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 2023
Issue 212

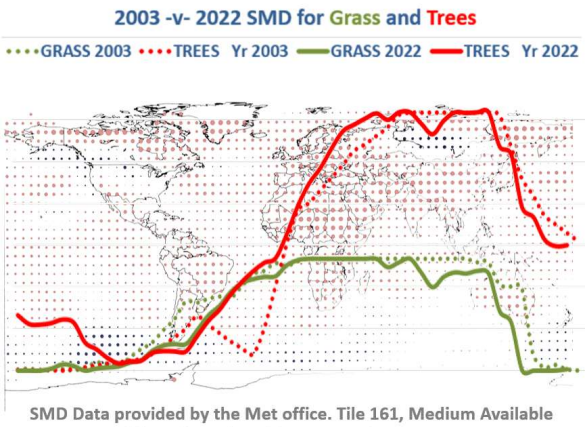
The Clay Research Group

CONTENTS

Issue 212, January 2023

Soil Moisture Deficit

Below, SMD values provided by the Met Office from the Heathrow weather station for both grass and tree cover for 2022.



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

On the following page, the Met Office confirms 2022 to have been the warmest year since records began, with more sunshine and less rainfall than the average.

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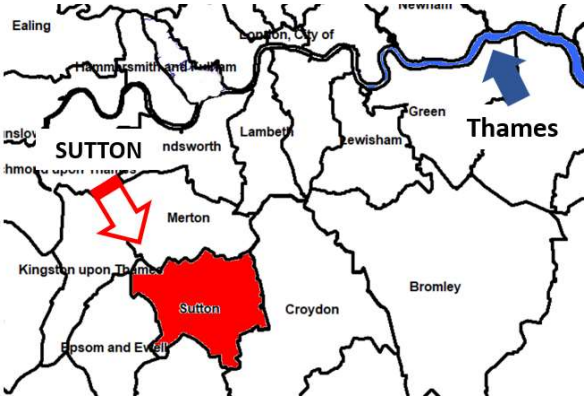
District and Sector Risk

An updated model of Sutton, south London, is the topic of the District Risk series in this month's edition and increased resolution is provided with two examples at postcode sector level.



TDAG Diary

The Tree Design Action Group has a series of meetings planned, the first of which is scheduled to take place on 8th February 2023. Contact Dr. Emma Ferranti at E.Ferranti@bham.ac.uk for more information.

The link to join the meetings is:

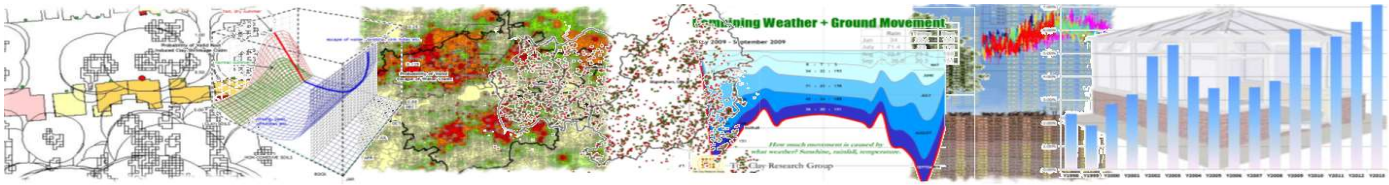
https://www.eventbrite.co.uk/e/tdag-seminar-series-2023-why-plant-a-tree-tickets-483055541127

A recording of the previous session, entitled Fragility of Soils, can be found at:

https://www.tdag.org.uk/past-events.html

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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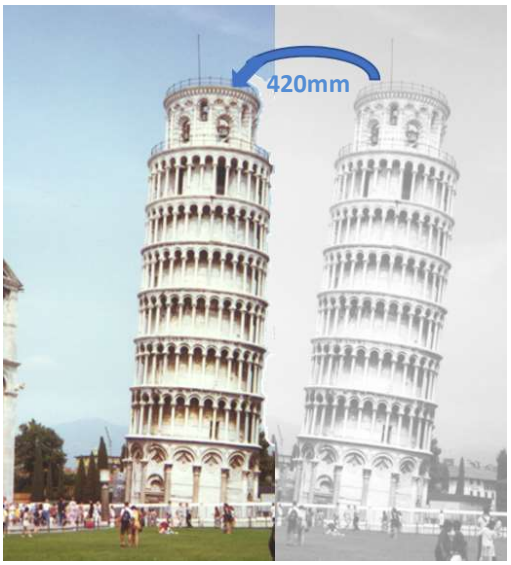
Correcting the Leaning Tower of Pisa

The Leaning Tower of Pisa was built in 1173. It is around 57m tall with 3m deep foundations.

The tower was leaning 5.5° in 1990 and in recognition of the potential for collapse if movement continued, a team of experts (including Professor Burland from Imperial College) set about trying to reduce the movement and stabilise the structure.

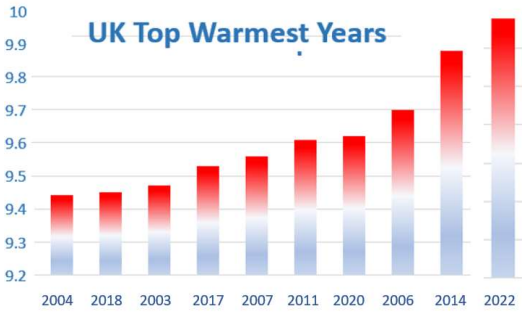
Since remedial work commenced, the lean has reduced by 420mm. According to Nunziante Squeglia, professor of geotechnics from the the University of Pisa, whilst the tilt has been reduced, it still sways at an average of about 0.5 mm a year.



https://www.ansa.it/english/news/2022/11/30/leaning-tower-of-pisa-in-excellent-health_82b7d747-464a-4670-8c
f01d66447758.html

