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

November 2021
Issue 198

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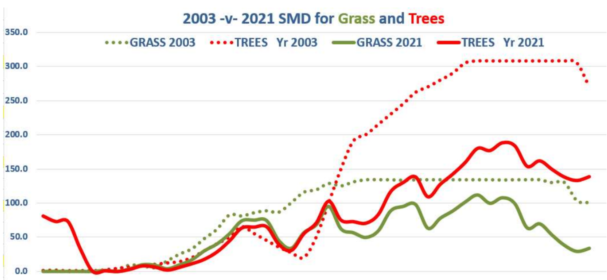
Issue 198, November 2021

Soil Moisture Deficit

Below, the SMD values provided by the Met Office for both grass and tree cover, comparing the 2003 event year (dotted lines) with 2021. Both 2021 lines fall well below the surge year profiles.



Soil Moisture Deficit data supplied by the Met Office for tile 161, medium available water capacity soils for grass cover and medium available water capacity for trees.

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Risk by District

This month we look at Leeds and see a different outcome in terms of risk to that expected. Although clay does not appear to be a significant risk either in terms of the BGS or our own maps, there are a number of claims involving root induced clay shrinkage. Most appear to involve fairly minor damage and involve a combination of shallow foundations and drift deposits, but it illustrates the potential risk.

Seminars and Webinars

TDAG (https://www.tdag.org.uk/) are holding a seminar on the 8th December at 14.00hrs entitled Urban Health and the Role of Green Infrastructure.

View slides from the last seminar (access password: TDAG2021) at:

https://beardatashare.bham.ac.uk/getlink/fiHRRhXVMAzqoq1GB1gfwVkn/

For more information contact Dr Emma Ferranti at E.Ferranti@bham.ac.uk or Sue James at sue.jamesriba@gmail.com

The Subsidence Forum have produced a series of YouTube videos covering webinars delivered in October and they can be accessed at: https://www.youtube.com/channel/UCEgDmLmNTY7xU_Svv3829Og

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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Intervention Technique

The Intervention Technique, patented by Innovation Group, is delivering an environmentally sustainable resolution to the more complex claims involving root induced clay shrinkage.

Trees are being retained, rainwater is used instead of water from the mains water supply and the carbon footprint significantly reduced by avoiding the use of concrete for underpinning and piling.

Over 500 homes have been treated so far. Dr Allan Tew has sent in the picture, right, of a recent installation.

Predicting Rainfall using Google's Deep Mind

MetNet from Google's Deep Mind predicts rainfall 8 hours ahead of it arriving with an accuracy of 80%. A paper outlining the approach was published in March 2020, entitled *"MetNet: A Neural Weather Model for Precipitation"* by Kaae Sønderby, Casper *et al.*

The method has a spatial resolution of 1 km^2 and outperforms all other numerical weather models, including the current state-of-the-art physics-based model used by NOAA. Reviewers from the Met Office rated it as their first choice for 'accuracy and usefulness'.

It makes a prediction over the entire US in a matter of seconds as opposed to an hour.

Visitors to CRG Web Site

The number of visitors to the CRG web site has grown steadily over the years and as the graph below shows, numbers exceeded 4,000 in May and July.

The first edition was issued in August 2006 and attracted fewer than 100 visitors. In 2009 the figure reached 600 and by 2017, around 2,000, variable by month.

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Ground Movement by Month - 2007
Aldenham willow

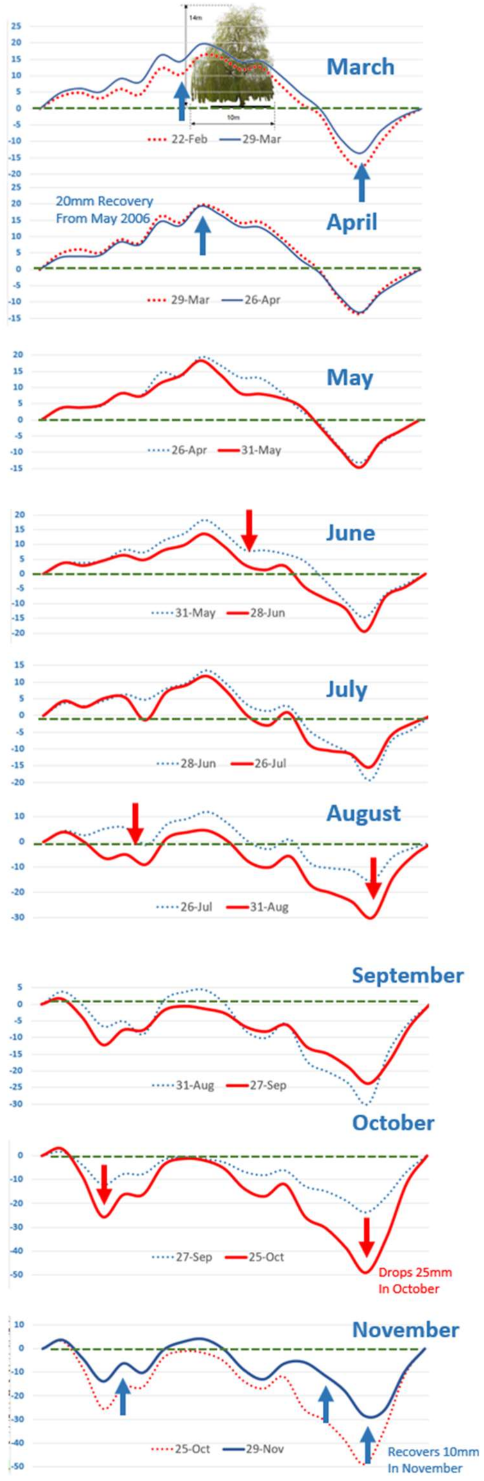
In edition 195 of the newsletter, ground movement profiles for the Aldenham willow were plotted for the period May 2006 through to January 2007.

