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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 2025
Issue 236

The Clay Research Group

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Subsidence Risk Analysis by District
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Global Warming

The Met Office confirm that 2024 was Britain’s fourth warmest year on record with an average temperature of 9.78°C, 0.64°C above the 1991 – 2020 average. Warmer years were 2022, 2023 and 2014.

Worldwide, 2024 is the warmest year on record according to an analysis by the World Meteorological Organisation – “2024 is on track to be the warmest year on record after an extended streak of exceptionally high monthly global mean temperatures.”

Contributions Welcome

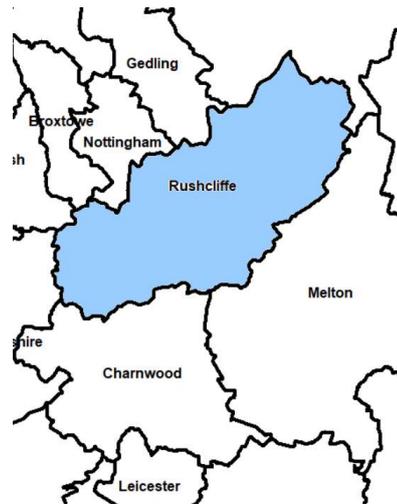
We welcome articles and comments from readers. If you have a contribution, please Email us at: clayresearchgroup@gmail.com

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District and Sector Risk

Rushcliffe is a borough lying to the south of Nottinghamshire and is the subject of the ‘Risk by District’ series in this month’s edition. Its geology is predominantly Till and Alluvium deposits overlying Mudstones and the Lower Lias series – see Page 7.



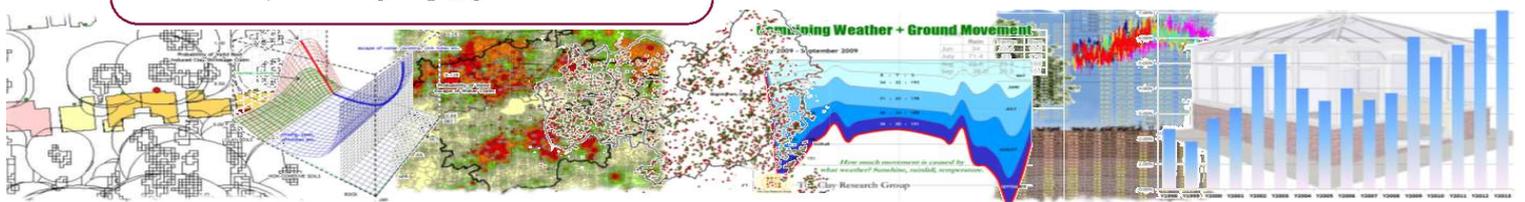
The risk maps are built from a data sample covering four claim years, including one surge and three ‘normal’ years.

Tree Data

Thanks to Keiron Hart of Tamla Trees Ltd., for drawing attention to “Handbook of UK Urban Tree Allometric Equations and Size Characteristics (Version 1.4)”, published in December, 2024.

The authors, Joe Fennell and Luke Fay, supported by funding from the Open University and data from a number of sources listed in the paper, investigate data from 46 tree species to derive estimates of tree height, crown radius and diameter at breast height for each species. Download a copy from the CRG web site via the ‘Monthly Newsletter’ tab and selecting “Tree Allometric”.

Fennell, J.T., & Fay, L. (2024). Handbook of UK Urban Tree Allometric Equations and Size Characteristics (Version 1.4)



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ChatGPT – Global Warming and Claim Numbers



Question to ChatGPT

Will global warming increase the number of domestic subsidence claims related to root induced clay shrinkage?

ChatGPT Response

Yes, global warming is likely to increase the number of domestic subsidence claims related to root-induced clay shrinkage. Subsidence occurs when the ground beneath a property sinks, often due to changes in soil moisture levels. The main factors connecting global warming to an increase in such claims are:

1. Increased Temperature and Drier Summers

- Global warming is projected to bring hotter and drier summers in many regions, leading to significant drying of clay soils.
- Clay soils are particularly prone to shrinkage as they lose moisture, and this can cause the ground to settle unevenly, affecting building foundations.