2022 UK Climate Review

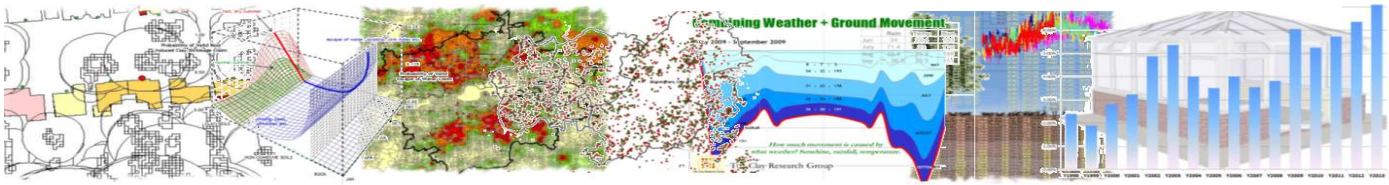
2022 looks set to be the warmest year on record according to provision data from the Met Office, with an average temperature of 10degC. There was 9% more sunshine and less rainfall – only 75% of the yearly average on the south coast – the area of highest risk relating to clay shrinkage. https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2022/2022-provisionally-warmest-year-on-record-for-uk



Average annual temperatures for top 10 warmest years since records began, with 2022 setting a new peak at 10°C

Met Office also report that UK temperatures in 2022 remained above average for every month of the year except December, which was cooler than average.

Dr Mark McCarthy, head of the Met Office National Climate Information Centre, said "2022 is going to be the warmest year on record for the UK. Although it doesn't mean every year will be the warmest on record, climate change continues to increase the chances of increasingly warm years over the coming decades."



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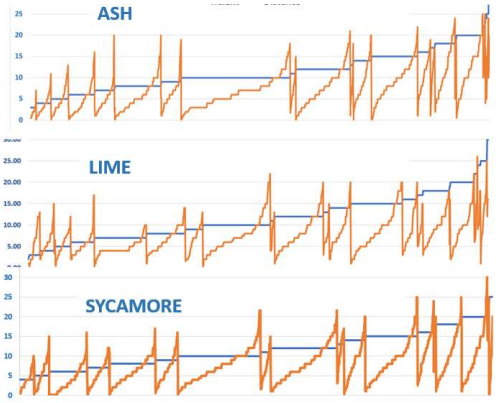
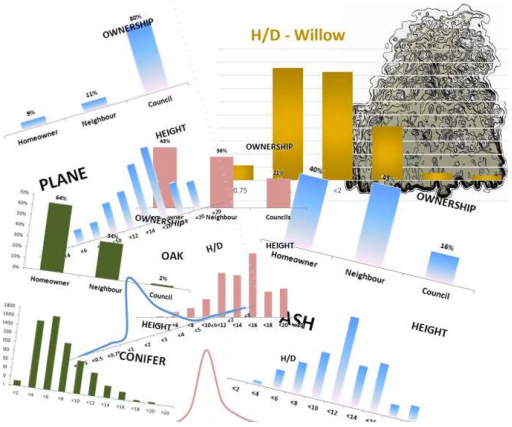
Assessing the Risk of Trees - H/D

Past editions of the newsletter have included graphs showing the variable risk by species derived using the distribution by height of trees that have caused damage and their distance from the subject property.

Right, some examples.

Plotting the value of 'D' (distance – orange) relative to the value of 'H' (height) for tree species. Above, trees regarded as high risk in terms of domestic subsidence and below lower risk species.





The problem is, the output is distorted when concentrating on peak values. For a high proportion of the tree species the peak risk will be when the distance to the damaged building equals the tree height - an H/D value of around 1

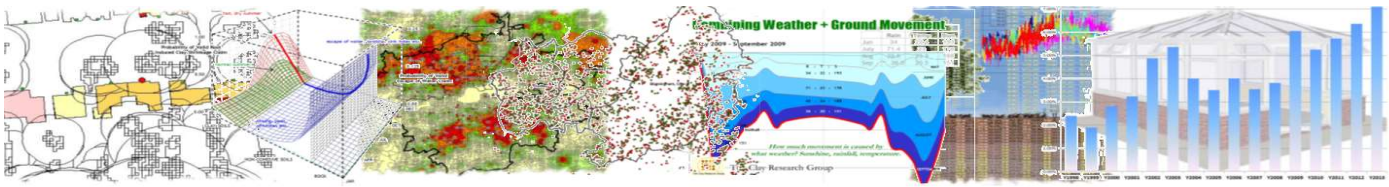
We use the term 'around' to take account of the fact many values will be estimates of height and distance and not always accurate measurements.

Left, plots showing the relationship for several species across the full range of H/D values. Height is shown by a blue line and distance by an orange line.

The top four (plane, poplar, willow and oak) present a relatively high risk in terms of claim count and the lower three (ash, lime and sycamore), a lower risk.

Interestingly, the willow appears to have a root system that can extend well beyond the tree height in around 50% of cases, replicating the situation at the Aldenham site.

Whilst plateau's do exist when the value H equals, or is close to, the value of D, the graphs reveal the distribution, and explain why the notional risk value of 1 is of little use as a guide to taking pro-active action.



