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

January 2021
Edition 188

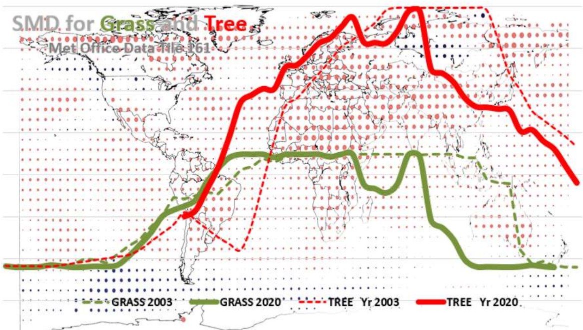
The Clay Research Group

CONTENTS

Issue 188, January 2021

SMD – 2020 Review

SMD data for both grass (green) and trees (red). Dotted lines plot data for the 2003 surge year.



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.

Predicting Surge

Up until 2006, using SMD data for grass cover at the end of May provided a reasonable basis for predicting whether the summer months would deliver a surge in claims, or a normal year. Climate change and greater variability in rainfall has had an impact on the use of this approach.

Prior to 2006, the method delivered a success rate of around 80%. Not only was it a tool for predicting surge but also for predicting normal years some 3 months in advance.

Variable weather conditions, alternating between higher temperatures and intermittent rainfall have reduced its effectiveness. See page 2.

Intervening

A picture from site showing the installation of the Intervention Technique. Bores are being sunk into the base of a trench to accept a rehydration medium targeting root induced desiccation.

Contributions Welcome

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

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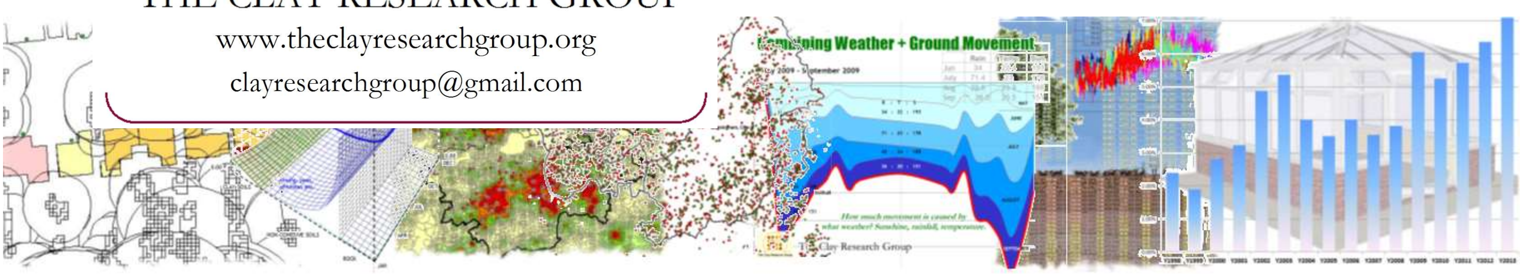

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Predicting Surge – the Value of the Soil Moisture Deficit

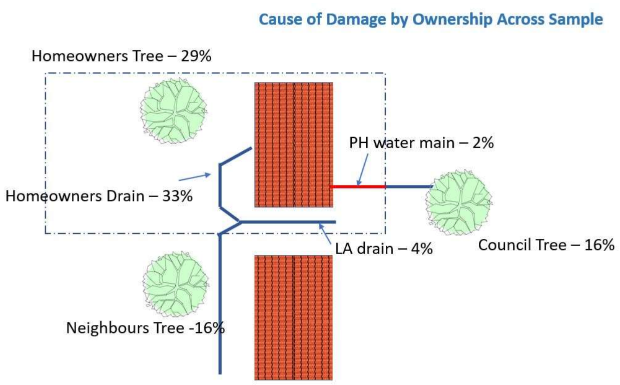
We have used Soil Moisture Deficit (SMD) data from the Met Office for many years as an indicator in late May of whether an August/September surge was likely. Briefly, before 2006 if the SMD reached or exceeded a value of 100mm at the end of May, then a surge was likely. If the value fell below 100mm then a surge was unlikely - the prediction of a normal year is as valuable as predicting surge.

Until 2006, the model delivered a correct answer in around 80% of the years reviewed, which is high given the imponderables of the UK weather.

Of the fourteen years since 2006, the model has incorrectly predicted four surge years, missed the 2018 surge (although total claims for 2018 were low compared with pre-2006 surge years) and delivered a ‘zero surge’ value correctly for the other 10 years. A success rate of around 70% but with a reduced confidence in the output.

Cause by Numbers

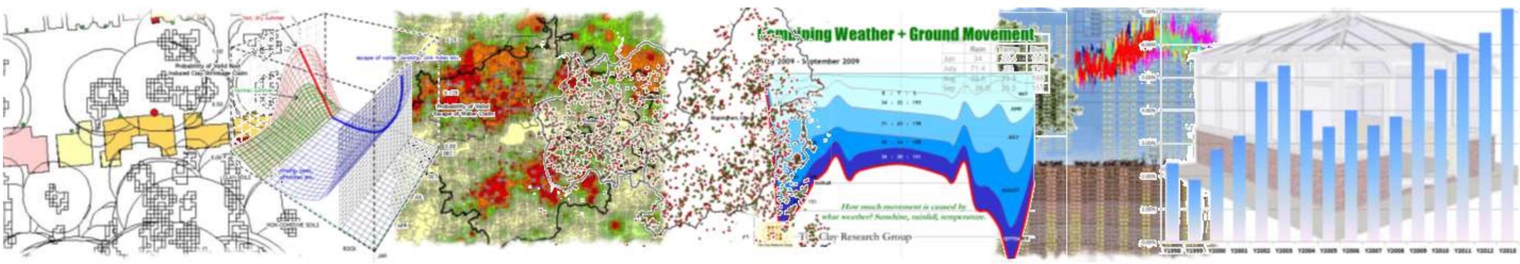
The illustration below plots the distribution by cause from a sample of over 20,000 claims. The highest percentage of claims (33%) were the result of an escape of water from the homeowners own drains. Next, root induced clay shrinkage with the policyholder’s tree or vegetation found to be the cause of damage.



At the other end of the scale, leakage from an incoming water service (2%) and drains under the control of the local authority (4%). Council and neighbour’s trees accounted for 16% each.

Heave, landslip and mining combined accounted for less than 1% of the total claims in the sample and have been discounted.

Heave claims have reduced over the last 20 years or so, perhaps as a result of the excellent work of the NHBC. The percentage of Council Tree claims is higher than expected and doesn’t tally with past analysis which suggests they account for between 10 – 12% of tree related claims.



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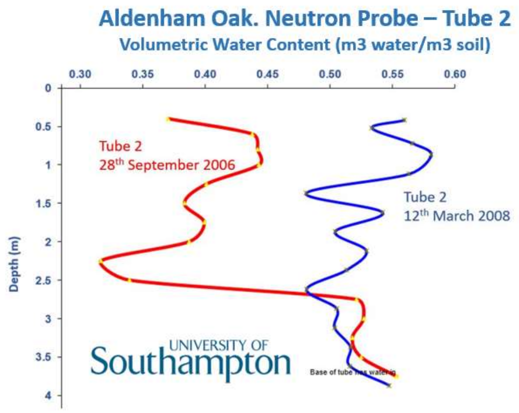
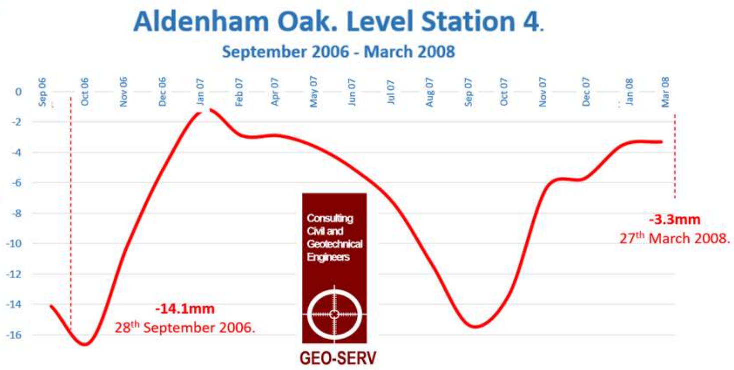
Moisture Change -v- Ground Movement. Predicting Swell.

