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

February 2015
Edition 117

The Clay Research Group

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Issue 117, February, 2015

The Role of the BRE

Guidance from the Building Research Establishment in the form of Digests improved our understanding of subsidence and changed the way that claims are handled.

In this and future editions we will be taking a look at some of their work and discussing their contribution. In this edition and by way of introduction we look at BRE Digest 352, issued in 1990 at a time of claims surge.

Next month Richard Driscoll recalls his introduction to the BRE and provides some interesting background.

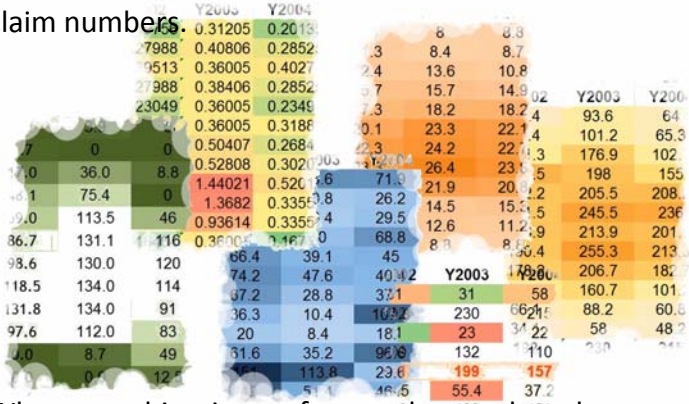
UKCRIC

The CRG are supporting Birmingham University's application to EPSRC for funding to build a large-scale test facility as part of their UK Collaboration for Research in Infrastructure and Cities (UKCRIC). The project has the potential to deliver significant benefits to UK insurers across a range of perils, subsidence in particular.

Tom Clinton is gathering data from the site of the Aldenham willow and hopefully the results will be delivered later in the year.

Weather Study

This month we look at the correlation between the various weather elements (hours of sunshine, temperature and rainfall) and compare them with claim numbers.

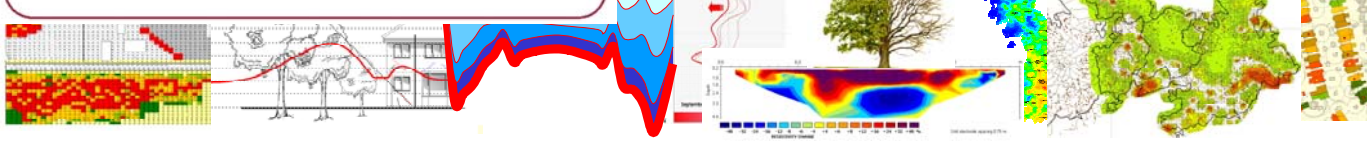


What combination of months and values are associated with higher than average claim numbers?

Essential Reads – Roots and Shoots

Neil Hipps has published his work on crown manipulation undertaken at East Malling. See page 10. A study of tree root growth illustrating the determining role of soil type and water availability over species appears on page 7.

THE CLAY RESEARCH GROUP
www.theclayresearchgroup.org
clayresearchgroup@gmail.com



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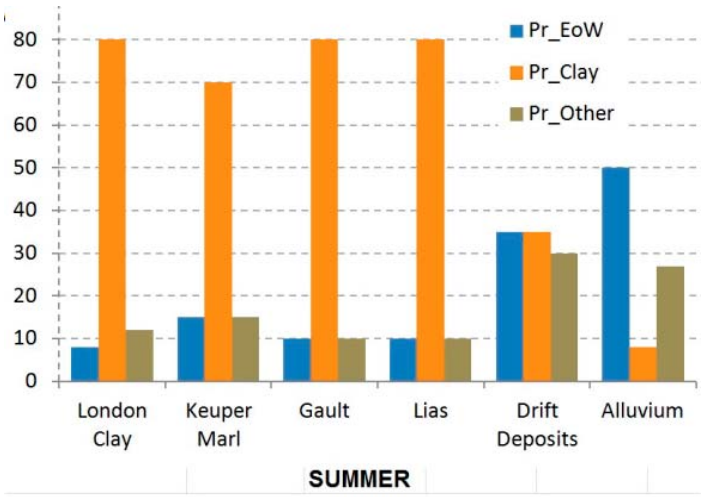
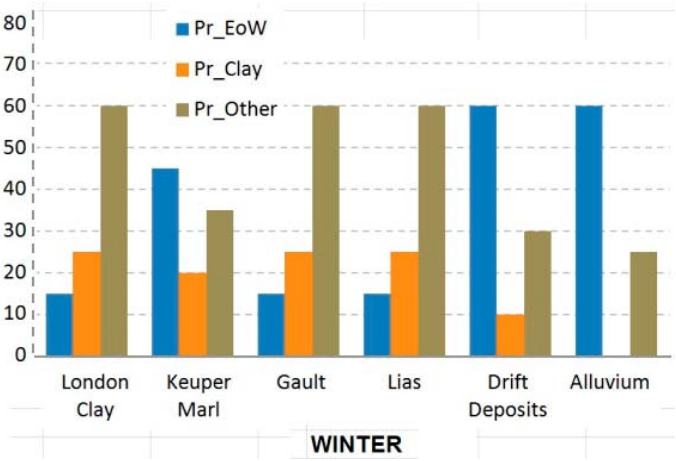
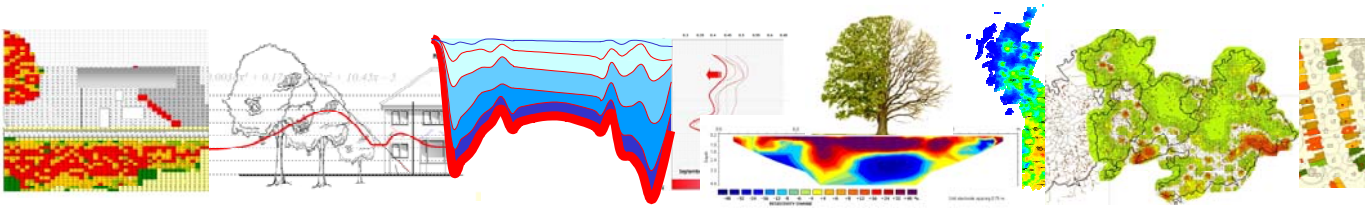
Probability of Validity and Causation

If a claim is valid, the probability of causation is largely dictated by the geology. In areas of North London for example, if the claim is notified in the summer months then there is something like an 80% probability that the cause will be clay shrinkage. This reduces to 25% in the winter. The category 'other' relates to repudiations.





Charts showing the 'probability by cause of subsidence' for winter and summer months, by geology. The data will be skewed due to soil variability. Although the data for the more homogenous clay series is clear, data relating to the drift series will inevitably be less accurate. The values will also vary with the weather.



