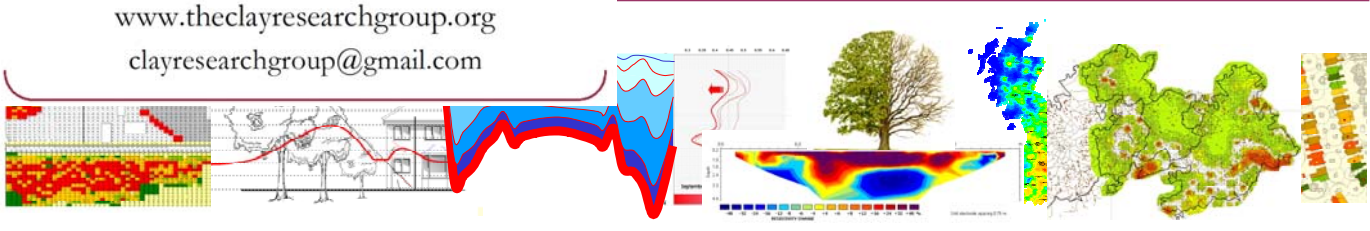

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NEXT MONTH

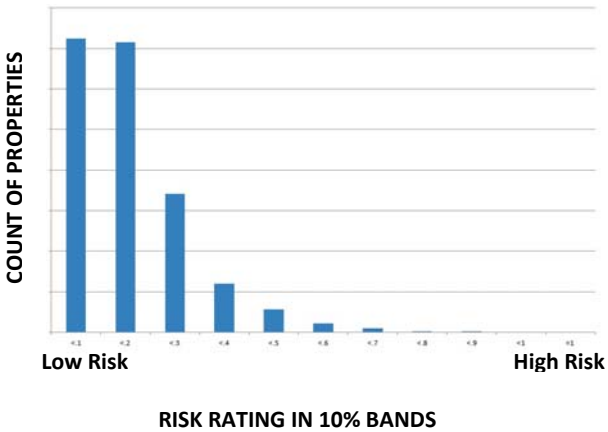
We will be looking at two roads where we have more detailed data of claims over time, to help understand the key drivers of subsidence and claims frequency.

In any year the industry reports 'x' number of claims, but what is the cumulative risk, over time? It is true to say that the risk model can't predict in any year which tree will cause damage, but is that the question we should be asking? Should we be considering its value over a longer period?

We will also be looking at how industry claim frequencies relate to the number of trees felled by London Boroughs to see if there is a relationship. Quoting the industry average for claim frequency across the UK gives very little clue as to what is happening in the high risk areas.

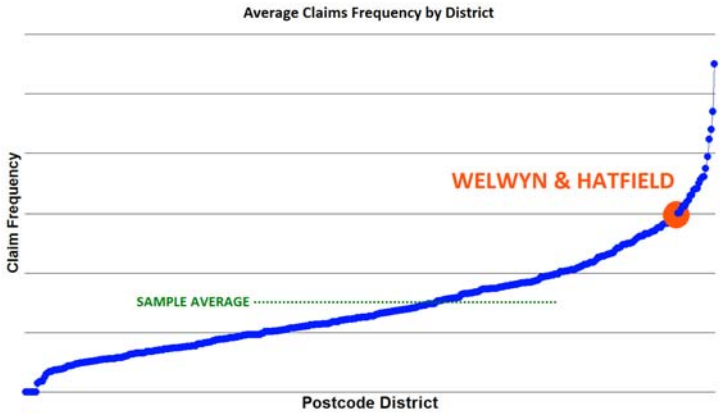
RISK DISTRIBUTION

Below is the distribution of risk in 10% bands, putting the threat of subsidence into perspective across the UK.



