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

September 2021
Issue 196

The Clay Research Group

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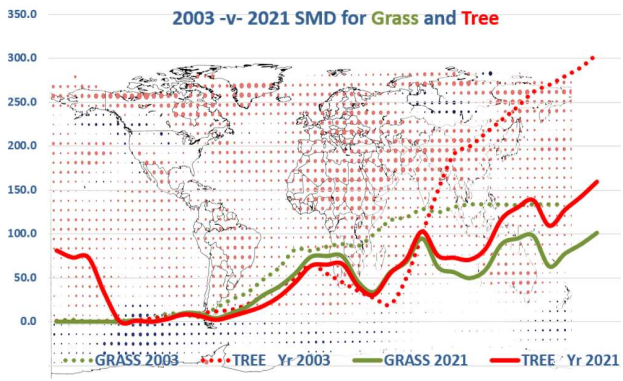
Issue 196, September 2021

Soil Moisture Deficit

Below, the updated Soil Moisture Deficit values for grass (green) and tree (red) cover recorded by the Meteorological Office for tile 161.

The chart compares this year's figures with those of the 2003 event year.



Both values (i.e. trees and grass) for 2021 are significantly less than those for 2003 which is reflected in current claim notifications.

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Warmer … and Wetter

The Intergovernmental Panel on Climate Change says there is unequivocal evidence that humans are warming the planet and that the outcome is likely to be an increase in rainfall and flooding.

The World Weather Attribution (WWA) group concluded that intense rainfall and flooding of the sort experienced in Germany and Belgium recently will be between 1.2 and 9 times more likely as a result and that the amount of rain in one day could increase by between 3% and 19%.

The WWA includes scientists from the Met Office, University of Oxford together with universities and meteorological institutes across Europe and the United States.

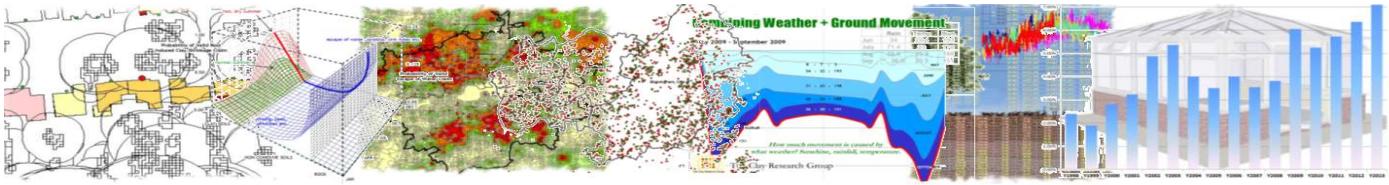
Risk Modelling

This month's edition touches on the CRG's approach to modelling the risk of domestic subsidence and continues the 'Risk by Area' series with a return visit to Lewisham.

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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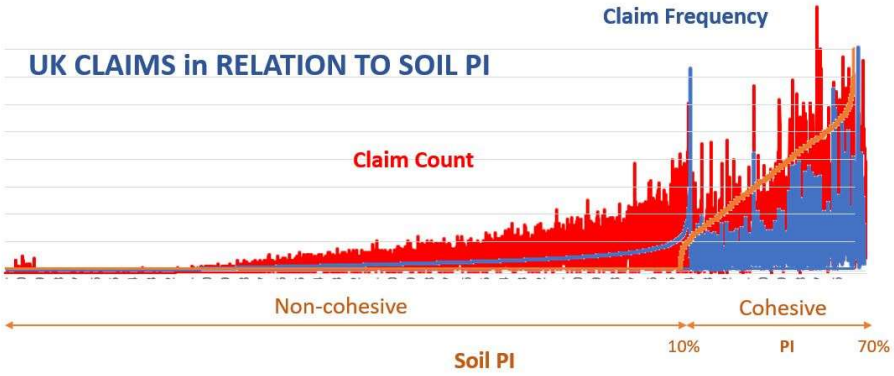
Risk by Soil Plasticity Index

The graph below illustrates the risk of subsidence in relation to the soil properties, revealing the difference between cohesive and non-cohesive soils from a sample of 103,000 claims.

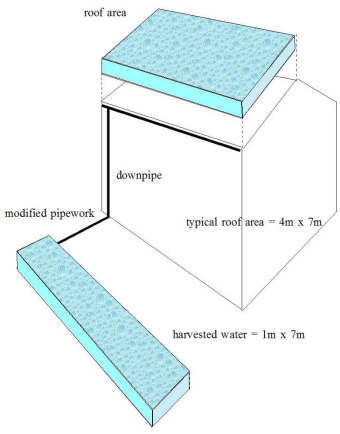
The 'x' axis plots the plasticity index (PI) by postcode sector. Around 20% of the UK has a geology of clay and the index properties are shown by the orange line in the range 10 – 70%. The red line plots the count from the sample by postcode sector and the blue line, the claim frequency – claim count divided by the private housing population.

Clay soils (to the right of the graph) deliver the highest count and frequency. The high count isn't a surprise bearing in mind that it includes London but the increased risk is revealed by the frequency, which is generally far higher than the remainder of the UK.



