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

August 2021
Issue 195

The Clay Research Group

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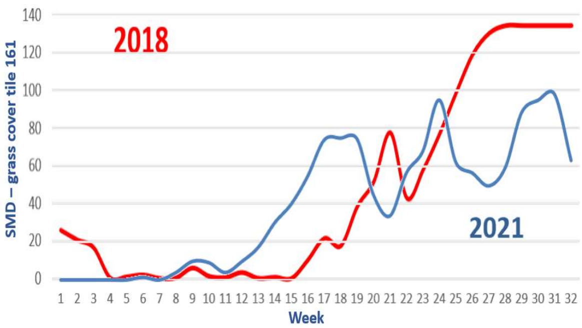
Soil Moisture Deficit

Below, the SMD for grass cover recorded in the south east of England at tile 161 of the Met Offices UK grid records the effect of regular periods of heavy rainfall. The Soil Moisture Deficit is quite low (i.e. the ground is wetter than we would expect for a surge year) for both grass and tree cover even though there have been record temperatures with spells of warm, dry weather.



A third quarter surge of the sort experienced in 2018 (red line in above graph) seems unlikely.

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2020 Climate Update

The Met Office report that 2020 was both warmer and wetter with a record temperature of 37.80C recorded at Heathrow weather station on the 31st July 2020 - *"the UK's climate has continued to warm, with 2020 the first year to have temperature, rain and sunshine rankings all in the top 10."*

2020 Claim Number Revision

Thanks to Richard Rollit, Subsidence Director of Innovation Group, for drawing our attention to updated domestic subsidence claim numbers issued by the ABI last week.

Figures for the last quarter of 2020 have been amended from 27k to 19k, delivering an average settled cost for the year of £6,579.

Subsidence Forum Training Day

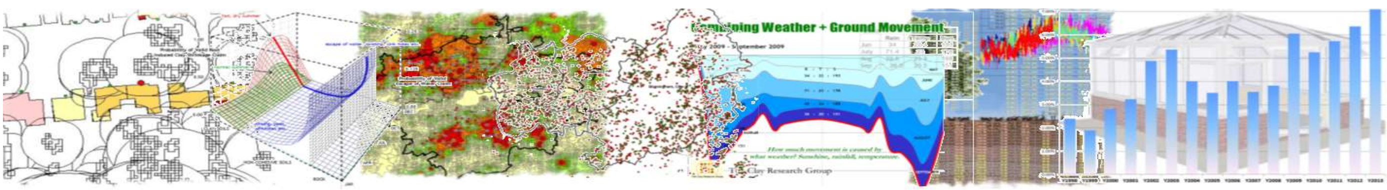
The Subsidence Forum are arranging a series of webinars to take place on the 1st, 8th and 15th October. Please check their web site at:

https://www.subsidenceforum.org.uk/events-seminars/

Contributions Welcome

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

clayresearchgroup@gmail.com



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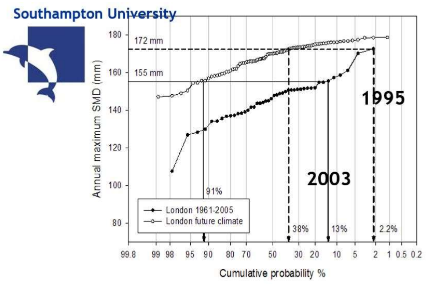
SUBSIDENCE - MODELLING FUTURE RISK

Last month's edition outlined the work undertaken to model the risk associated with climate change. Current data suggests increased warming and rainfall.

An earlier study by our colleagues at Southampton University under the leadership of Professor Powrie suggested that in a hundred years' time, every year could resemble a surge year.

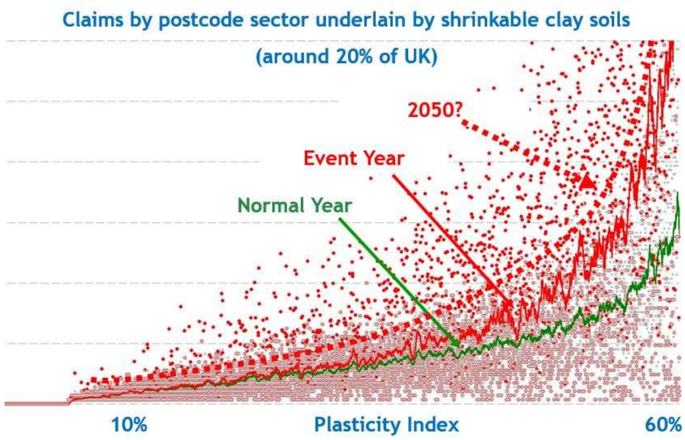
Climate Change -v- Subsidence Risk



"Expected changes in frequency of maximum summer soil moisture deficit for London (Heathrow), 1961-90 and 2100-2090, for grass/shrub cover, and medium-high emissions scenario"

Right, estimating the impact of future warming in terms of possible claim numbers based on past experience, by location. Profiles of the magnitude of claims looking at postcode sectors on shrinkable clay soils – those with a PI greater than 10%.

The trendline plots the frequency of claim numbers for those postcode sectors on clay soil (covering around 20% of the UK) as mapped using interpolated data from investigations undertaken.



The apparently random scatter of dots records claim numbers by postcode and the trendline represents frequency – the number of claims divided by the private housing population.