2. Tree and Vegetation Water Uptake

- Trees and shrubs draw water from the soil, exacerbating drying and shrinkage in clay-rich areas.
- As temperatures rise, vegetation may increase its water uptake, particularly during drought periods, intensifying the effect.

3. Extreme Weather Patterns

- Global warming contributes to more extreme weather events, including alternating periods of heavy rainfall and prolonged drought.
- These fluctuations can cause soils to swell during wet periods and shrink during dry periods, creating cycles of stress on foundations.

4. Increased Plant Growth

- Higher levels of CO₂ and warmer temperatures may stimulate faster and more extensive growth of vegetation.
- This growth could lead to increased root penetration into clay soils, amplifying shrinkage and the risk of subsidence.

5. Vulnerable Areas

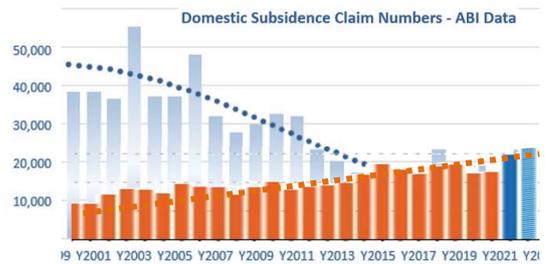
- Areas with a high prevalence of clay-rich soils, such as parts of the UK, are particularly vulnerable.
- As the impacts of global warming become more pronounced, regions with clay soil foundations may see a rise in subsidence-related claims.



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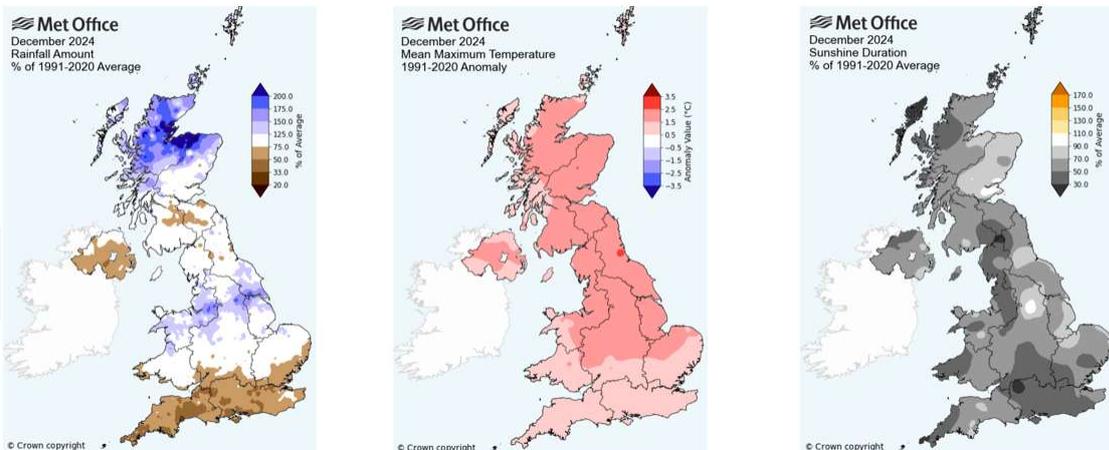
- **Mitigation and Planning**
- Proper management of vegetation near buildings, such as careful tree planting and pruning, can help mitigate risks.
- Improved building design and foundations that account for soil shrinkage and expansion can also reduce damage.
- Insurers and homeowners may need to adapt to the increased risk by adjusting policies and implementing preventative measures.
- Given these factors, insurers, property owners, and policymakers will need to consider climate resilience in both urban planning and individual property maintenance to address the growing challenge of subsidence due to root-induced clay shrinkage.

The ChatGPT view is interesting and makes sense. After all, we assume water uptake by tree roots increases in warm, dry weather. This is what causes the majority of subsidence claims (blue bar graph) in clay soils. The puzzle is, the warming climate (superimposed graph from Nature journal based on data from Copernicus Climate Change study) - doesn't appear to be delivering an increase in claim numbers? See CRG newsletter edition 233 for more.