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Revisiting BRE Digest 352

It's worth re-visiting what would typically happen before the publication of BRE Digest 352. The appearance of even small cracks was regarded as a serious matter. In many cases it would result in full or partial underpinning. After all, if the building moved again, the engineer could be liable – not the insurer – and the risk was regarded as unnecessary.

The Digest reports that in any year "as many as 14,000 families will experience the anxiety and disruption of the underpinning process". Something our own research at the time confirmed. Our estimate was that nearly half of all valid claims ended up being underpinned.

The Digest was published in June 1990 and would have been using figures from earlier years. In 1989 there were 30,000 subsidence claims notified according to the ABI and we were simply underpinning too many houses for what was, in many instances, fairly minor damage.

The Digest posed the question "why has this growth in underpinning occurred? What indeed is underpinning and why is it carried out at such expense?"

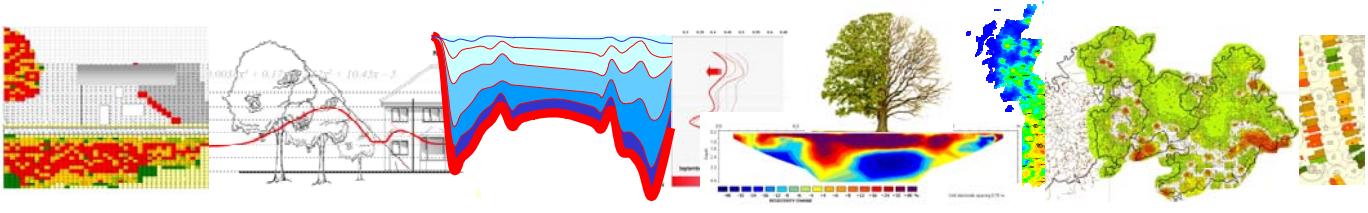
The Building Research Establishment set about trying to answer these questions and published "Foundation movement and remedial underpinning in low-rise buildings". The advice was the cornerstone to how we handle subsidence today.

They arrived at the conclusion that "the degree of movement and consequent cracking that causes concern to homeowners is rarely of structural significance".

Over time, and sometimes with the support of insurers who effectively agreed to underwrite the engineer's decision to cover those cases that did return, underpinning became something of a rarity. Many contractors and some engineers forecast lots of claims would re-open, but that didn't happen.

Instead, efforts were directed to removing the cause of damage. Dealing with the tree, repairing the leaking drain became the new norm. The work of the BRE changed the way we dealt with claims for the better.

Next month we have an article from Richard entitled "My Introduction to Subsidence".



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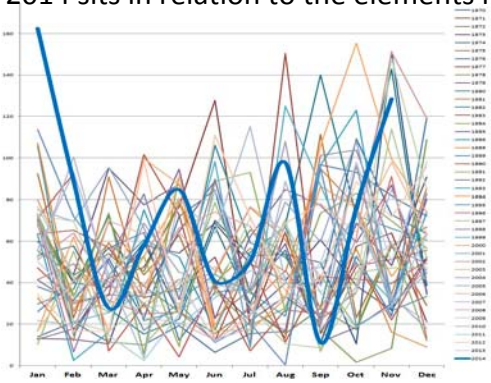
2014 Weather – Warmer and Wetter

The various climate authorities (NOAA, NASA, the UK Met Office, WMO and Japan Meteorological Association) report that 2014 was the warmest both globally and for the UK, which poses the question why it wasn't accompanied by higher claim numbers? The most likely answer is an increase in rainfall. The Met Office advises that 2014 was the fourth wettest since records began in 2010. Yes it is warmer, but it is also wetter.

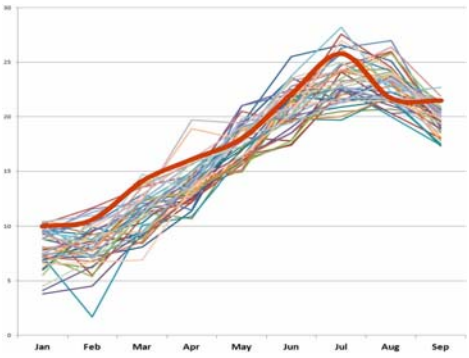
Since the 2006 event, it has been generally wetter but more important than the total is perhaps the fact that the rainfall is breaking up the long summer months and providing much needed water to rehydrate the soil.

Below, Met Office data from the Heathrow weather station are plotted to see where 2014 sits in relation to the elements noted.



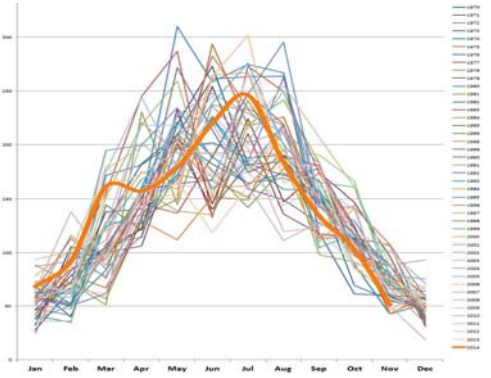
ANNUAL RAINFALL

Rainfall 1970 onwards with 2014 superimposed in blue. Met Office report that 2014 was the fourth wettest since records began in 1910. The intermittent nature of the rainfall helps to mitigate against soil drying in warm years.



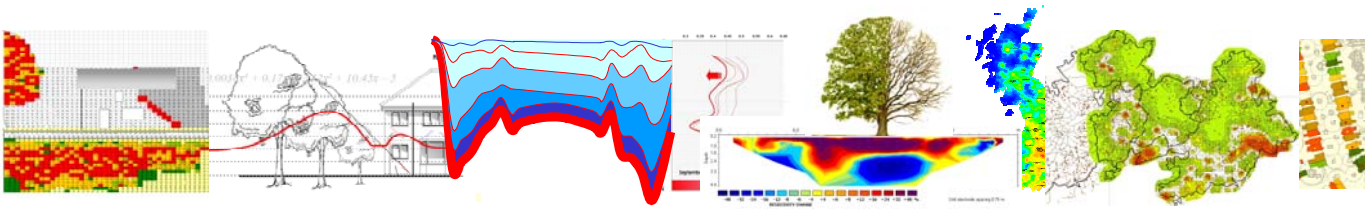
Maximum Temperature

Max temperature for 1970 onwards with 2014 superimposed in red. As can be seen on the following pages, temperature alone isn't always the driver behind claim numbers.



Hours of Sunshine

Hours of Sunshine 1970 onwards with 2014 superimposed in orange. Hours of sunshine are an important factor in delivering claim numbers – possibly more significant than temperature.