How ‘accurate’ are estimates of ground movement? Using data collected at the site of the Aldenham oak tree, we compare estimates of swell with actual ground movement recorded at a nearby levelling station.

Below, left, moisture change between September 2006 and March 2008 measured at Tube 2 by the team from Southampton University using the neutron probe and right, associated ground movement at level station No. 4, nearest to where the moisture readings were taken, taken by GeoServ Limited.



Moisture content by volume from Tube 2 taken by Southampton University on the dates noted.



Precise levels from station 4 of the Aldenham oak, situated nearest to Tube 2.

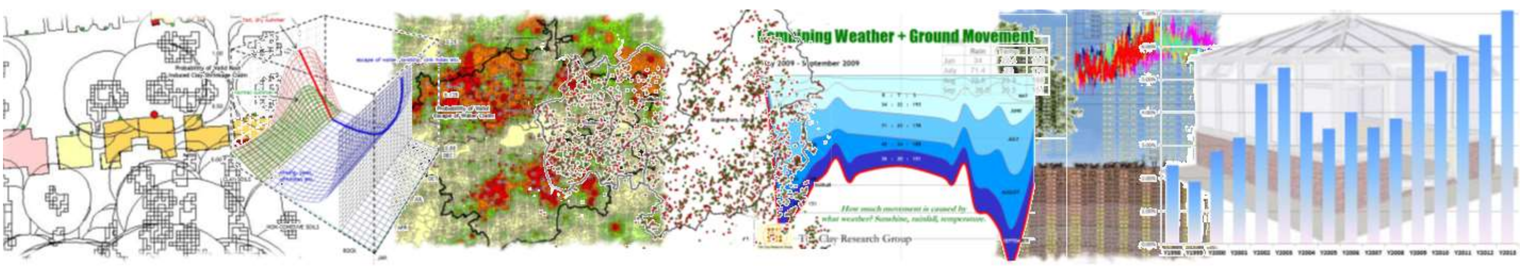
A maximum Mc deficit of 21.3% is recorded at 2.25m bGL in September 2006 with an average over the depth of the bore of around 14.5%. Estimating ground movement from moistures using a water shrinkage factor of 4 = 10mm.

The precise level reading in September 2006 was -14.1mm and in March 2008, -3.3mm. A recovery of 10.8mm associated with winter rainfall.

How does this estimate of swell fare over subsequent years? Does recovery take place exceeding the March value, rendering the initial estimate as flawed? More next month.

Mc Sep-06	Mc Mar-08	Diff	Layer Thick	Shrink	WSF	TOTAL
37	55.9	18.9	0.5	9.45	2.3625	**9.8963**
43.8	53.3	9.5	0.2	1.9	0.475	
44.2	56.6	12.4	0.2	2.48	0.62	
44.3	58.1	13.8	0.225	3.105	0.7763	
40.1	56.3	16.2	0.25	4.05	1.0125	
38.3	48.1	9.8	0.25	2.45	0.6125	
39.9	54.2	14.3	0.25	3.575	0.8938	
38.7	50.4	11.7	0.25	2.925	0.7313	
31.6	52.9	21.3	0.25	5.325	1.3313	
34	51.3	17.3	0.25	4.325	1.0813	

Estimating swell using neutron probe moisture content readings taken in September 06 and comparing with March 2008 readings using a WSF of 4.



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COVID – Promoting Remote Assessment

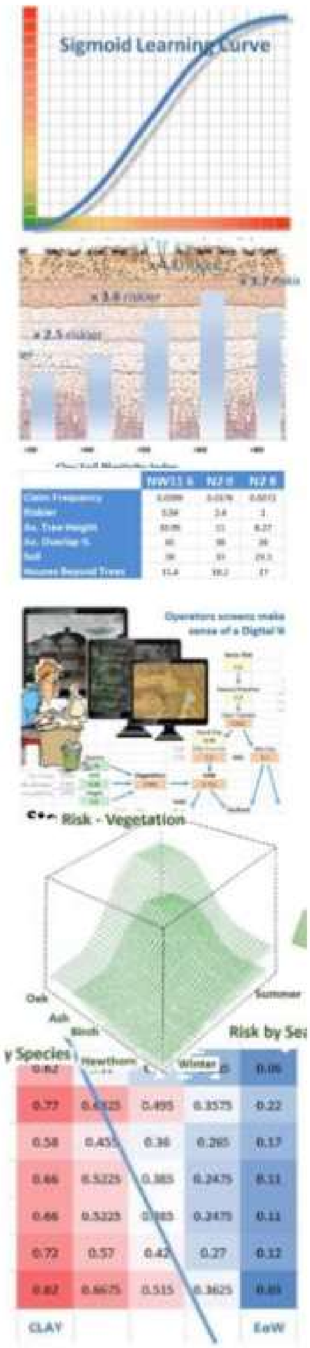
COVID is driving change. Many adjusters are adopting the remote assessment of claims, asking homeowners that are comfortable with technology to take photographs of damage before carrying out a desktop review.

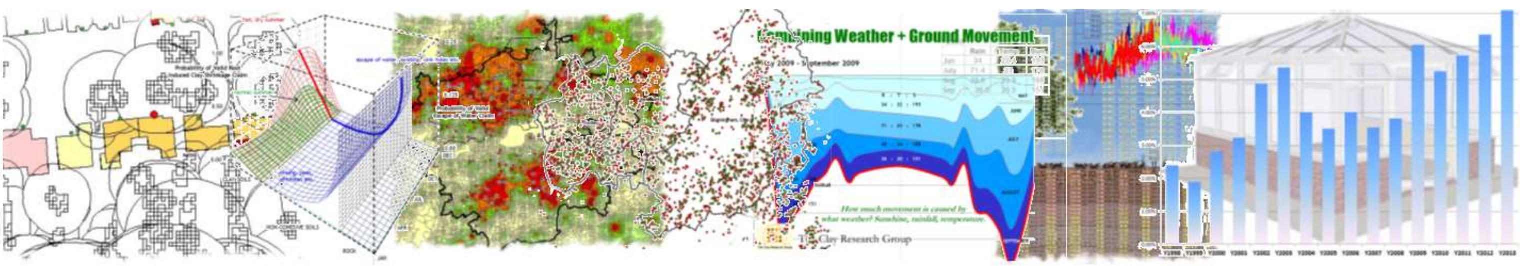
The computer screens on this page illustrate how we can view the property from our desk using Google Street View, and then review the BGS maps on-line before pressing the button to trigger a system evaluation of the potential risk.

The answer is rarely 'yes' or 'no' due to the vagary introduced by trees, climate and soils, but it can make intelligent assessments in much the same way as an engineer – after all, the input has been taken from engineers assessments and outcomes. The approach helps the claims handler determine what happens next - full site investigation, monitoring and/or drainage investigations etc.