They revealed the movement that took place by month, reflecting the situation in what was a dry year delivering a substantial number of claims – 2006 is regarded as a surge year.

The data is of interest, but how does it compare with a normal year? Right, ground movement for the period March through to November 2007.

Recovery near to the tree and the subsequent increased subsidence at the root periphery provides an interesting indication of how the tree root system cope to meet its needs.

Recovery close to the tree suggests roots in the zone have 'closed down' whilst those extending further afield, with a larger circumference in terms of uptake area (rather than root diameter) are satisfying the increasing needs as the tree grows.

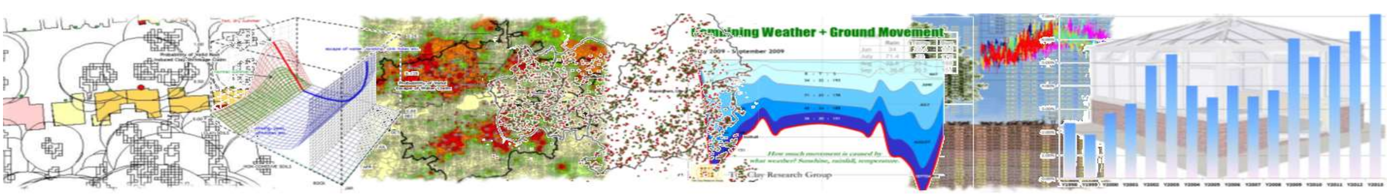


In 2007 ground profiles remain fairly stable until August, when there is a dip of 15.6mm at station 23, bringing the total at this station to 30mm from the first reading in May 2006.

Little change in September before a noticeable dip in October when the overall movement at station 23 reached 49mm.

Recovery begins in November with recovery at this station of 10mm.

The rainfall data from Heathrow weather station (following page) provides some explanation with movement following weather trends. Perhaps the 2006 surge was triggered by the June deficit.



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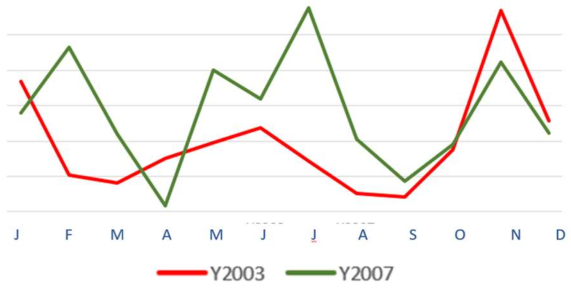
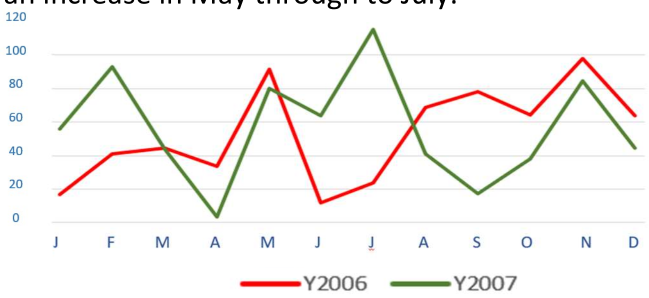
Normal Year Rainfall -v- Surge

RAINFALL – HEATHROW WEATHER STATION

Below, comparing rainfall for the surge years 2006 (48,100 claims) and 2003 (55,400 claims) with the relatively normal year of 2007 (31,895 claims) to show the likely trigger. Referring to the levelling data (see page 3) low rainfall in April in 2007 would probably have little influence on deciduous trees and was quickly resolved by an increase in May through to July.



Monthly rainfall comparing 2003 (red) with 2007 (green). In 2003 rainfall was lower from May through to August compared with 2007.