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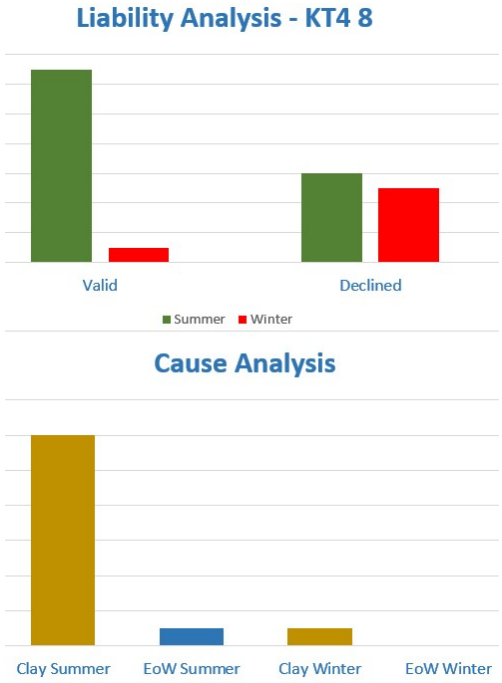
Sutton Area Sector Level Sample.
Using Past Claims Data to Infer Geology and Derive Probability of Cause and Liability



KT4 8 – from the sample we hold, 80% of valid subsidence claims were caused by clay shrinkage in the summer and around 20% in the winter with the balance attributable to escape of water.

It is rated 2.9 times the UK average risk at postcode sector level and 0.135 on a normalised scale.

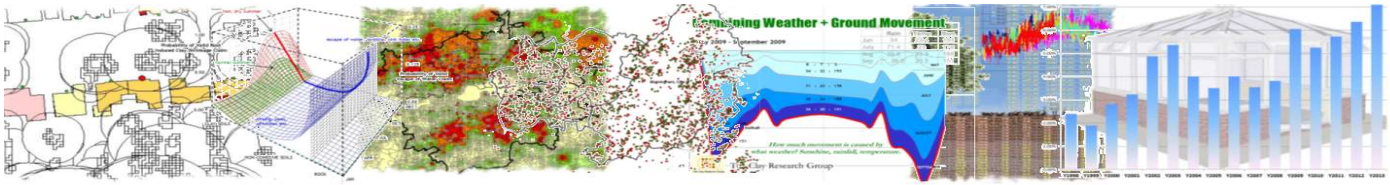
The BGS maps on page 7 show a solid geology of outcropping London clay to the north of the borough.

As might be expected from the underlying geology, clay shrinkage is the dominant cause of subsidence in the sector.

SM6 9 – SM6 9 comprises predominantly semi-detached houses in private ownership. It is rated 0.78 times the UK average risk at postcode sector level and 0.036 on a normalised scale.

The BGS maps on page 7 shows the geology to be outcropping chalk.

As might be expected from the underlying geology, escape of water is the dominant cause of subsidence in the sector as indicated by the 'Cause Analysis' graph, bottom right.



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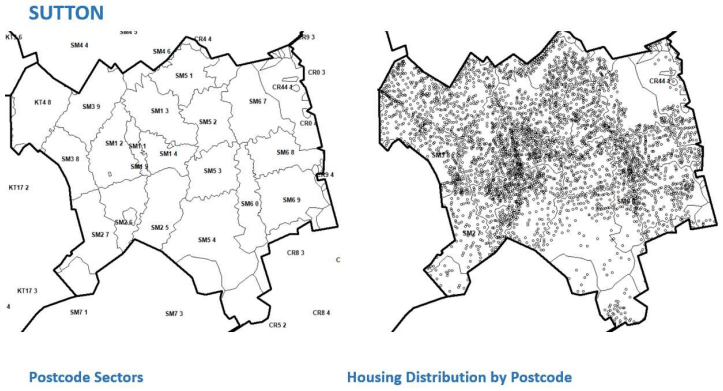
Subsidence Risk Analysis – SUTTON

Sutton is situated in south west London and occupies an area of 43.8km^2 with a population of around 209,500.



Distribution of housing stock using full postcode as a proxy. Each sector covers around 2,000 houses on average and full postcodes include around 15 – 20 houses on average, although there are large variations.

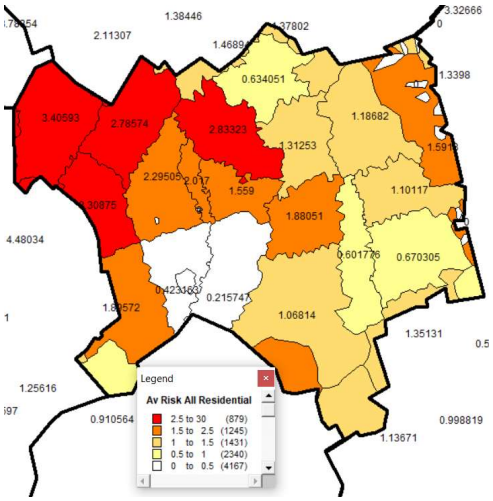
Sector and housing distribution across the district (left, using full postcode as a proxy) helps to clarify the significance of the risk maps on the following pages. Are there simply more claims in a sector because there are more houses?

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.

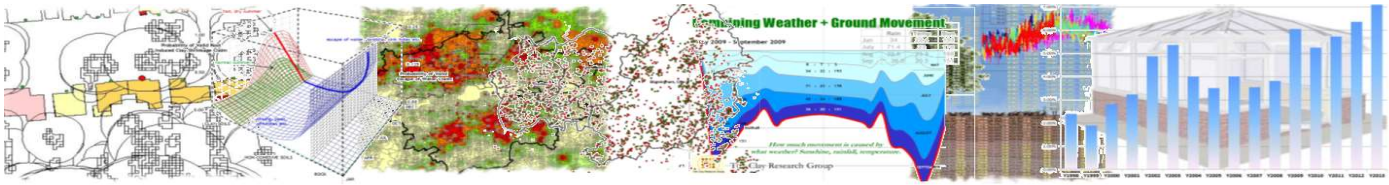
From the sample we hold, sectors are rated for the risk of domestic subsidence compared with the UK average – see map, right.

Sutton is rated 74th out of 413 districts in the UK from the sample analysed and is around 1.53x the risk of the UK average, or 0.39 on a normalised scale.

There is an increased risk to the north of the borough as can be seen from the sector map, right, which corresponds with outcropping London clay.