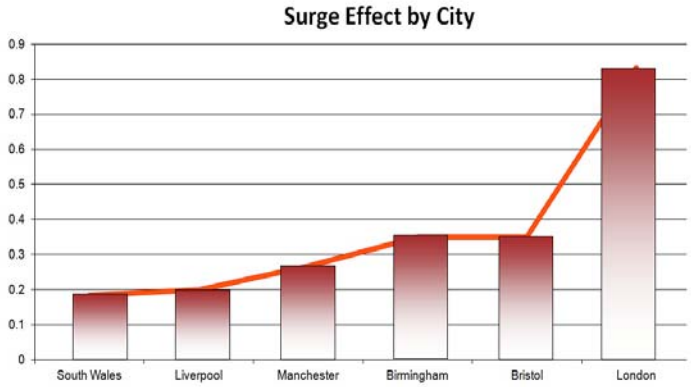
WELWYN & HATFIELD BOROUGH STUDY

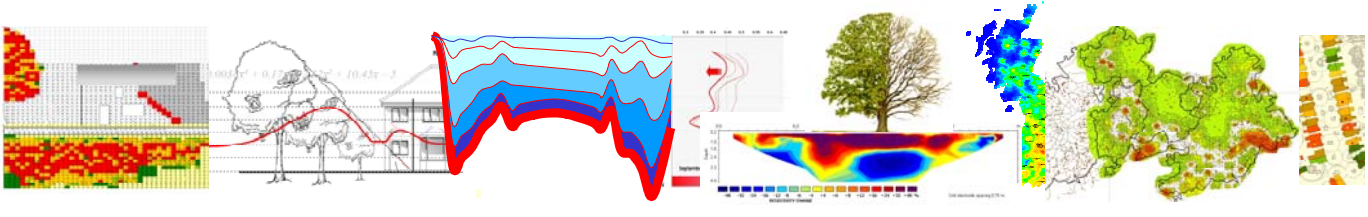
How does Welwyn compare with other nearby Boroughs in terms of subsidence risk? Plotting each postcode district reveals that it is placed near the top of the frequency table. More details inside.



SURGE

Surge effects some cities more than others, but by how much? Using our claim sample we can see that London is typically just over 4.1 times riskier than Liverpool, and 2.348 times riskier than Birmingham and Bristol, in terms of increase in claims in busy years.





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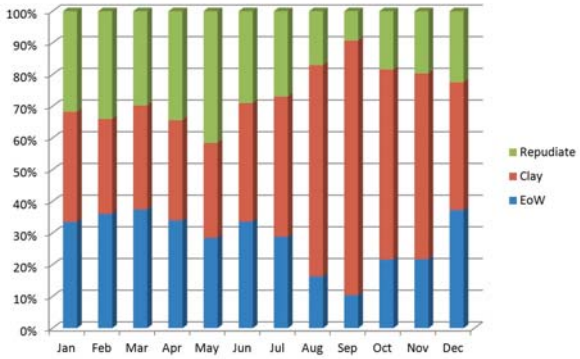
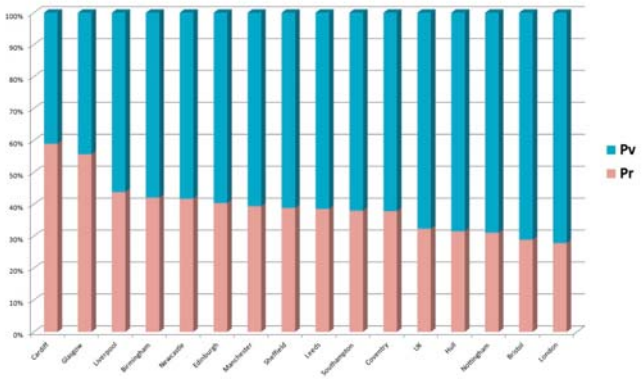
RISK - 1



A normalised by-month view of a 15,000 claim sample showing the percentage frequency of valid clay shrinkage and escape of water claims and repudiations. Repudiations (green) decrease in the summer months, as do escape of water claims when expressed as a percentage of the total. This will vary considerably by month and year.

In contrast, root induced clay shrinkage claims increase from July, tailing off in November.

RISK - 2



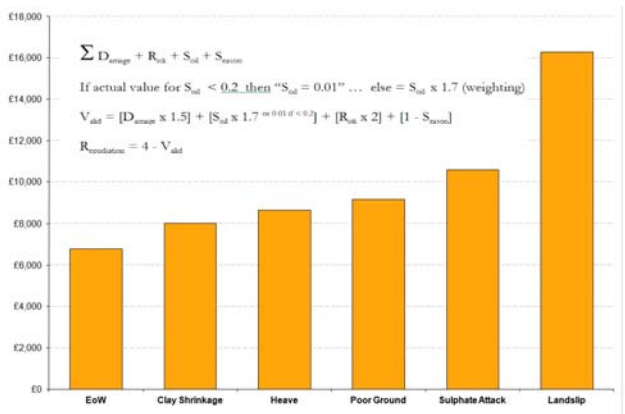
Above, and from the same sample as the graph, left, the probability of a claim being valid (blue) or repudiated (pink), by city.

Over the twelve month term, the probability varies by location and geology and the variation increases between years depending on climate. The data suggest that claims in London for example are far more likely to be valid than claims notified in Cardiff (extreme left of graph).

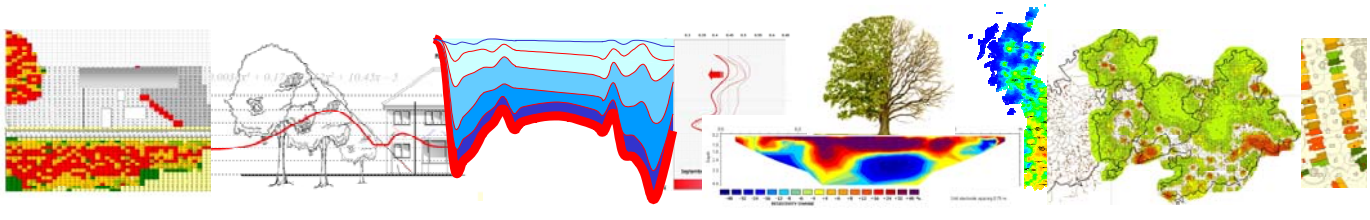
RISK – 3

Add the geology and claims experience to build some idea of frequency and severity, and plug in the weather using SMD to take account of the combined effect on the soil of sunshine, wind, rainfall etc.,

Soil type provides a good proxy for severity (cost), and right we have plotted data relating to average cost for a range of perils. Escape of water claims don't cost as much as clay shrinkage claims, but by how much? Geology is the determining factor in most instances, along with historic experience.