The system needs a memory of what has gone before. Have past claims in the locality with similar patterns of damage and timing been caused by an escape of water or clay shrinkage? Has there been a seasonal element? Was there a rapid increase in claims in a dry year?

The next stage will be building more sophisticated Ai systems, incorporating the Sigmoid function to account for change over time and pattern matching. The COVID virus is driving change, but at a high cost.





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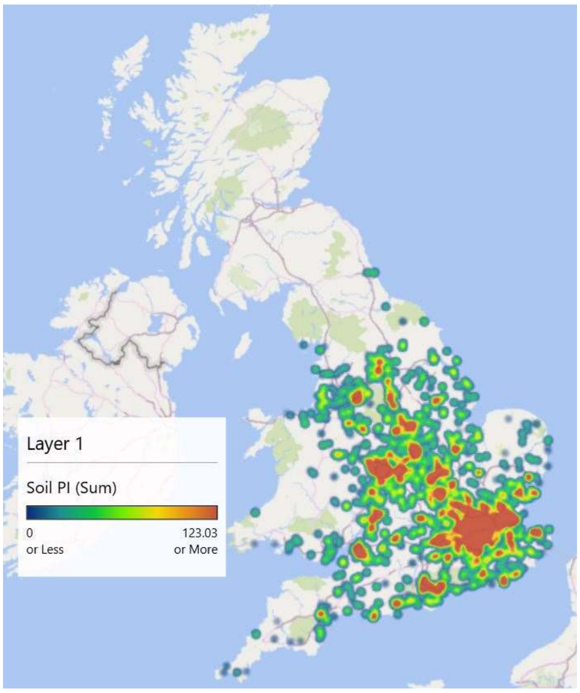
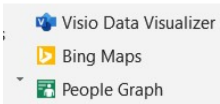
Access a Geographic Information System in MS Excel

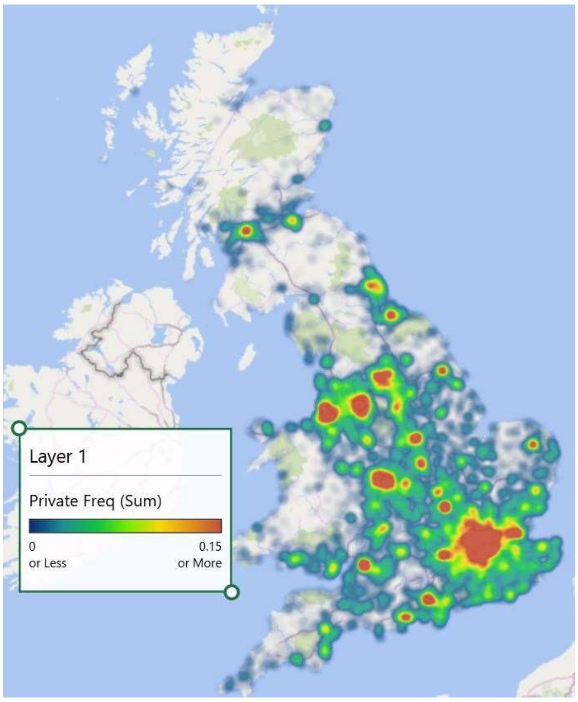


Presenting data in map form is far easier to understand than the raw figures, but Geographic Information Systems can be expensive and a little difficult to use so why not try the MS Office Excel application instead?

Just select your data as shown right and then select the 'Insert' tab and press 'Bing Maps' – see below.

	Sector	Total Claims	Soil PI
27	CT6 6	50	63
28	NW7 2	50	63
29	NW2 3	58	63
30	HA1 4	62	63
31	CT6 7	75	63
32	PO17 5	5	64
33	RG31 5	18	64
34	PE11 3	25	64
35	CO13 0	30	64
36	NN9 6	42	64
37	HA7 4	46	64
38	BR5 1	65	64
39	CT3 4	14	65

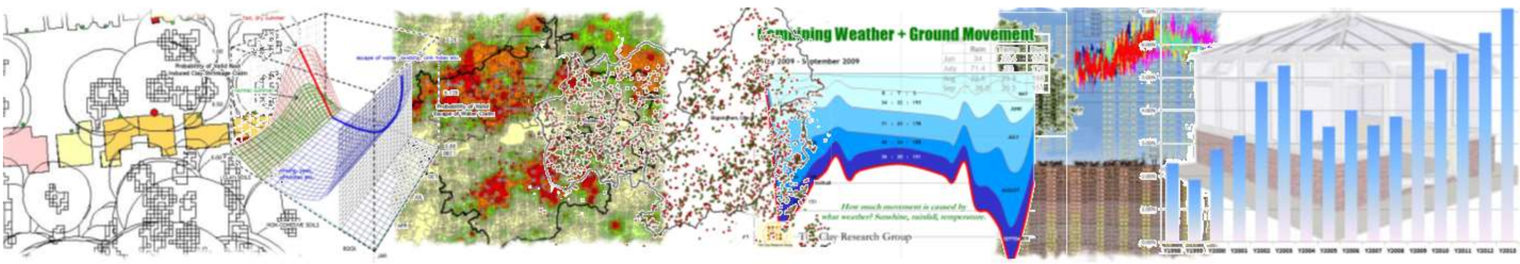




To open the Bing map application and select the data you would like to plot.

The maps on this page show the results for Soil PI (above) and frequency of subsidence claims across the UK (left) from a sample.

The link between them is immediately obvious. Although this could be achieved statistically by undertaking correlation analysis, visualising the various hotspots provides far greater understanding of exactly what is happening and where.



Clay Shrinkage Research Papers - Abstracts from 2020

Behaviour of Discrete Piles used to Stabilise a Tree-covered Railway Embankment

Joel A. Smethurst* Nicola Bicocchi† William Powrie* Anthony S. O'Brien

Geotechnique, Volume 70, Issue 9, September, 2020

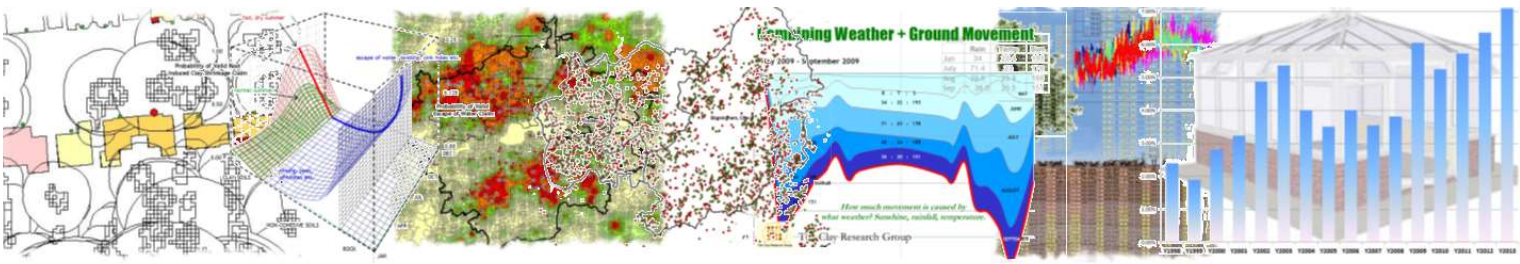
Our colleagues from Southampton University (Dr. Joel Smethhurst and Prof. Powrie were involved with the CRG research project at Aldenham) look at the problem of railway embankments and attempts to stabilise them using piles, often placed mid-slope. In the above paper they record field data from 9m deep piles in an embankment at Mill Hill in north London. They found that moisture contents were at a reduced level throughout the year due to the presence of trees. The trees were therefore beneficial and were retained to help maintain slope stability. They sum up their findings as follows, "The piles initially bent upslope, as a result of inward shrinkage of the embankment over a period of dry weather, before then being loaded by shallower downslope movements of the clay. Later cycles of seasonal movement caused a small but gradual ratcheting upward of pile bending moments. The largest bending moments measured over 6 years of monitoring were those resulting from the initial inward shrinkage of embankment, which reached about 25% of the design capacity of the piles. At the end of the monitoring period, the measured bending moments resulting from shallower downslope ground movements were about 20% of the pile design capacity."