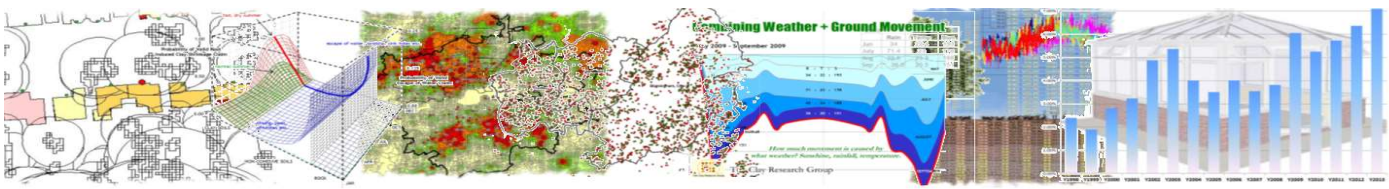
The graph also reveals that the risk increases with the soil PI. In total there are 54k claims on non-cohesive soils and over 49k claims on clay soil.

Intervention Technique - Clarification



There is a misunderstanding that the harvesting chamber of the Intervention Technique (IT) is designed to satisfy the water deficit of a tree in dry periods. That isn't the case. When the soil is dry, the roots and leaves naturally produce the hormone Abscisic Acid (ABA), which acts by closing the leaf stomata. By watering half the root zone (partial root drying) water uptake is significantly reduced – research on plants records a 50% reduction in water uptake. The root zone under stress due to drying generates ABA, whilst the other half has access to water via the IT chamber. Water balance in the root zone equilibrates overnight, allowing the water to transport ABA to the leaves, triggering the stomatal response. Water uptake by the tree is consequently reduced significantly.

In summary, water from the chamber does not replenish the moisture deficit to replicate the 'normal', undesiccated situation. It reduces water demand whilst maintaining the health of the tree. Innovation Group hold the patent to the Intervention Technique.



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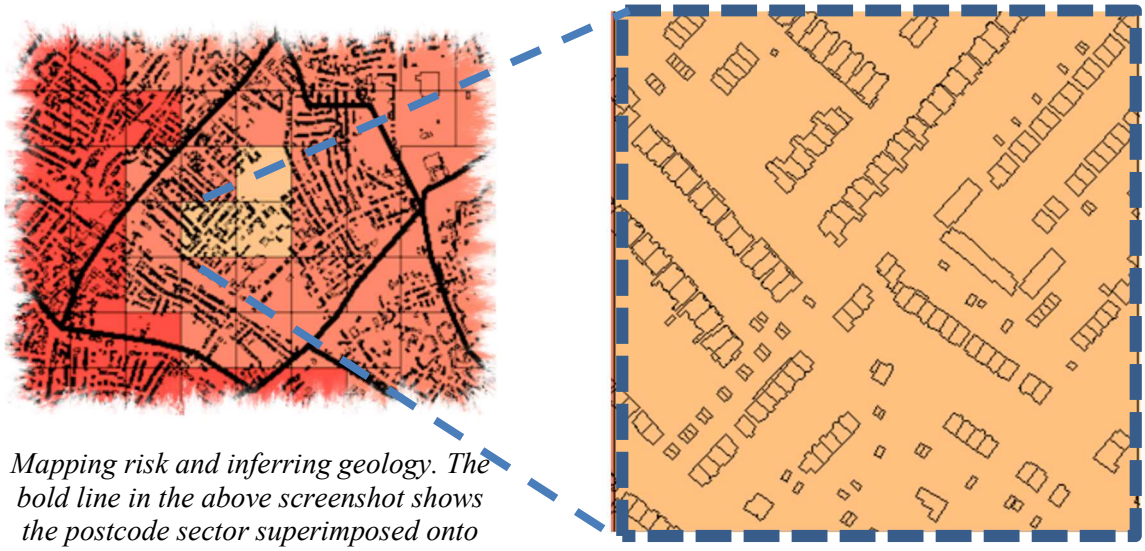
Risk Map Resolution

In edition 194 we touched on the enhanced definition delivered using a 0.25km grid when compared with postcode sectors. Below, an illustration with housing superimposed onto each.

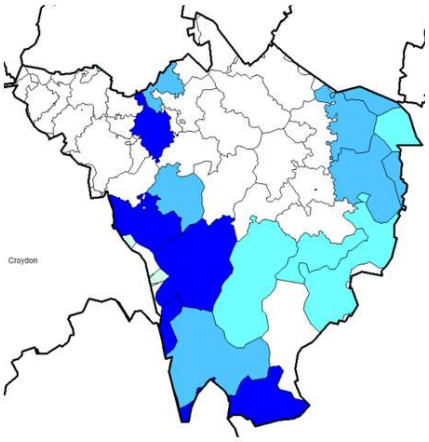
Left, the outline of a postcode sector superimposed onto the grid and right the higher definition using the grid.



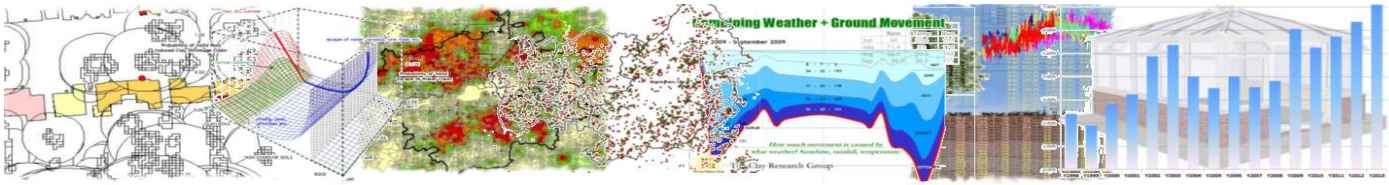
Mapping risk and inferring geology. The bold line in the above screenshot shows the postcode sector superimposed onto the 0.25km grid, illustrating the improved resolution.

The grid improves resolution by a factor of around 20 in the above example and although there can be no suggestion that clay soils follow these rigid borders, they do provide an indication of both geology and claims experience.