Sutton district is rated around 1.53 times the UK average risk for domestic subsidence claims from the sample analysed. Above, risk by sector.



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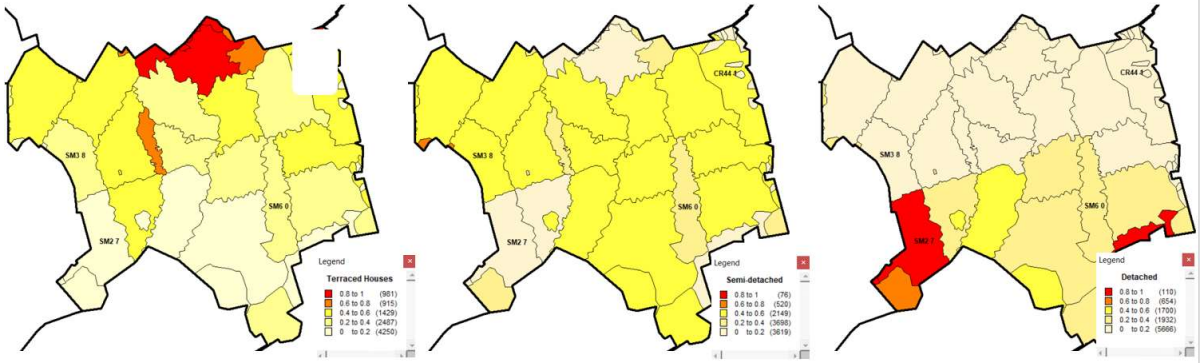
SUTTON - Properties by Style and Ownership

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 the model can be further refined if this information is provided by the homeowner at the time of application.

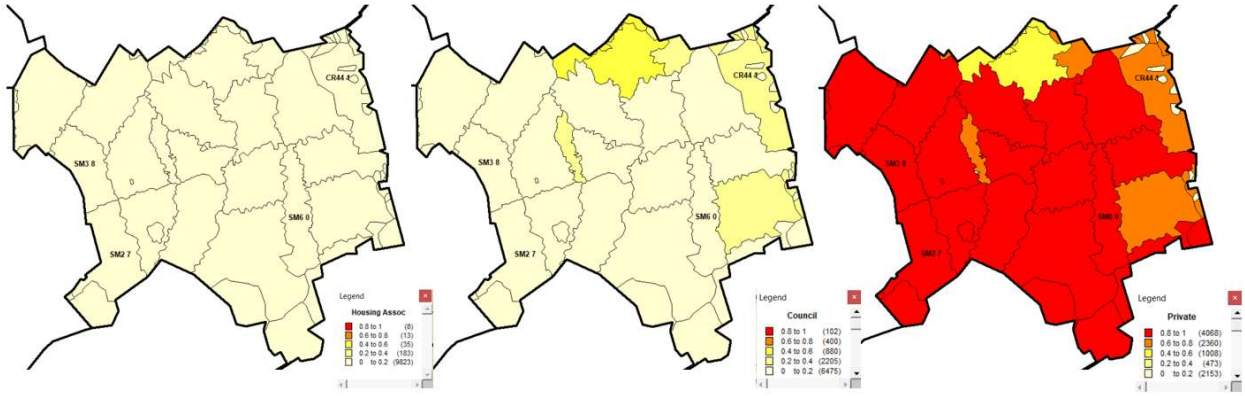
SUTTON - Distribution by House Type



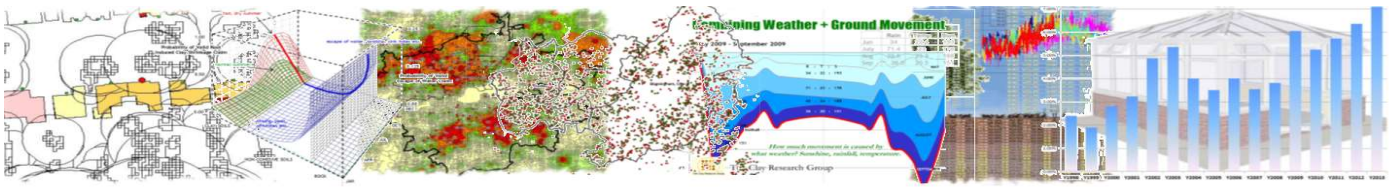
Terraced **Semi-Detached** **Detached**

Distribution by ownership is shown below. Privately owned, terraced properties are the dominant class and are spread across the borough. See page 10 for distribution of risk by ownership.

SUTTON - Distribution by Ownership



Housing Association **Council Ownership** **Private Ownership**



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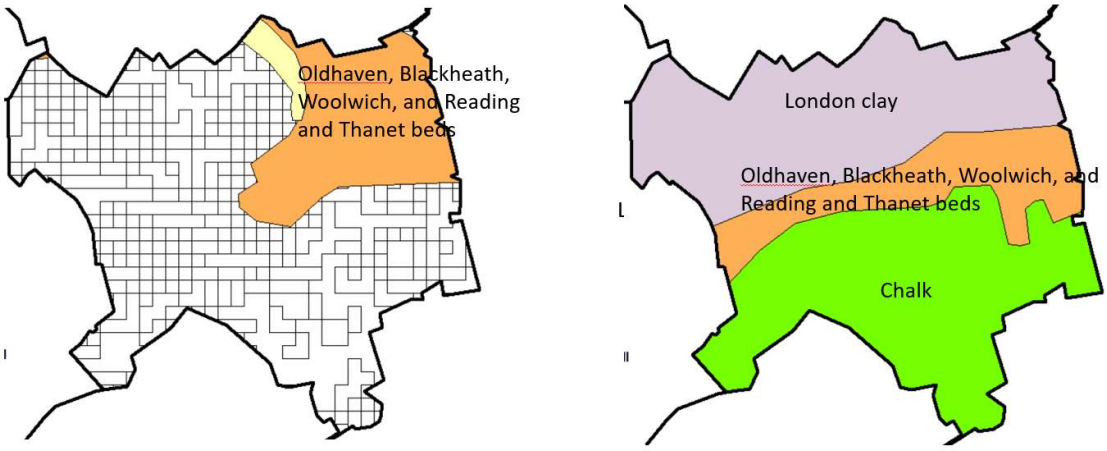
Subsidence Risk Analysis – SUTTON

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 which reveals that, at district level, there is a greater than 70% probability of a claim being valid in the summer and of the valid claims, there is a high probability (greater than 80% in the sample) that the cause will be clay shrinkage.

