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
Artificial Intelligence

February 2021
Edition 189

The Clay Research Group

CONTENTS

Issue 189, February 2021

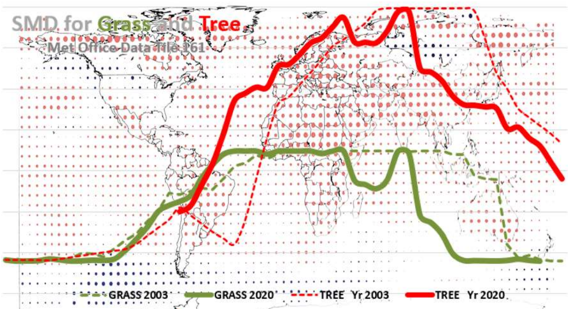
Surge and Weather

How much rainfall is needed to convert a surge year to a normal year? In this edition, using data from the Met Office weather station at Heathrow, we compare rainfall in 2003 (a surge year) with four years that delivered lower claim numbers. Is there as value that identifies surge years and what are the months when the absence of rain is most likely to have an impact? We re-visit the *temp(max)-rain* equation to see if it helps to identify problem months and years. Also included, Met Office anomaly maps to help understand the third quarter claim surge in 2018.

Finally, bringing together the above, can we build a digital model to determine risk using these weather elements? If we can't predict surge with any accuracy, would links to weather stations to gather live data help to understand risk at the time of claim notification?

SMD – 2020 Review

SMD data for both grass (green) and trees (red). Dotted lines plot data for the 2003 surge year. Both datasets suggested that 2020 might deliver higher claim numbers earlier in the year, but this prediction was thwarted by August rainfall.



SMD Data provided by the Met office. Tile 161, Medium Available Water Capacity with grass and tree cover

Data supplied by the Met Office for Tile 161 situated to the SE of England.

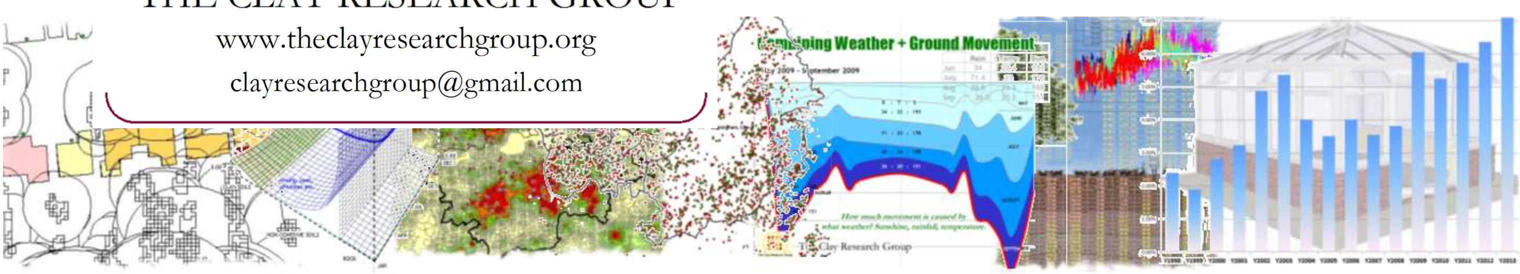
Risk Mapping - Harrow

In this edition we continue the series on mapping the risk of subsidence by district and postcode sector by re-visiting Harrow. Originally covered in a less detailed format in November 2017, Edition 150, the maps follow the format set in more recent editions.

Contributions Welcome

We welcome articles and comments from readers. If you have a contribution please Email us at:
clayresearchgroup@gmail.com

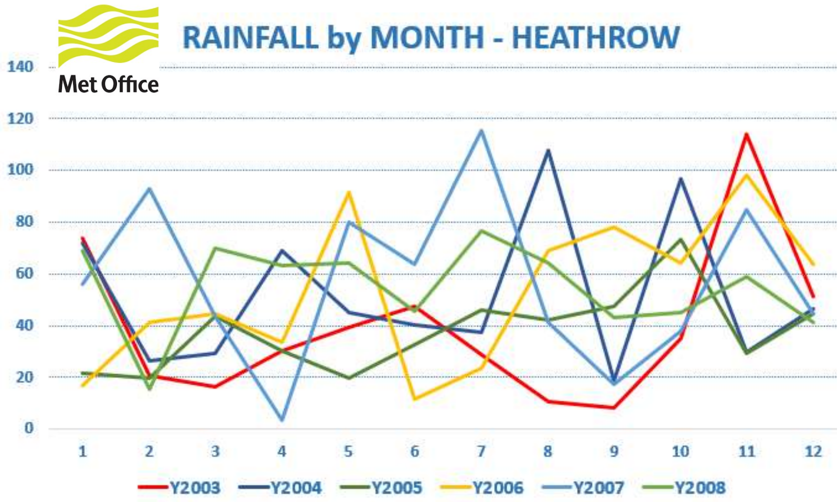
THE CLAY RESEARCH GROUP
www.theclayresearchgroup.org
clayresearchgroup@gmail.com



The Clay Research Group

Weather Patterns Behind Surge

What combination of weather patterns are behind surge years, and is it possible to predict them? Below, graph plotting rainfall by month from the Heathrow weather station – data courtesy of the Met Office - comparing a full blown surge year (2003), one with slightly less impact (2006) and four 'normal' years. The chart below indicates the link between claim numbers and rainfall.

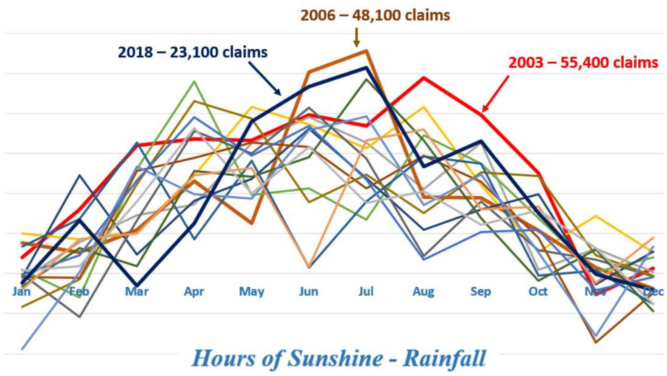


2003 delivered 55,400 claims and was particularly dry from February through to October. 2006, another surge year, was quite wet in May followed by a sharp reduction in rainfall in June continuing through July.

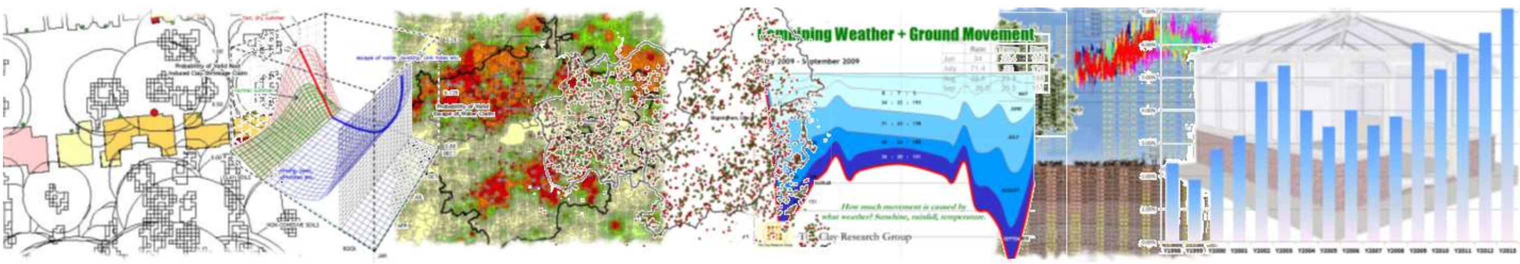
Although 2007, a normal claims year, had low rainfall in April, it was too early to influence decideous vegetation.

The remaining 'normal' claim years in the above graph, 2004, 2005, 2007 and 2008, all have higher values. Just how much rainfall is needed to turn a surge year into a normal year, and what role does the Intervention Technique play in delivering this? Clearly rainfall plays a central role but temperature and hours of sunshine make significant contributions as we see below and on the following pages.

The three elements, temperature, hours of sunshine and rainfall are the drivers, but what happened in 2018? After a spell of over ten years of low claim numbers, 2018 delivered a third quarter surge with around 20,000 claims notified in total.



The graph above indicates the profile using the formula *hrs of Sunshine – Rainfall* and identifies the years with high claim numbers, but unfortunately there is no predictive element. On the following page, Met Office anomaly maps reveal the difference in monthly weather that distinguish 2018 from 2020.