Modelled Root Overlap - TQ29

2099	22%	1%	1%	2.50%	3.40%	8%	1%	1%	3.20%	5%
2098	12%	3%	1.50%	0.30%	7%	2%	34%	17%	5.40%	2%
2097	34%	2%	2%	3%	31%	25%	29%	18%	5%	24%
2096	30%	9%	22%	58%	73%	46%	45%	44%	19%	13%
2095	24%	23%	30%	26%	28%	40%	54%	45%	49%	45%
2094	5%	14%	10%	13%	40%	28%	67%	44%	43%	63%
2093	26%	39%	15%	2.70%	15%	52%	74%	49%	34%	53%
2092	48%	51%	39%	36%	16%	73%	98%	54%	57%	58%
2091	43%	44%	30%	30%	36%	83%	57%	30%	31%	48%
2090	52%	82%	24%	34%	99%	86%	48%	26%	86%	62%
	2090	2190	2290	2390	2490	2590	2690	2790	2890	2990

This data can be transposed onto the 250m grid discussed in the last edition, improving the resolution and allowing adjustment for prevailing weather conditions.

Left, tree data - canopy density for OS tile TQ29 shown left, together with height, distance, modelled root overlap enhances the risk analysis.

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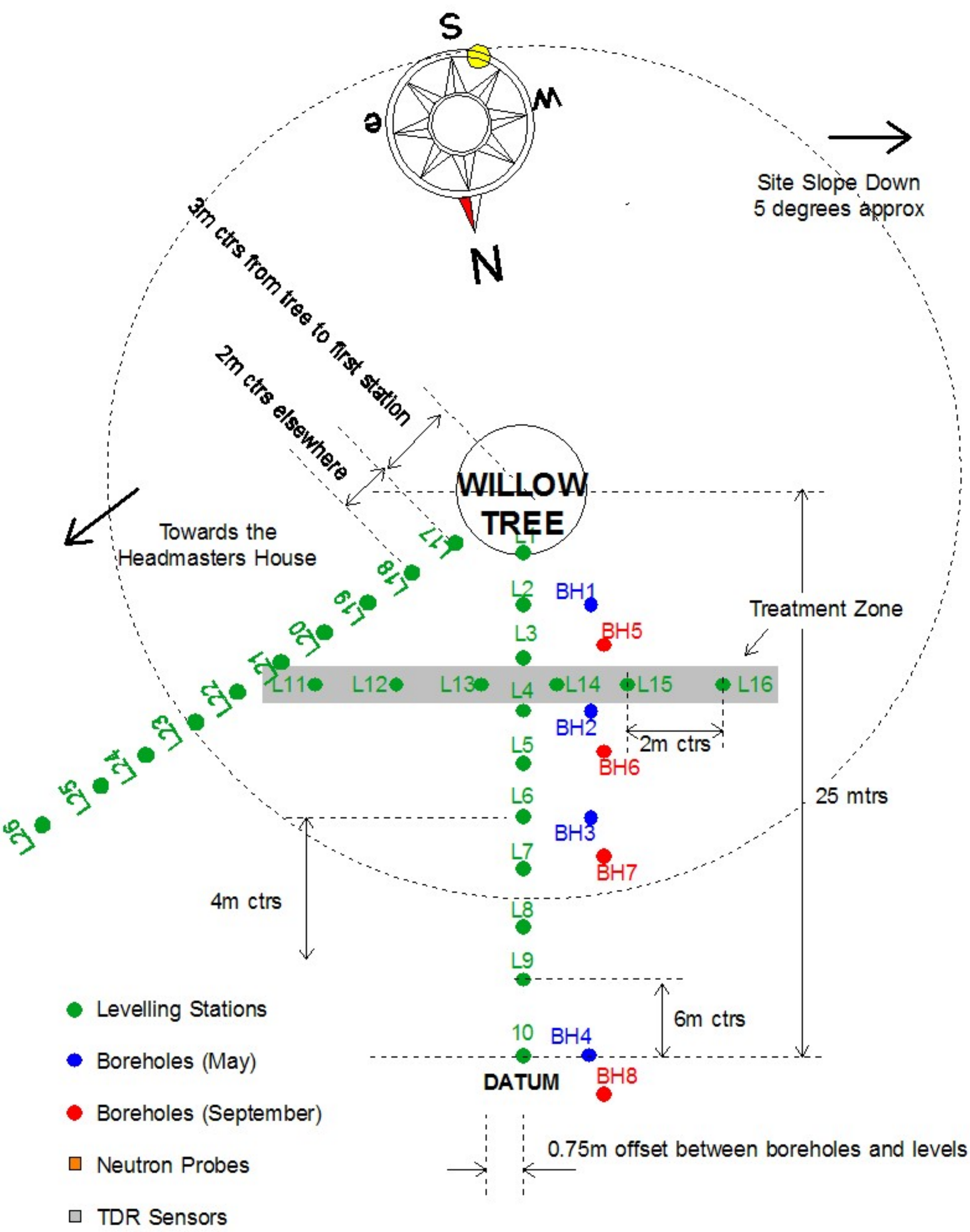
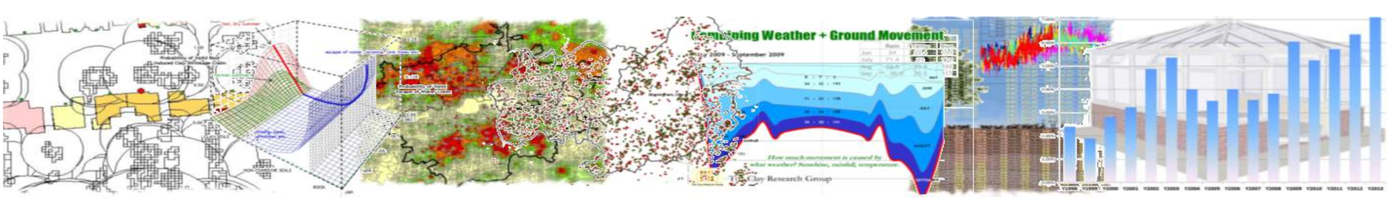
Ground Movement by Month – the Aldenham Willow