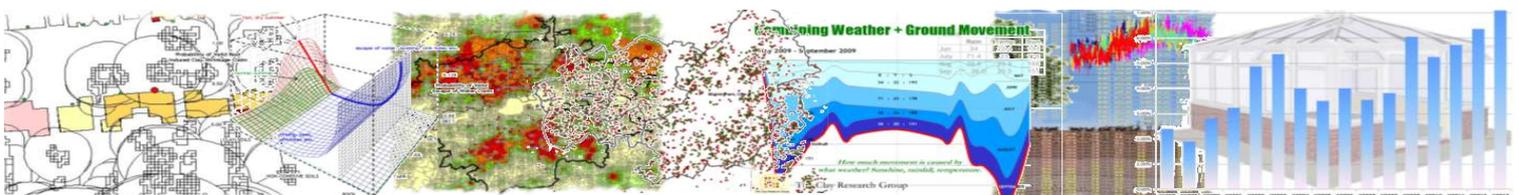


Met Office Anomaly Maps for December 2024

Anomaly maps from the Met Office web site for the month of December 2024 reproduced below comparing values with the average for the period 1991 - 2020. The month can be summed up as being warmer across the UK with reduced hours of sunshine. Wetter in Scotland and drier along the south coast.



<https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-actual-and-anomaly-maps>



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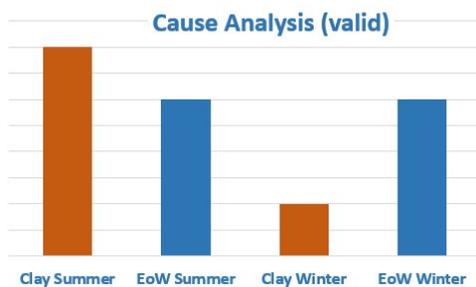
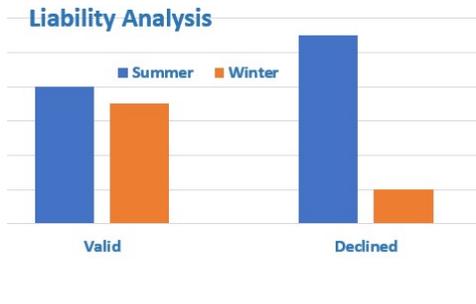
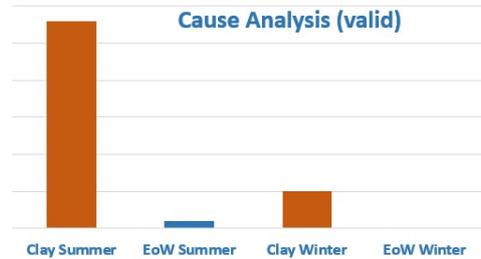
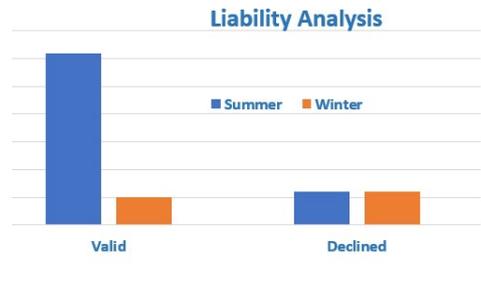
Rushcliffe - Area Sector Level Sample Using Past Claims Data to Infer Geology and Derive Probability of Cause and Liability

NG12 3 – Shallow superficial deposits of Till and Alluvium on the western border overlying Lower Lias to the south and Mudstone to the north.

Predominantly semi-detached and detached housing in private ownership with higher claim numbers in the summer months and relatively few declinatures throughout the year. Relatively low housing density.

There are a relatively high number of claims due to clay shrinkage in the summer months most likely associated with clay content in the solid geology.

Although the sector is rated above average in terms of subsidence risk, this reflects the predominantly lower risk across the UK.



NG13 8 –Alluvium overlying mudstone - see page 7 for extract from BGS 625,000 scale maps and page 8 for the results of investigations related to subsidence claims. Shrinkable clay soils and alluvial soils extend into the sector along its southern border with a maximum PI of 46% noted from our records.

Valid claim numbers are similar in the summer and winter, with higher number of declinatures in the winter. Causation predominantly associated with clay shrinkage in the summer and Escape of Water in the winter.