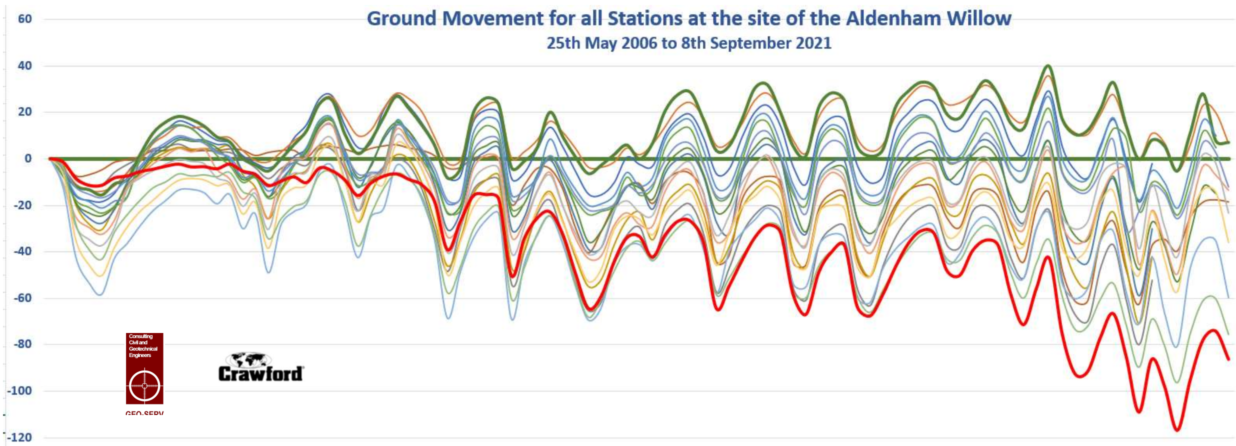


In 2006, rainfall was lower than 2007 in June and July.

PRECISE LEVEL DATA

Aldenham Willow

Below, precise level data for the various stations at the site of the Aldenham willow in north west London. The data is collected by GeoServ Ltd., and funded by Crawford & Co. The exercise commenced in May 2006 and the most recent readings were taken on the 8th September 2021.



The red line, the station where maximum subsidence has taken place, is No. 25 where 90mm of ground movement has been recorded.

In contrast, station 1 nearest the tree has recorded the maximum recovery at 40mm.

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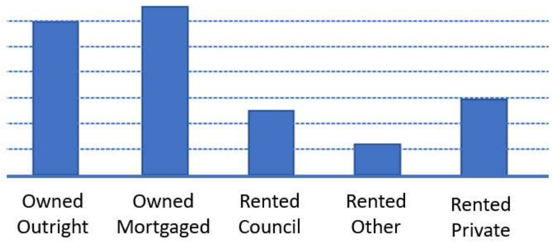
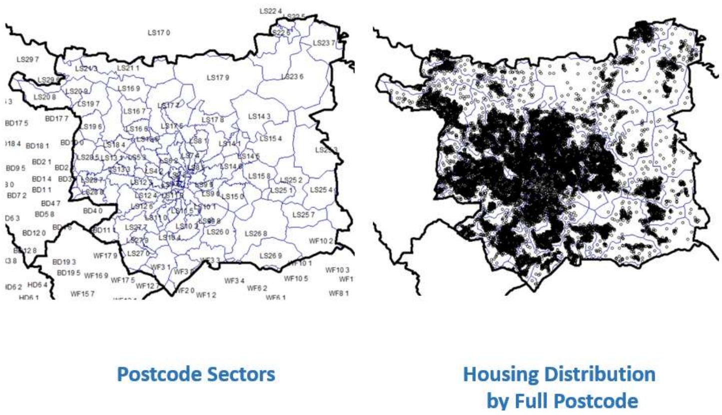
Subsidence Risk Analysis – LEEDS

Leeds occupies an area of 551.7km^2 with a population of around 800,000. The broad distribution of occupancy by ownership is shown right. Private housing accounts for nearly double the number of rented properties.





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

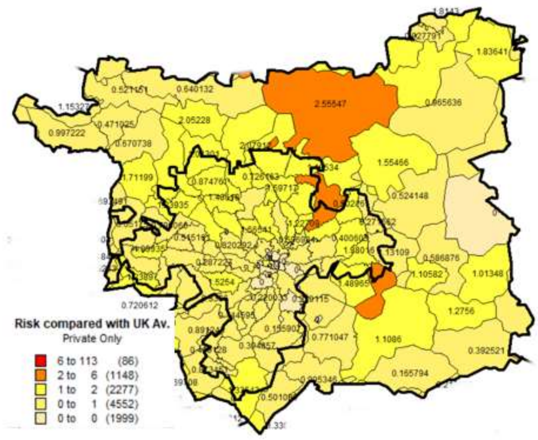
Housing distribution across the district (left, using full postcode as a proxy) helps to clarify the significance of the risk maps on the following pages. Are there simply more claims in a sector because there are more houses?