Just how variable was ground movement resulting from water uptake across the root zone of the Aldenham willow? On the following two pages we plot movement that took place from 25th May 2006 through to 25th January 2007 for the levelling stations shown below. Precise levels were taken by GeoServ Limited and funded by Crawford & Company.





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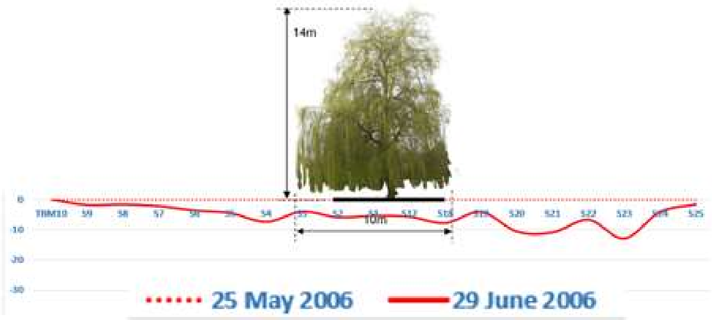
Ground Movement over Time – the Aldenham Willow



The images, left and on the following page, reveal ground movement at the site of the Aldenham willow using precise levels month-by-month for the period May 2006 – January 2007.

Solid lines indicate levels for the month noted. Dotted lines indicate the previous month's profile.

Little movement is recorded in May – maximum value = 12.9mm at station 23.

In July, maximum movement = 42.8mm from the start position in May – 29.9mm over the month.

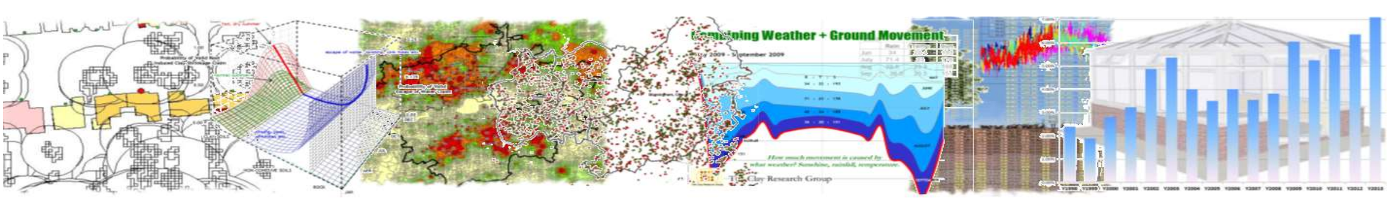
Movement in August is less at 10.7mm and in September, 4.7mm.

Total movement at station 23 from May to the end of September = 58.2mm.

ly regular pattern throughout the year.

y from October onwards.

Next month, ground movement in a year with fewer recorded claims. How does the root system of the Aldenham willow respond to a year with higher rainfall?



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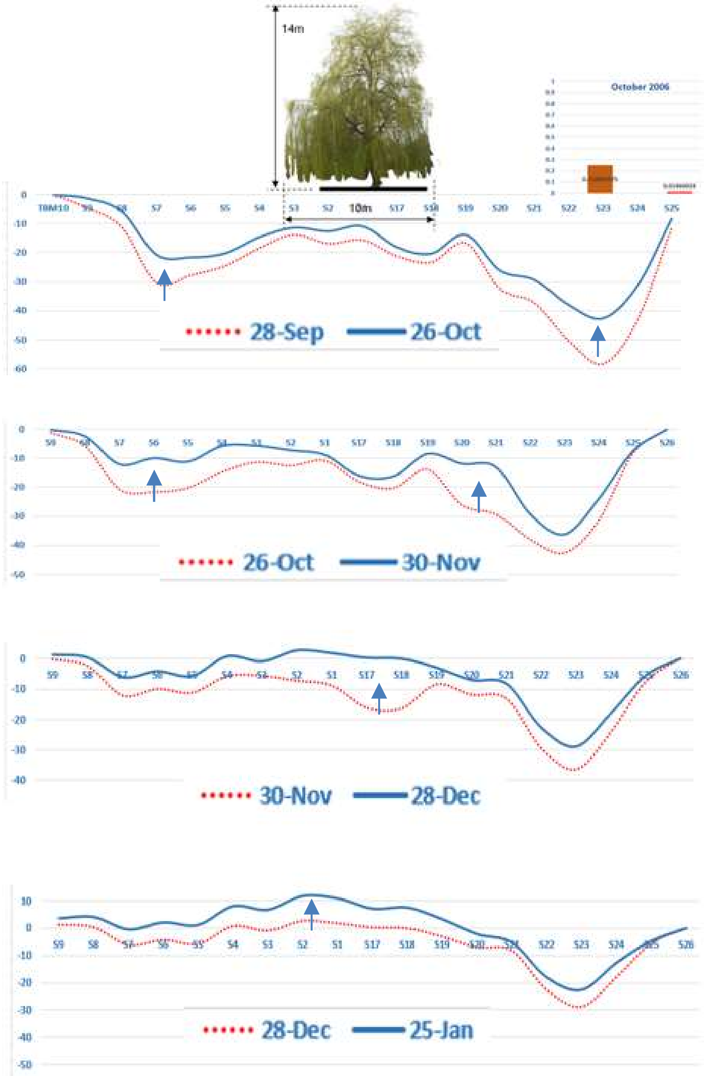
Ground Movement over Time – the Aldenham Willow



Recovery starts in October and again, station 23 delivers the most movement = 15.5mm.