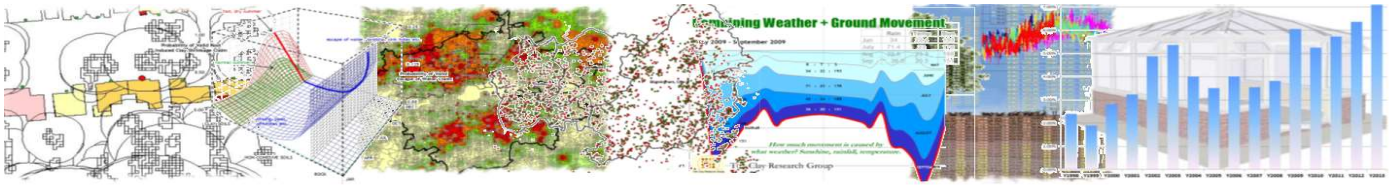
In the winter the likelihood of a claim being valid falls to around 50% - and if valid, there is a greater than 80% probability the cause will be due to an escape of water. Maps at the foot of the following page plot the seasonal distribution.

SUTTON: BGS Geology – 1:625,000 scale



DRIFT DEPOSITS **SOLID GEOLOGY**

1:625,000 series British Geological Survey maps. Working at postcode sector level and referring to the 1:50,000 series maps deliver far greater benefit when assessing risk. Clay shrinkage is the dominant cause of valid claims in the summer and escape of water is the dominant peril in the winter months.



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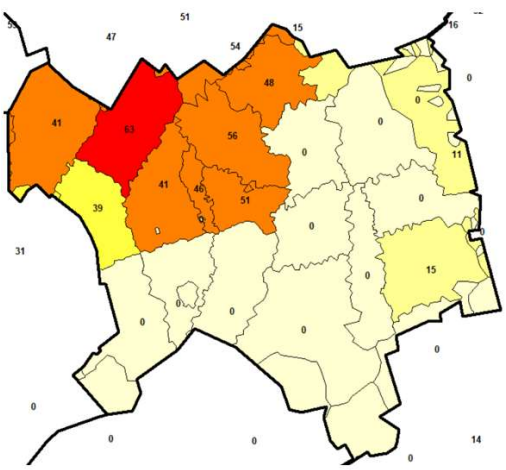
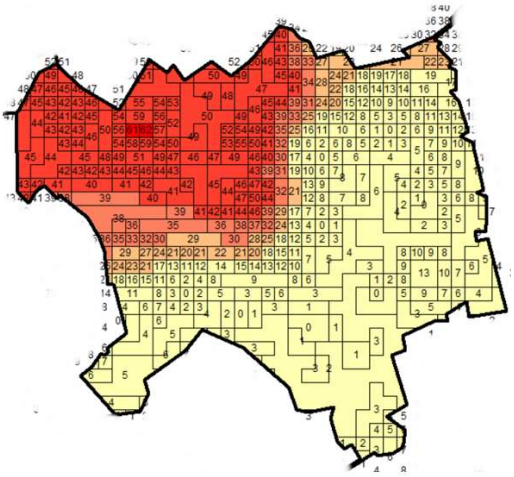
Liability by Geology and Season

Below, the average PI by postcode sector (left) derived from site investigations and interpolated to develop the CRG 250m grid (right). The higher the PI values, the darker red the CRG grid. Claim investigations reveal a small zone of clay to the south of the borough which we assume relates to a shallow depth of drift deposits in the area.

SUTTON – Soil Plasticity Index



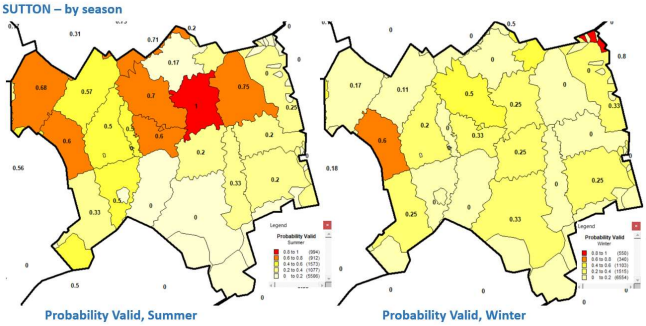
Soil PI Averaged by Sector



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. A single claim in an area with low population can raise the risk as a result of using frequency estimates.

SUTTON – by season



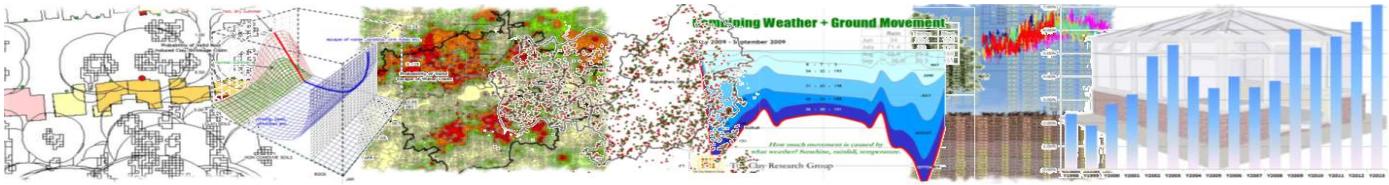
Probability Valid, Summer

Probability Valid, Winter

The maps, left, show the seasonal difference from the sample used.