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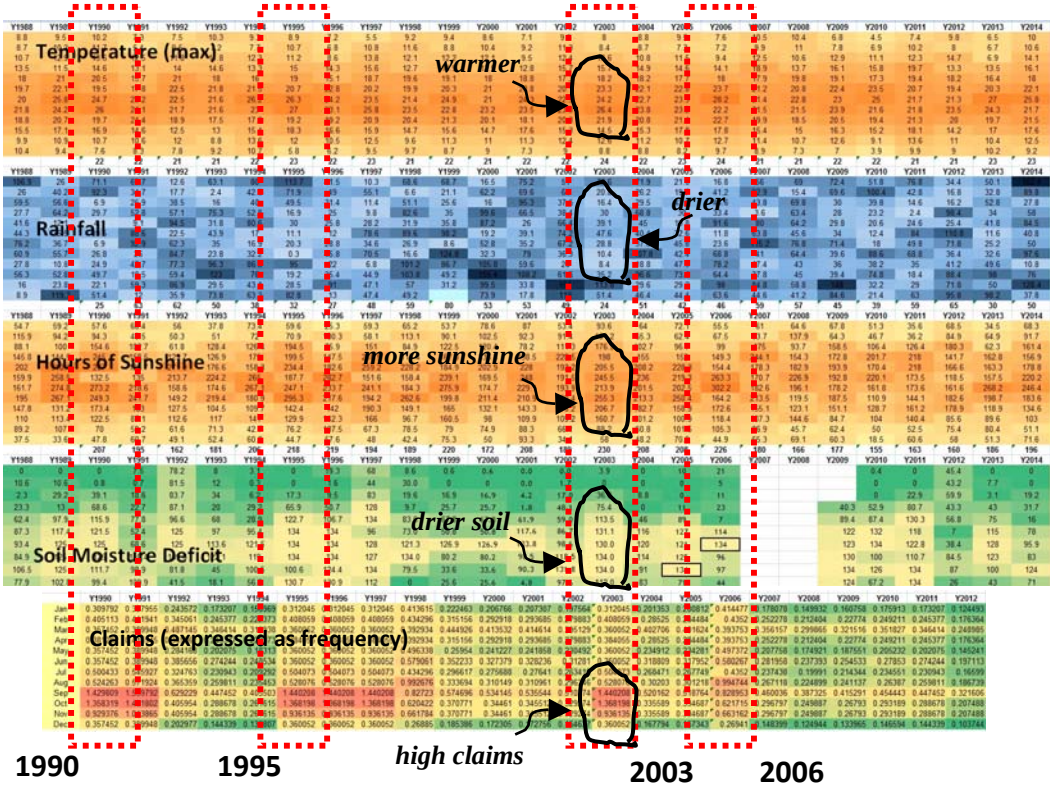
Root Induced Clay Shrinkage Claims - Analysis of Risk Elements using Correlation Techniques

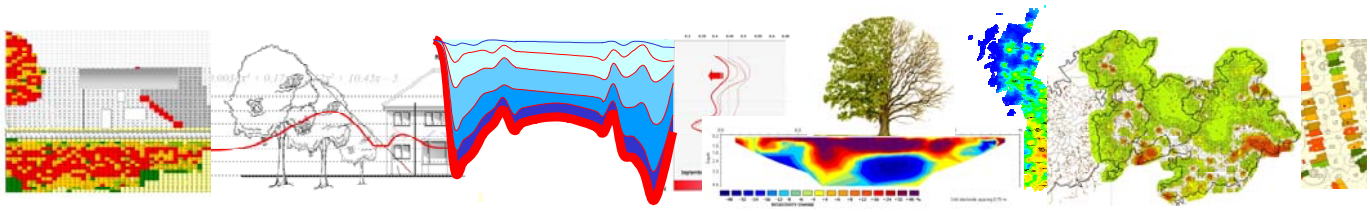
Below, charts showing temperature, rainfall, hours of sunshine and soil moisture deficit by month for the Heathrow weather station (SMD values from tile 161, NW London), as supplied by the Met Office.



Previous editions have made linear comparisons between the elements over individual years. This project sought to determine if there were more general patterns that would improve our understanding of claims when the elements were combined.

Colour graduation has been applied to illustrate the known risk factors. Warmer months and longer hours of sunshine have a darker shade. Tiles with less rainfall are lighter than those with more. The drier the soil, the lighter the tile. The higher the number of claims notified the redder the tile. Low claim numbers are green and yellow is intermediate.

A number of permutations have been used, combining differing elements and months to establish which have the most influence on claim numbers.



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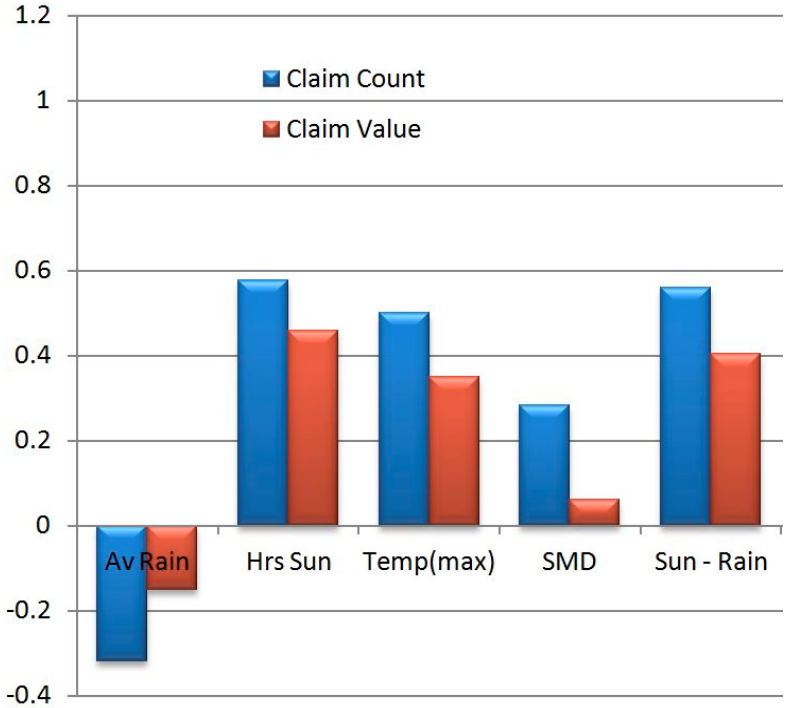
What are the weather conditions that deliver high subsidence claim numbers? Is it the temperature? Or does the absence of rainfall determine risk? We looked at different combinations for a range of summer months, comparing values for June and July, May to August, June to September and May to September (inclusive). As trees were the main driver, the study was restricted to combinations between May and October.