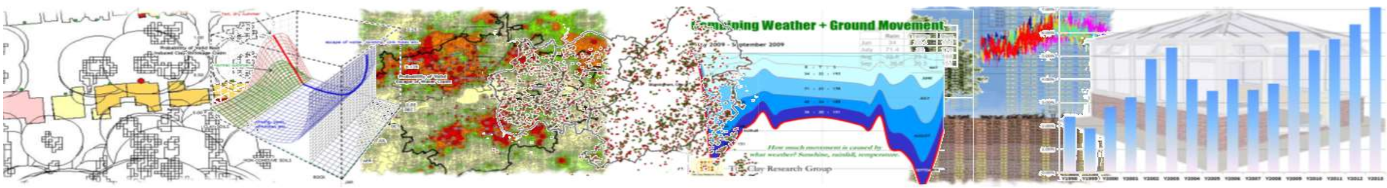
November, December and January see recovery across most stations with those nearest the willow recovering beyond the starting point at the 25th May 2006 indicating that the ground was desiccated when levelling commenced.

Upward movement in the month of January saw station 2 recovering above the initial May 2006 value by 11.8mm.

Maximum recovery in the monitoring term (May 2006 to July 2021) was recorded at station 1 = 39.6mm.

Below, seasonal movement over the duration of the full monitoring term at station 1.

May 2018



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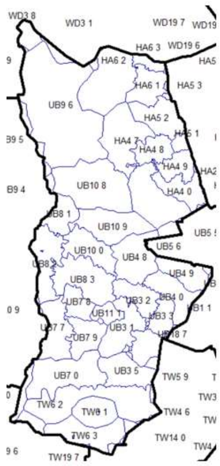
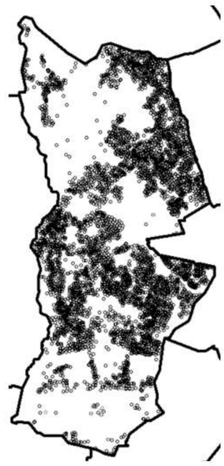
Subsidence Risk Analysis – HILLINGDON

Hillingdon occupies an area of 116km^2 with a population of around 305,000 and was originally covered the March 2014 edition of the CRG newsletter, No. 106. It is re-visited here to bring it in line with the current series and allow comparisons between districts in terms of the risk of subsidence.



Postcode Sectors



Housing Distribution by Full Postcode

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.

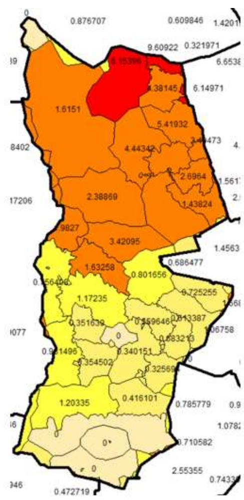
Housing distribution across the district (left, using full postcode as a proxy) helps to clarify the significance of the risk maps on the following pages. Are there simply more claims because there are more houses?

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.

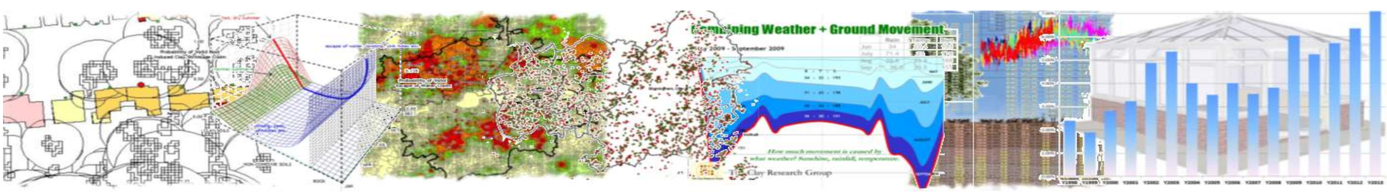
Hillingdon is rated 45th out of 413 districts in the UK from the sample analysed and is around 1.8x the risk of the UK average.

The distribution varies considerably across the borough as can be seen from the sector map.