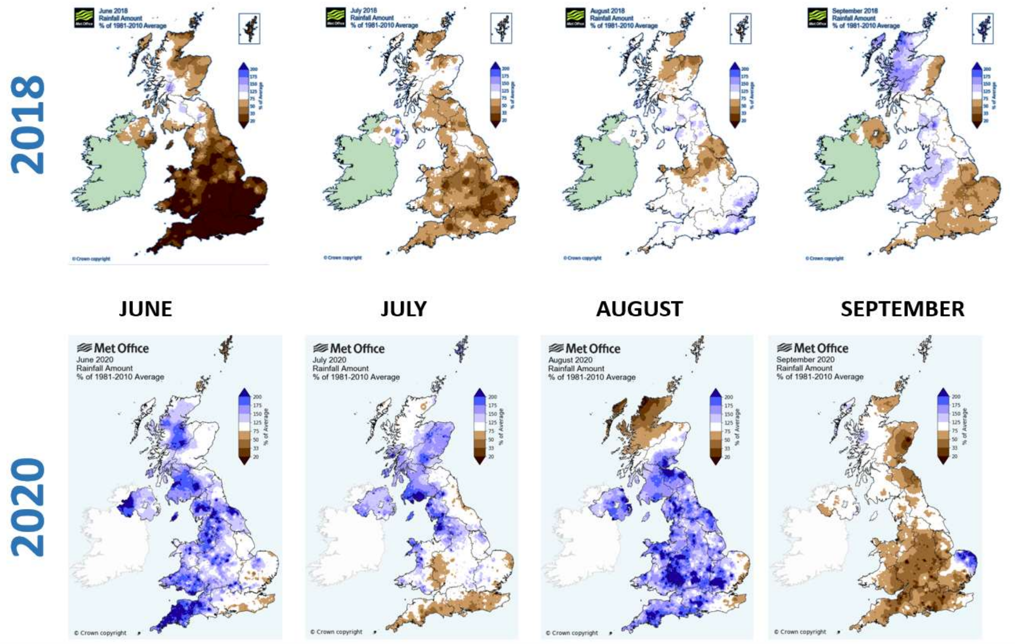


The Clay Research Group

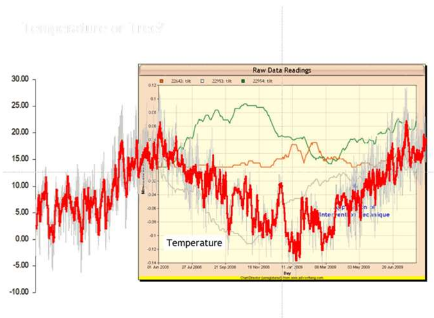
2018 -v- 2020. Met Office Anomaly Maps

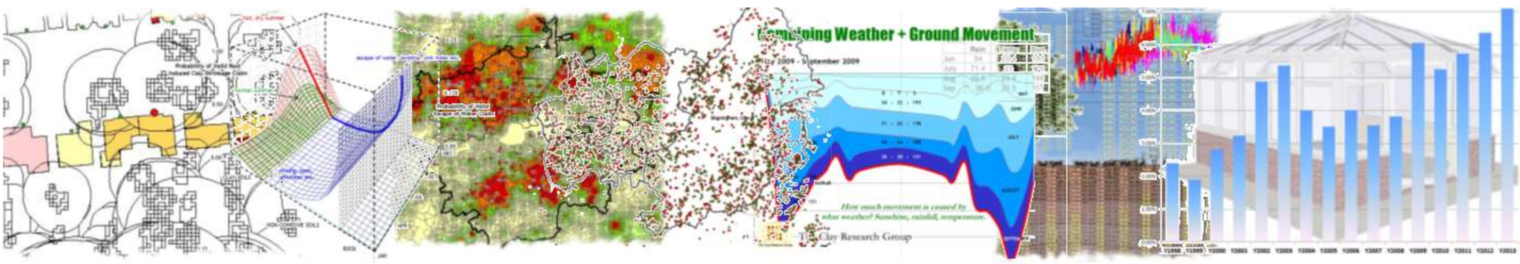
Below, anomaly maps from the Met Office revealing differences in rainfall between a surge year (2018) and a normal claims year (2020). The maps compare rainfall in the noted years as a percentage of the average for the period 1981 – 2010.

In 2018, June was much drier than the comparison period, continuing through into July. August data reveals 'normal' rainfall, with drying returning in September. In comparison, 2020 was wetter in June and August, fairly average in July and drier in September. June and July 2018 were the drivers behind the third quarter surge in 2018.



Retrospective analysis of this sort is of little use to the practitioner when handling a new claim, and averaging the data over the month doesn't allow detailed analysis, particularly when there are several elements (rainfall, humidity, temperature, hours of sunshine etc.) interacting. That said, the hourly record (graph right) contains too many factors – perhaps daily or weekly data would be sufficient.





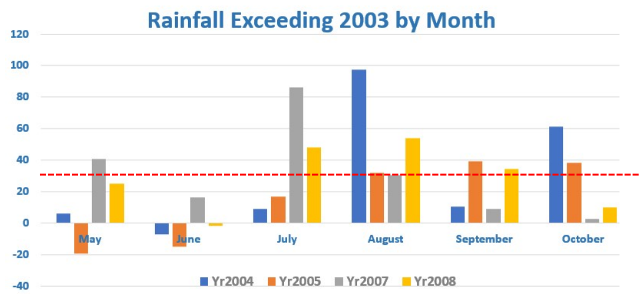
The Clay Research Group

Comparing 2003 Rainfall with 2004, 2005, 2007 and 2008

Just how much rainfall is required in a month to reduce the likelihood of a surge? Using Met Office data, the graphs on this page compare the rainfall of several normal claim years (2004, 2005, 2007 and 2008) with rainfall in the 2003 surge. The graphs plot monthly average rainfall from May through to October, inclusive.

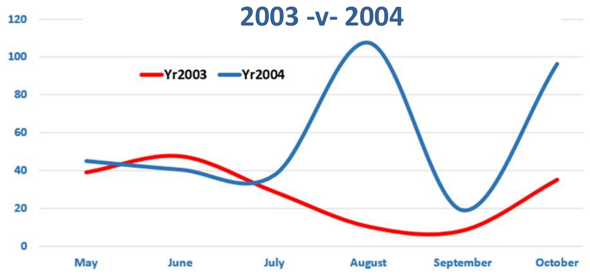
Rainfall in 2003 (red line) was low throughout the summer. In 2004, cumulative rainfall for the period May through to October exceeded 2003 by 176mm, in 2005 by 92mm, in 2007 by 185mm and in 2008 by 170mm.

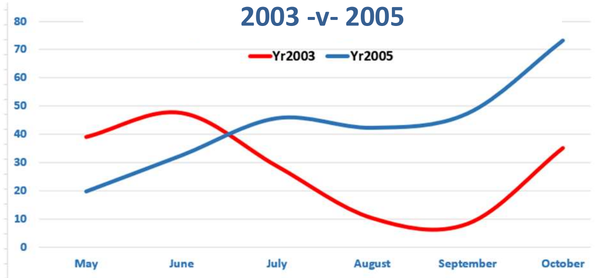
The monthly data are plotted in the graph below.

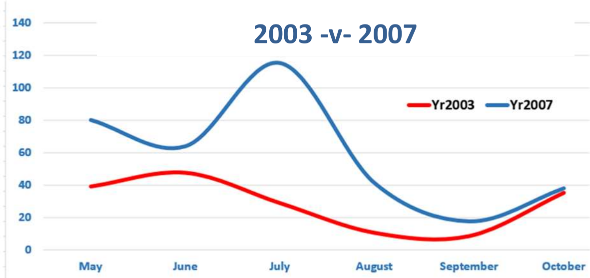


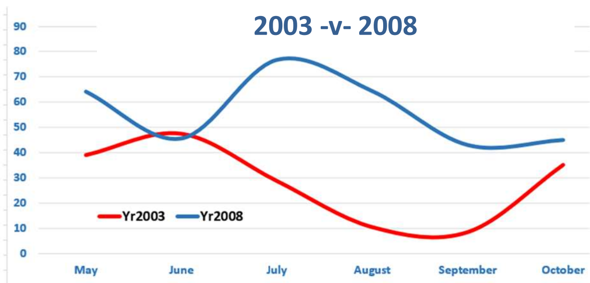
This initial appraisal suggests that watering of around 30mm across the root zone in July and August might be sufficient to mitigate against a full-blown surge.

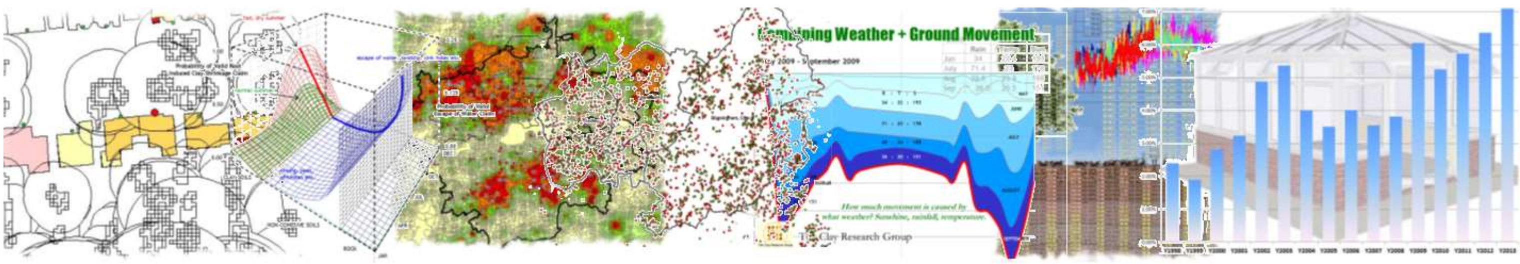
The Intervention Technique employs a different strategy, replenishing the deficit in the soil between the tree and the building and transporting the hormone, ABA, to the leaf by overnight equilibration of water in the root zone to close leaf stomata and reduce water uptake.