The correlation between claims and rainfall was the weakest at 0.33, followed by temperature with a score of 0.368. The correlation of claims with 'hours of sunshine – rainfall' for this period (May to August) was higher at 0.53.

The period May to August gave a correlation between hours of sunshine alone and claims of 0.558.

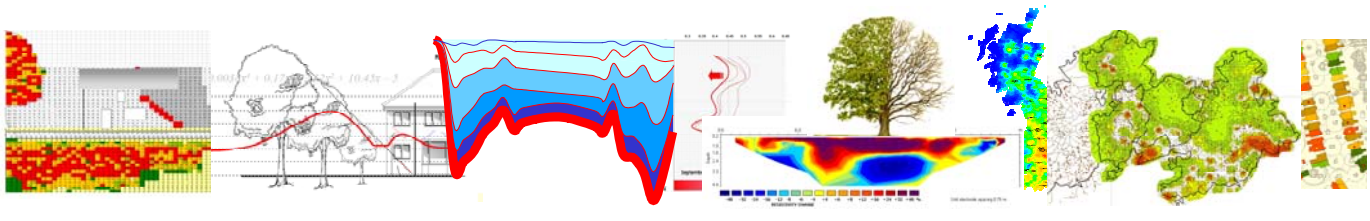
The highest score was the period May to September. The correlation with hours of sunshine of 0.64 may be regarded as quite good given the fact that we are dealing with the vagaries of weather, soil and vegetation. The value for 'hours of sunshine – rainfall' was 0.617.

Unfortunately the exercise did not have access to weather data that is likely to have a significant contribution to modelling – wind and relative humidity. The chart below plots the correlation between claims in terms of both count and value.



Hours of sunshine and 'sunshine – rainfall' are ahead of temperature, with the Soil Moisture Deficit having the lowest correlation.

That said, the SMD has been a fairly reliable predictive measure and scores around 85% when predicting claim numbers for September as early as the end of May, beginning of June.



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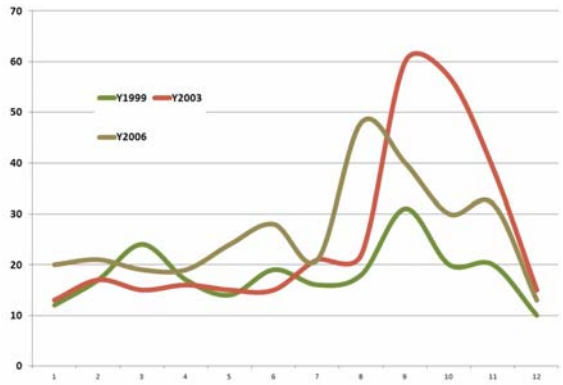


Monthly claim data uses ABI annual figures redistributed according to the profiles shown (left) for a range of scenarios.

For a surge year we have used the 2003 profile, 2006 for an intermediate year and 1999 for a normal claim year.

So, why the relatively low correlation between claims and weather? Although the weather is an important driver, the real trigger is the tree. It is a little like discovering that root induced clay shrinkage claims have a link with the geology. Yes, of course that is the case, but that doesn't mean that all trees cause damage on clay soils, and similarly, the missing link in our exercise is the fact we haven't taken account of the tree.

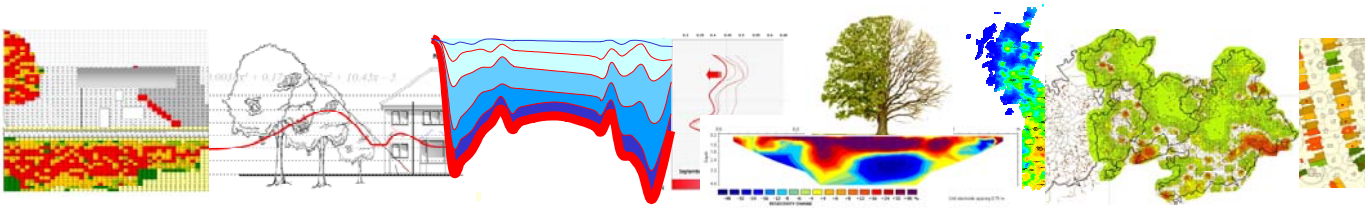
We can see from the analysis that the warning bells with regard to the weather are (a) a temperature of 23degC., in excess of 220 hours of sunshine per year and low (often in the mid-twenties) rainfall for the combined months, but the final determinant lies with the tree and its immediate environment.

"Plasticity of tree root system structure in contrasting soil materials and environmental conditions".

Caroline Zanetti *et al.,* Plant and Soil Journal. February 2015, Volume 387

This paper looks at the root structure of several trees and concludes that their environment – the structure of the soil in which they grow – rather than tree species, determines their distribution and growth patterns. The authors conclude "Root system structure was mainly influenced by soil material and water availability and far less by tree species."

"Heart root systems were limited to fine material while mixed and tap root systems were found on coarse material. In coarse materials, trees developed few but rather large roots. In fine materials, root systems had three times more roots but they were 40% smaller and shorter. Roots were 20% more numerous and 65 % larger on the downslope side due to water availability at dike or riverbank toe."



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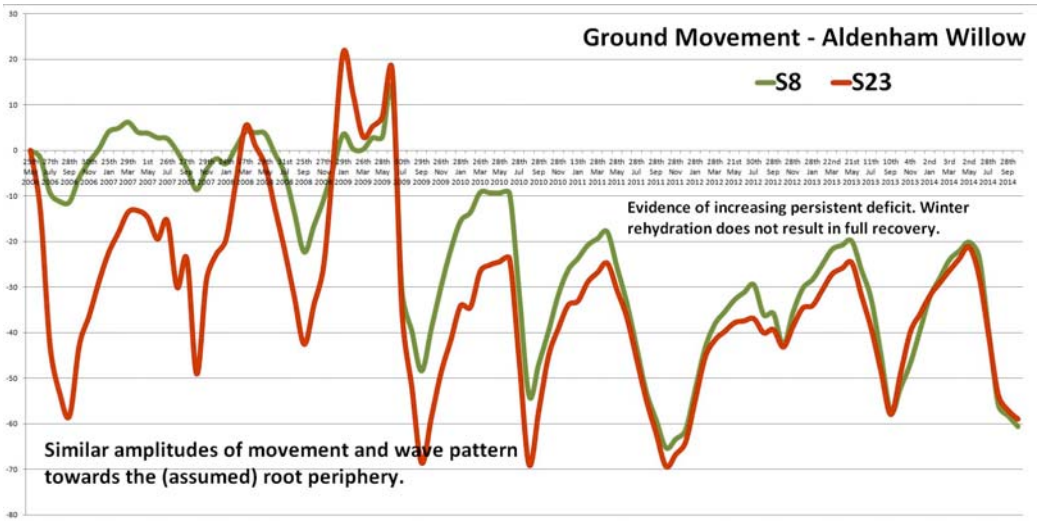
Ground movement comparing heave following unloading with seasonal root induced clay shrinkage.