Postcode Sector Risk Compared with UK Average

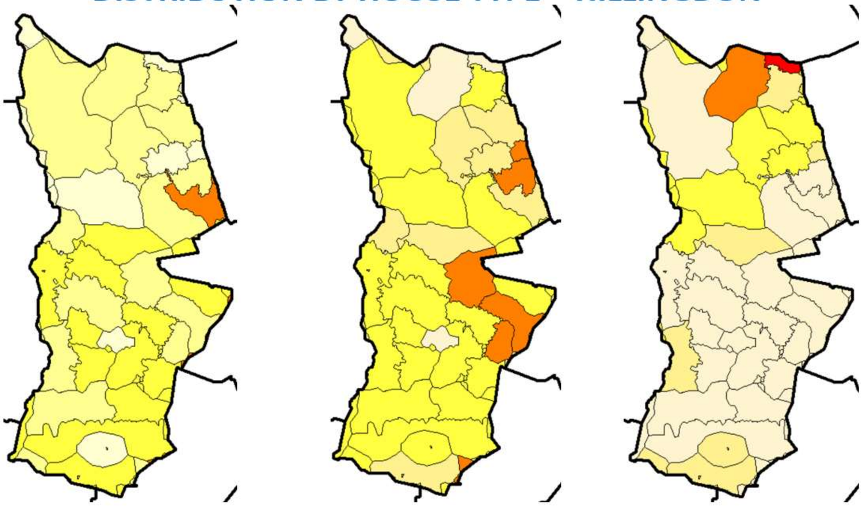
Risk compared with UK Average.
Hillingdon is rated 1.8 times the UK average risk for domestic subsidence claims from the sample analysed based on the high frequency to the north of the borough. Above, values at postcode sector level compared with UK average.



HILLINGDON - 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.

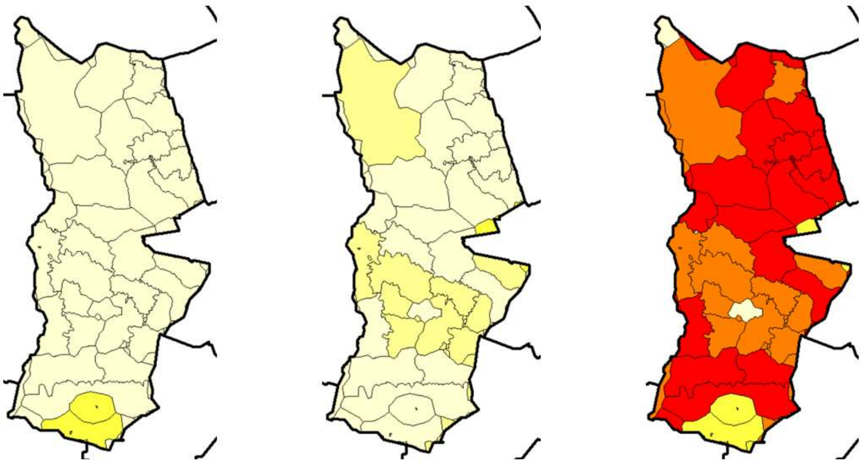
DISTRIBUTION BY HOUSE TYPE – HILLINGDON



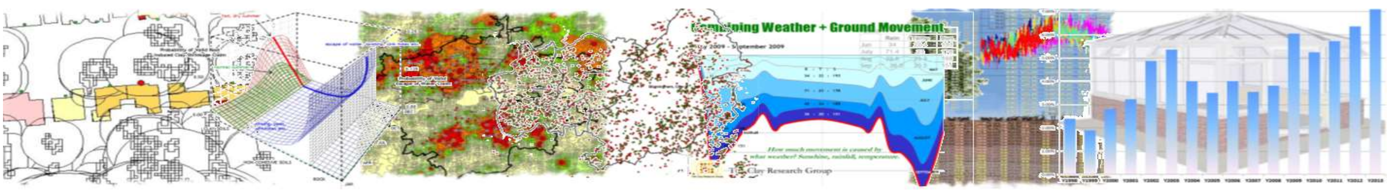
Terraced Semi-Detached Detached

Distribution by ownership is shown below. Privately owned properties are spread across the borough.

DISTRIBUTION BY OWNERSHIP – HILLINGDON



Housing Association Council Ownership Private Ownership



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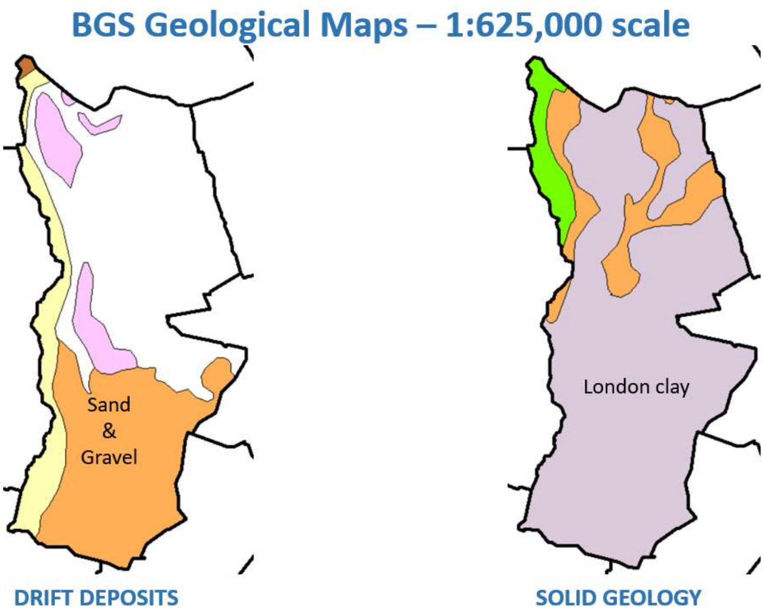
Subsidence Risk Analysis – HILLINGDON