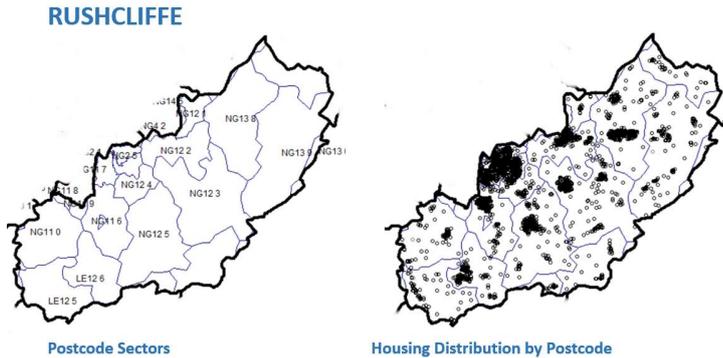
The sector has low density housing, predominantly in private ownership.



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Subsidence Risk Analysis – Rushcliffe

Rushcliffe is located in south Nottinghamshire and occupies an area of around 400km² with a population of around 120,000.



Distribution of housing stock using full postcode as a proxy. Each sector covers around 3,000 houses on average across the UK and full postcodes include around 15 – 20 houses on average, although there are large variations.

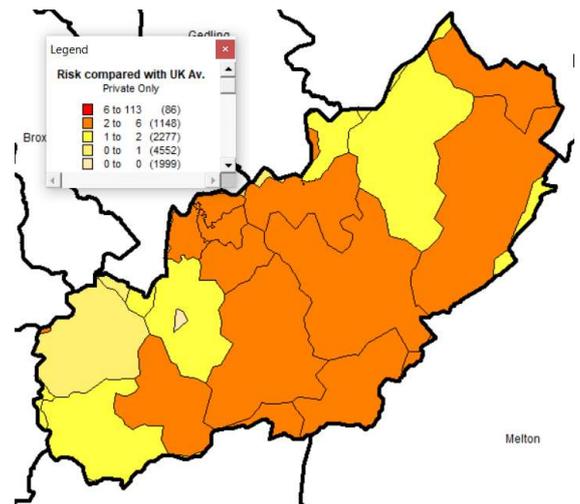
From the sample we hold sectors are rated for the risk of domestic subsidence compared with the UK average – see map, right.

Rushcliffe is rated 8th out of 413 districts in the UK from the sample analysed and is around 2.6x the risk of the UK average, or 0.69 on a normalised 0 - 1 scale.

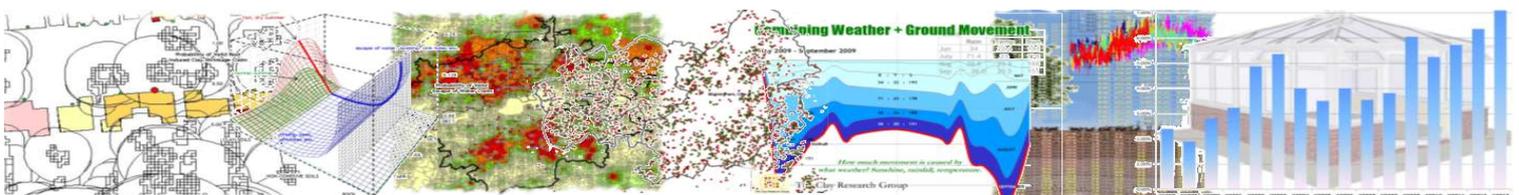
There is a slightly greater than average risk spread across the district as can be seen from the sector map, right.

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.



Sector risk compared to UK average from the sample analysed. Private ownership only.