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

Leeds is rated 120th out of 413 districts in the UK from the sample analysed and is around 0.74x the risk of the UK average, or 0.193 on a normalised scale.

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



Risk compared with UK Average.
Leeds district is rated around 0.74 times the UK average risk for domestic subsidence claims from the sample analysed

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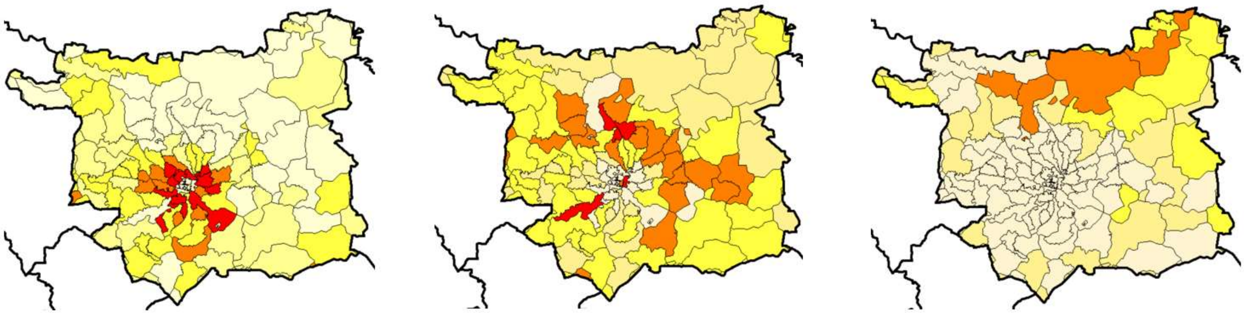
LEEDS - Properties by Style and Ownership

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.

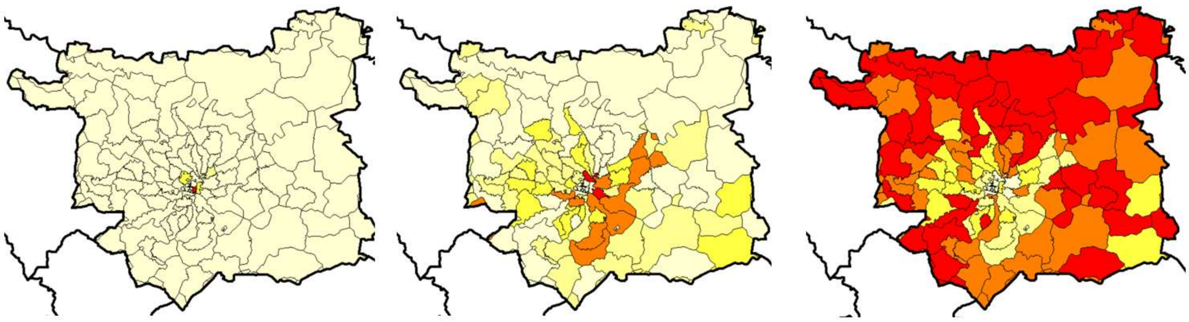
DISTRIBUTION BY HOUSE TYPE – LEEDS



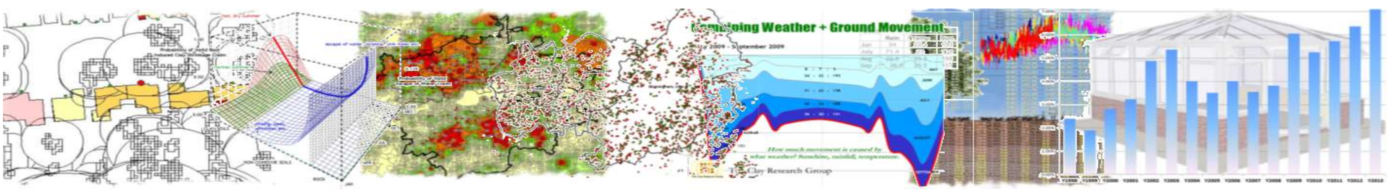
Terraced **Semi-Detached** **Detached**

Distribution by ownership is shown below. Privately owned properties are the dominant class and are spread across the borough. Council ownership is denser towards the city.