Electrokinetic Treatment of Desiccated Expansive Clay

Omar Hamza* Jamie Ikin

Geotechnique, Volume 70, Issue 5, May, 2020

This paper explores seasonal clay shrinkage and heave potential on shallow foundations, using electrokinesis to stabilise moisture content. "This study explores a system that could be operated during prolonged drought periods to rehydrate and neutralise the negative pore pressures of expansive clay, avoiding the development of excessive desiccation. The hypothesis presented is to reverse the electrokinetics process by extracting water from a saturated stratum below the groundwater level and force it into the 'early-stage' desiccated area, accelerating rehydration and reducing suction." After draining the soil for 23 days to reach a moderate desiccation state, water was allowed into the lower part of the soil while applying the EK treatment using nine electrodes, placed in a radial pattern and inserted 110 mm into the soil with approximately 30% of their lengths below the water level. As a result of the electro-osmotic process, the average moisture content increased in the model by more than two-fold within 8 h. The suction measurement (taken in the middle of the desiccated area) showed an initial slow response followed by fast and consistent reduction rate, where suction dropped by 93% within 5 h and ultimately down to 1 kPa at the end of the treatment."



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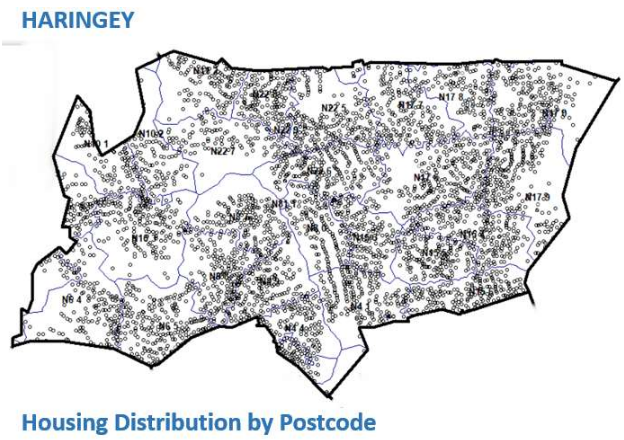
Subsidence Risk Analysis – Haringey

Haringey occupies an area of around 30km^2 with a population of around 270,000. The district was originally covered in the May 2011 edition (Issue 72) of the CRG newsletter. It is re-visited here to bring it in line with the current series and allow district/sector comparisons of subsidence risk.



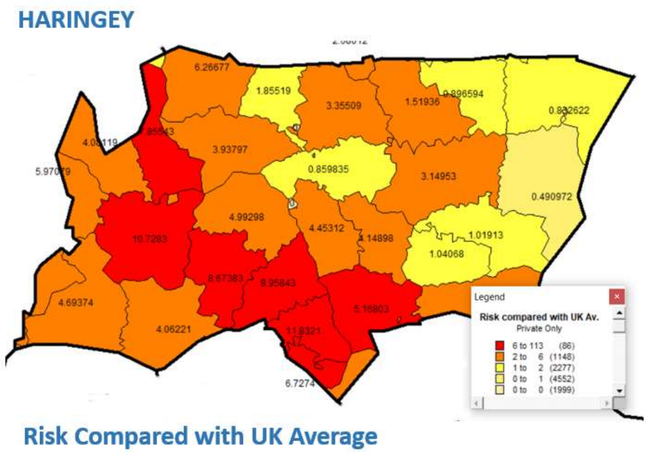
Distribution of housing stock using full postcode as a proxy. Each postcode in the UK covers on average 15 – 20 houses, although there are large variations.

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?

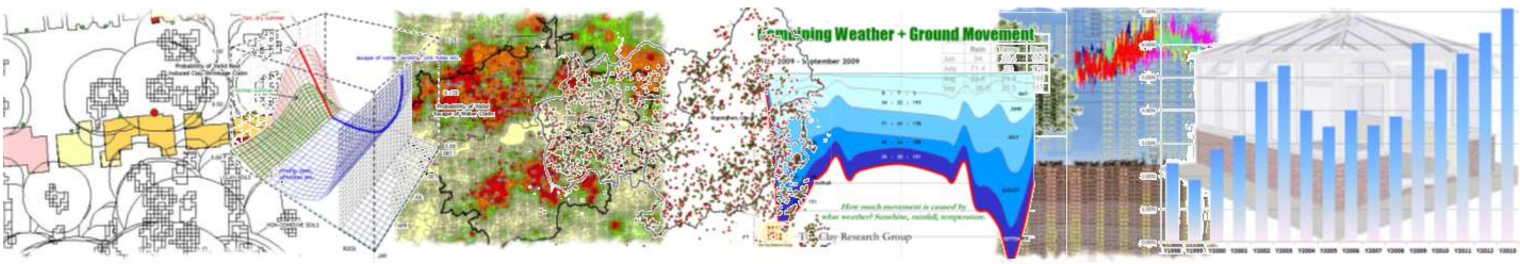
Using a frequency calculation (number of claims divided by private housing population) the relative risk across the borough at postcode sector level is revealed, rather than a 'claim count' value.

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

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



Haringey is ranked as a high risk in the UK in terms of 'risk by district' for domestic subsidence claims from the sample analysed. Above, values at postcode sector level compared with UK average.