Of course, the soil PI varies both with depth and spatial distribution and there can be no claim to accuracy – this is a risk model designed to assist in Triage and underwriting as well as providing engineers and claims handlers with useful information about the area under investigation when new claims are notified.



Plotting the risk of subsidence resulting predominantly from leaking drains and poor ground in areas with non-cohesive soils is often a function of property age - shallow foundations and ageing drains. Consequently, the system uses a postcode sector base with a lower resolution. See example, right, covering the Bromley area.



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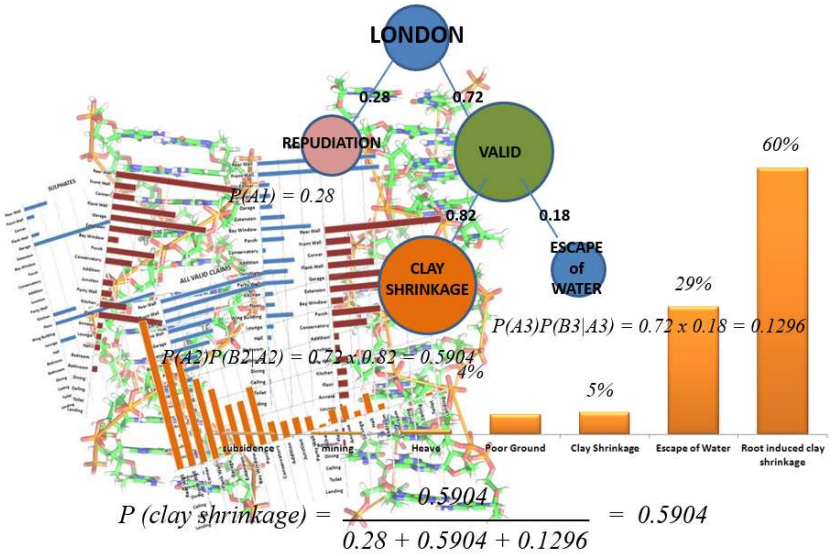
Risk Map Resolution

The Ai module uses underlying data (geology, past claims experience, season etc.) to estimate probability of claim validity and cause at time of notification. It adjusts the outcome as fresh evidence is added to the system.



Left, an illustration of the model showing the underlying data (trees, season etc) past outcomes (bar graph) and the resulting assessment using condition probabilities.

In this example the probabilities are based on a claim being notified in the summer months on London clay.

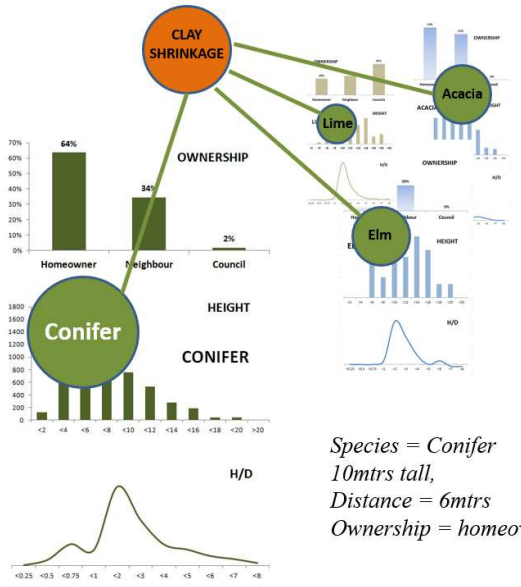
The initial assessment in the above example suggests that the claim has a probability of the claim being valid is 0.72 on a scale 0 - 1 and the likelihood of the cause being clay shrinkage = 0.82.

The figure is adjusted as further information becomes available – tree data, the results of investigations, monitoring and soil testing for example.

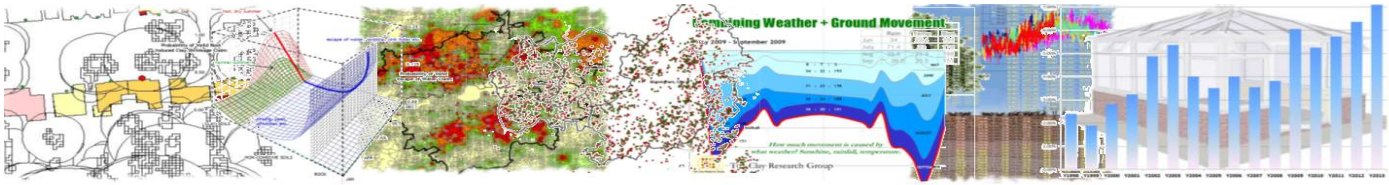
Right, an example of the probabilistic model assessing vegetation. Enter the tree species, height and distance from the building. Does the root zone relate to the area of damage? Does monitoring reveal a seasonal element?

In the example, the operator selects 'conifer' following the site inspection and the probability that it is involved is assessed using the underlying model based on past experience.

More next month.



Species = Conifer
10mtrs tall,
Distance = 6mtrs
Ownership = homeowner



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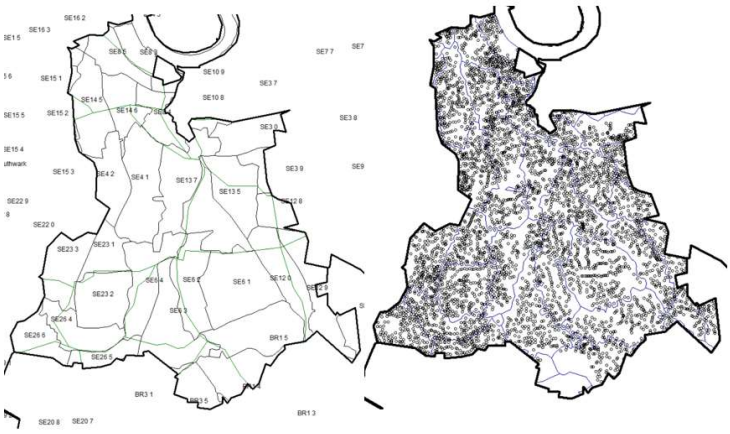
Subsidence Risk Analysis – LEWISHAM

Lewisham occupies an area of 35km^2 with a population of around 303,000 and was originally covered issue No. 157 of the CRG newsletter, June 2018. 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 variation within this figures.