DISTRIBUTION BY OWNERSHIP – LEEDS



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



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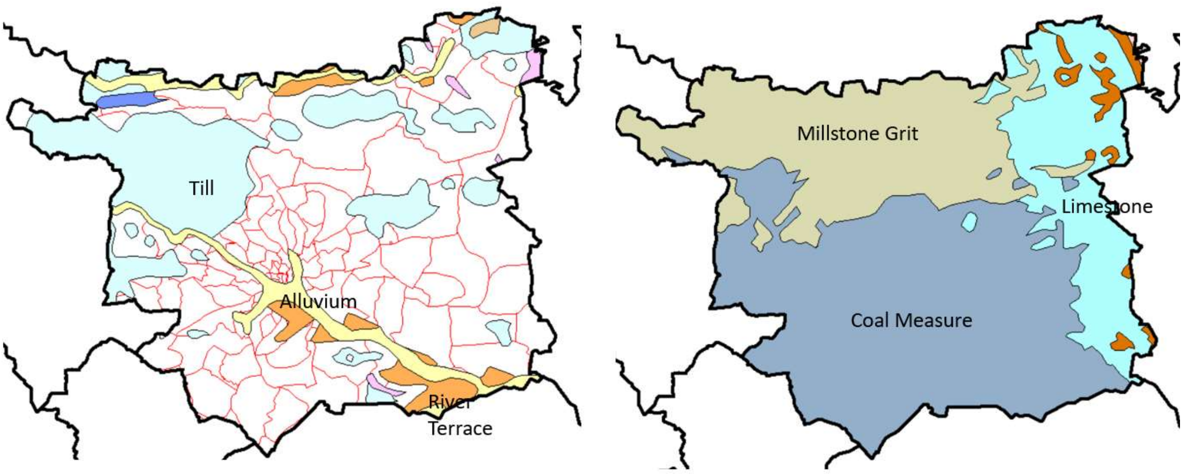
Subsidence Risk Analysis – LEEDS

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 a greater than 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.

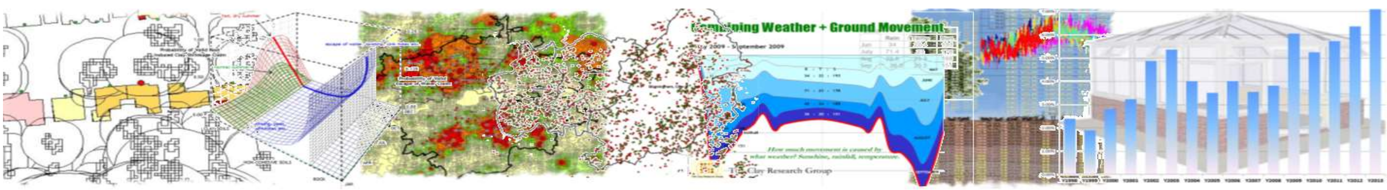
In the winter the situation reverses. The likelihood of a claim being declined is around 50% and if valid, there is greater than 70% probability the cause will be due to an escape of water. Maps at the foot of Page 8 shows the seasonal distribution.

1:625,000 scale British Geological Survey Maps



DRIFT SOLID

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. The geology suggests that subsidence associated with water escaping from drains and water service pipes, as well as heavy rainfall, would be the dominant cause. The figures quoted above inferring a higher risk from root induced clay shrinkage is unexpected and will form the subject of a more detailed study in a future edition.



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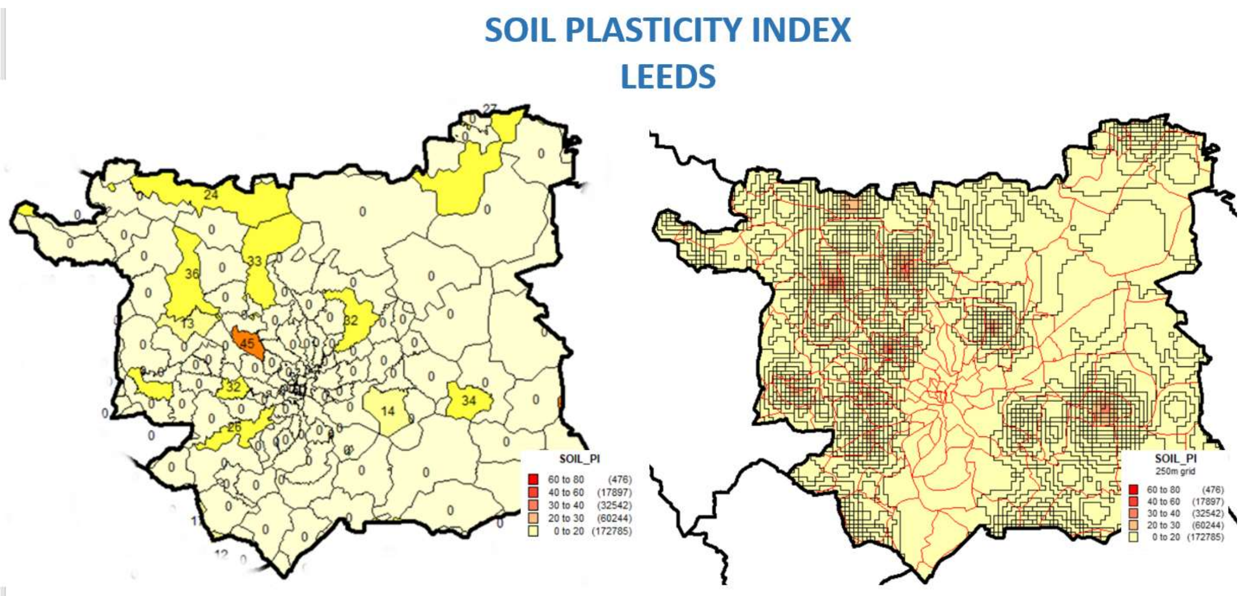
Liability by Geology and Season