Combining all elements to build a risk model/triage application that takes account of historic claims and current weather (triage only), using geology as a proxy for cost along with house type, age of construction etc.



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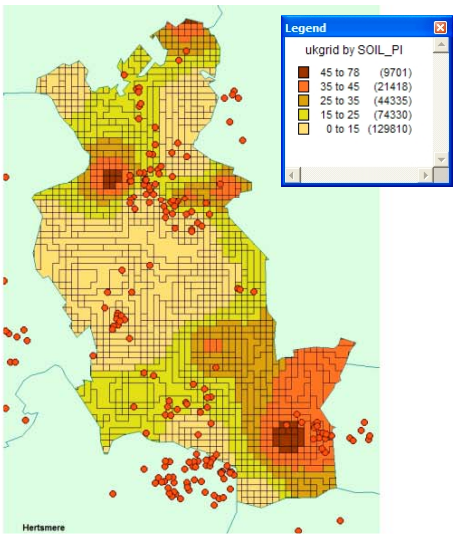
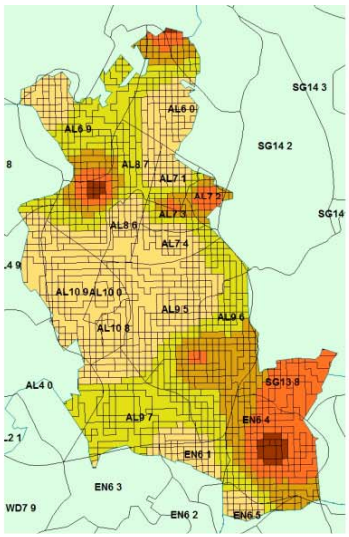
WELWYN GARDEN

The insurance eye view of the Borough, illustrating the claim distribution (both valid and repudiated), the CRG unique 250m geology grid and index properties, together with extracts from the British Geological Survey maps (large scale) for the area. There are pockets of highly shrinkable clay shown on the CRG map, with index properties of around 45 – 50% but the geology is, in the main of low shrinkability, suggesting a high proportion of escape of water claims.