Combining the risk maps by season combined with the table on page 10 is perhaps the most useful way of assessing the likely cause, potential liability and geology using the values listed.

The claim distribution and the risk posed by the soil types is illustrated at the foot of the following page. Escape of water related claims are associated with the superficial deposits or simply shallow foundations on poor ground and the dominant clay shrinkage claim, the outcropping clay. A high frequency risk can be the product of just a few claims in an area with a low housing density of course and claim count should be used to identify such anomalies.



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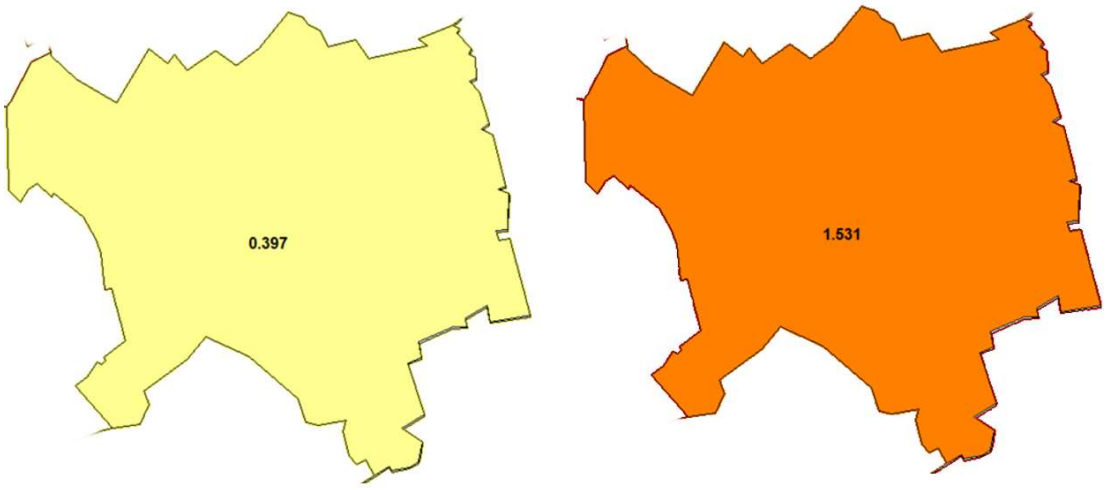
District Risk -v- UK Average. EoW and Council Tree Risk.

SUTTON - Subsidence Risk Relative to UK



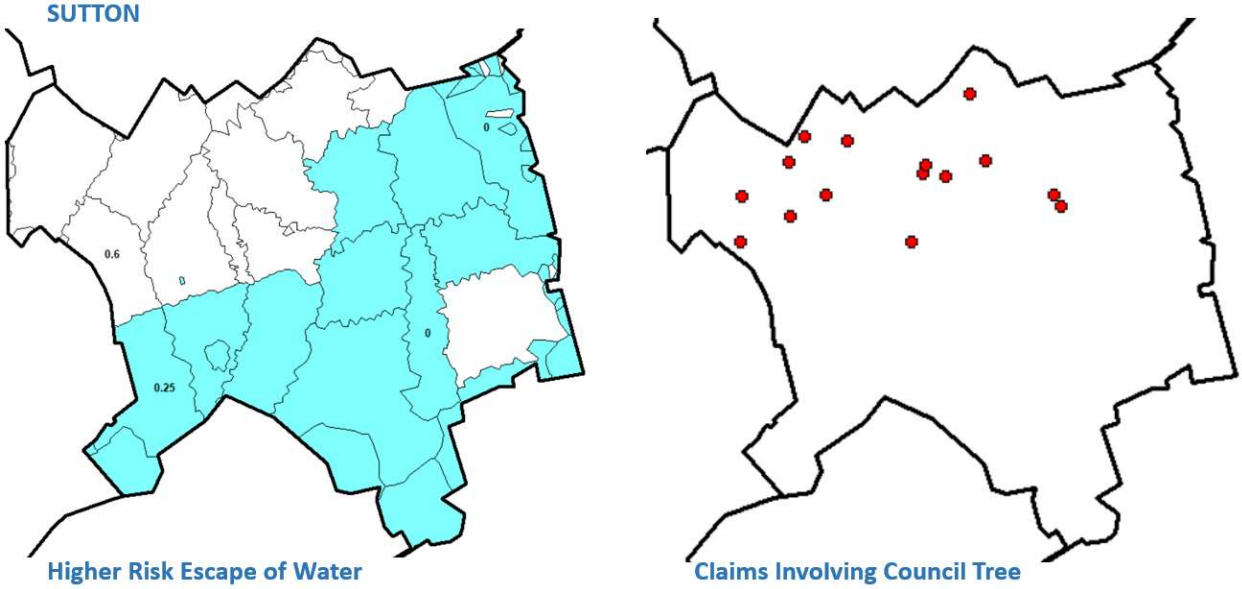
Normalised (0 – 1) Scale

Relative to UK Average

Below, left, mapping the frequency of escape of water claims reflects the presence of non-cohesive soils – River Terrace deposits of alluvium, sands and gravels etc. The absence of shading can indicate a low frequency rather than the absence of claims.

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. The location corresponds with the presence of outcropping London clay soil.