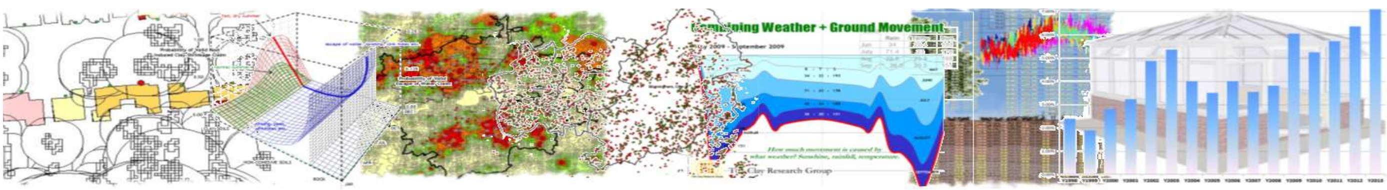
Below, extracts from the British Geological Survey low resolution 1:625,000 scale geological maps showing the solid and drift series. View at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html for more detail.

See page 10 for a seasonal analysis of the sample we hold which reveals that in the summer there is around a 70% probability of a claim being valid, and of the valid claims, there is a high probability (greater than 80% in the sample) that the cause will be clay shrinkage.

In the winter the situation reverses. The likelihood of a claim being declined is around 70% and if valid, there is greater than 80% probability the cause will be due to an escape of water. The maps at the foot of Page 8 show the seasonal distribution.



1:625,000 and 1:50,000 series extract from the British Geological Survey maps. Working at postcode sector and referring to the 1:50,000 series maps deliver far greater benefit when assessing risk.



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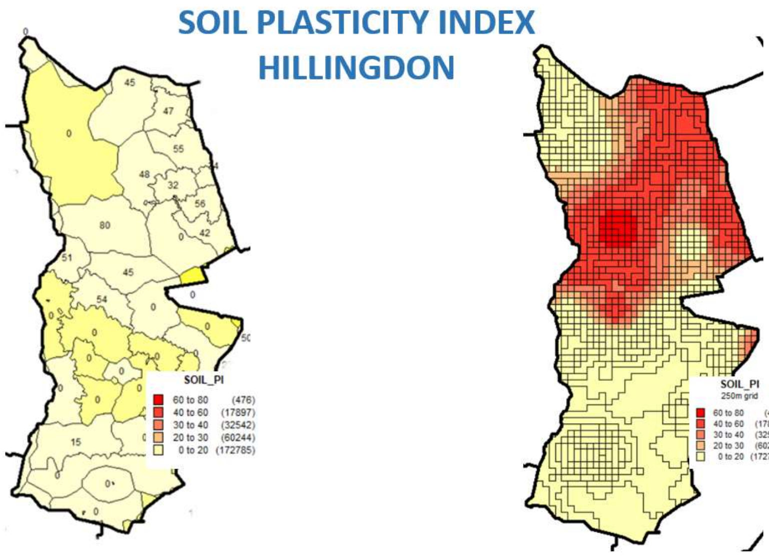
Liability by Geology and Season

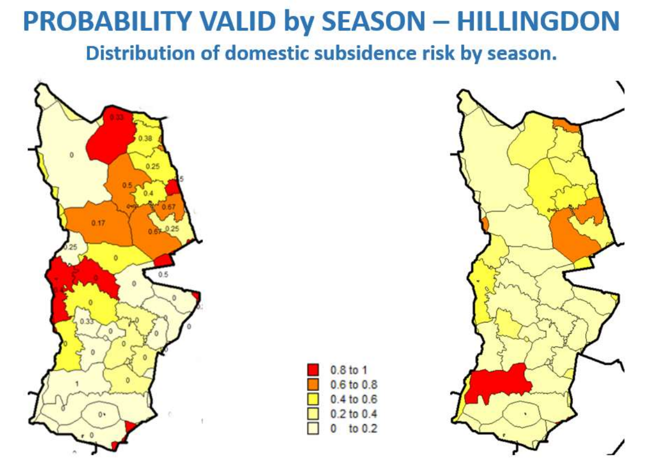
Below, the average PI by postcode sector (left) derived from site investigations and interpolated to develop the CRG 250m grid (right). The presence of a shrinkable clay in the CRG model differs from the BGS maps on the previous page suggesting a variable thickness of drift and higher concentration of clay in some areas. 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.

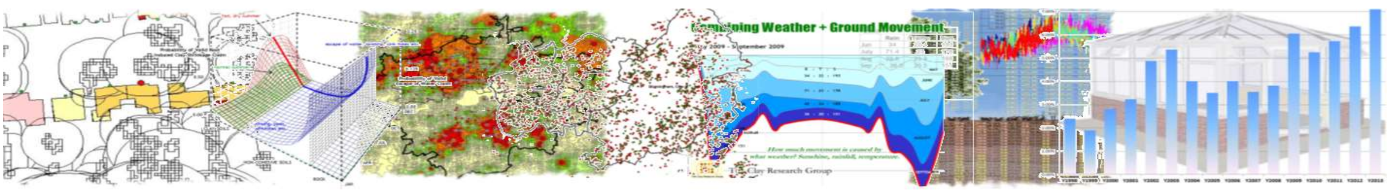


Probability Valid, Summer

Probability Valid, Winter

Mapping the risk by season (table at foot of page 11) is perhaps the most useful way of assessing the most likely cause, liability and geology using the values listed.

The maps left show the seasonal difference from the sample used. An enhanced version using a different approach is shown on the following page.