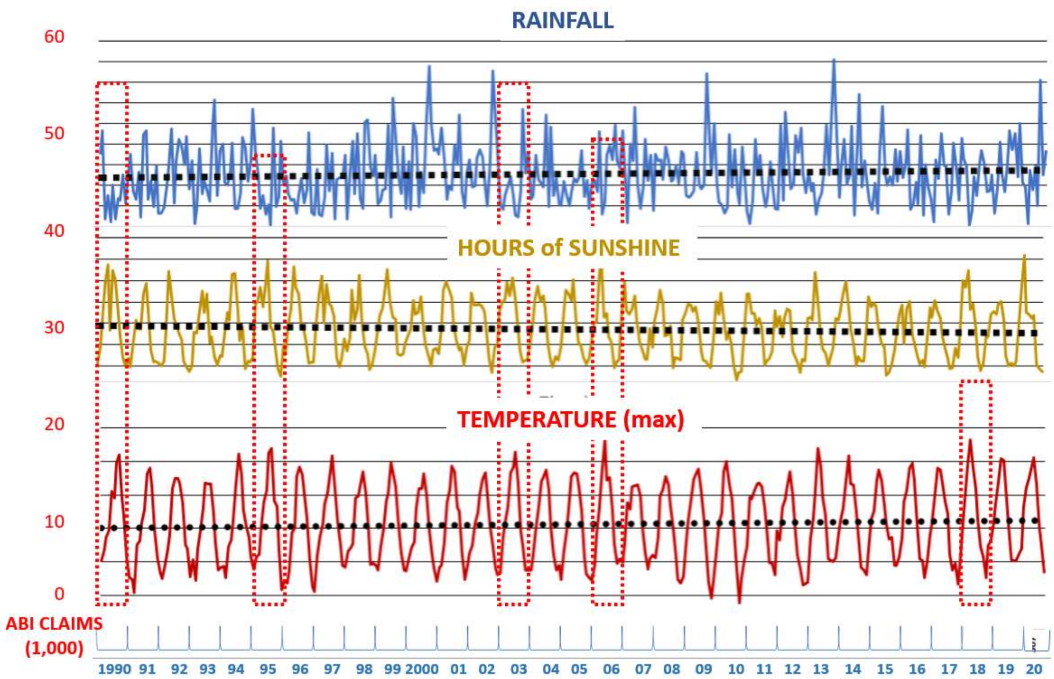




The Clay Research Group

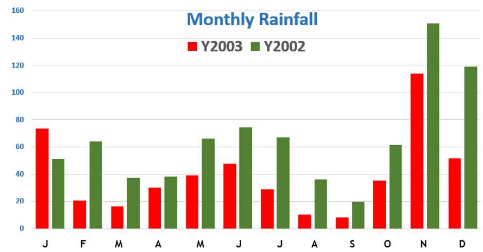
SURGE – Temperature, Rainfall and Sunshine

Monthly data from the Met Office weather station at Heathrow for rainfall, hours of sunshine and temperature for the period 1990 through to 2000 are plotted on the graphs below. The vertical broken red bars identify surge years - see following page.

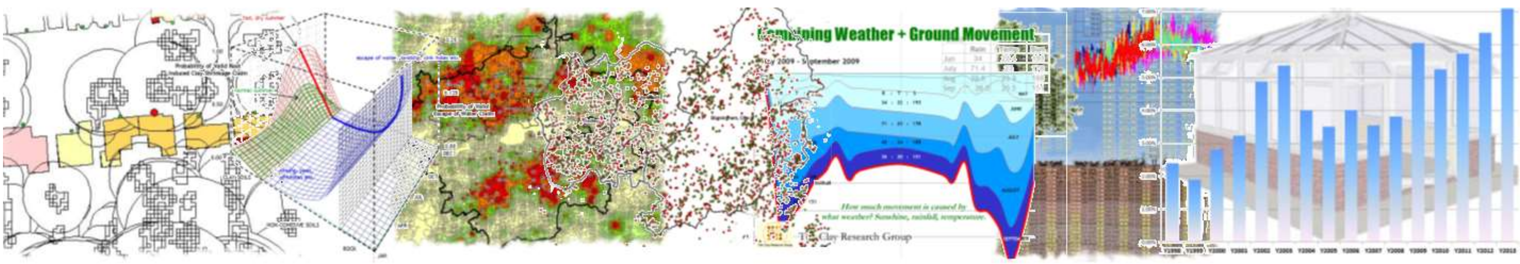


The linear trendlines indicates an increase in rainfall and temperature and a decrease in hours of sunshine over the study period. The decline in claim numbers since 2006 is most likely associated with the increase in rainfall.

Using differences of 'rainfall by month' between surge and normal years provides useful information regarding the amount of water systems like the Intervention Technique, implemented under patent by Innovation Group, need to supply to abate the nuisance. See graph right.



Rainfall required by month to convert a dry, surge year to a normal claims year.

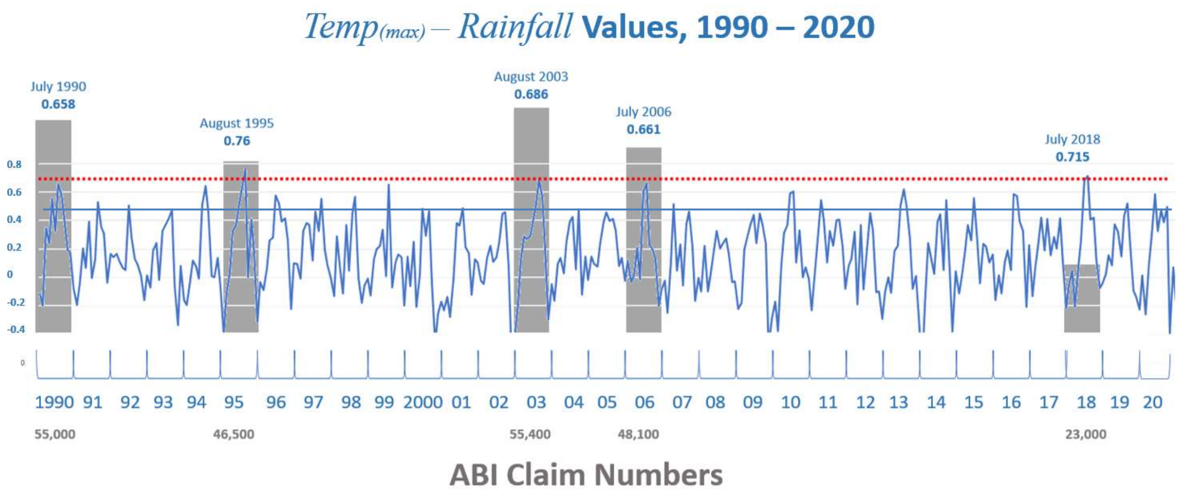


The Clay Research Group

SURGE – Temperature and Rainfall

Below, graphs showing normalised (i.e. on a scale 0 – 1) values for *temperature - rainfall* for the period 1990 through to 2000, identifying the values behind surge and the peak month.

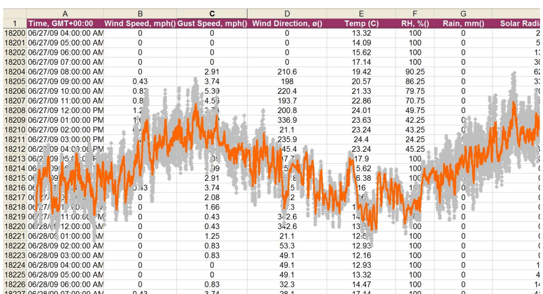
In 1990, surge was triggered by a *Temp-Rain* value of 0.658 in July. In 1995 a value of 0.76 and in 2003 a value of 0.686, both recorded in August.

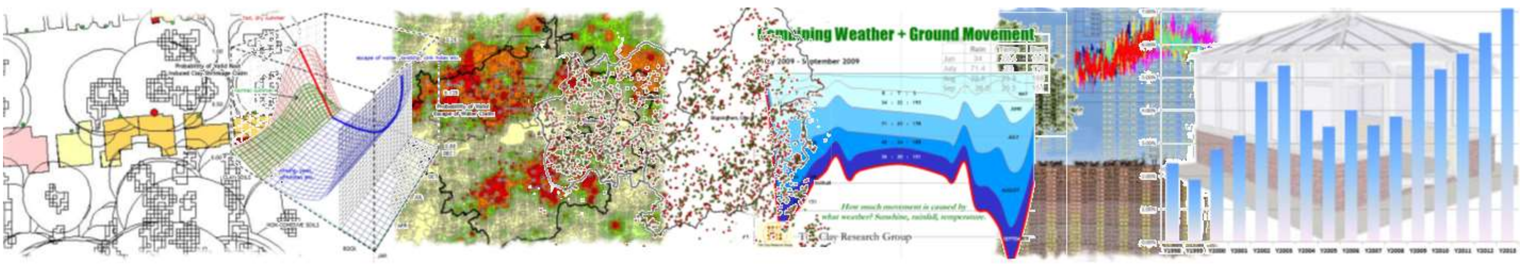


The latest surge in 2018 delivered lower annual claim numbers, but the third quarter surge was triggered by a *temp-rain* value of 0.715 in July.