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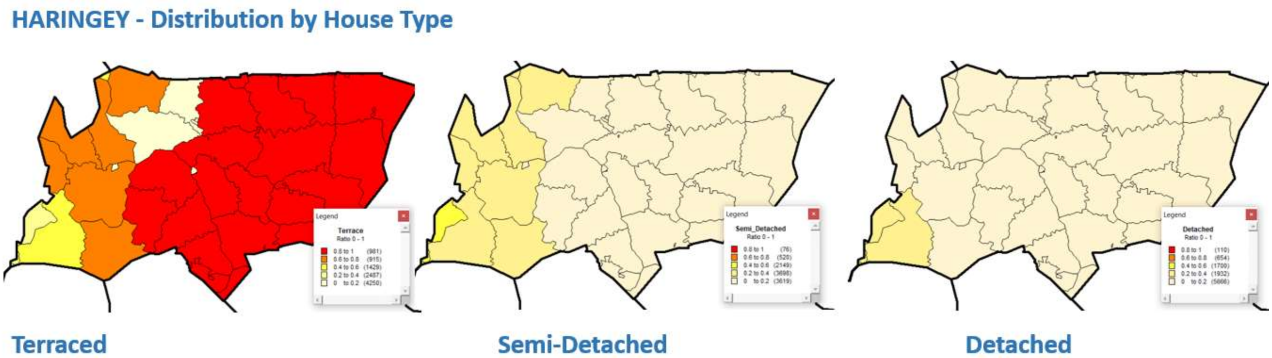
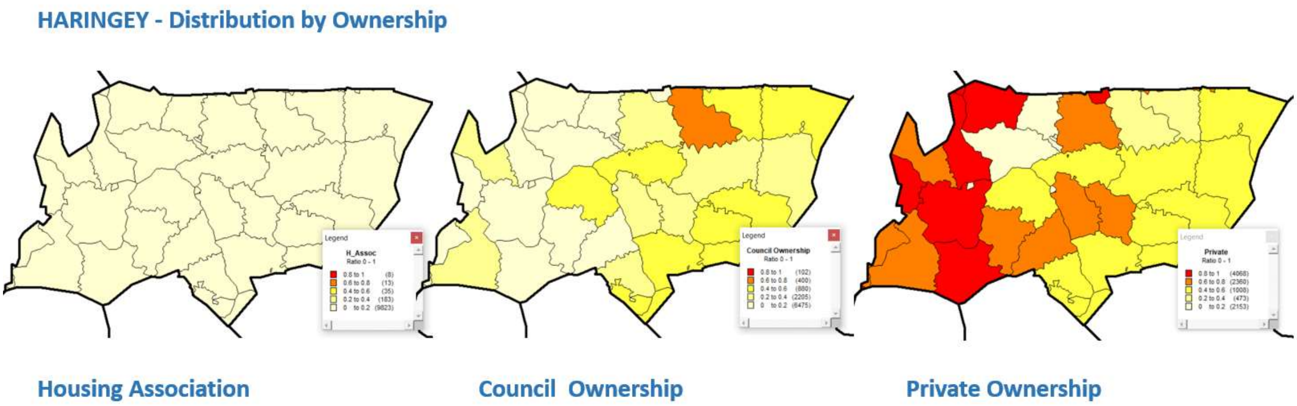
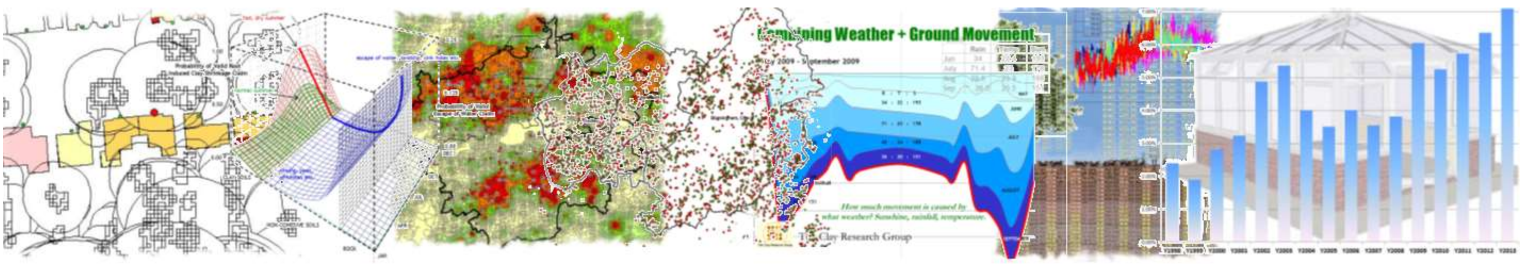
HARINGEY - Properties by Style and Ownership

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.



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





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Subsidence Risk Analysis – HARINGEY

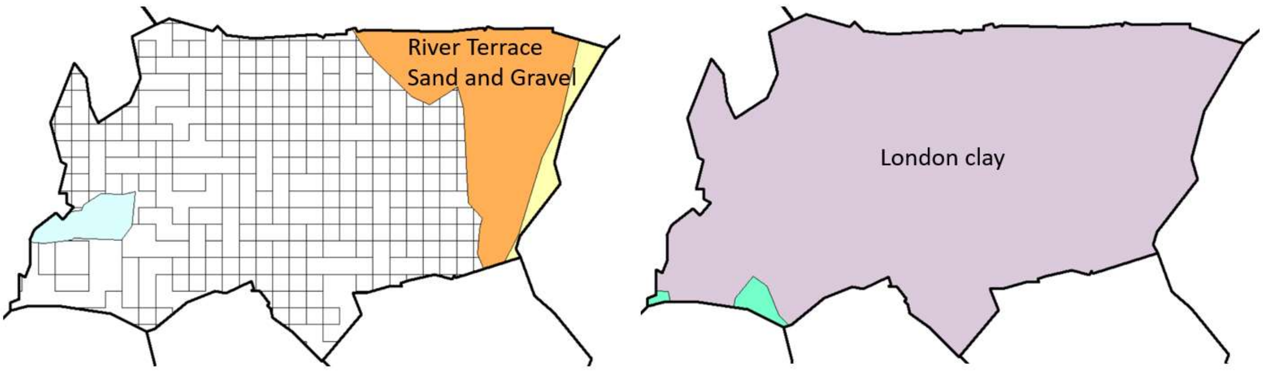
Below, extracts from the British Geological Survey low resolution 1:625,000 scale geological maps showing the solid and drift series. View at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html for more detail.

See page 12 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%.

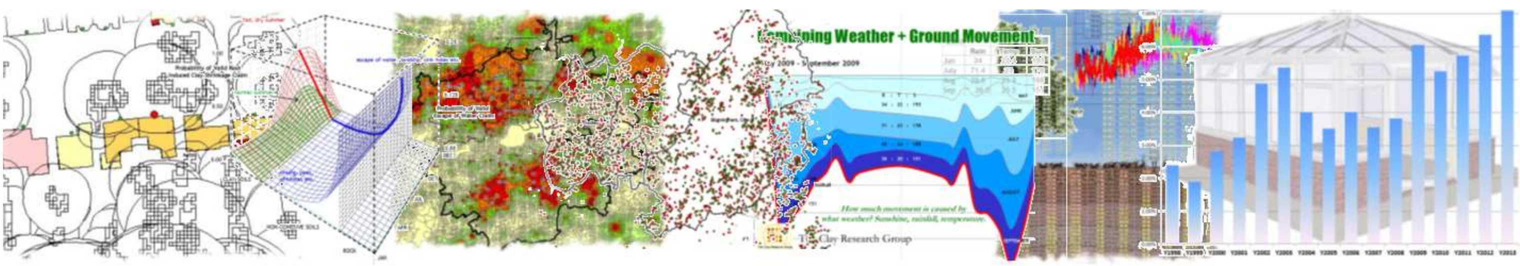
The analysis reflects the influence of the underlying clay series and the apparent shallow thickness of the superficial deposits.

HARINGEY : BGS Geology – 1:625,000 scale



DRIFT DEPOSITS

SOLID GEOLOGY



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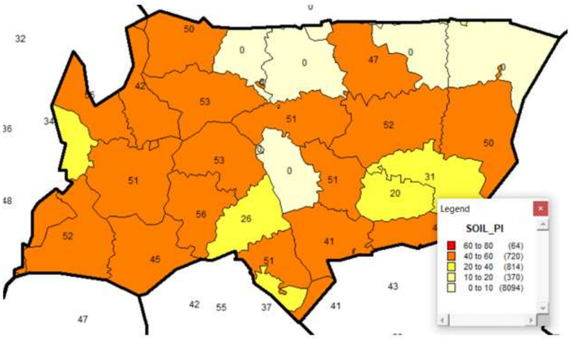
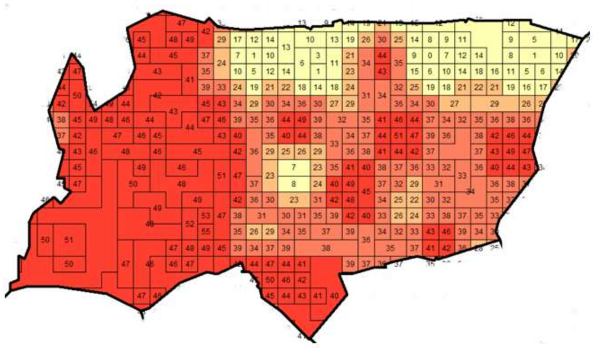
Geology and Liability by Season

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.