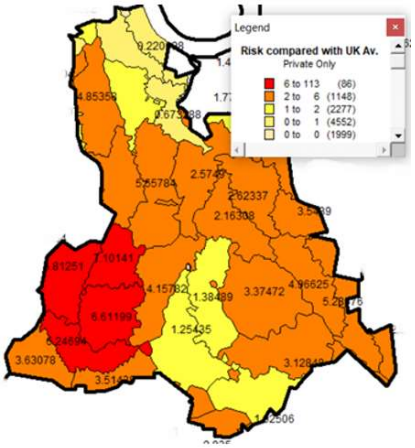
From the sample we have, sectors are rated for the risk of domestic subsidence compared with the UK average – see map, right.

Lewisham is rated 7th out of 413 districts in the UK from the sample analysed and is around 2.8x the risk of the UK average.

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

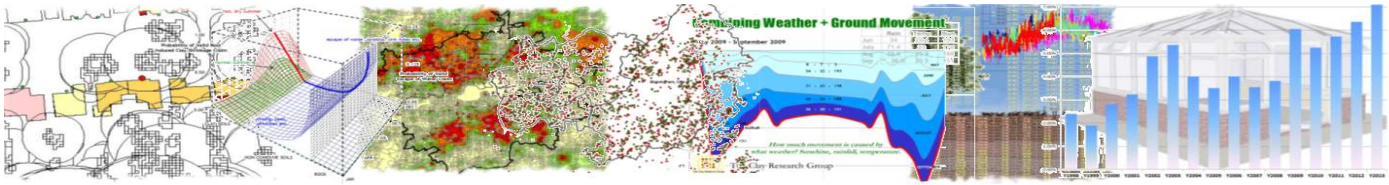
Housing distribution across the district (left, using full postcode as a proxy) helps to clarify the significance of the risk maps on the following pages. Are there simply more claims because there are more houses?

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.



Postcode Sector Risk Compared with UK Average

Risk compared with UK Average.
Lewisham is rated 2.8 times the UK average risk for domestic subsidence claims from the sample analysed. Above, values at postcode sector level compared with UK average.



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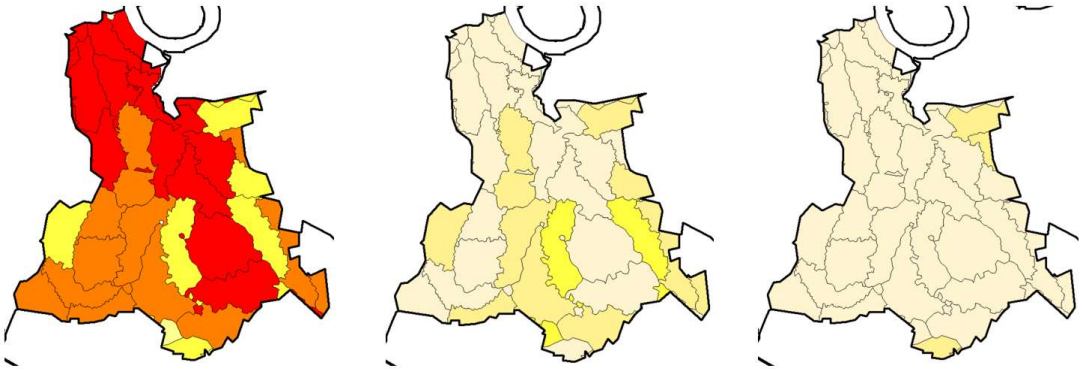
LEWISHAM - Properties by Style and Ownership

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.