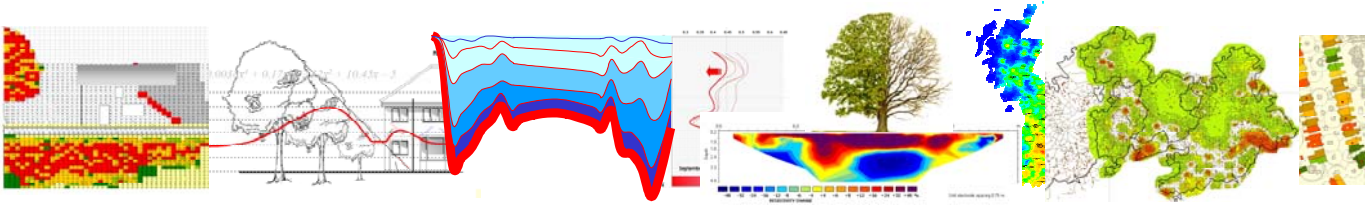
The University of Arizona reports that the "Earth's crust under Iceland is rebounding as global warming melts the island's great ice caps. In south-central Iceland some sites are moving upward as much as 1.4 inches (35 mm) per year. A new paper is the first to show the current fast uplift of the Icelandic crust is a result of accelerated melting of the island's glaciers and coincides with the onset of warming that began about 30 years ago."

Re-visiting levels at Aldenham in the vicinity of the willow, movement of 35mm in any year is unremarkable. Not that the two scenarios have any direct link but it did lead us to consider how much movement does take place over time. For example, at Station 23 there was something like 0.75mm a day between the end of May and the end of September.



A little less at Station 8, which led us to consider the variation around the circumference of the tree at varying radii. Over the page is plotted the movement at Station 3 and 19. Each are situated on a different array, and although they are not too far apart spatially the amplitudes are similar.

Obviously this will change with variations in the geology as we saw at the Aldenham oak site where sand strata reduced the movement. It would also be subject to water availability and tree physiology but in a fairly homogenous environment the movement appears to be similar both close to the tree and further away.



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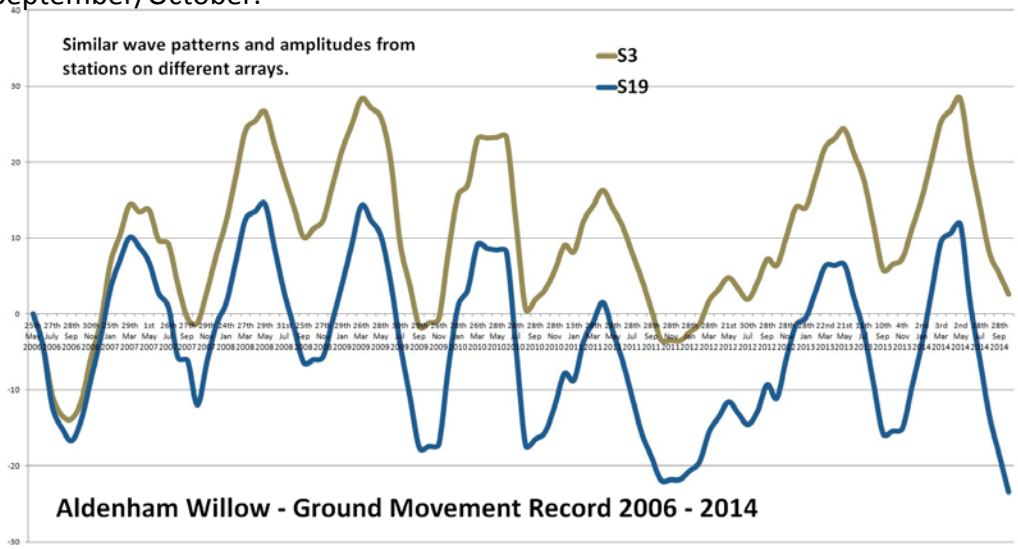
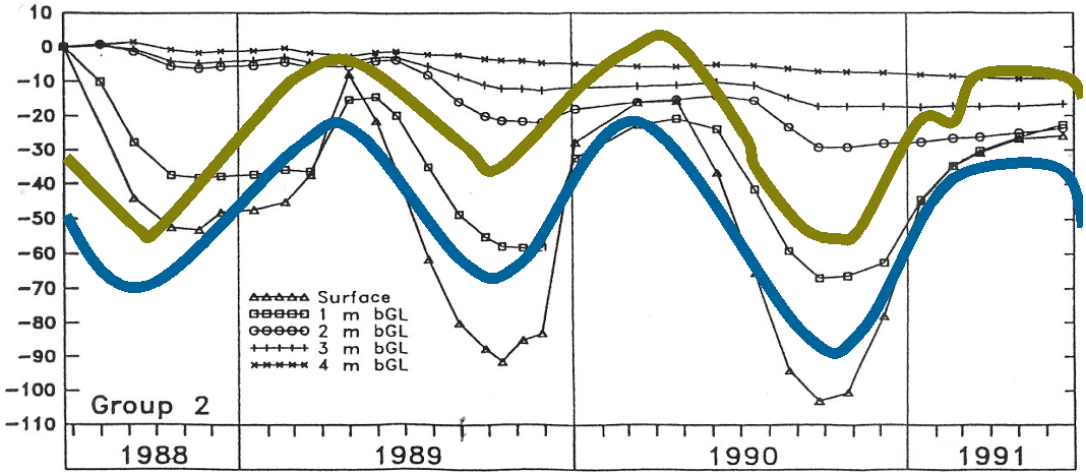
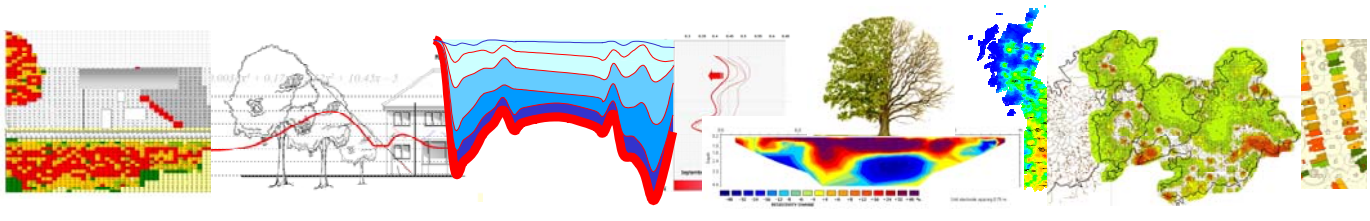
In total over the monitoring term we estimate there has been around 800 – 850mm of travel over an area of some 1,500sq metres including both subsidence and swell cycles. Quite a remarkable feat by the willow and requiring a lot of energy.