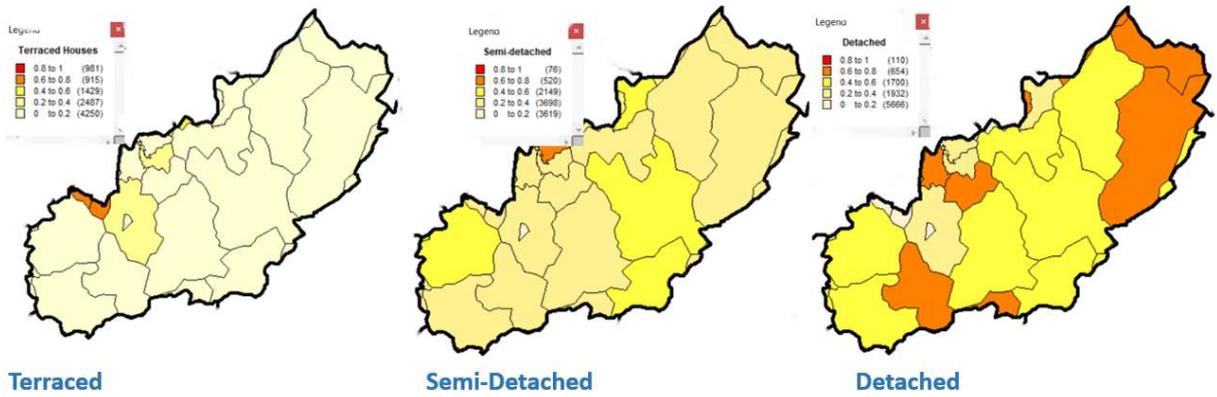


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Rushcliffe - Properties by Style and Ownership

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 taking out the policy.

RUSHCLIFFE - Distribution by House Type



Distribution by ownership is shown below. Detached, private properties are the dominant class across the district.

RUSHCLIFFE - Distribution by Ownership



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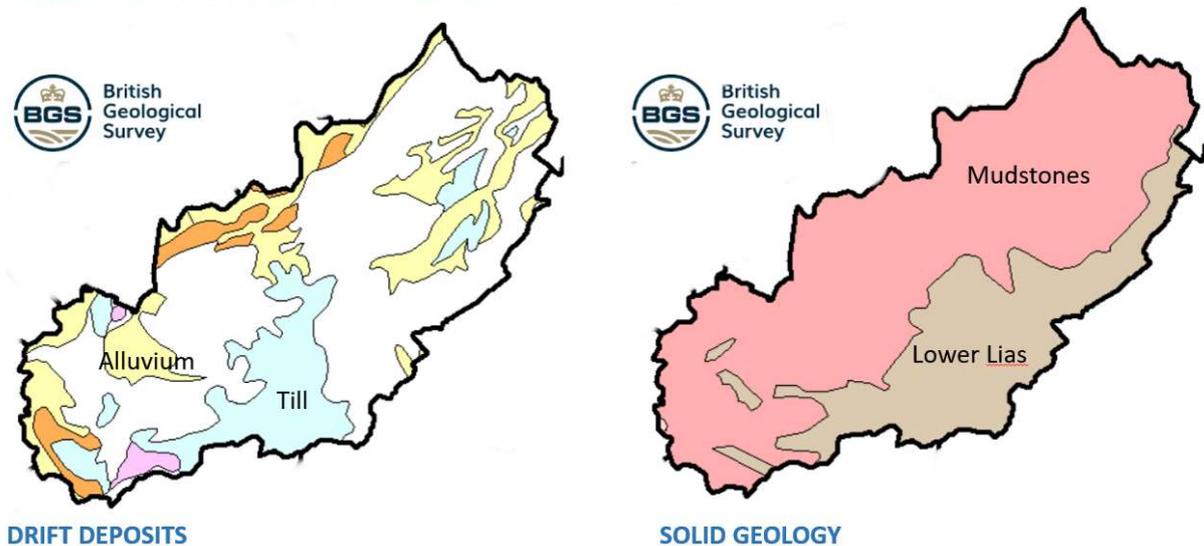
Subsidence Risk Analysis – Rushcliffe

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 around an 70% probability of a claim being valid in the summer and, of the valid claims, there is a 78% probability that the damage will have been caused by clay shrinkage. In the winter, the likelihood of a claim being valid drops to around 50% and of the valid claims, escape of water is the most likely cause.

A postcode sector map on the following page records the PI of soils retrieved following site investigations from the claims associated with the data held.