HARINGEY – Soil Plasticity Index



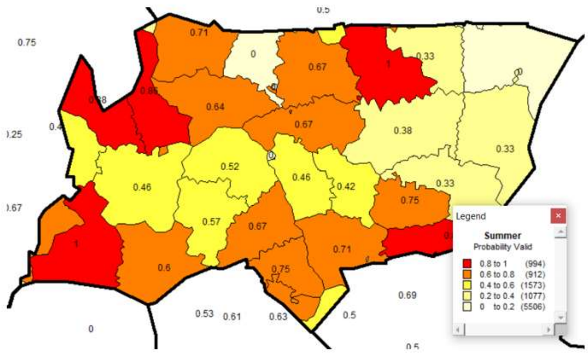
Soil PI Averaged by Sector



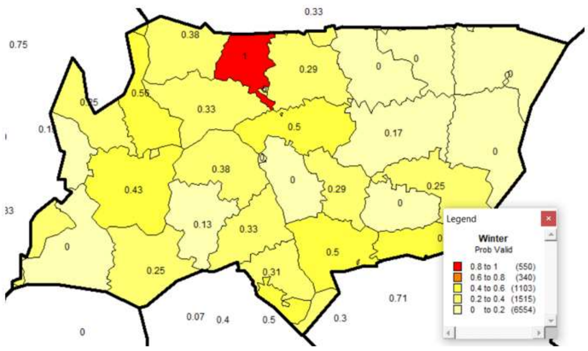
PI Interpolated on 250m CRG grid

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.

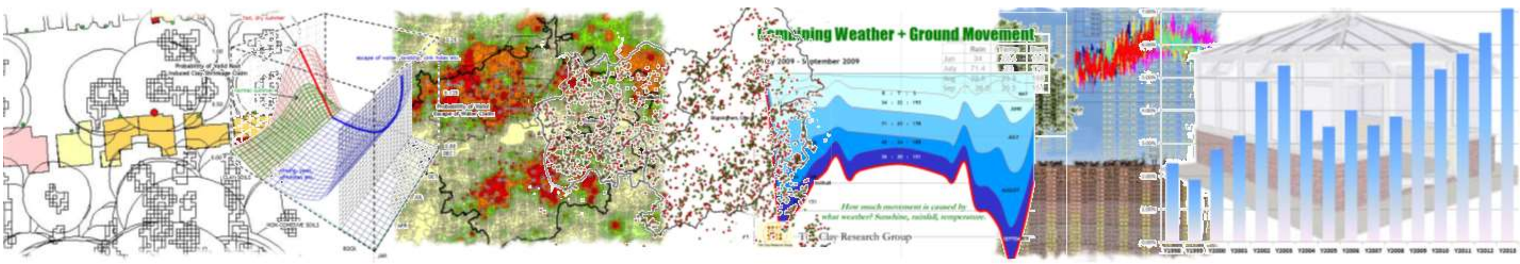
HARINGEY



Probability Valid, Summer



Probability Valid, Winter



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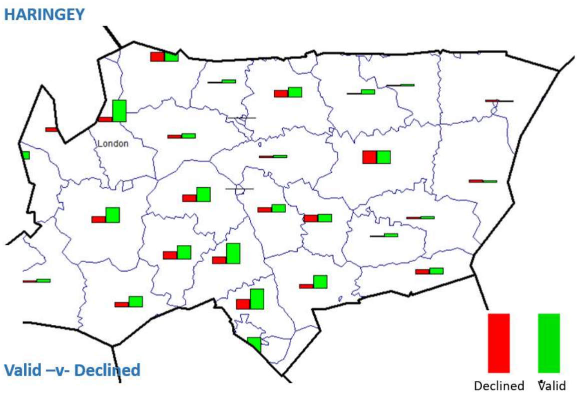
District Layout. Liability, EoW and Council Tree Risk.

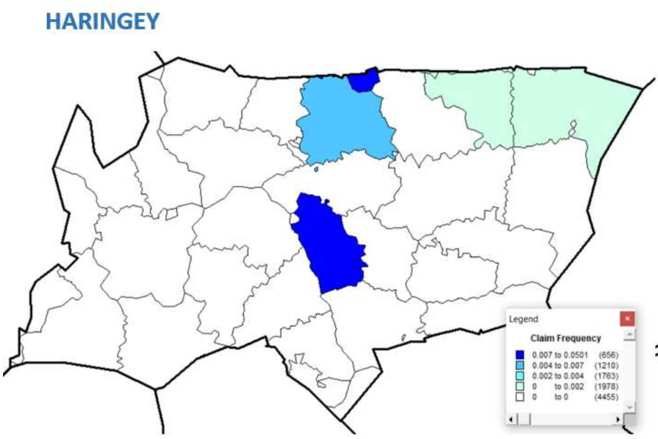


Left, annual valid-v-declined data which changes significantly when considering seasonal data – see page 10.

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.

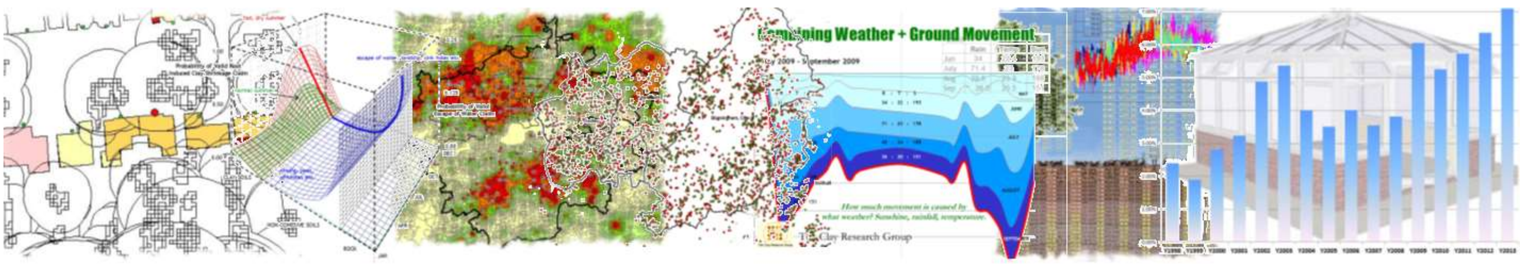
In this study, risk values are often based on small housing population densities.

Below, left, mapping the frequency of escape of water claims from the sample reflects the presence of the non-cohesive drift deposits (sands and gravels). 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
(2,700 claim sample)



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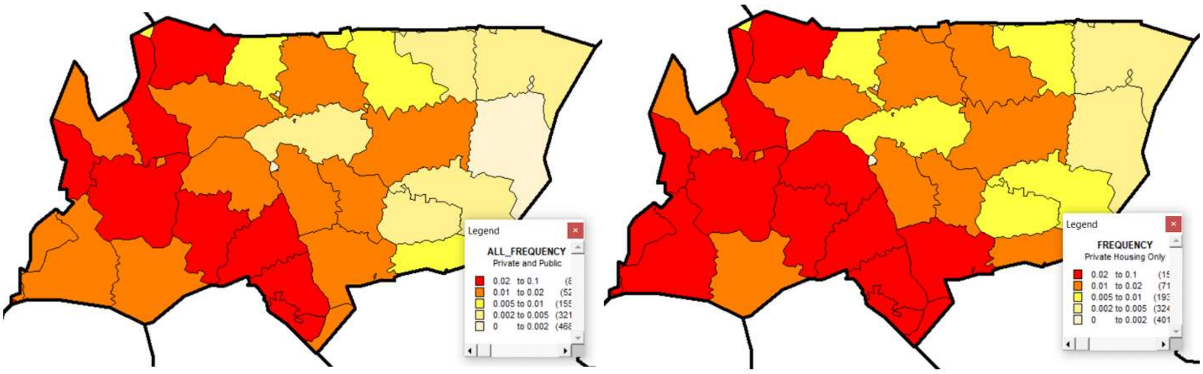
HARINGEY - Frequencies & Probabilities

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.