Normal year claim numbers either (a) have a figure well below or (b) a peak with a shorter duration – for example 1999. Unfortunately, the findings don't offer a predictive value and the general form of the graphs by year is too irregular to benefit from any attempt at pattern matching.

There is also an issue around the use of monthly averages to build predictive models as we saw from the raw hourly data recorded at the Aldenham research site – see sample right. Does a light watering every hour improve risk rather than a heavy downfall once a week? Do averages reflect risk and particularly when combining several weather elements?





The Clay Research Group

Building a Digital Model

Claims handlers would benefit from a model that delivers ‘real time’ information about the risk of an increase in numbers and the grid below outlines a possible approach. The graph on the previous page provides a value for *temp-rain* of around 0.6 as an indicator of an increase in claim numbers related to a dry, warm year delivering surge based on monthly averages.

Below, an example of a ‘live’ table of values that calculates the risk by week, receiving data from weather stations in areas where there are clay soils and comparing temperature, hours of sunshine, rainfall etc., with past years. The data would be analysed by an artificial intelligence module to detect patterns.

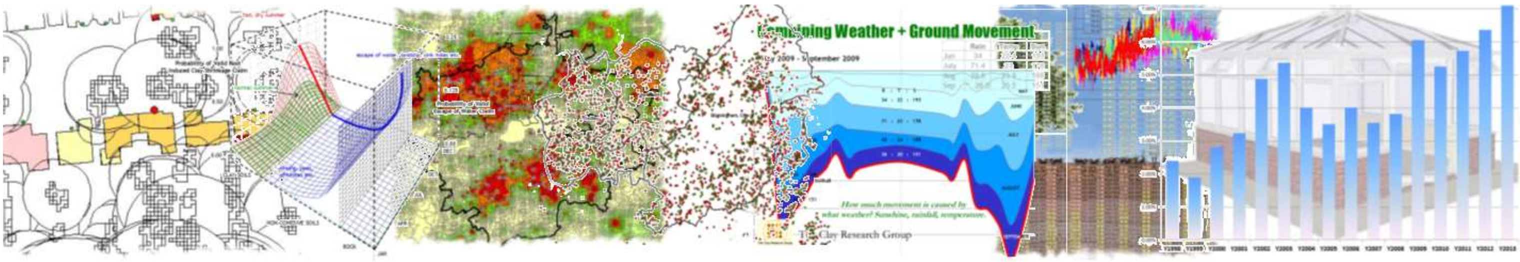
colder ← TEMPERATURE → warmer

drier	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
↑	0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90
	0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80
RAINFALL	0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.60	0.70
	0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50	0.60
	0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40	0.50
	0.60	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30	0.40
	0.70	-0.60	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20	0.30
	0.80	-0.70	-0.60	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10	0.20
↓	0.90	-0.80	-0.70	-0.60	-0.50	-0.40	-0.30	-0.20	-0.10	0.00	0.10
wetter	1.00	-0.90	-0.80	-0.70	-0.60	-0.50	-0.40	-0.30	-0.20	-0.10	0.00

Both the x and y axis use normalised values on a scale 0 – 1 from the lowest and highest values listed in the Met Office dataset for rainfall and temperature at Heathrow weather station.

The red zone signifies an increased risk of root induced clay shrinkage claims in surge, the intermediate zone (yellow) a ‘normal’ claim year and the blue zone indicates an increased risk of water related claims.

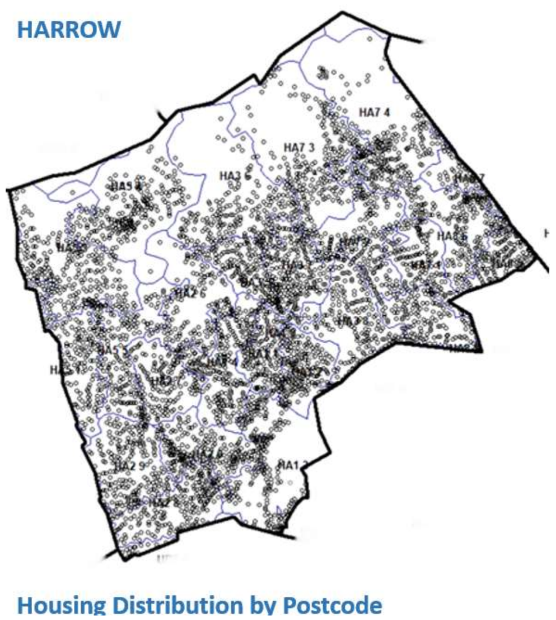
Briefly, higher temperatures combined with lower rainfall (red shaded tiles) reveal a greater risk of surge (i.e. more root induced clay shrinkage claims) bearing in mind the risk factor of 0.6 on page 6. The yellow zone suggests a normal year (in the range -0.4 to +0.4) and the blue shaded area indicates values that are more likely related to escape of water, sinkholes and landslip claims. By linking these live values to the geology, past claims experience by postcode sector and the presence or absence of nearby vegetation/drains etc., would be valuable in terms of triage. Monthly data is too coarse for this to be useful in its present form – it could span the last week of one month and first week of the following for example, and hourly data would be too refined.



The Clay Research Group

Subsidence Risk Analysis – HARROW

Harrow occupies an area of 50.47km^2 with a population of around 250,000. The district was originally covered in edition 150, November 2007 of the CRG newsletter. It is re-visited here to bring it in line with the current series and allow comparisons in terms of risk.



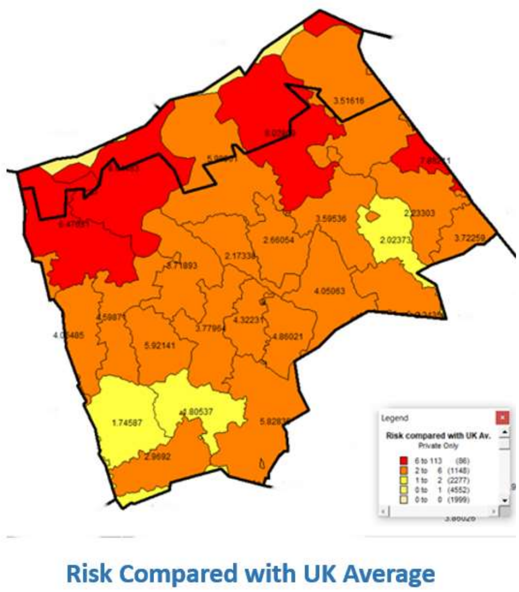
Distribution of housing stock using full postcode as a proxy. Each postcode in the UK covers on average 15 – 20 houses, although there are large variations.

Housing distribution across the district (left, using full postcode as a proxy) helps to clarify the significance of the risk maps on the following pages. Are there simply more claims because there are more houses?

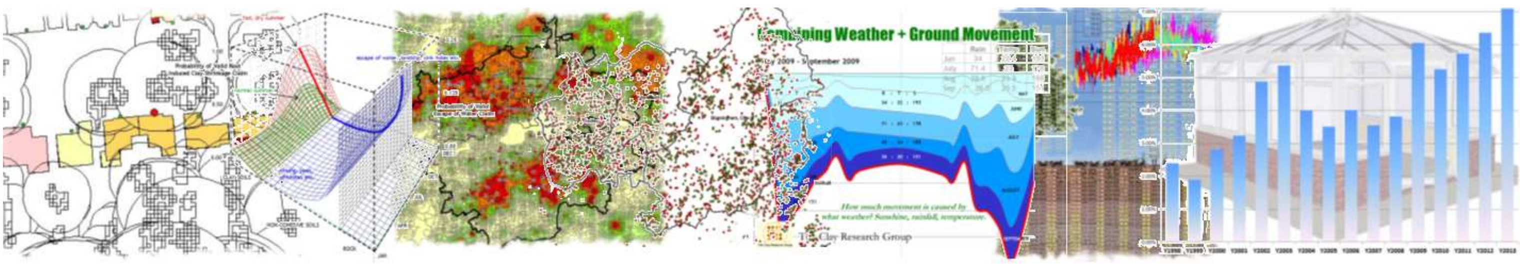
Using a frequency calculation (number of claims divided by private housing population) the relative risk across the borough at postcode sector level is revealed, rather than a 'claim count' value.

From the sample we have, sectors are rated for the risk of domestic subsidence compared with the UK average – see map, right.

Harrow is rated as high risk and in the top ten districts in the UK.