Bottom, data from Aldenham (years 2008, 2009 and 2010) superimposed onto the BRE levels taken from their test site at Chattenden where ground movement near to poplar trees was measured (1988 – 1990). Although the years and tree species differ the waveforms are similar. Movement peaks in September/October.







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Canopy Manipulation

Neil Hipps *et al* (2014) "Effect of two contrasting canopy manipulations on growth and water use on London plane *(Platinus x acerifolia)* trees." Plant and Soil.

Neil Hipps and colleagues describe the results of their research into canopy manipulation at the East Malling site.

The paper compares moisture uptake for 24 / 20m tall poplar trees over a four year term (April 1999 to June 2004) following different treatments. 8 trees were crown reduced, 8 crown thinned and the remaining 8 were used as a control.

Moisture uptake was measured using a variety of techniques.

The paper is essential reading and compares the effect of the two treatments. Below is an extract explaining their findings.

"Seventy per cent canopy volume reduction showed greater soil moisture conservation at 6 m from the tree and this suggests that the tree roots in this experiment spread at least this far and were within the distance range that caused a high frequency of damage to buildings on swelling clay soils according to Cutler and Richardson (1997)."

To summarise, the team found that severe crown reduction delivered better results than crown thinning in terms of reducing water uptake but the crown reduction required to deliver this benefit had to be severe and carried out on a regular basis.

emr east malling research

The research was undertaken at East Malling and supported by (amongst others) Cambridge University (statistics), Delta T Devices (TDR moisture sensor), Arboricultural Association, BRE, Association of British Insurers and Giles Biddle

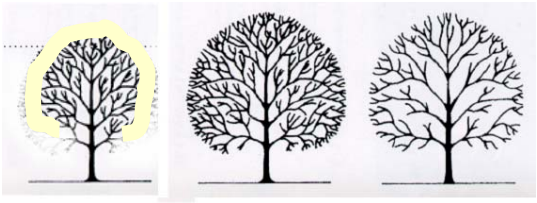
Summary of Findings:

1. Reduction of up to 50% of crown volume is not consistently effective for decreasing soil drying.

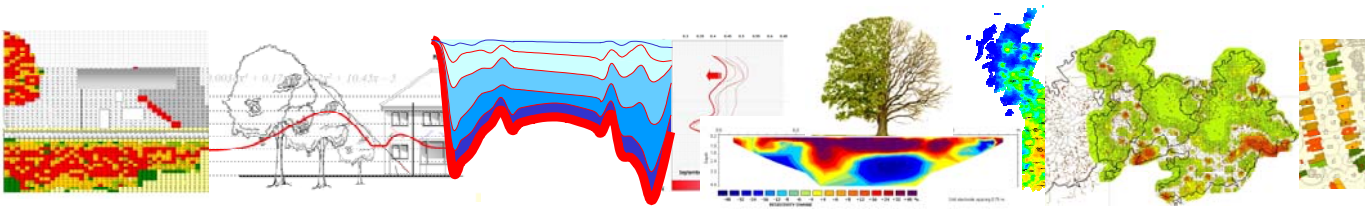
2. For practical soil moisture conservation, severe crown-reduction 70 - 90% of crown volume would need to be applied.

3. Crown reductions should be repeated on a regular managed cycle with an interval based on monitoring re-growth.

4. Crown-thinning is not an effective method to control soil drying by trees.



Diagrammatic illustration of crown reduction (left) and thinning (right).



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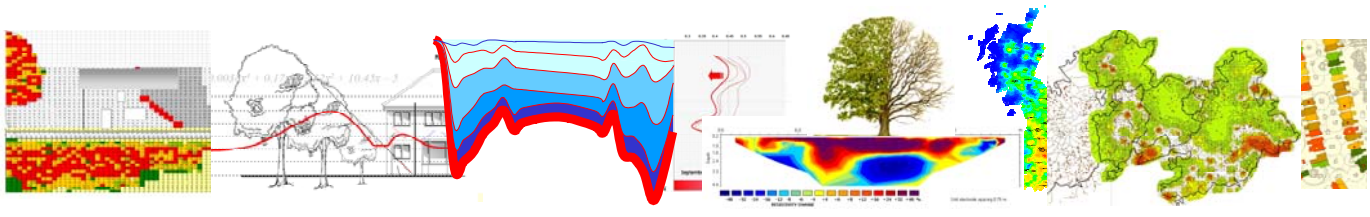
Google Maps – 3D Imagery

Google maps have added a 3D viewer that appears on the screen where the data is available – mainly cities at the moment. Select the satellite viewing option from the bottom left hand corner of the screen to switch between maps and aerial imagery. Rotate image to display in 3D using the icon, right. The option is only available when the icon is present.



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Risk Distribution by Region

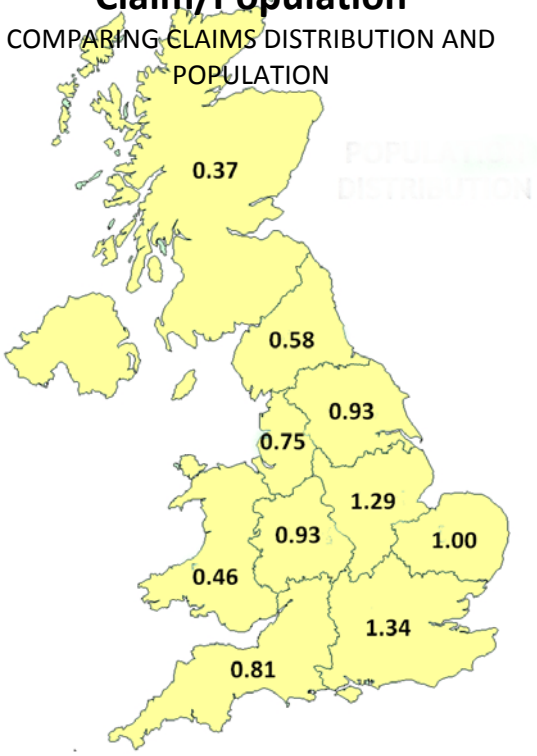
Below, maps showing claim and population distribution.