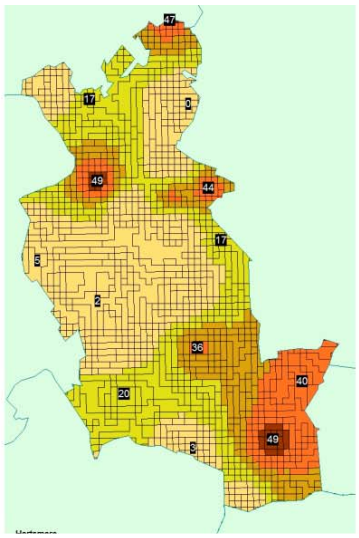
250 GRID AND CLAIMS

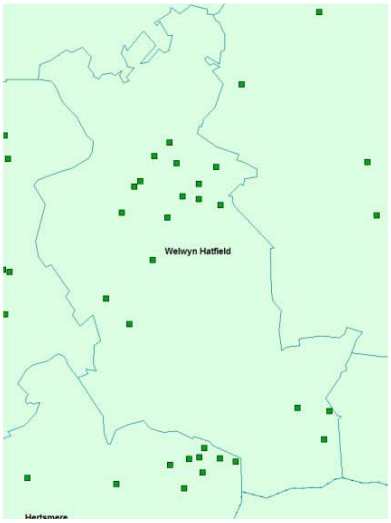


POSTCODE SECTORS

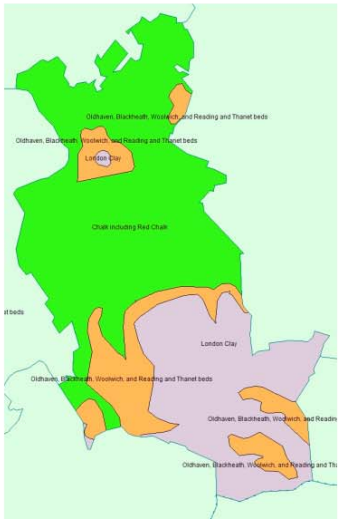


GEOLOGY & INDEX PROPERTIES

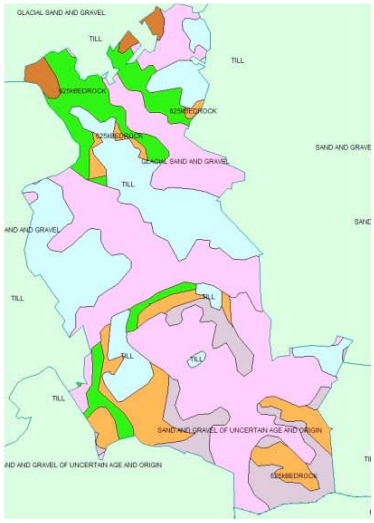




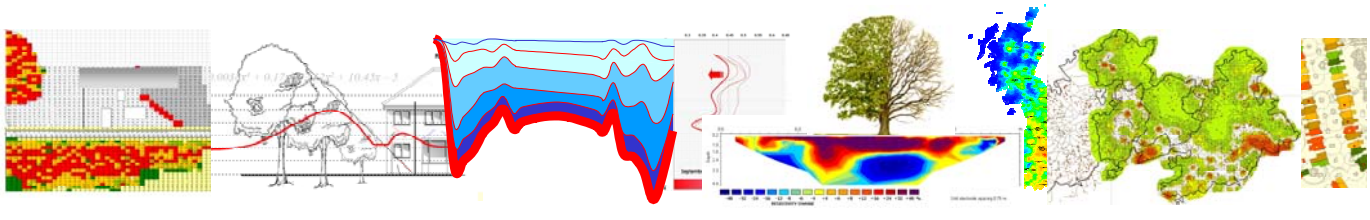
REPUDIATIONS



BGS SOLID GEOLOGY



BGS DRIFT GEOLOGY



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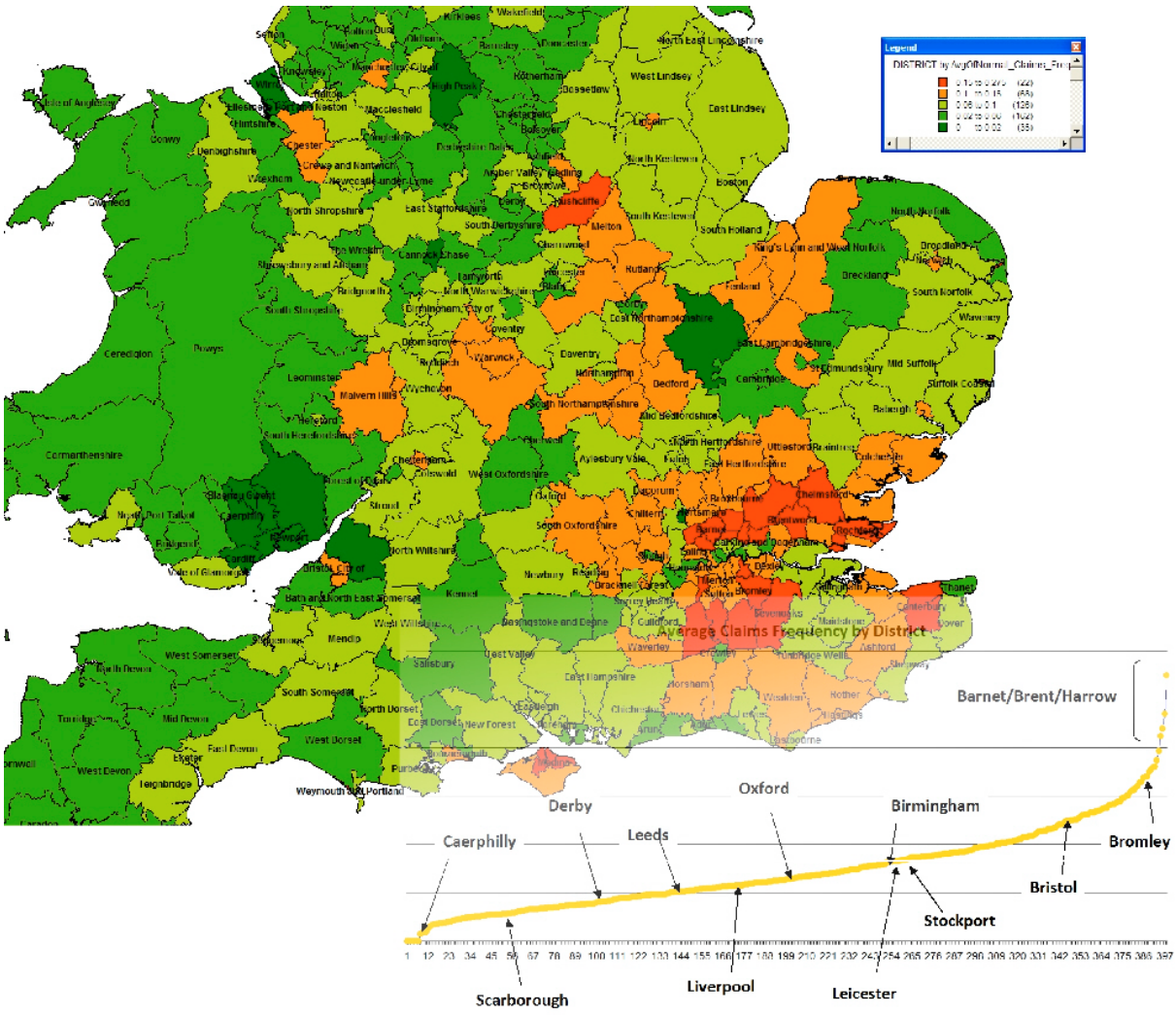
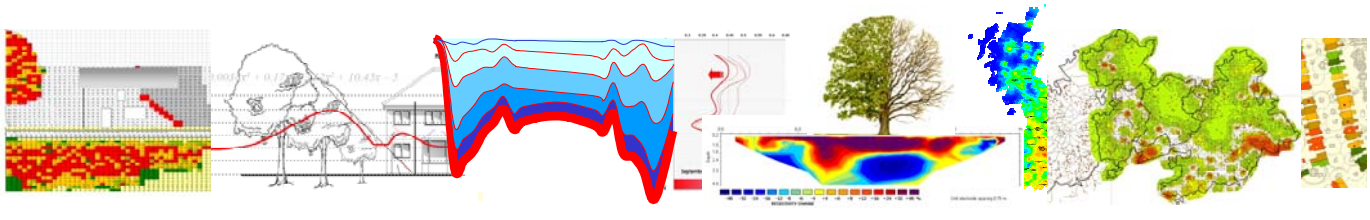
RISK by DISTRICT