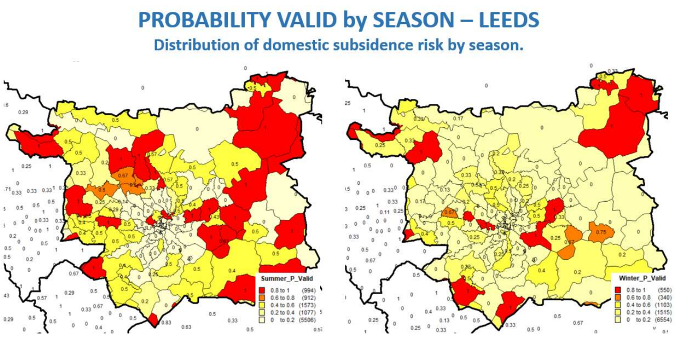
Below, the average PI by postcode sector (left) derived from site investigations and interpolated to develop the CRG 250m grid (right). The presence of a shrinkable clay in the CRG model differs from the BGS maps on the previous page suggesting a variable thickness of drift and higher concentration of clay in some areas. The higher the PI values, the darker red the CRG grid. The values below indicate low plasticity values across the borough possibly associated with clay bearing drift deposits and soils with an organic content that could be susceptible to shrinkage.



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.



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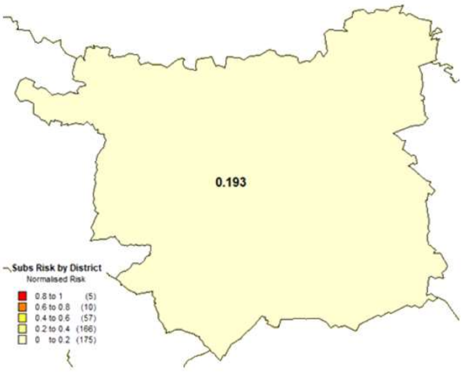
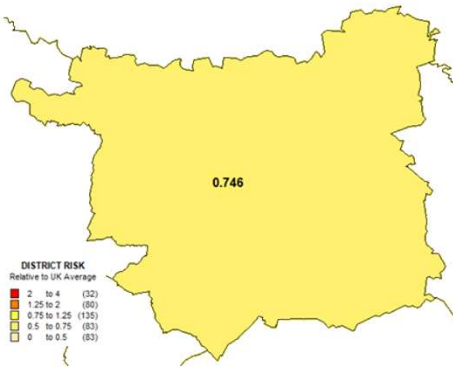
District Risk -v- UK Average. EoW and Council Tree Risk.

SUBSIDENCE RISK RELATIVE TO UK
LEEDS



Normalised (0 – 1) Scale

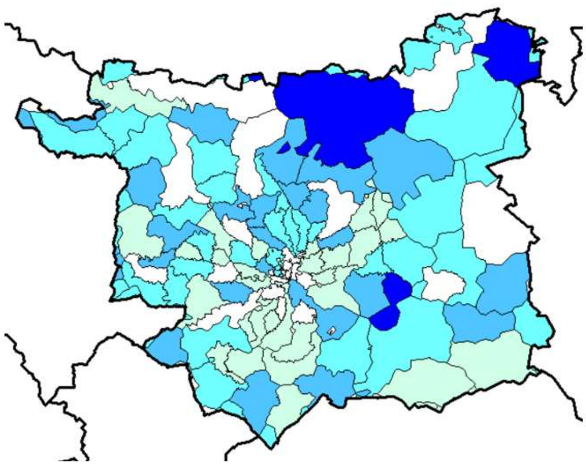


Compared with UK Average

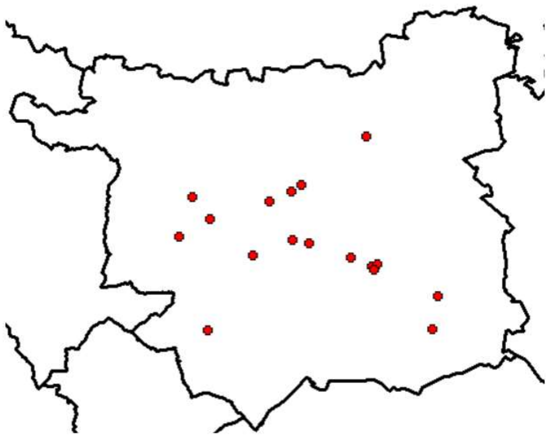
Below, left, mapping the frequency of escape of water claims from the sample reflects the presence of drift deposits (chalk, alluvium, sands and gravels etc) and possibly shallow foundations with older housing stock. The absence of shading often indicates a low frequency rather than the absence of claims.