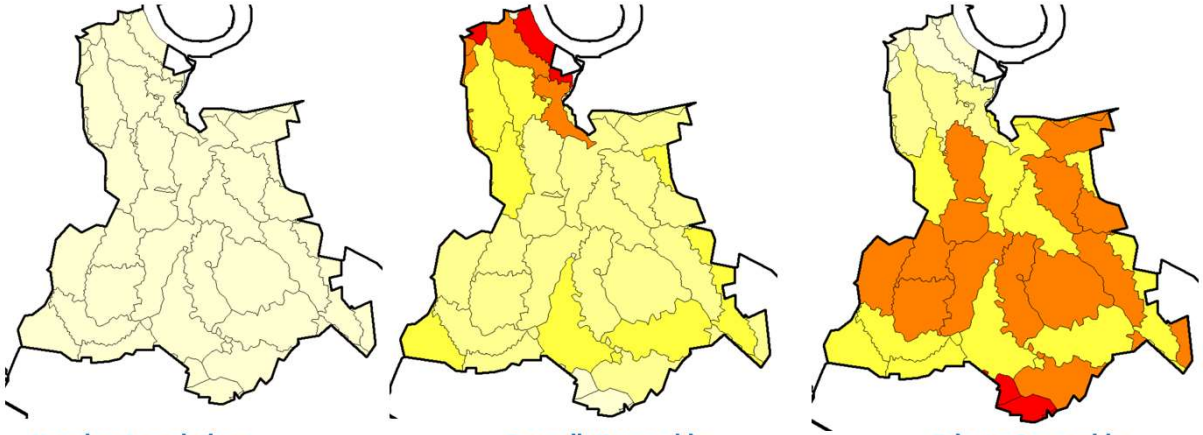
DISTRIBUTION BY HOUSE TYPE – LEWISHAM



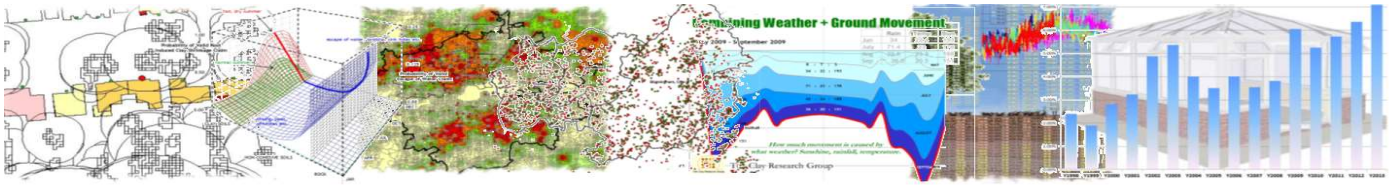
Terraced | Semi-Detached | Detached

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

DISTRIBUTION BY OWNERSHIP – LEWISHAM



Housing Association | Council Ownership | Private Ownership



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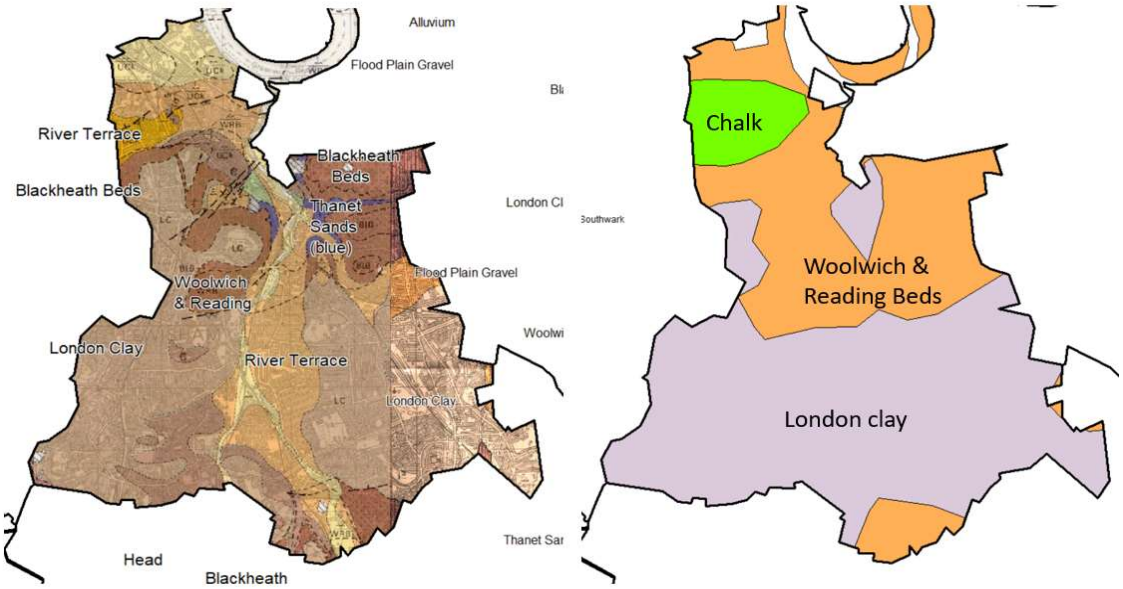
Subsidence Risk Analysis – LEWISHAM

Below, extracts from the British Geological Survey 1:50,000 and 1:625,000 scale geological maps. Go to: http://mapapps.bgs.ac.uk/geologyofbritain/home.html for more detail.

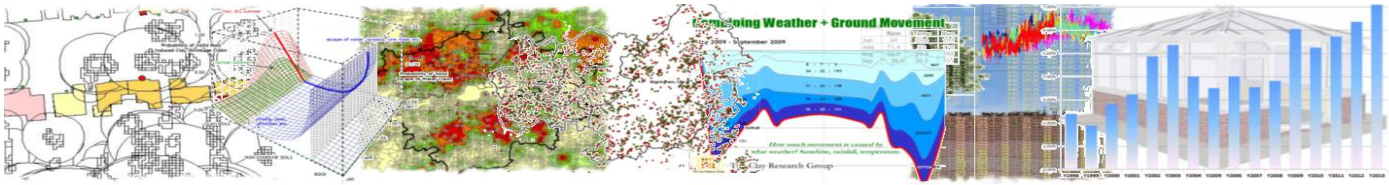
See page 10 for a seasonal analysis of the sample we hold which reveals that in the summer there is around a 70% probability of a claim being valid, and of the valid claims, there is a high probability (greater than 80% in the sample) that the cause will be clay shrinkage.

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.

British Geological Survey Maps



Comparing 1:50,000 and 1:625,000 scale maps provided by the British Geological Survey. Working at postcode sector and referring to the 1:50,000 series delivers far greater benefit when assessing risk.