Risk compared with UK Average. *Harrow is ranked as high risk for domestic subsidence claims from the sample analysed. Above, values at postcode sector level compared with UK average.*

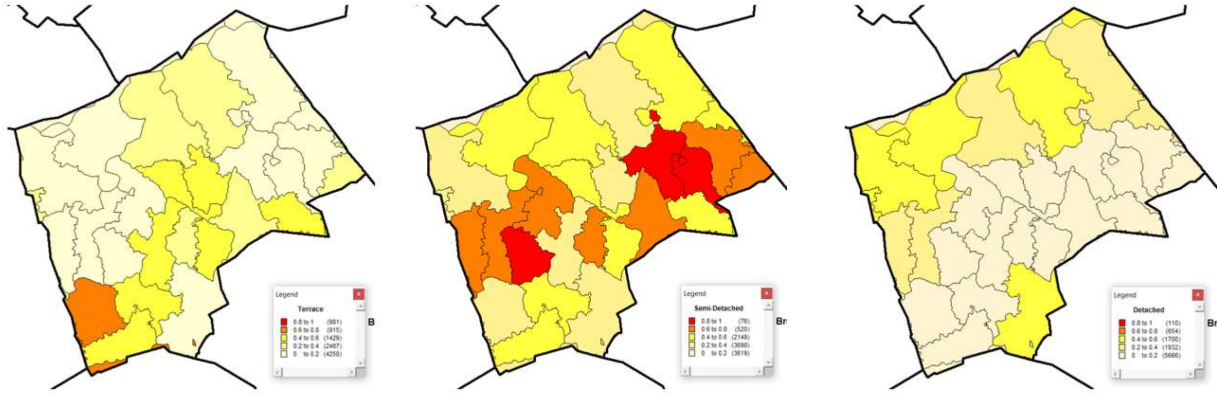


The Clay Research Group

HARROW - Properties by Style and Ownership

Below, the general distribution of properties by style of construction, distinguishing between terraced, semi-detached and detached. Unfortunately, the more useful data is missing at sector level – property age. Risk increases with age of property and policies allow insurers to assign a rating to individual properties.

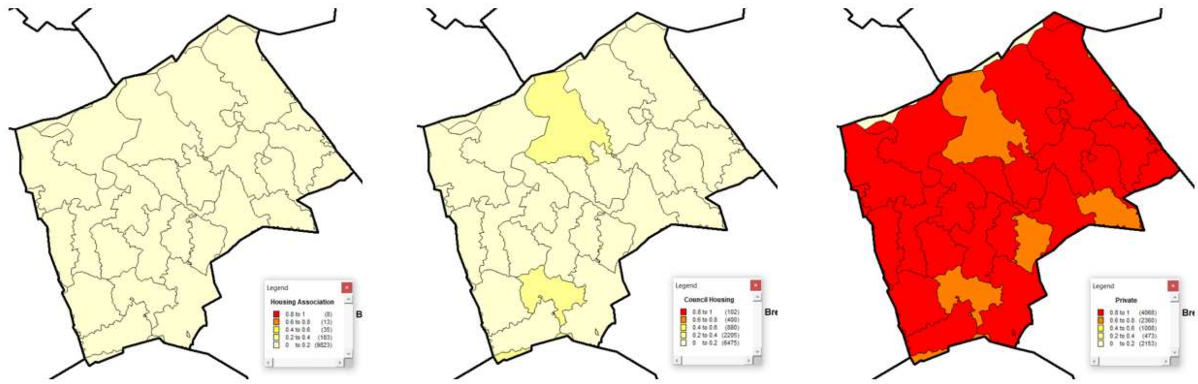
HARROW - Distribution by House Type



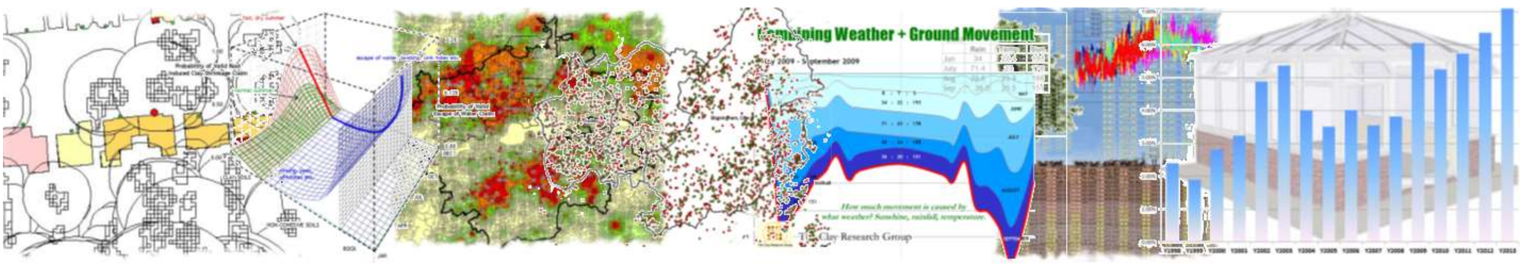
Terraced Semi-Detached Detached

Distribution by ownership is shown below. The maps reveal predominantly privately-owned properties across the borough with a high number of terraced properties to the east.

HARROW - Distribution by Ownership



Housing Association Council Ownership Private Ownership



The Clay Research Group

Subsidence Risk Analysis – HARROW

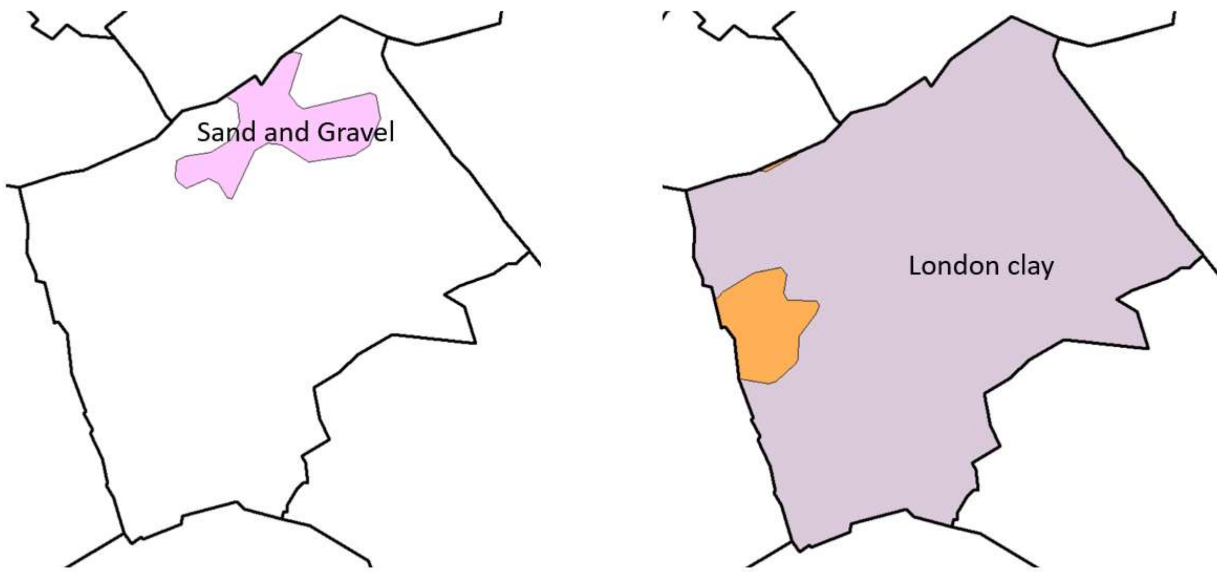
Below, extracts from the British Geological Survey low resolution 1:625,000 scale geological maps showing the solid and drift series. View at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html for more detail.

See page 13 for a seasonal analysis which reveals that in the summer there is around an 80% probability of a claim being valid, and of the valid claims, there is a high probability (90% in the sample) that the cause will be due to clay shrinkage.

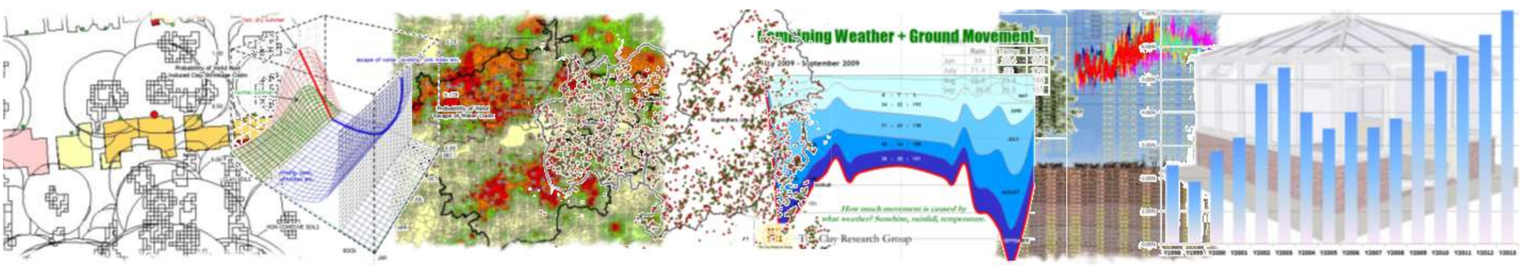
In the winter the situation reverses. The likelihood of a claim being declined exceeds 80%.