The benefit of having the underlying data is the ability to map risk at different levels, and above we have plotted the risk by district, which allows comparisons (subject to comments on the following page) between various regions. For example how does Liverpool compare with say Powys, Birmingham, Merton or Scarborough?

The downside of recording frequency (claims divided by residential properties) is that one claim in a small village can distort its place in the league table of risk. The analysis prior to issue usually involves a visual sense-check to account for these outliers.



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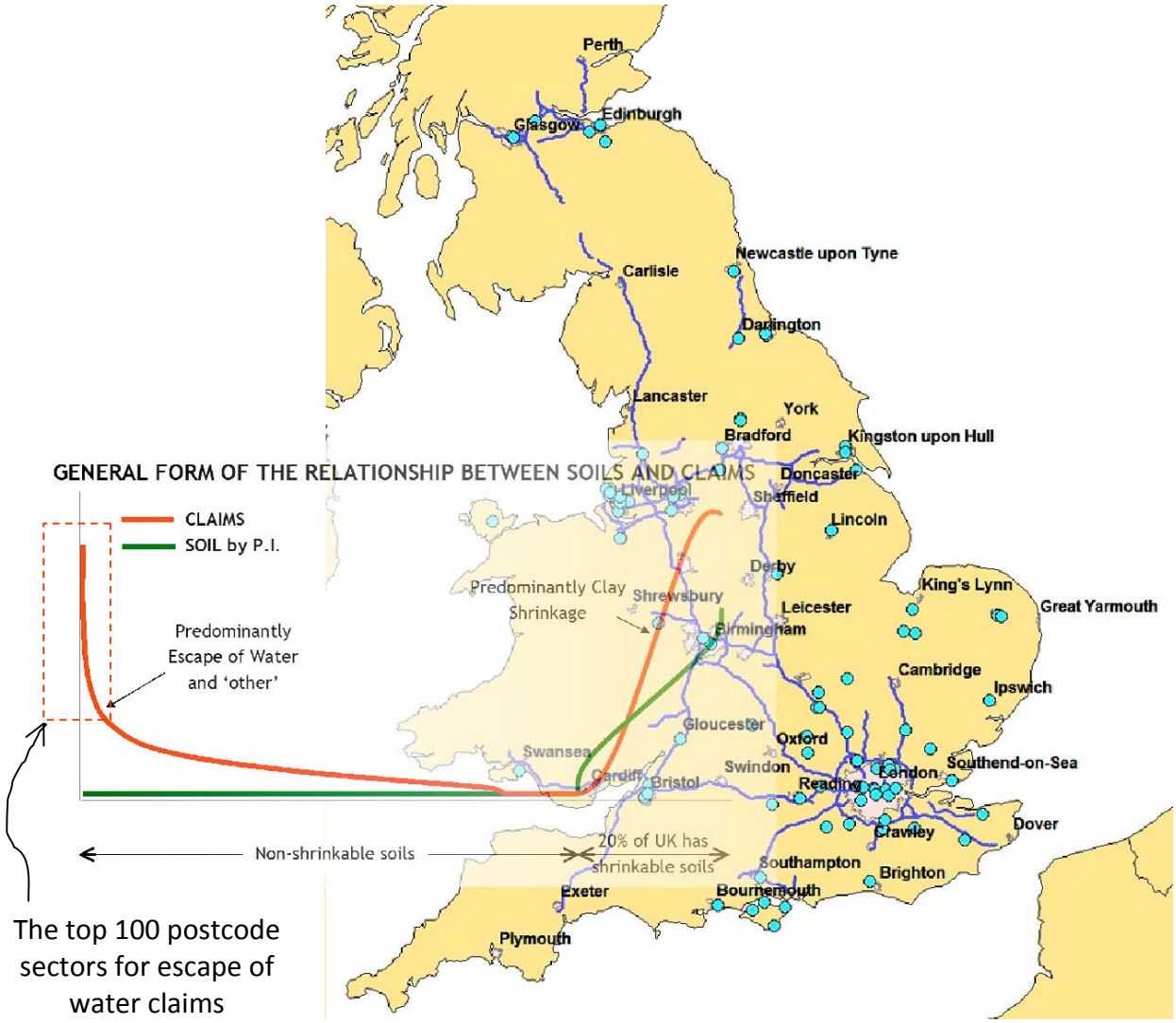
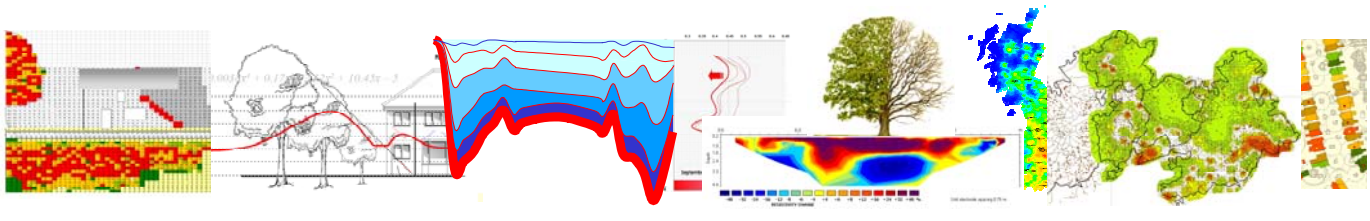
ESCAPE of WATER CLAIMS