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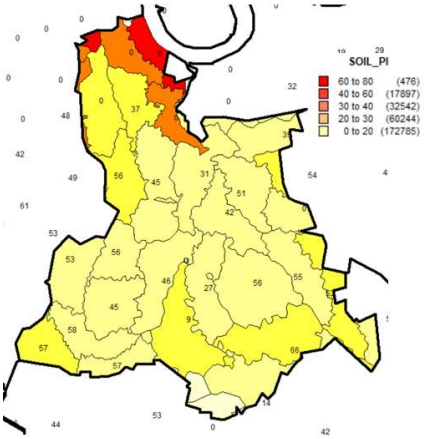
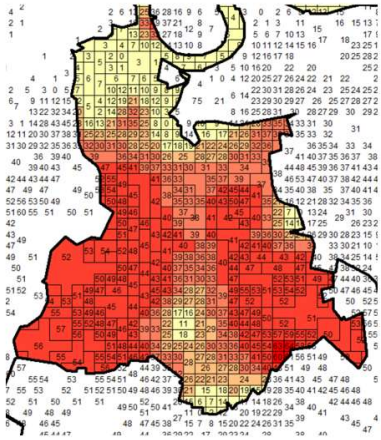
Liability by Geology and Season

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 agrees broadly with the BGS maps on the previous page. The higher the PI values, the darker red the CRG grid.

SOIL PLASTICITY INDEX
LEWISHAM



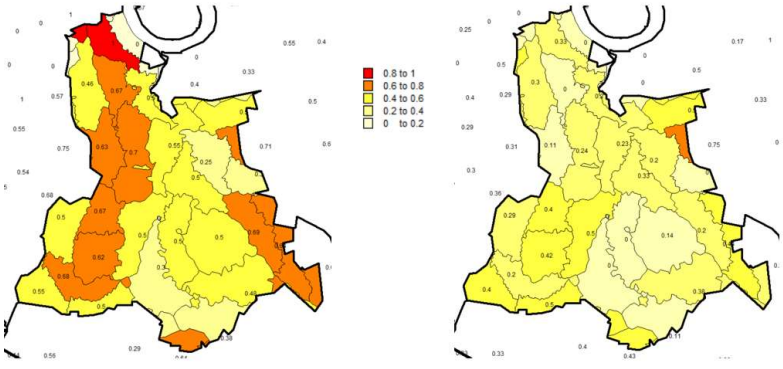
Soil PI Averaged by Sector



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 by SEASON – LEWISHAM
Distribution of domestic subsidence risk by season.

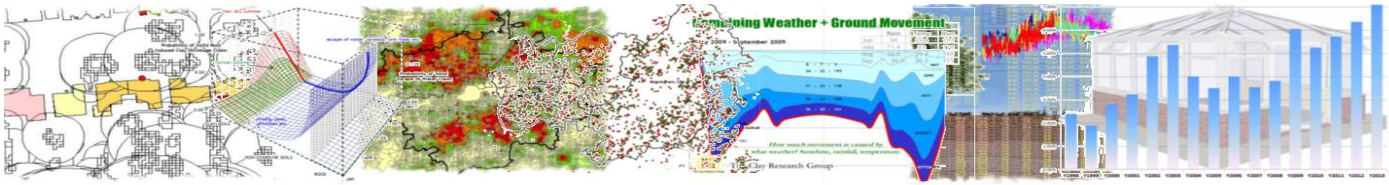


Probability Valid, Summer

Probability Valid, Winter

Mapping the risk by season (table at foot of page 10) 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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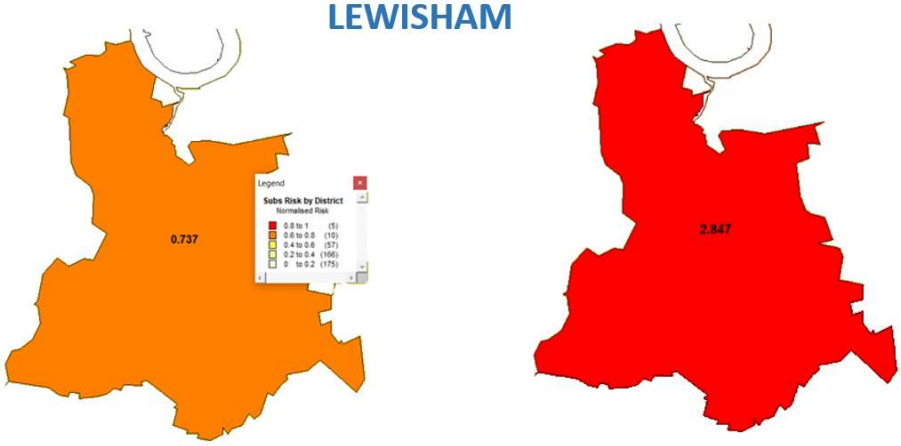
District Risk -v- UK Average. EoW and Council Tree Risk.