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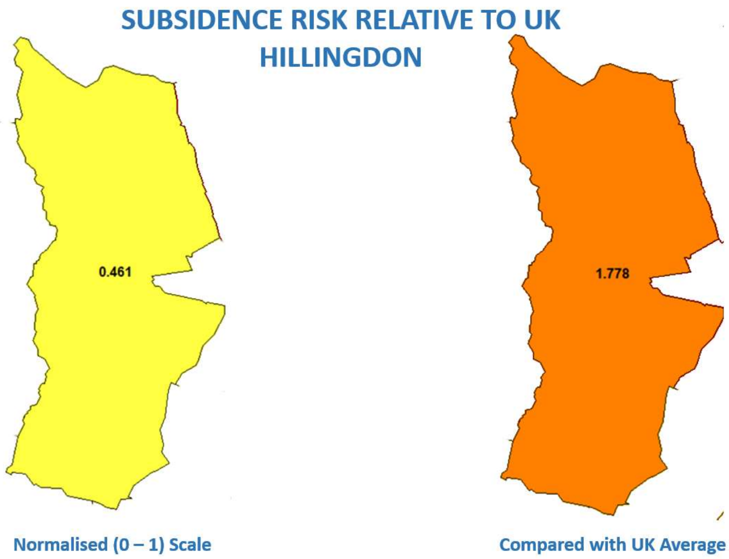
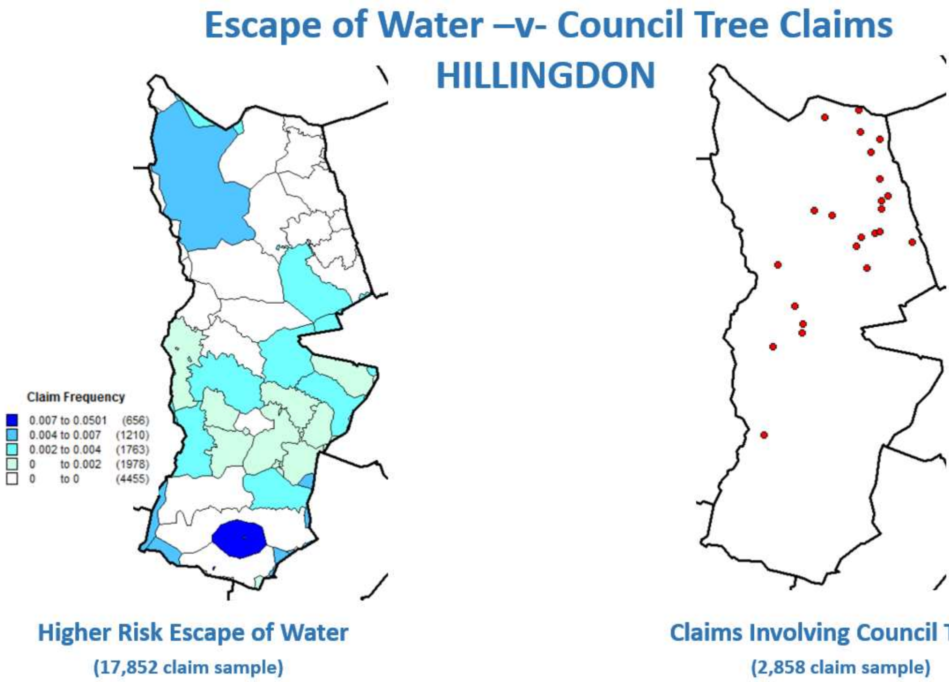
District Risk -v- UK Average. EoW and Council Tree Risk.



Below, left, mapping the frequency of escape of water claims from the sample reflects the presence of drift deposits (sands and gravels etc) to the south of the borough. The absence of shading does not indicate an absence of claims, but a low frequency.

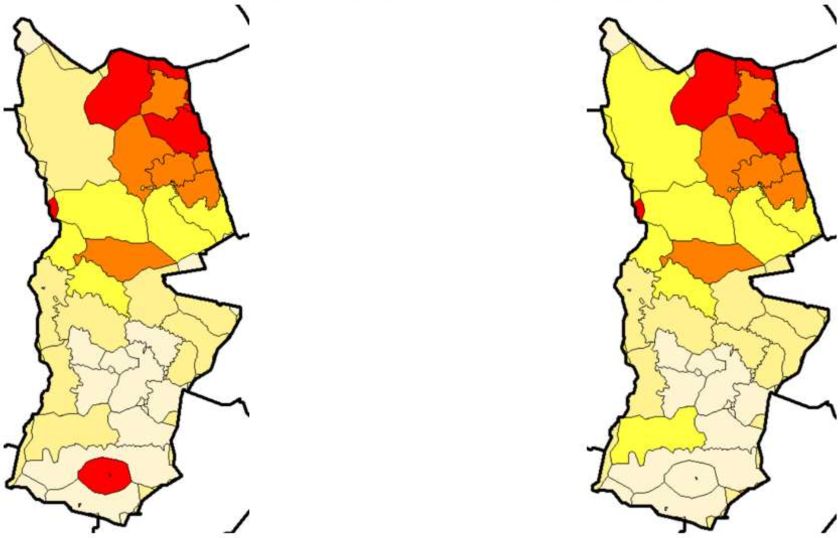
Below right, map plotting claims where damage has been attributable to vegetation in the ownership of the local authority from a sample of around 2,858 UK claims.