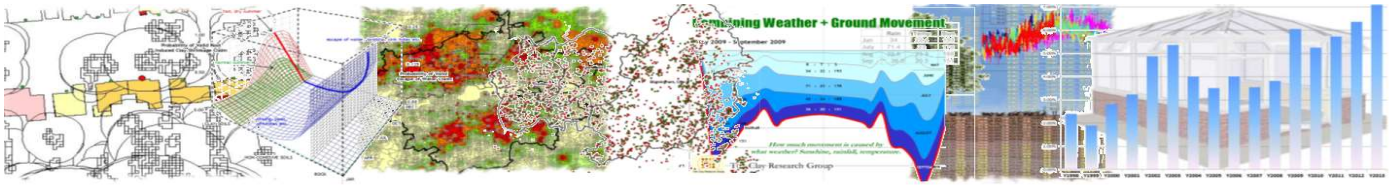
SUTTON



Higher Risk Escape of Water

Claims Involving Council Tree

(2,858 UK claim sample)



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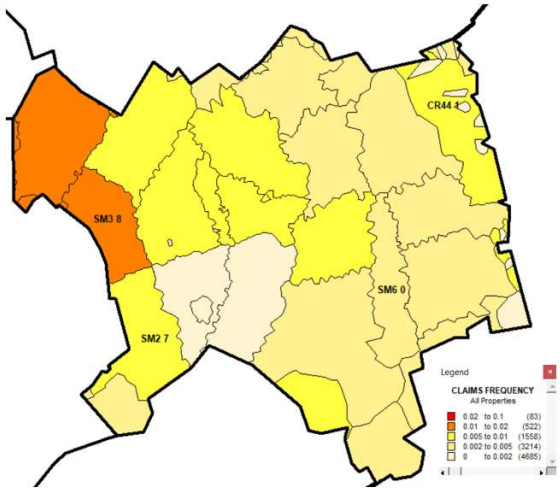
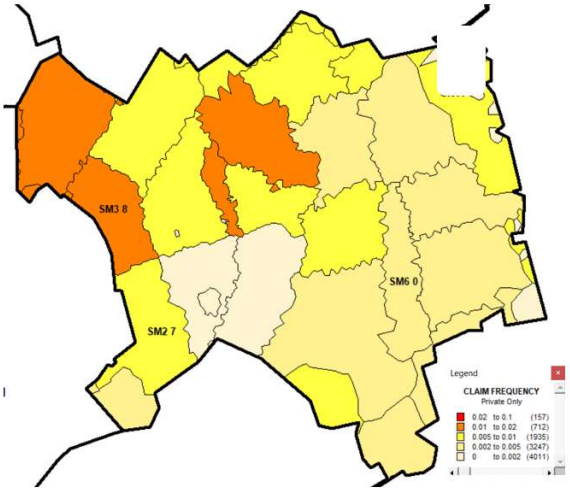
SUTTON - Frequencies & Probabilities

Mapping claims frequency against the total housing stock by ownership (left, private council and housing association combined and right, private ownership only revealing an increased risk), the importance of understanding properties at risk by portfolio.

SUTTON - Postcode Sector Subsidence Frequency Risk by Ownership



Combined Public and Private Frequency

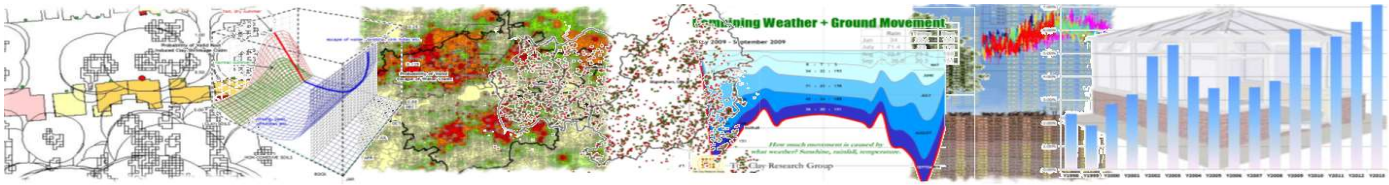


Private Only

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 low, and in the winter, it is high. Valid claims in the summer are likely to be due to clay shrinkage, and in the winter, escape of water. For non-cohesive soils, sands gravels etc., the numbers tend to be fairly steady throughout the year.

Liability by Season - SUTTON

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Sutton	0.574	0.159	0.267	0.11	0.42	0.47



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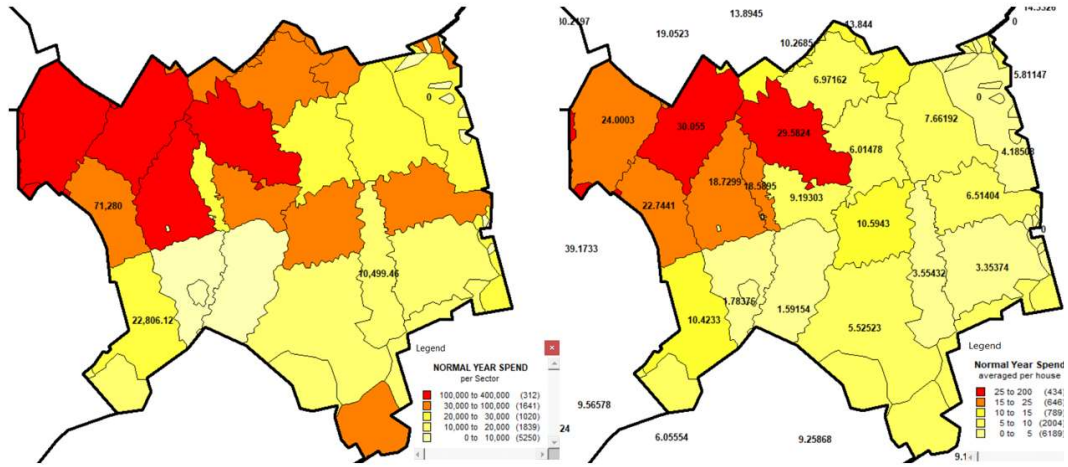
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

The maps below show the aggregated claim cost from the 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.