SUBSIDENCE RISK RELATIVE TO UK
LEWISHAM

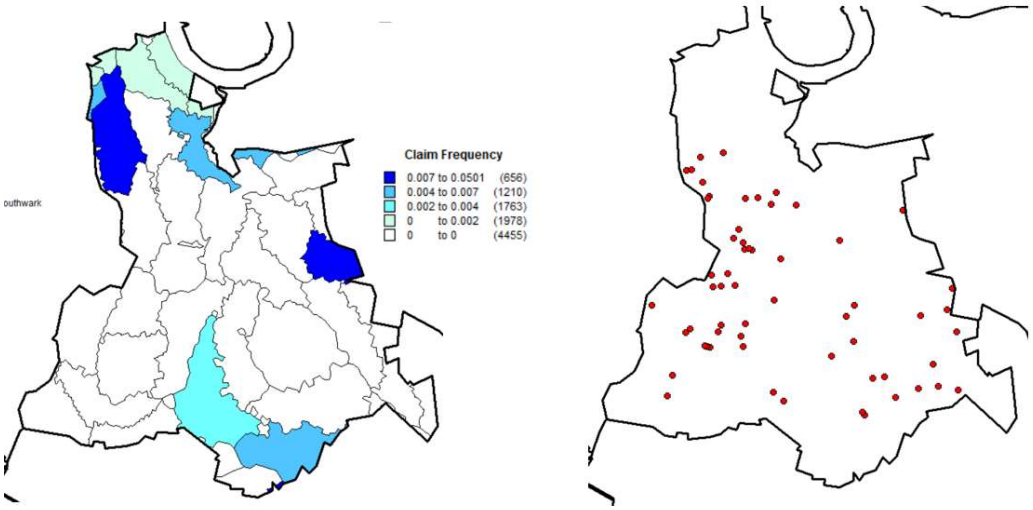


Normalised (0 – 1) Scale | **Compared with UK Average**

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

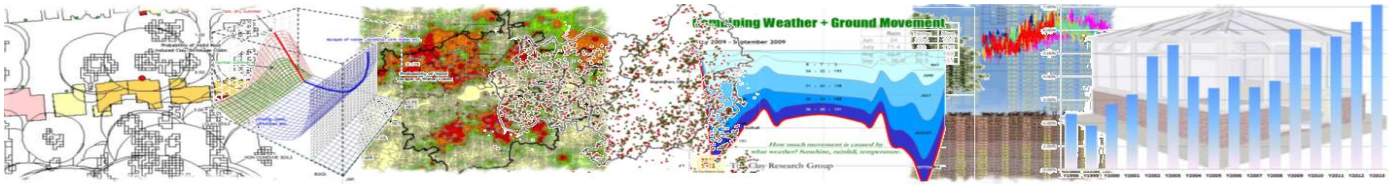
Below right, map plotting claims where damage has been attributable to vegetation in the ownership of the local authority from a sample of around 2,858 UK claims.

Escape of Water –v- Council Tree Claims
LEWISHAM



Higher Risk Escape of Water
(17,852 claim sample)

Claims Involving Council Trees
(2,858 claim sample)



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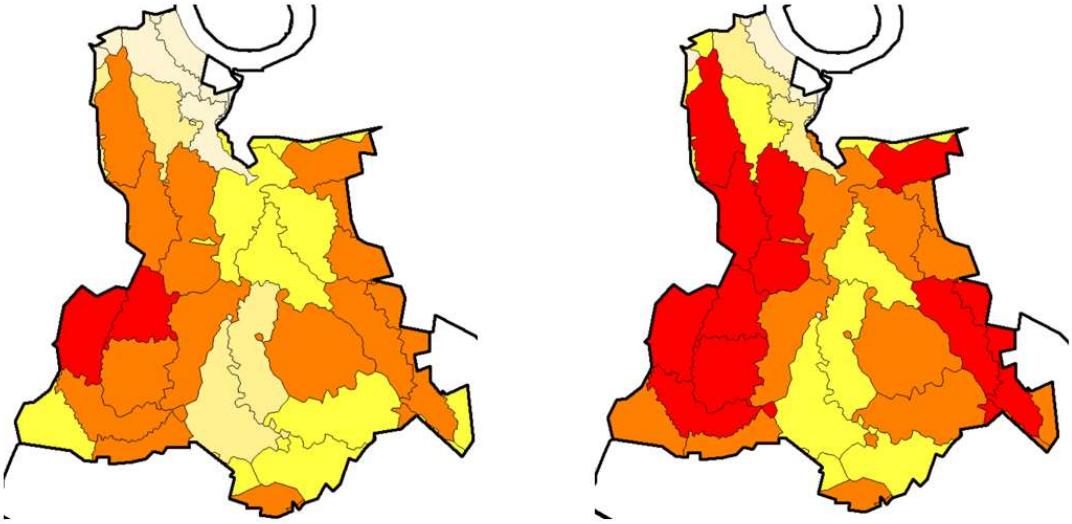
LEWISHAM - Frequencies & Probabilities

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 - LEWISHAM



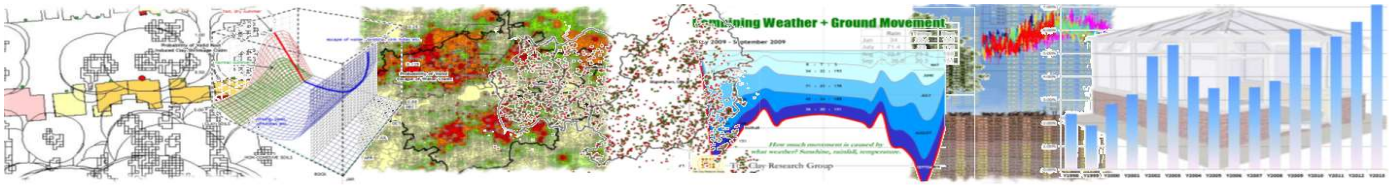
Combined Public and Private Frequency

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 80%. Valid claims in the summer are likely to be due to clay shrinkage, and in the winter, escape of water.