The analysis reflects the influence of the underlying clay series and the apparent shallow thickness of the superficial deposits.

HARROW : BGS Geology – 1:625,000 scale



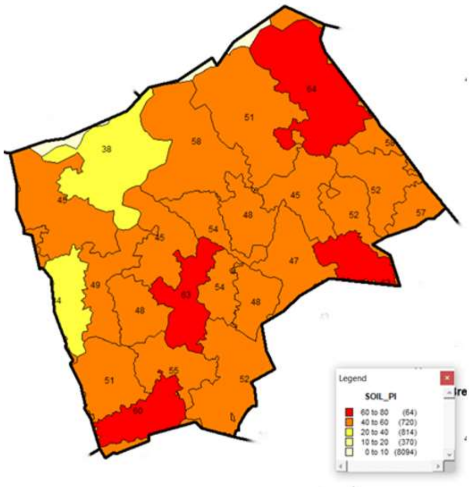
DRIFT DEPOSITS **SOLID GEOLOGY**



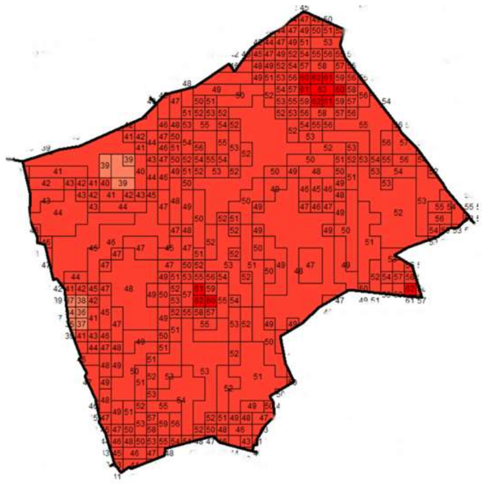
The Clay Research Group

Liability by Geology and Season

Below, the average PI by postcode sector (left) derived from site investigations and interpolated to develop the CRG 250m grid (right). The presence of a shrinkable clay in the CRG model matches the BGS maps on the previous page with clay having an average PI of around 50% where it exists. The higher the PI values, the darker red the CRG grid.

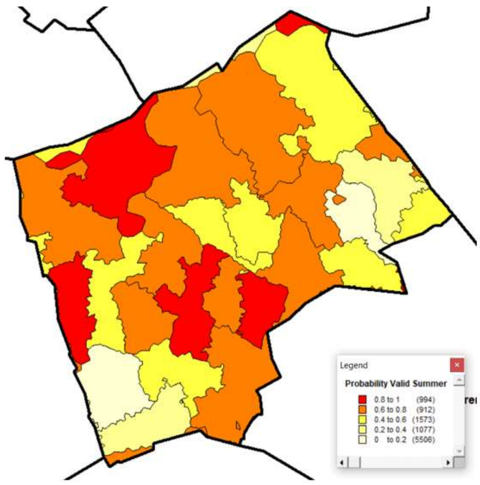


Soil PI Averaged by Sector

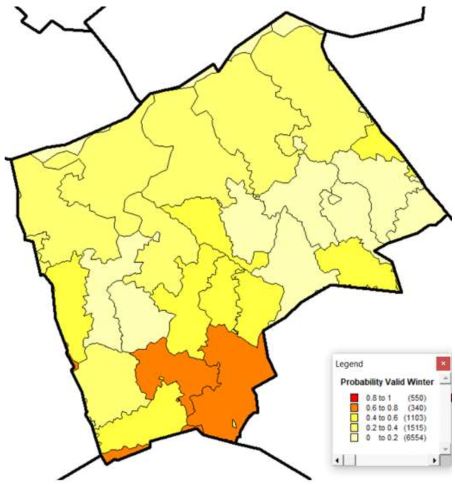


PI Interpolated on 250m CRG grid

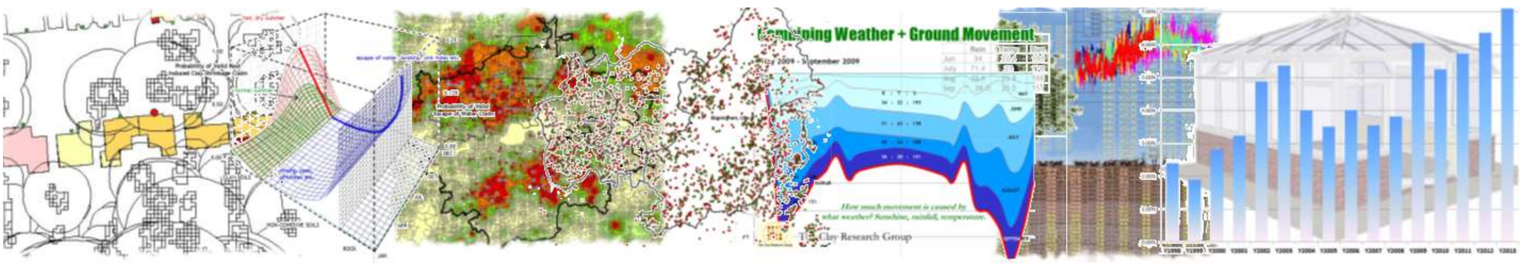
Zero values for PI in some sectors may reflect the absence of site investigation data - not necessarily the absence of shrinkable clay. The widespread influence of the shrinkable clay plays an important role in determining whether a claim is likely to be valid or declined by season. A single claim in an area with low population can raise the risk as a result of using frequency estimates.



Probability Valid, Summer

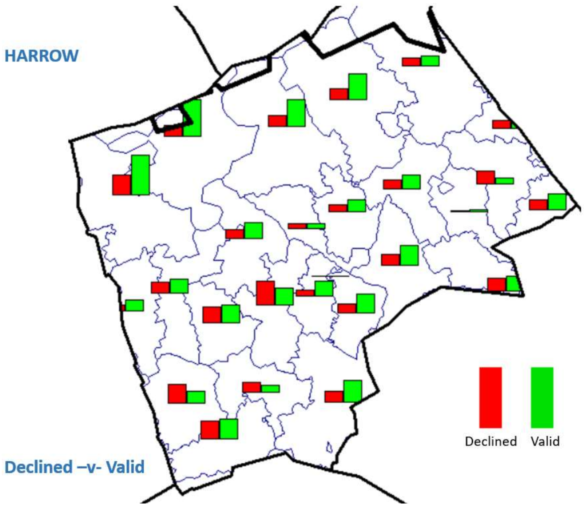


Probability Valid, Winter



The Clay Research Group

District Layout. Liability, EoW and Council Tree Risk.

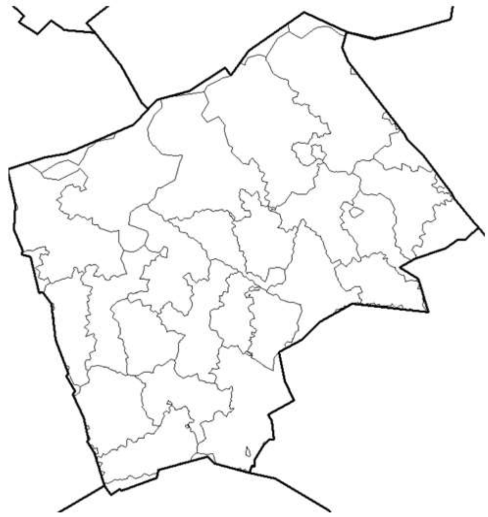


Left, annual valid-v-declined data which changes significantly when considering seasonal data – see page 12.

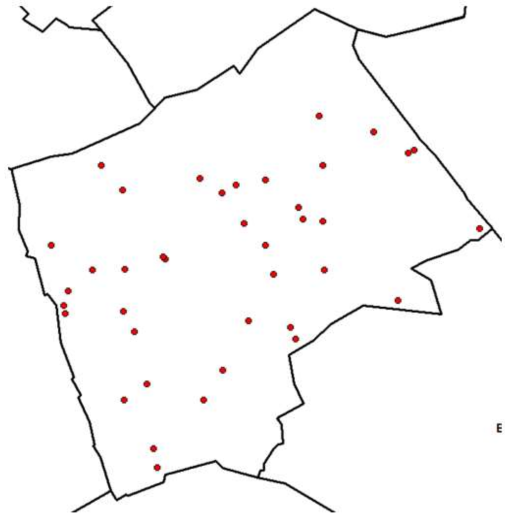
A review using Google Street View is useful in providing context and exploring the differences in property ages and styles of construction across the district.

In this study, risk values are often based on small housing population densities.