HARINGEY - Postcode Sector Subsidence Risk (frequency) by Ownership



Combined Public and Private Frequency

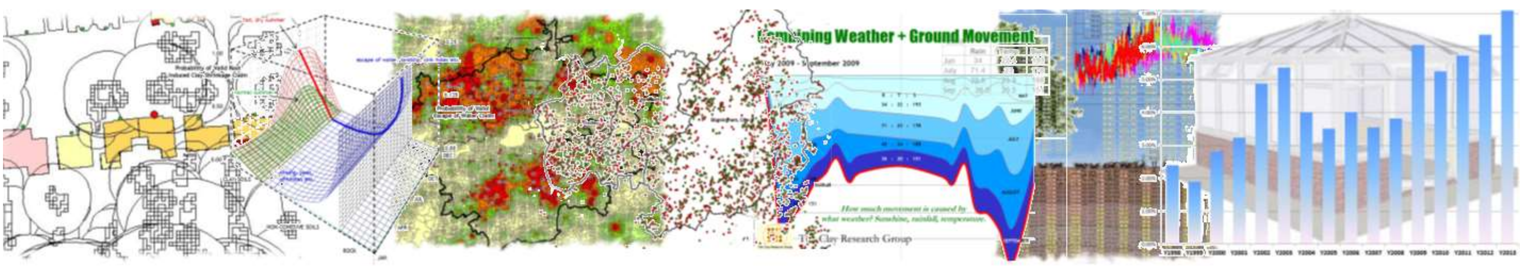
Private Only

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 - BRENT

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Brent	0.760	0.026	0.214	0.01	0.16	0.83



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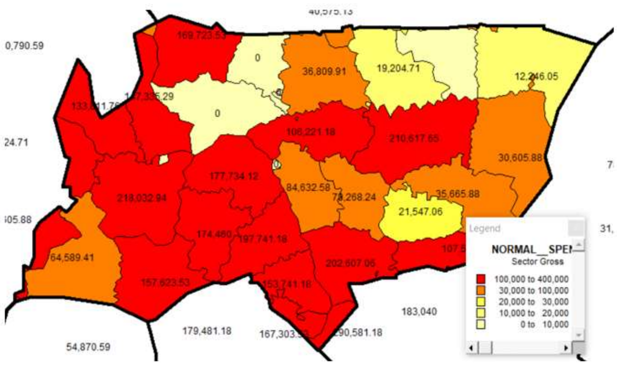
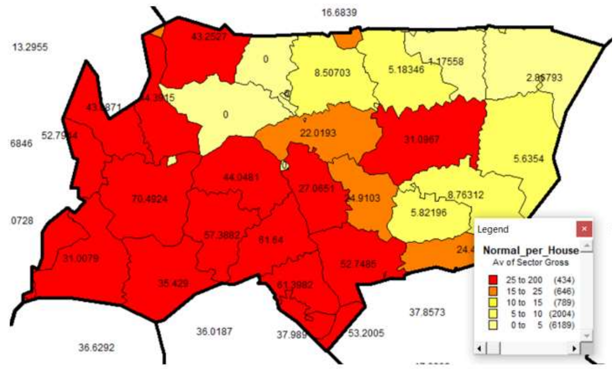
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

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 – HARINGEY

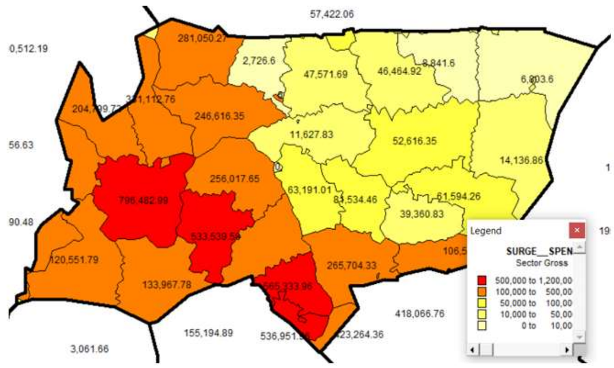


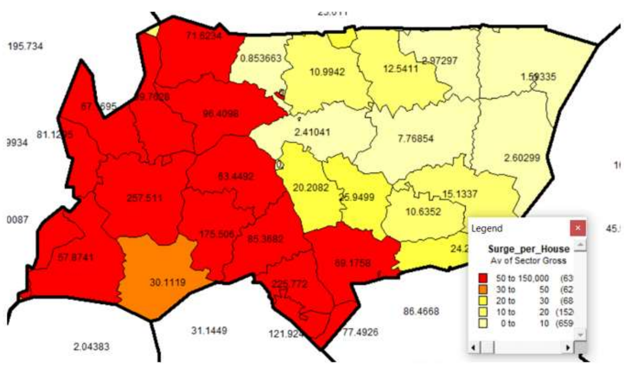


Spend by Sector **Spend Averaged over Housing Population**

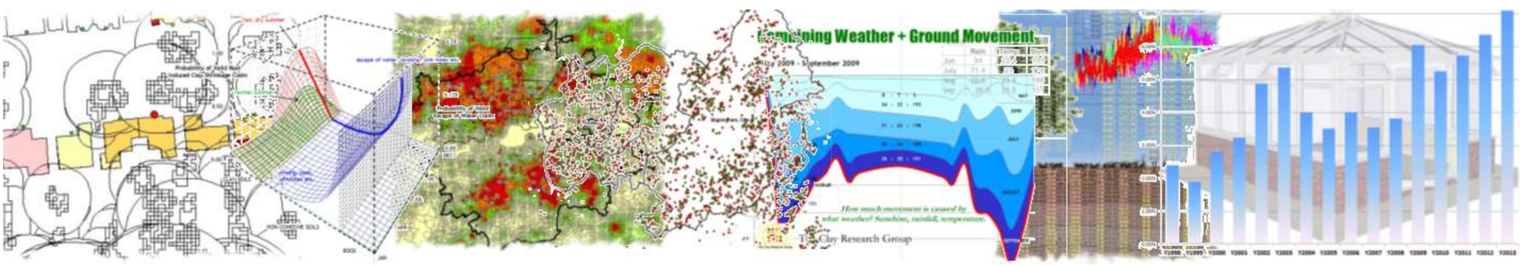
It will also be a function of the distribution of vegetation and age and style of construction of the housing stock. The images to the left in both examples (above and below) represent gross sector spend and those to the right, sector spend averaged across housing population to derive a notional premium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