Liability by Season - LEWISHAM

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Lewisham	0.697	0.082	0.221	0.02	0.15	0.83



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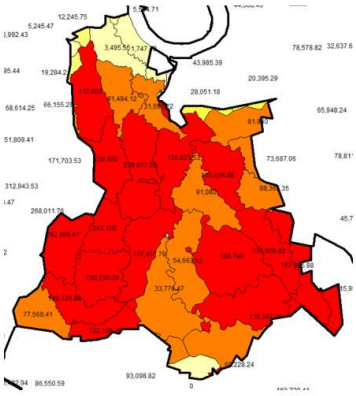
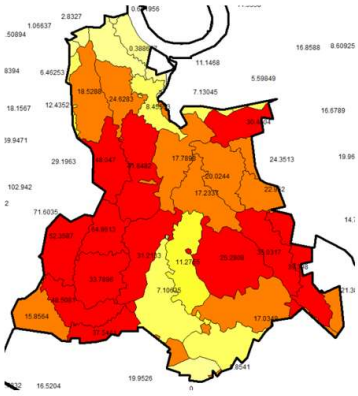
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

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 – UK SAMPLE £200m
LEWISHAM



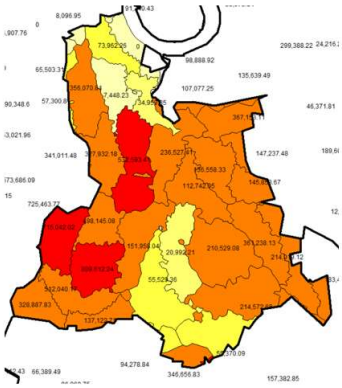
Spend by Sector



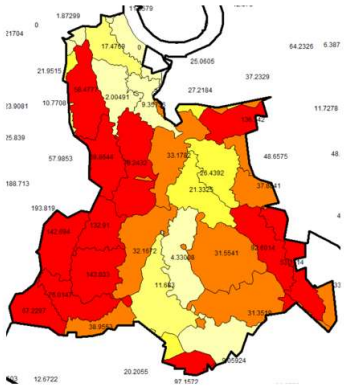
Spend Averaged over Housing Population

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.

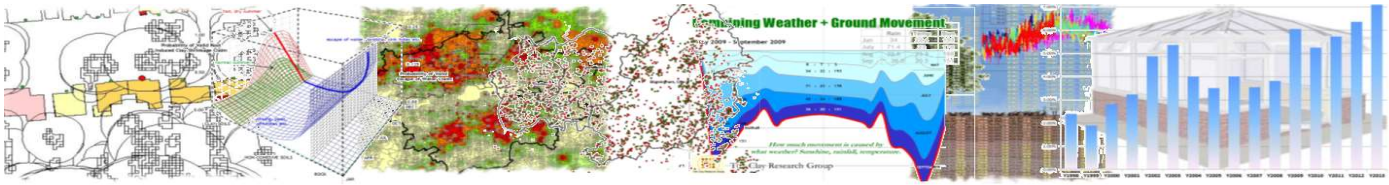
SPEND in SURGE – UK SAMPLE £419m
LEWISHAM



Spend by Sector



Spend Averaged over Housing Population



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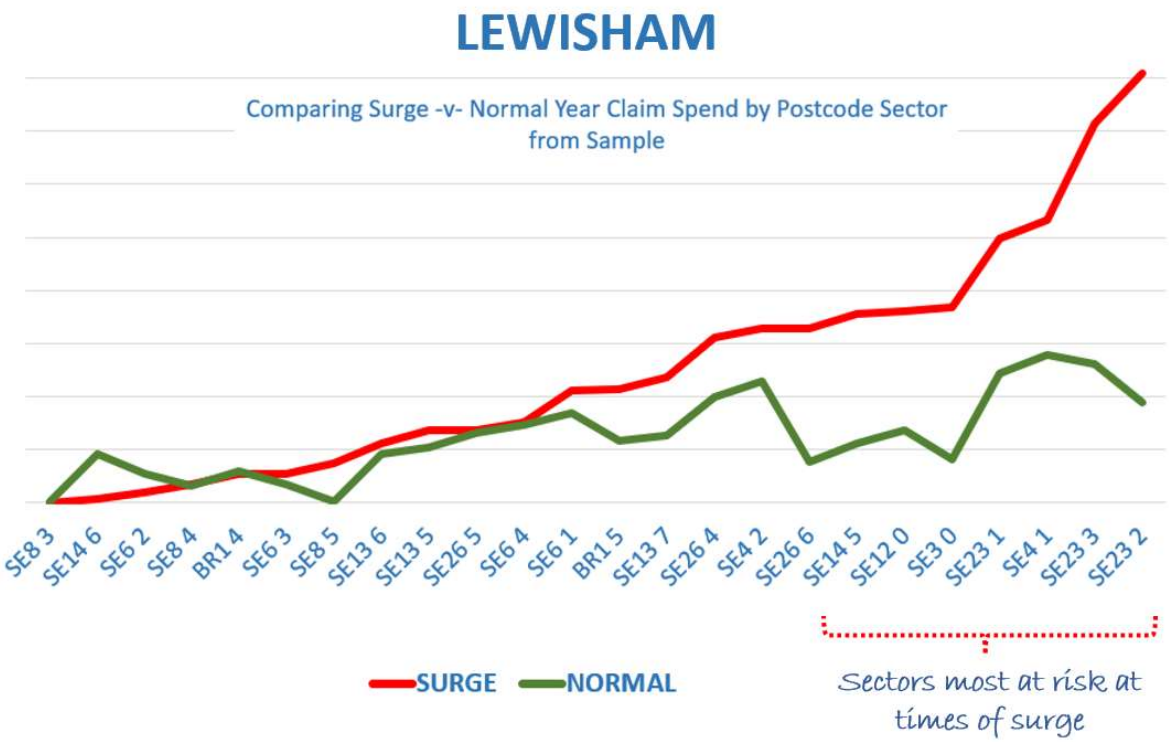

The above graph identifies the variable risk across the district at postcode sector level from the sample, distinguishing between normal and surge years. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

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 total UK losses for surge of just over £400m, and for normal years, £200m.