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.

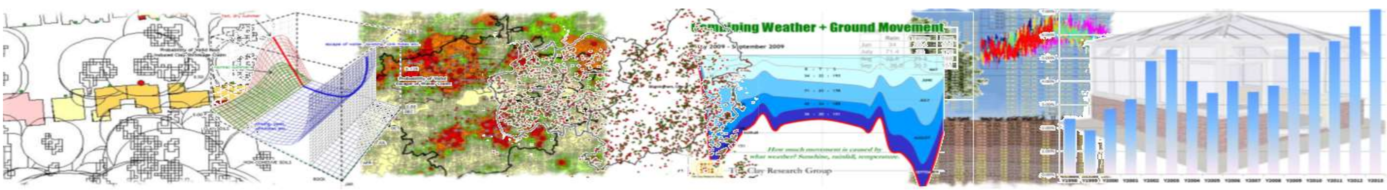
Escape of Water –v- Council Tree Claims
LEEDS



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



Claims Involving Council Trees
(2,858 claim sample)



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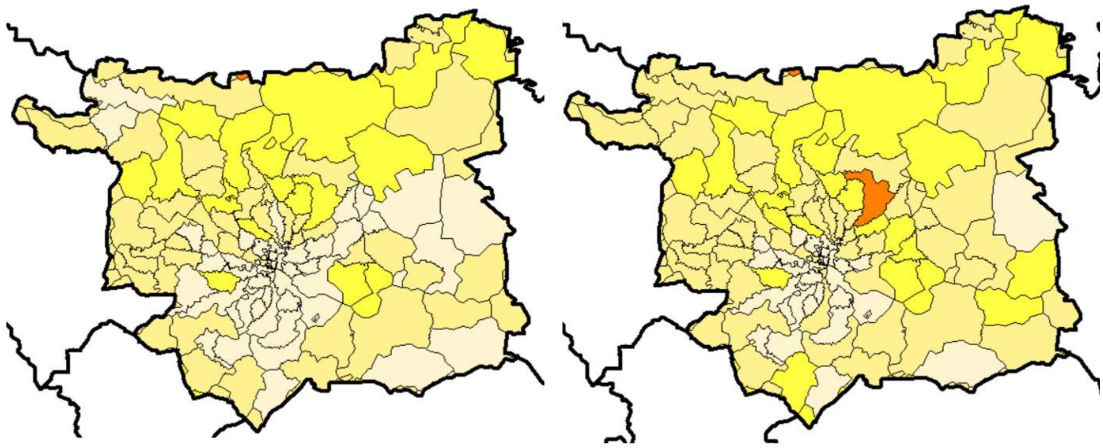
LEEDS - Frequencies & Probabilities

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 – LEEDS



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 lower throughout the year, with an increase in the winter months.

Liability by Season - LEEDS

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Leeds	0.575	0.158	0.267	0.10	0.35	0.55

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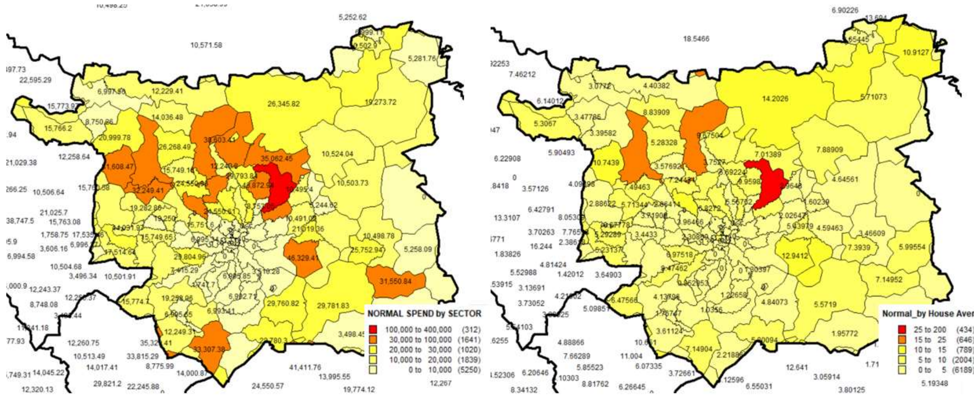
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

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.