The top 100 sectors in terms of risk from water escaping from drains or water services that cause subsidence due to softening or erosion of the underlying non-cohesive soil. The sectors are described by the risk graph (below, left) as a broken red line to the left of the 'x' axis, and indicated by high claims frequency. Top of the league are some sectors in Liverpool, Isle of Wight, Glasgow and Edinburgh. London has a high incidence and particularly on the alluvial soils bordering the Thames and adjoining the River Lea.



The top 100 postcode sectors for escape of water claims



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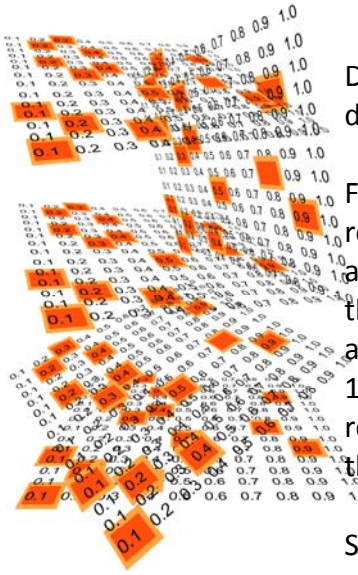
A NOTE ABOUT DATA



Data presents its own problems, and these include understanding what the data records in some instances.

For example, ABI claims data includes all claims notified, both valid and repudiated, and this is of little assistance when understanding risk when, on average, the number of valid claims in any year might be around 50 - 60% of those notified, fluctuating by month, so instead of 30,000 claims per annum, the more meaningful measure in terms of risk and cost, might be 15,000 claims. Then we have to take account of the fact that there are more repudiations (generally) in a benign year, and more valid claims in surge, so the measure will always be imprecise.

Similarly, there are a higher number of repudiations in the winter than the summer, so each quarter's data has to viewed in this light.

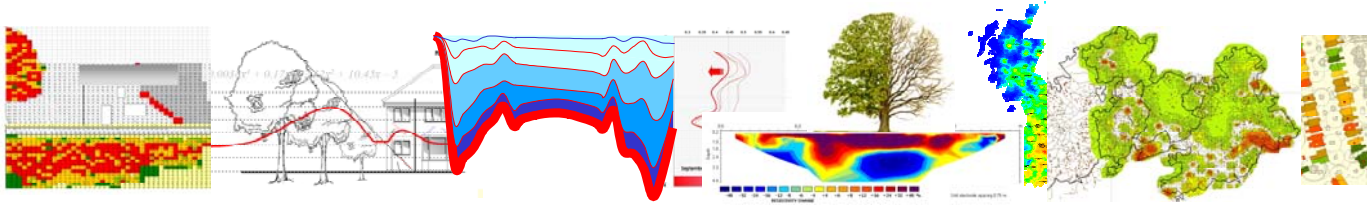
The ABI also list losses by quarter, but again this is of little assistance because once logged, it isn't updated to take account of deterioration or improvement. A precautionary reserve set by some companies at the time of notification (typically £5,000), will be an average of their claims experience across the UK in previous years.