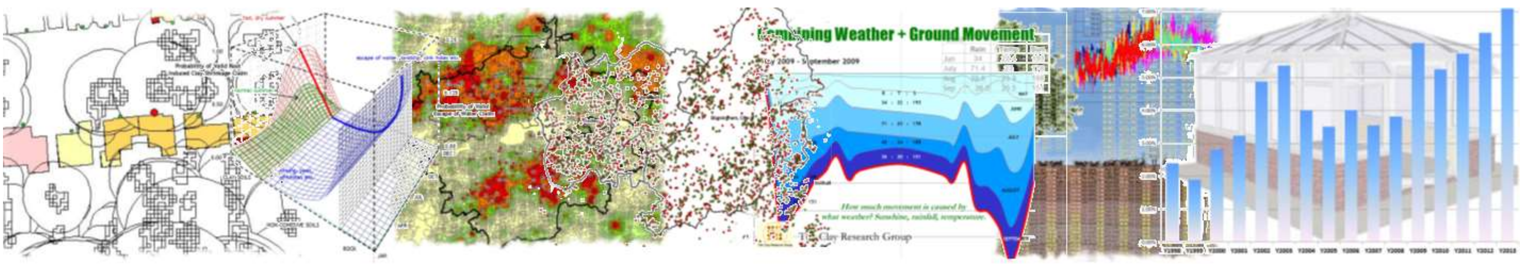
Below, left, mapping the frequency of escape of water claims from the sample reflects the absence of drift deposits (sands and gravels etc). The absence of shading does not indicate an absence of claims, but a low frequency. Such claims are often due to shallow foundations of older houses bearings onto disturbed ground or topsoil. Below, right, 'Council Tree Claims' map plotting claims from a small sample of around 2,700 UK claims where damage has been attributable to vegetation in the ownership of the local authority.



Higher Risk Escape of Water



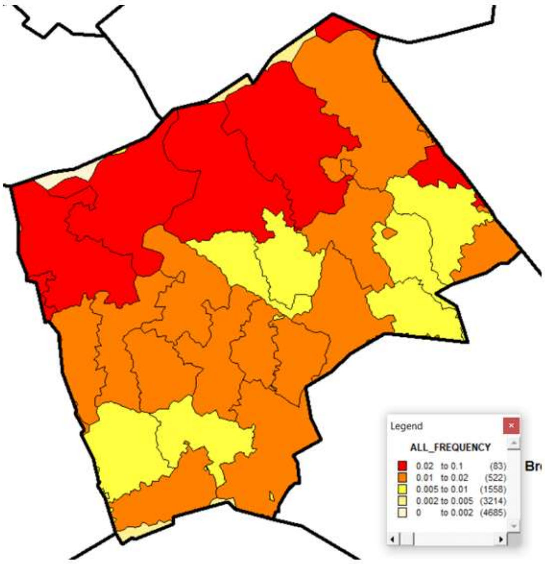
Claims Involving Council Tree



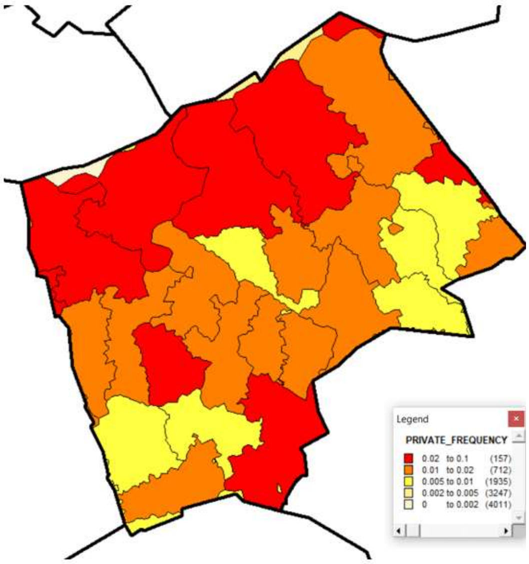
The Clay Research Group

HARROW - Frequencies & Probabilities

Mapping claims frequency against the total housing stock, left (council, housing association and private) and private housing only, right, reveals the importance of understanding risk by portfolio.



Combined Public and Private Frequency



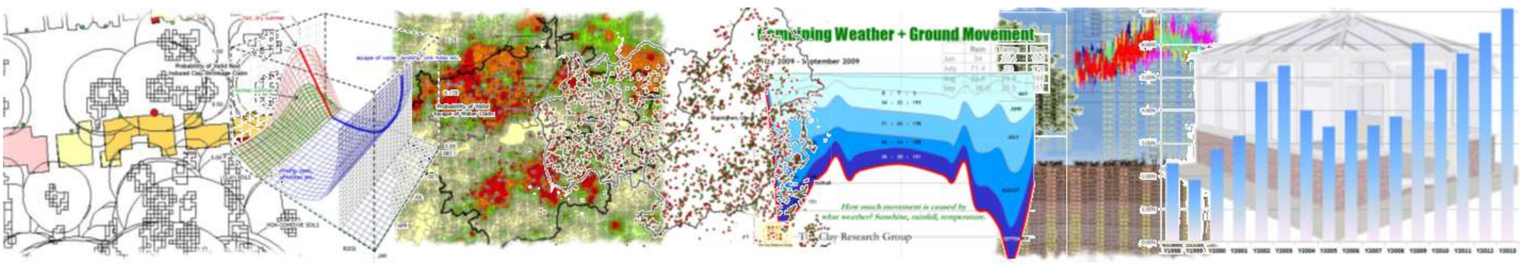
Private Only

The reversal of rates for valid -v- declined by season is a characteristic of the underlying geology. The probability of a claim being valid in the summer is just under 80%, and in the winter, it falls to less than 20%. Valid claims in the summer are likely to be due to clay shrinkage, and in the winter, escape of water.

The probabilities of causation reverse between the seasons and the values are typical signatures of an outcropping, highly shrinkable, clay soil.

Liability by Season - HARROW

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Harrow	0.728	0.057	0.215	0.01	0.16	0.83

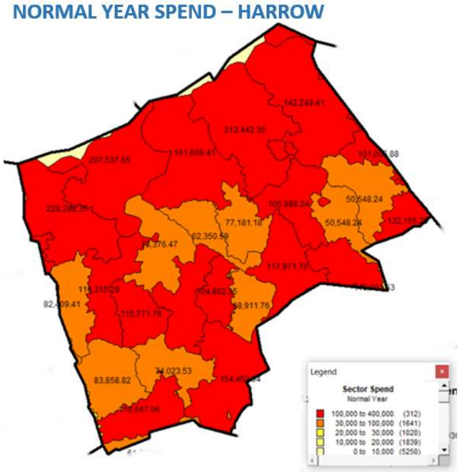


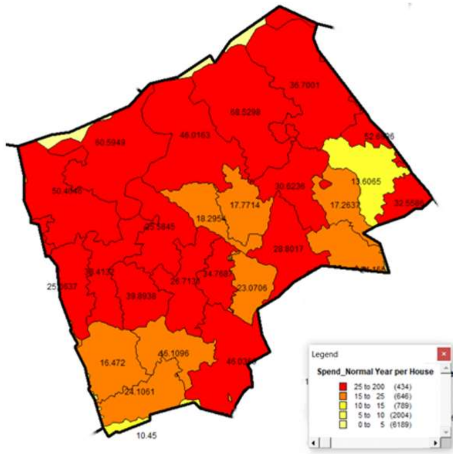
The Clay Research Group

Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

The maps below show the aggregated claim cost from the claim sample per postcode sector for both normal (top) and surge (bottom) years. The figures will vary by the insurer's exposure, claim sample and distribution.

NORMAL YEAR SPEND – HARROW

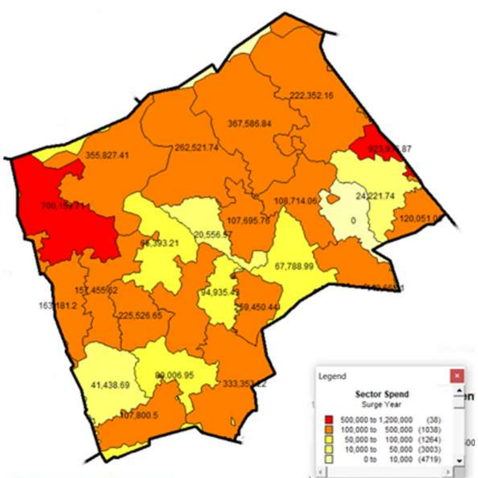


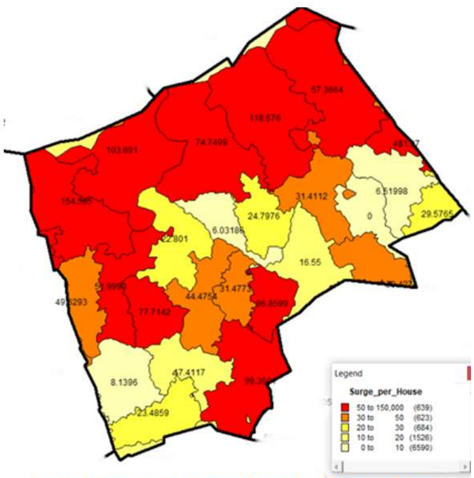


Spend by Sector — **Spend Averaged over Housing Population**

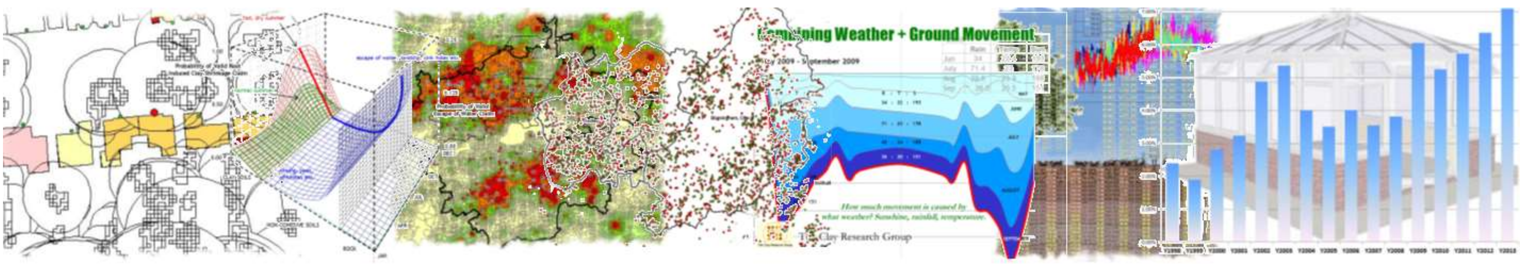
It will also be a function of the distribution of vegetation and age and style of construction of the housing stock. The images to the left in both examples (above and below) represent gross sector spend and those to the right, sector spend averaged across housing population to derive a notional premium per house for the subsidence peril. The figures can be distorted by a small number of high value claims.