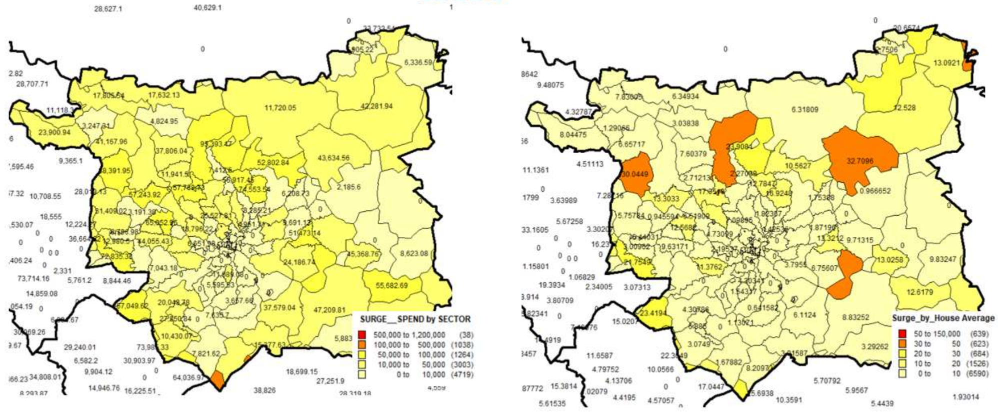
NORMAL YEAR SPEND – UK SAMPLE £200m
LEEDS



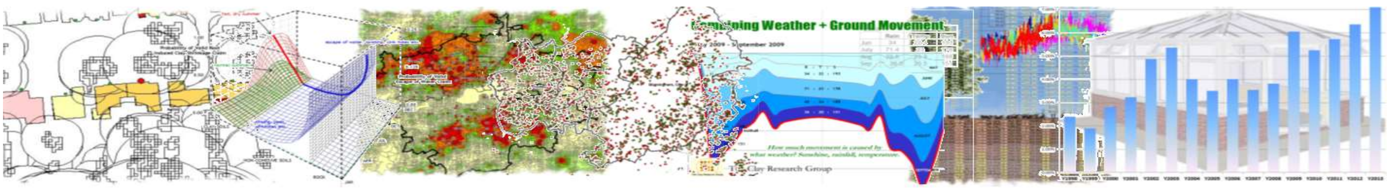
Spend by Sector — Spend Averaged over Housing Population

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
LEEDS



Spend by Sector — Spend Averaged over Housing Population



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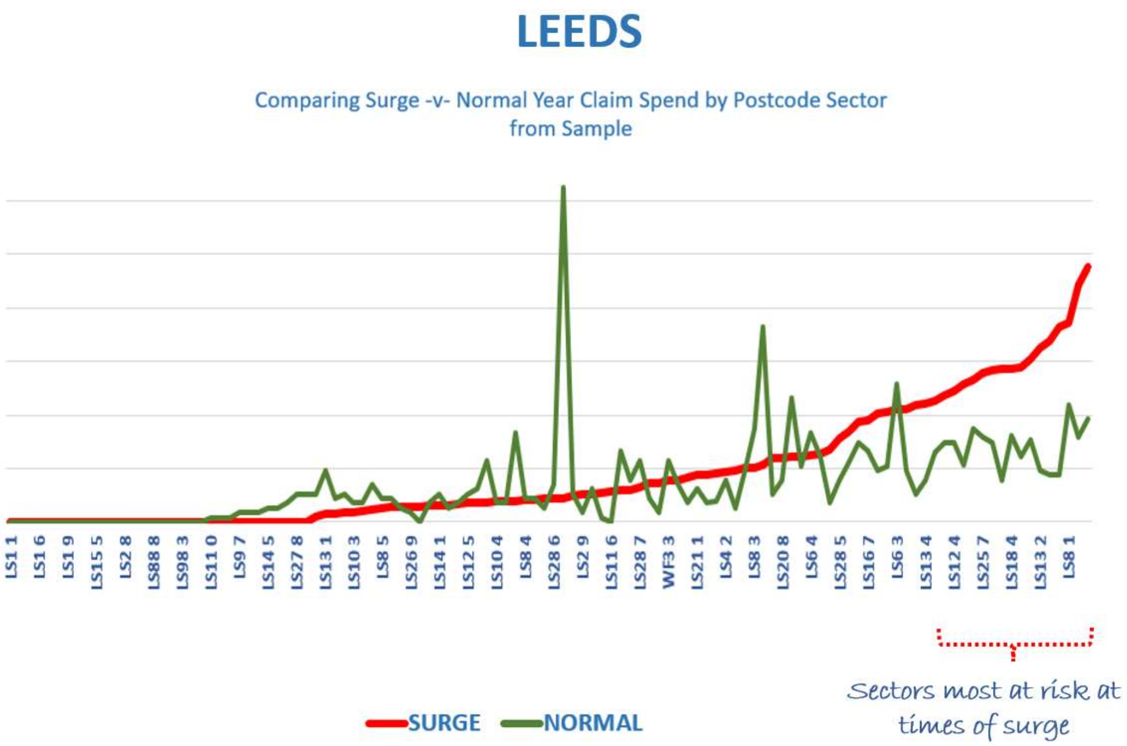

The above graph identifies the variable risk across the district at postcode sector level from the sample, distinguishing between normal and surge years. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

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.