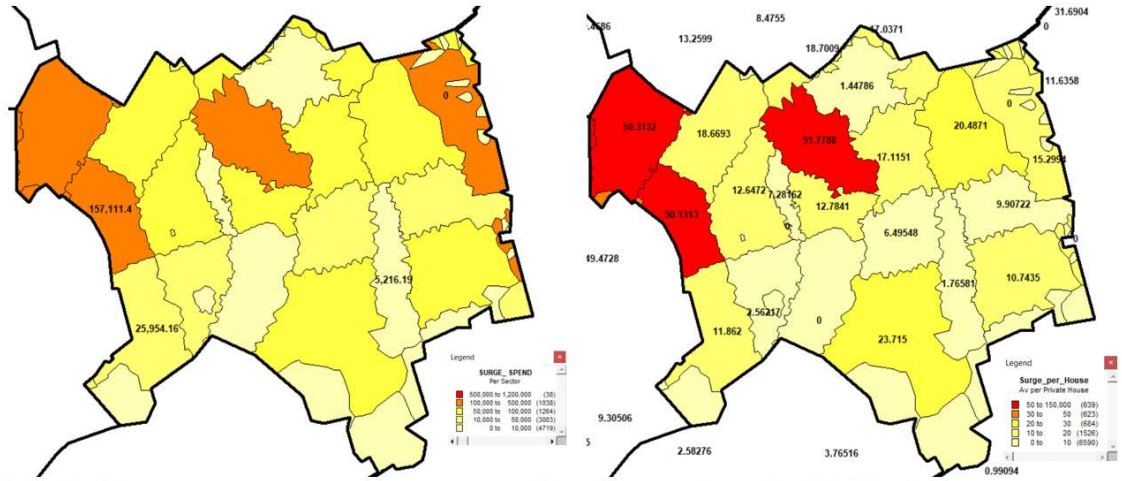
NORMAL YEAR SPEND – SUTTON



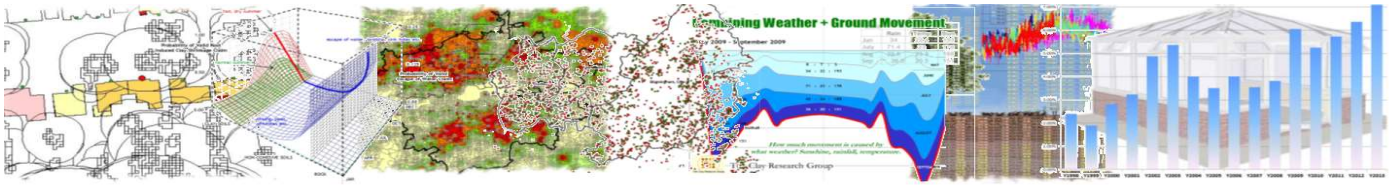
Spend by Sector | Spend Averaged over Housing Population

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 – SUTTON



Spend by Sector | Spend Averaged over Housing Population



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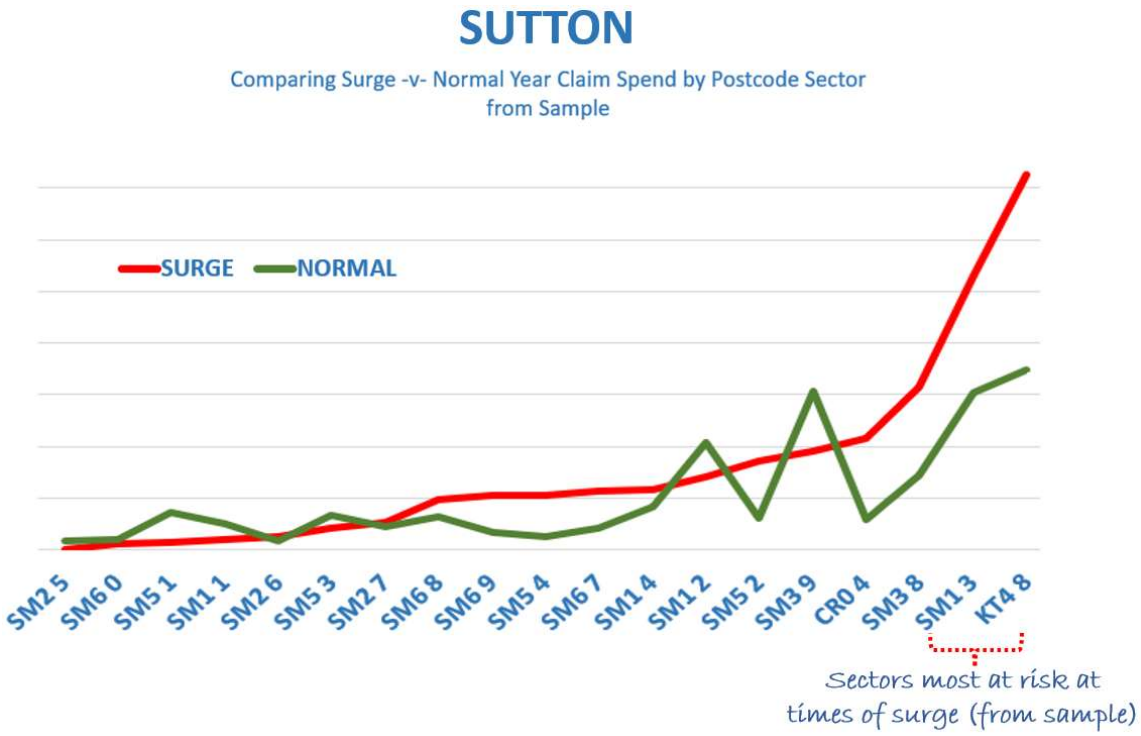

The above graph identifies the variable risk across the district at postcode sector level from the sample, distinguishing between normal and surge years. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

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.