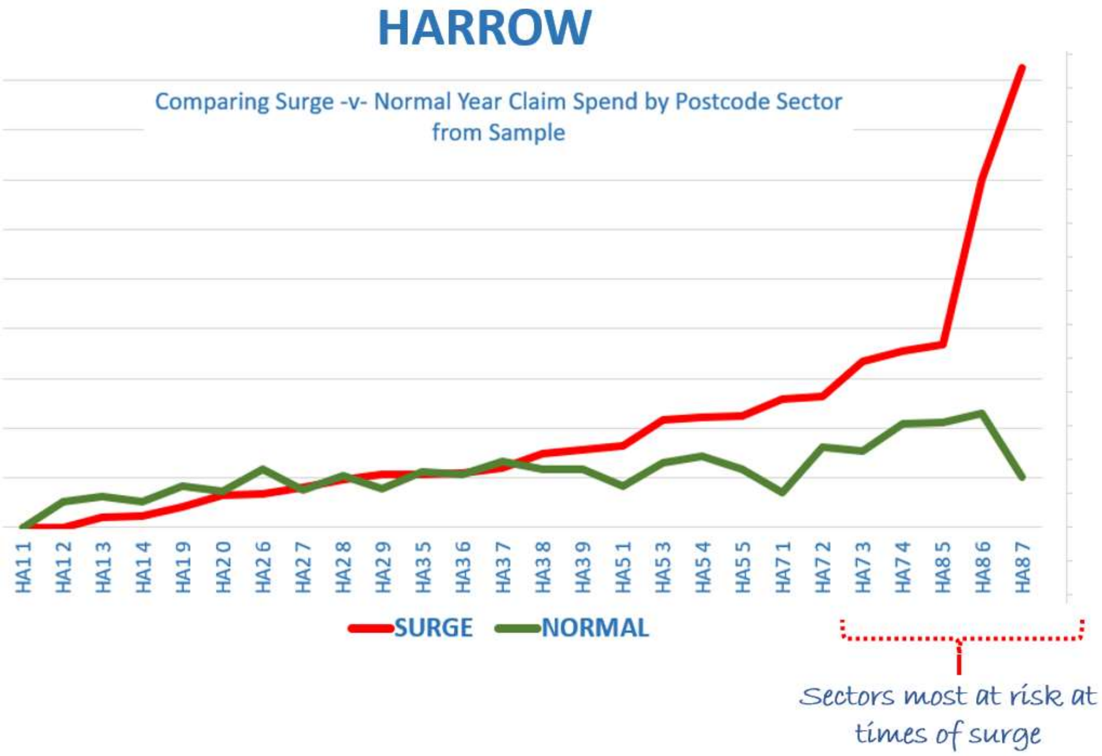
SPEND in SURGE – HARROW





Spend by Sector — **Spend Averaged over Housing Population**



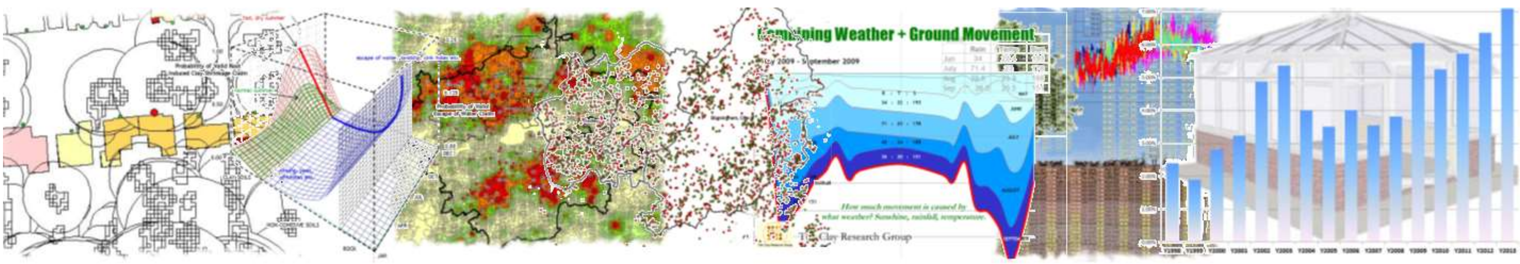


The above graph identifies the variable risk across the district at postcode sector level, distinguishing between normal and surge years. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

It is of course the case that a single expensive claim (a sinkhole for example) can distort the outcome using the above approach. With sufficient data it would be possible to build a street level model.

In making an assessment of risk, housing distribution and count by postcode sector play a significant role. One sector may appear to be a higher risk than another based on frequency, whereas basing the assessment on count can deliver a different outcome. This can also skew the assessment of risk related to the geology, making what appears to be a high-risk series less or more of a threat than it actually is.

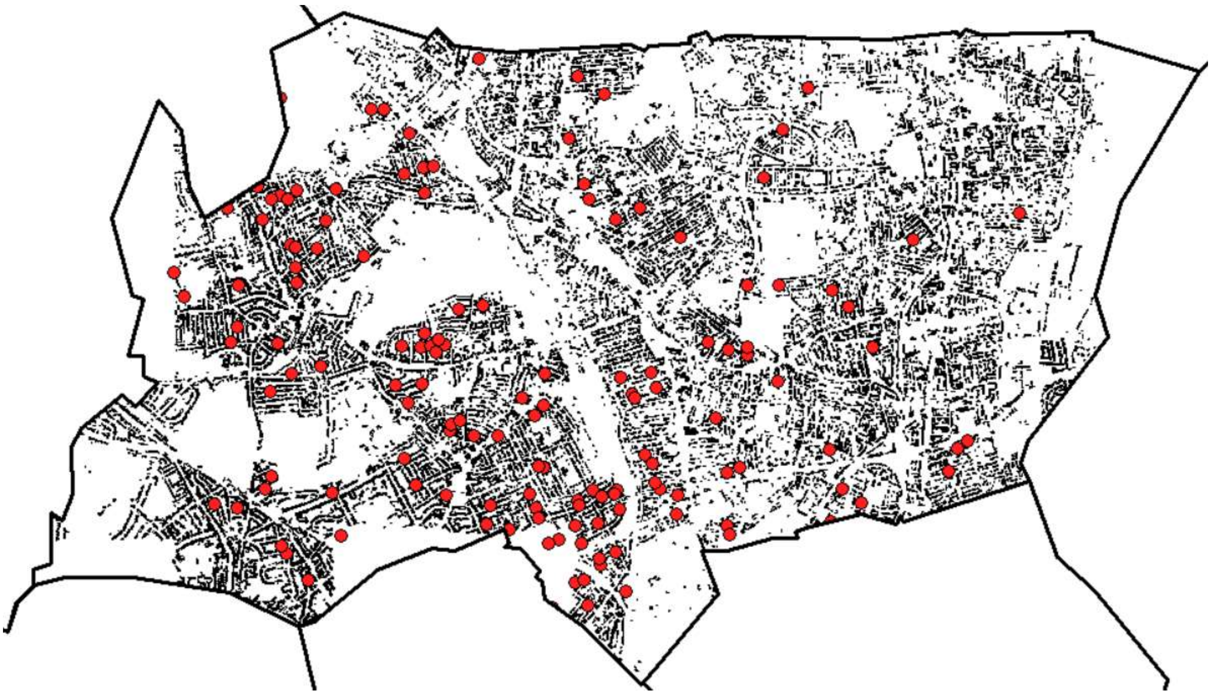
The models comparing the cost of surge and normal years is based on losses for surge of just over £400m, and for normal years, £200m.



The Clay Research Group

Modelled Root Overlap – Public and Private Trees

Below, a map showing the modelled root encroachment (grey shading - public and private trees) beneath domestic properties in the district of Haringey using a root radius value of 1.2 x the tree height.



Above, red dots indicate valid, root induced clay shrinkage claims. The datasets contain a sample of 54k claims covering the UK.