The south east is the predominant risk. Claims account for 43% of the UK total compared with a population percentage of 32%. Scotland is the least risky with only 3.5% of the UK claims compared with a population of 9.4% of the UK.

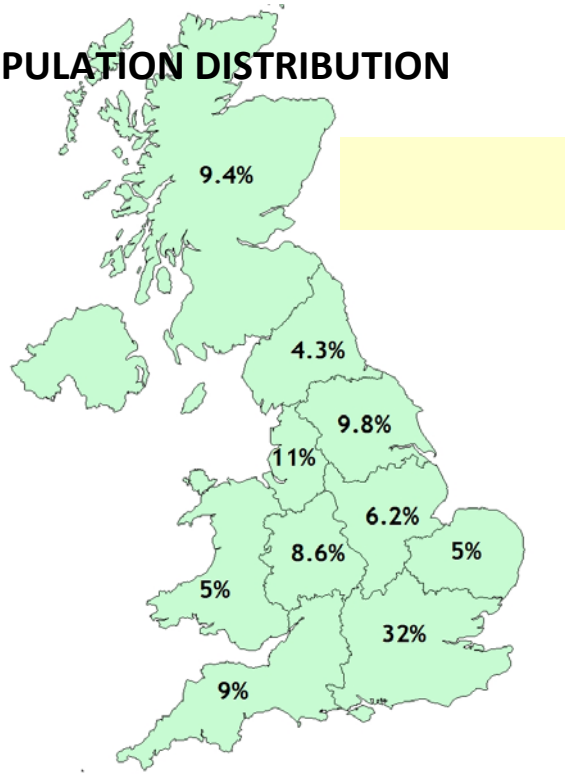
The 'Claim/Population' map, right, uses the values from the maps below. On the following pages are further maps showing regional risk on a normalised scale, and at district level.

'Claim/Population'

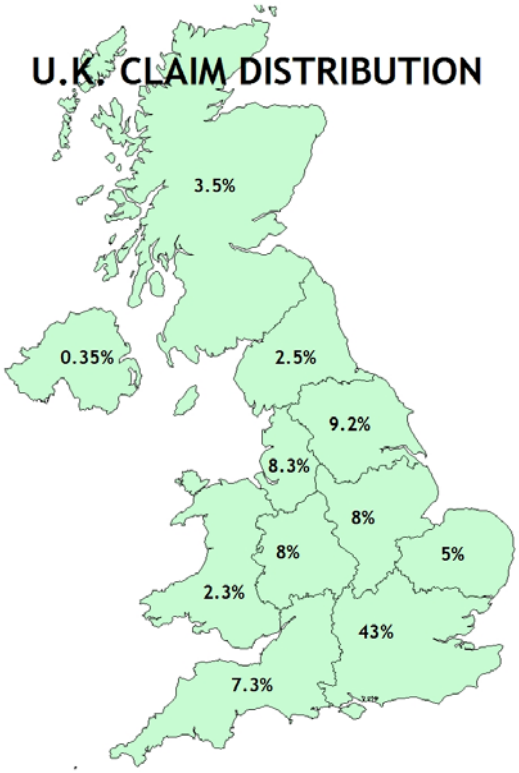
COMPARING CLAIMS DISTRIBUTION AND POPULATION

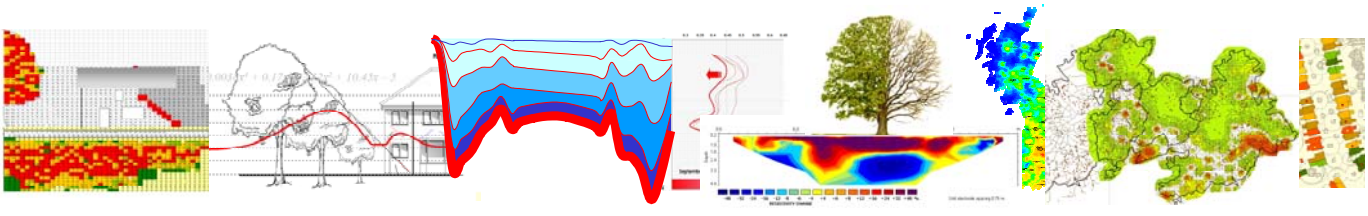


POPULATION DISTRIBUTION



U.K. CLAIM DISTRIBUTION





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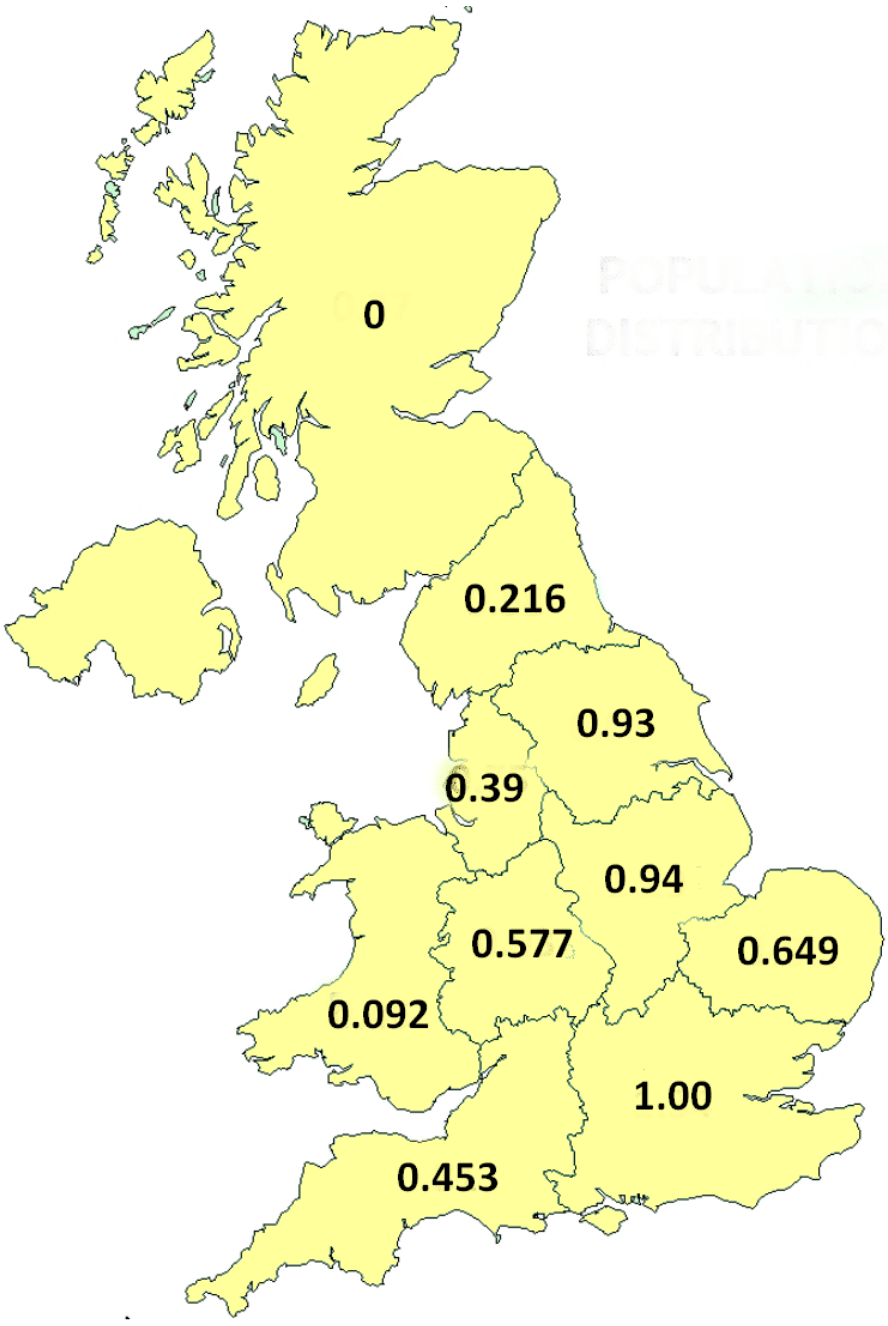
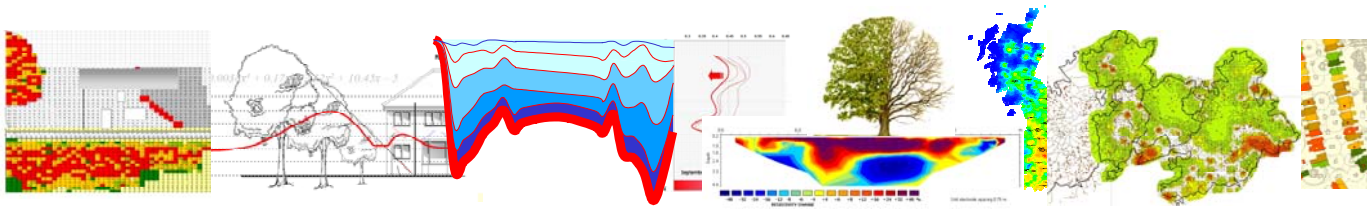
REGIONAL MAP OF RISK on a NORMALISED SCALE