Claim status will change as investigations are undertaken. Claims logged as being valid may be repudiated on investigation, or vice versa.

Other issues relating to the claim sample (rather than the ABI data) may include the possibility of a biased portfolio – insurers with broker interests perhaps and regional distribution channels. Gathering data from multiple sources (arborists, adjusters, insurers, site investigation and monitoring companies) can lead to duplicate or triplicate counts of the same information if care isn't taken.

Not to mention the technical competence of the initial diagnosis, and simple things like matching postcodes.

All of that said, in our favour is the fact we have a relatively large sample with sufficient numbers to reduce errors and we do take care to ensure the data is as clean as possible.



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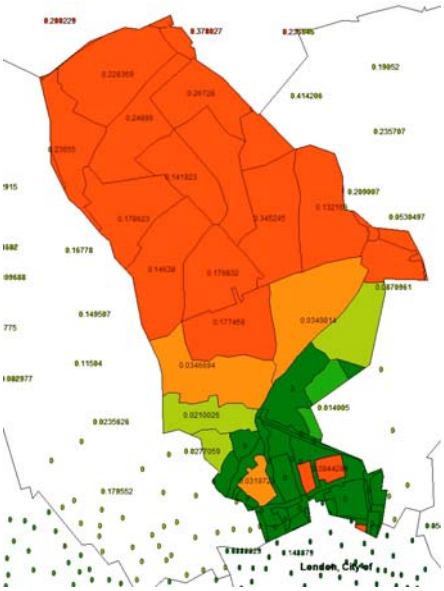
ISLINGTON & DATA – an example



SECTOR DATA

Red shaded sectors reveal high claims frequency.

DISTRICT DATA

Plotting the same data but with a different outcome.

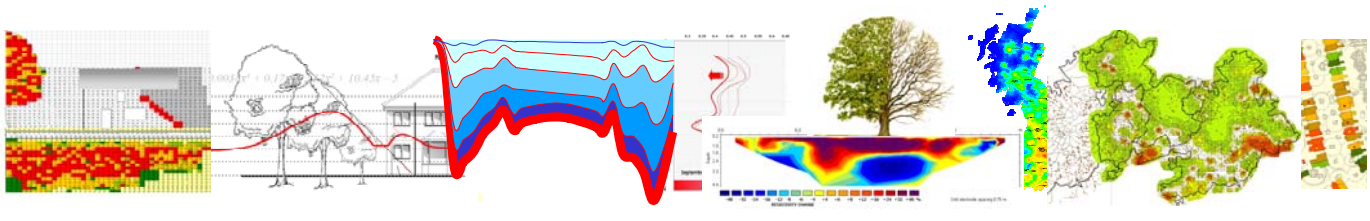
A Risk-by-District analysis illustrates the problems surrounding data modelling, and why it sometimes delivers apparently conflicting information even when using the same underlying information. The Postcode Sector map for Islington is above, left, and the District map, right.

To build a rating, the District map has been superimposed onto the Sector map, and an SQL query delivers the average of the sectors at District level. Islington is a busy (in terms of claims) Borough and yet it was placed much lower in the League Table of Risk than anticipated. Using averages, the Borough was placed below Peterborough or Poole, which doesn't reflect its true status.

Sector data puts it in the high risk category as can be seen from the red shading, so why the apparent anomaly?

The same data is shown on both maps, and although the sectors to the north are high risk, those to the southern part of the Borough with very low claims experience reduce the average considerably.

The exercise illustrates the problems in handling and reading data, and how the finer the resolution, the higher the value of the output.



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DROUGHT RESPONSE GENES

The Plant Journal, November 2009

Professor Campbell of Toronto University headed up a team that found trees used different drought response gene programs at different times of day.

That is, the drought response gene program that the trees used in the middle of the day was different from the program used in the middle of the night.

Previous research may have overemphasised the importance of some genes in helping trees to contend with drought, and totally missed others that are important.

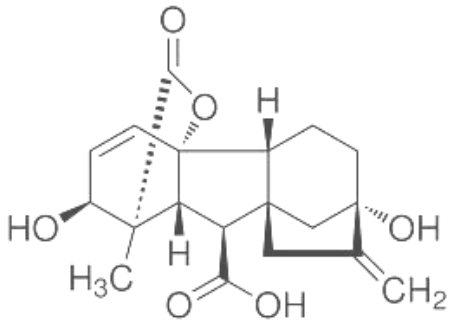
GIBBERELLINS

The Plant Cell, March 2010

Busov and colleagues at Michigan Tech, the University of Georgia, Oregon State University and the Beijing Forestry University in China analysed thousands of genes in the *Populus* genome, the only tree genome that has been completely sequenced.