HILLINGDON - Frequencies & Probabilities

Mapping claims frequency against the total housing stock by ownership, (left council and housing association combined and right, private ownership only), reveals the importance of understanding properties at risk by portfolio. There are several sectors in the 'private only' map with an increased risk.

POSTCODE SECTOR SUBSIDENCE RISK (FREQUENCY) BY OWNERSHIP - HILLINGDON



Combined Public and Private Frequency | **Private Only**

On a general note, the reversal of rates for valid-v-declined by season is a characteristic of the underlying geology. For clay soils, the probability of a claim being declined in the summer is just under 25%, and in the winter, it exceeds 50%. Valid claims in the summer are likely to be due to clay shrinkage, and in the winter, escape of water.

Liability by Season - HILLINGDON

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Hillingdon	0.686	0.094	0.22	0.04	0.27	0.69

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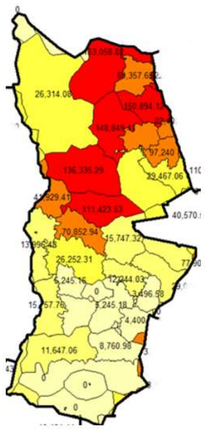
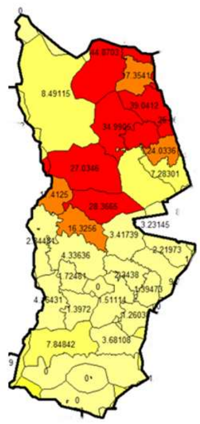
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

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 – UK SAMPLE £200m
HILLINGDON



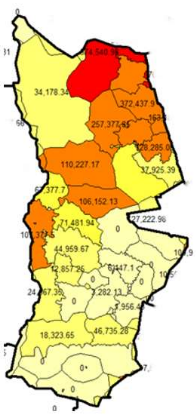


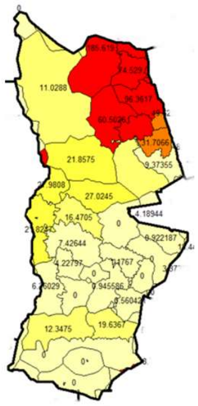
Spend by Sector

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 – UK SAMPLE £419m
HILLINGDON





Spend by Sector

Spend Averaged over Housing Population

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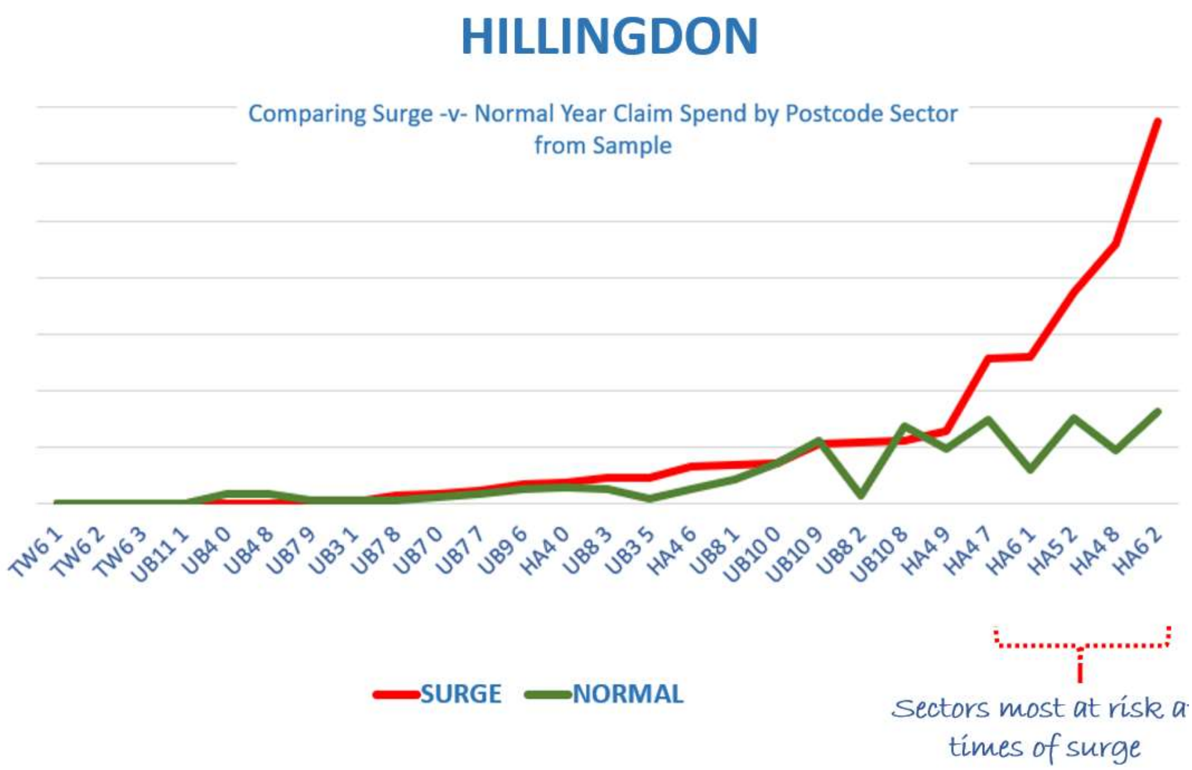

The above graph identifies the variable risk across the district at postcode sector level from the sample, distinguishing between normal and surge years. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

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 may 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.