SPEND in SURGE – HARINGEY





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



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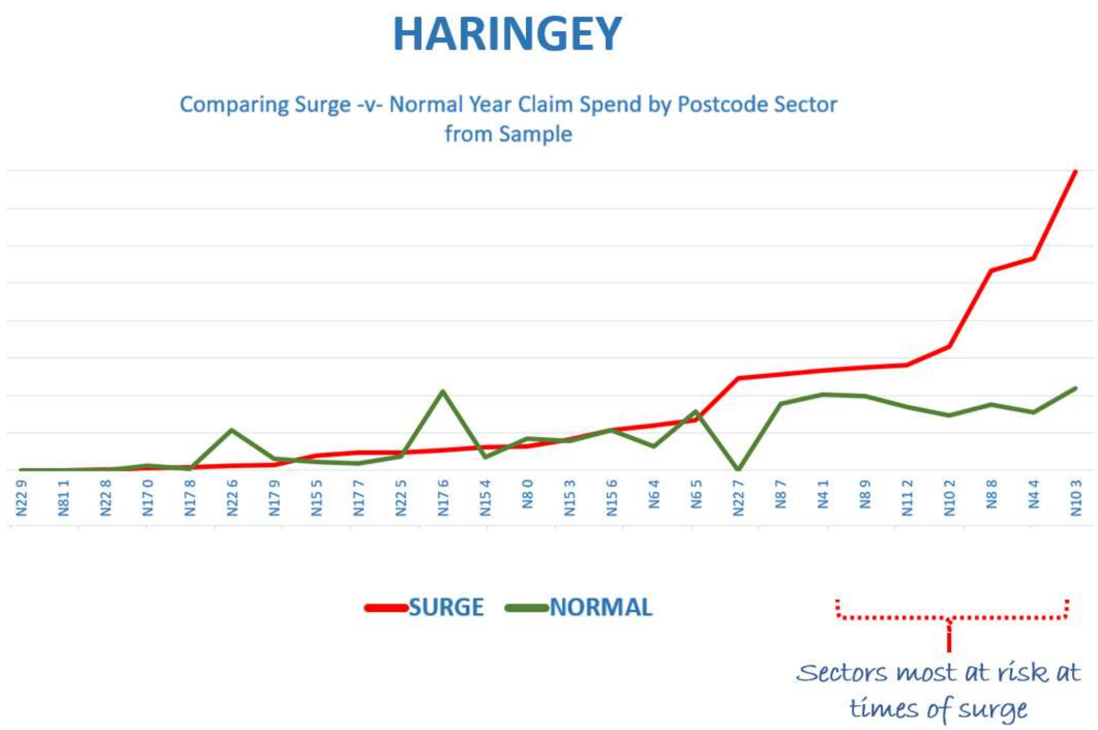
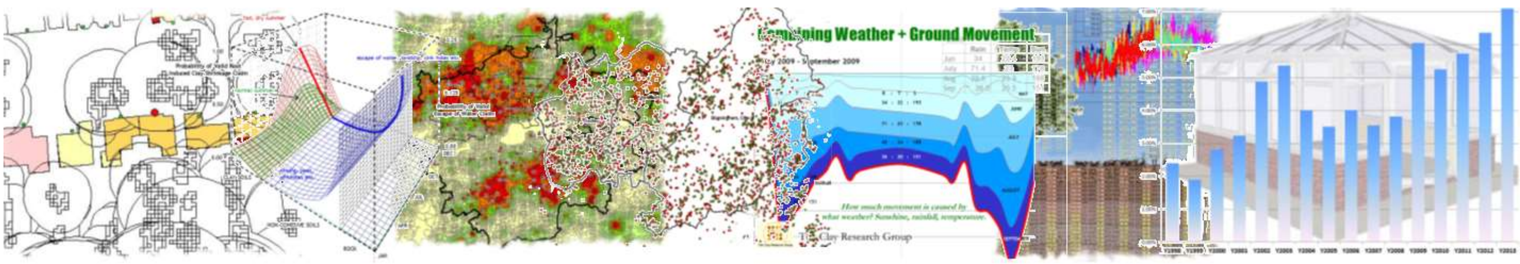


The above graph identifies the variable risk across the district at postcode sector level, distinguishing between normal and surge years. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

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.



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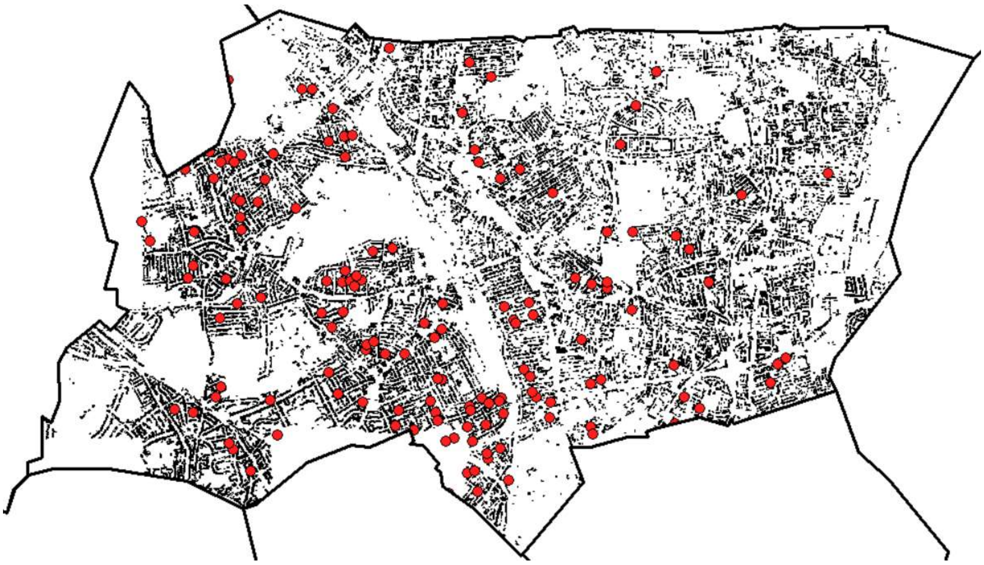
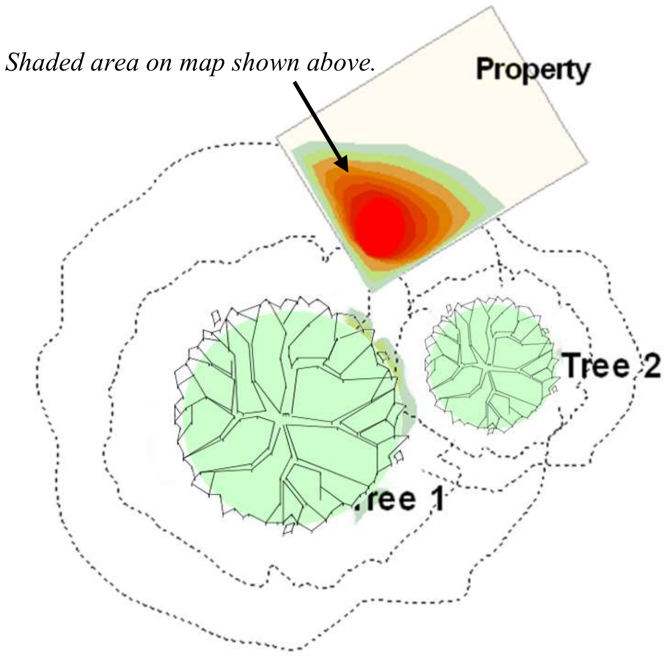
Modelled Root Overlap – Public and Private Trees

Below, a map showing the modelled root encroachment beneath domestic properties (grey shading) in the district of Haringey using a value of 1.2 x the tree height. Red dots indicate valid, root induced clay shrinkage claims from the sample we hold.





The above map plots the shaded area beneath the properties – see left for the methodology. The root zone radius is 1.2 times the height of the tree.