They were searching for the mechanism that regulates the plant's decision to grow tall or to spread its roots out in an extensive underground exploration system that can sample the soil near and far until it finds what the rest of the plant needs.

They found that the more GAs, the more a plant's stem flourished, but its roots remained spindly.



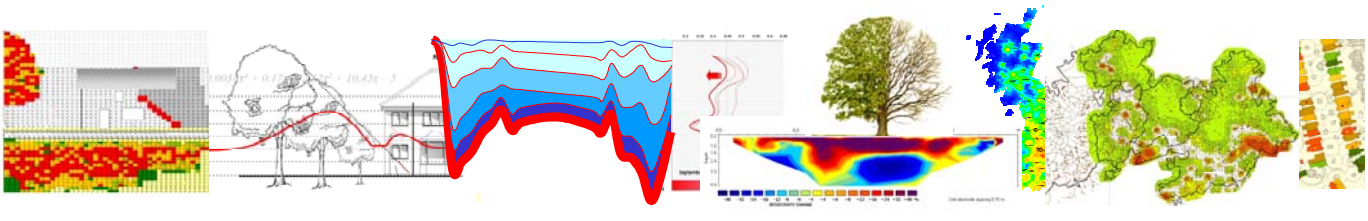
When GA production was shut down, either by using mutants that lacked the necessary genes or by silencing the genes that form the molecular on-off switch, the resulting plants looked dwarfed, but their lateral roots grew luxuriant and full.

ABA RECEPTORS

Proceedings of the National Academy of Sciences, Dec 2011

Professor Sean Cutler of the University of California is looking at Arabidopsis to develop an understanding of drought resistance based on improving the receptors of the ABA hormone. He explains that each stress hormone receptor is equipped with a lid that operates like a gate. For the receptor to be in the 'on' state, the lid must be closed. Using receptor genes engineered in the laboratory, the group created and tested more than 740 variants of the stress hormone receptor, hunting for the rare variants that caused the lid to be closed for longer periods of time.

"We found many of these mutations," Cutler said. "But each one on its own gave us only partly what we were looking for. But when we carefully stacked the right ones together, we got the desired effect: the receptor locked in its 'on' state, which, in turn, was able to activate the stress response pathway in plants.



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RootChip

The Plant Cell, December 2011

Extract from Science Daily

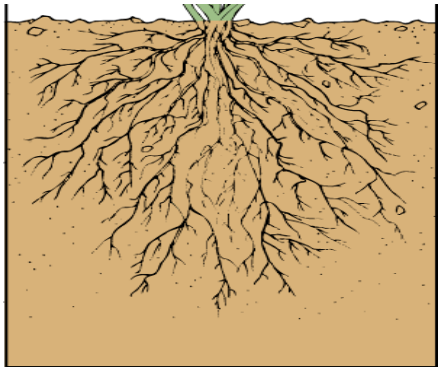
Understanding roots is crucial to the study of plant physiology because they serve as the interface between a plant and the soil and are solely responsible for taking up water and essential mineral nutrients.

Roots must respond quickly to various environmental conditions such as water availability (for example, when being soaked by rain after a period of drought).

They must find and exploit nutrients; they must respond to salinisation and acidification of the soil; and they must integrate diverse signals such as light and gravity. All of these aspects are very difficult to analyse because of a roots inaccessibility in the soil.

The research team is composed of a group of plant scientists, including the paper's lead author, Guido Grossmann, along with his Carnegie colleagues (Woei-Jiun Guo, David Ehrhardt and Wolf Frommer) and a group of chemical engineers from Stanford University and the Howard Hughes Medical Institute, (Rene Sit, Stephen Quake and Matthias Meier). Their efforts could revolutionise the entire field of root studies.

The new technology, called the RootChip, allowed the research team to study roots of eight individual seedlings at the same time, and to alter their growth environment simultaneously or independently and with extraordinary precision.



Optical sensors, developed and inserted into the root tissue by Frommer's team, allowed the researchers to examine how the roots responded to changes in nutrient supply levels in real time.

"This new tool provides a major advance for studying root biology at the cellular and subcellular level," said Wolf Frommer, director of Carnegie's plant biology department. "The growth conditions can be freely varied over several days, allowing us to monitor actual growth and development of roots and root hairs and using our optical biosensors to study nutrient acquisition and carbon sequestration in real time."

The RootChip was capable of monitoring a root's response to changing levels of the sugar glucose in the surrounding environment. Root growth slowed down when the leaves were not exposed to light, as predicted, because the leaf's photosynthesis is required to supply the energy for root growth. The RootChip also revealed the long-suspected fact that galactose, a sugar highly similar to glucose, is toxic to roots and inhibits their growth and function