Data from the previous page re-imaged on a normalised scale 0 – 1 showing risks relative to the SE of the UK. Scotland represents the lowest risk, followed by Wales, reflecting the geology.



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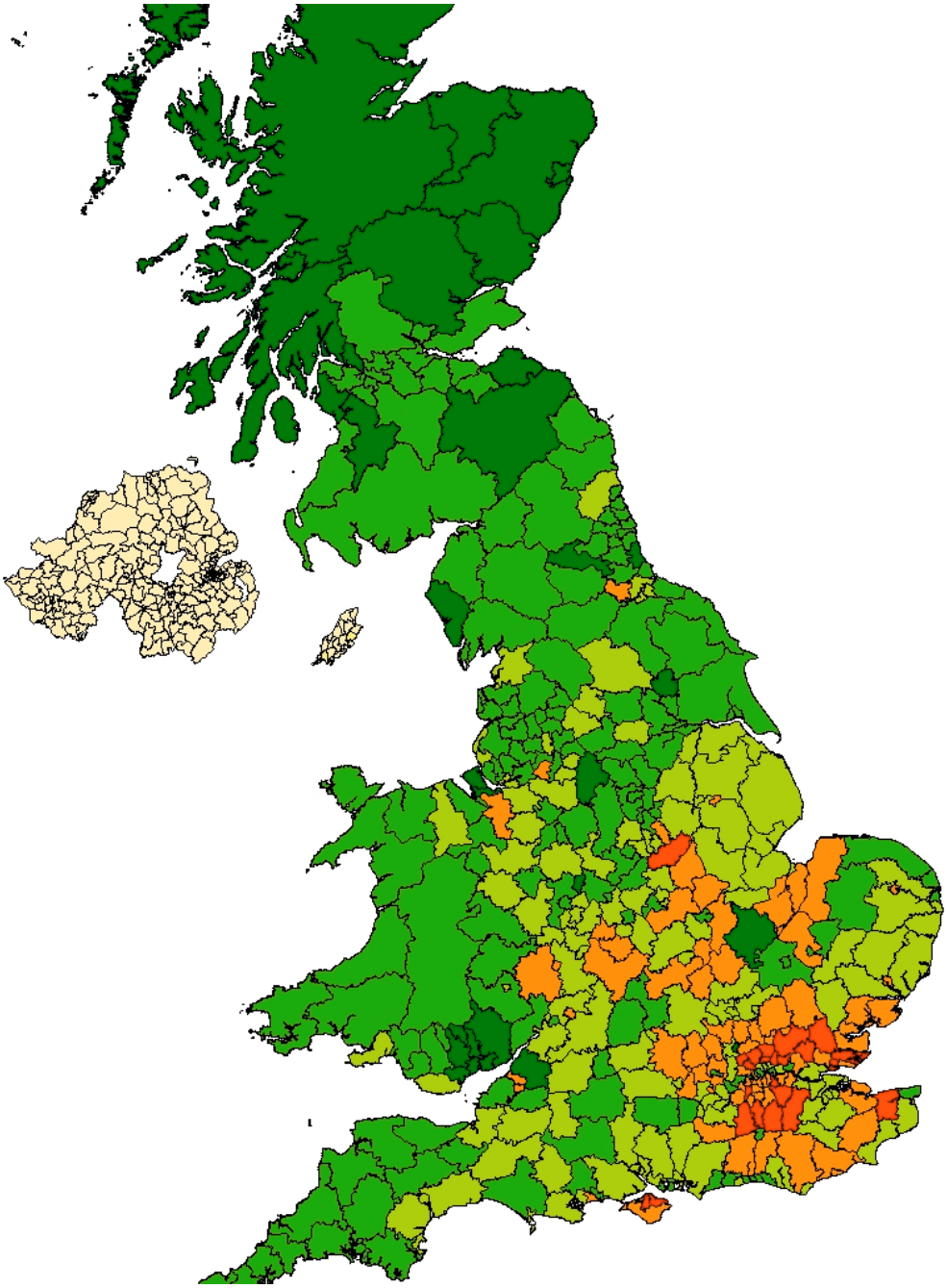
DISTRICT MAP OF RISK on a NORMALISED SCALE



Using the same data as the previous page but displayed at a higher resolution, showing the risk at district, rather than regional level.