RUSHCLIFFE : BGS Geology – 1:625,000 scale



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

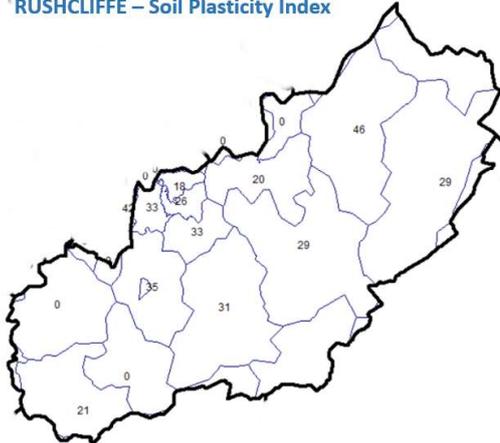


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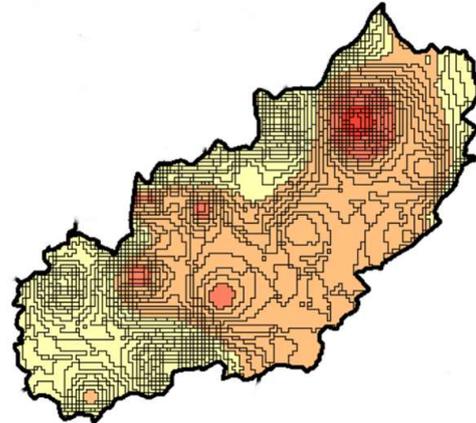
Liability by Geology and Season

Below, the average PI by postcode sector (left) derived from site investigations and interpolated to develop the CRG 250m grid (right). The higher the PI values, the darker red the CRG grid.

RUSHCLIFFE – Soil Plasticity Index



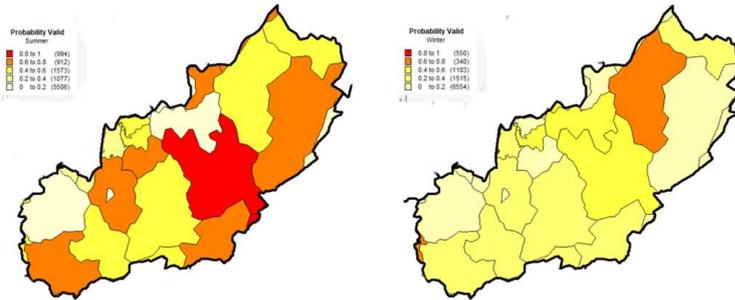
Soil PI Averaged by Sector



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.

RUSHCLIFFE – 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 and reviewing the table on page 10 is perhaps the most useful way of assessing the potential liability, likely cause and geology using the values listed.

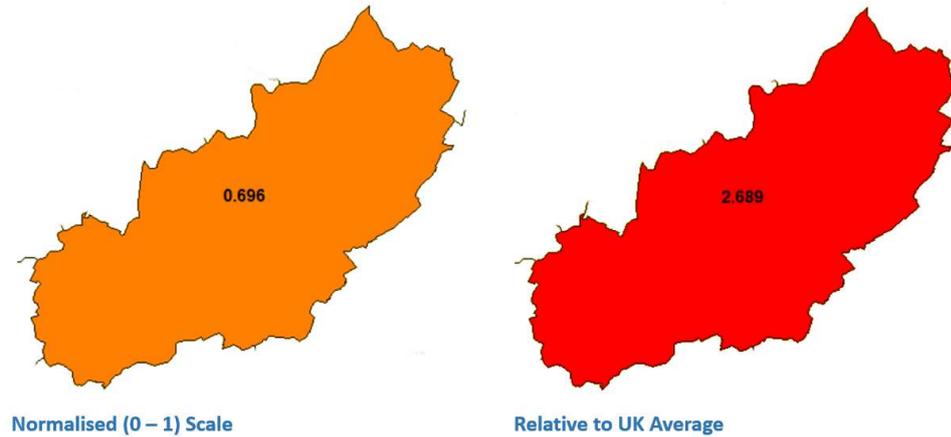
The 'claim by cause' distribution and the risk posed by the soil types is illustrated at the foot of the following page. A high frequency risk can be the product of just a few claims in an area with a low housing density of course and claim count should be used to identify such anomalies.



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District Risk. EoW and Council Tree Risk.

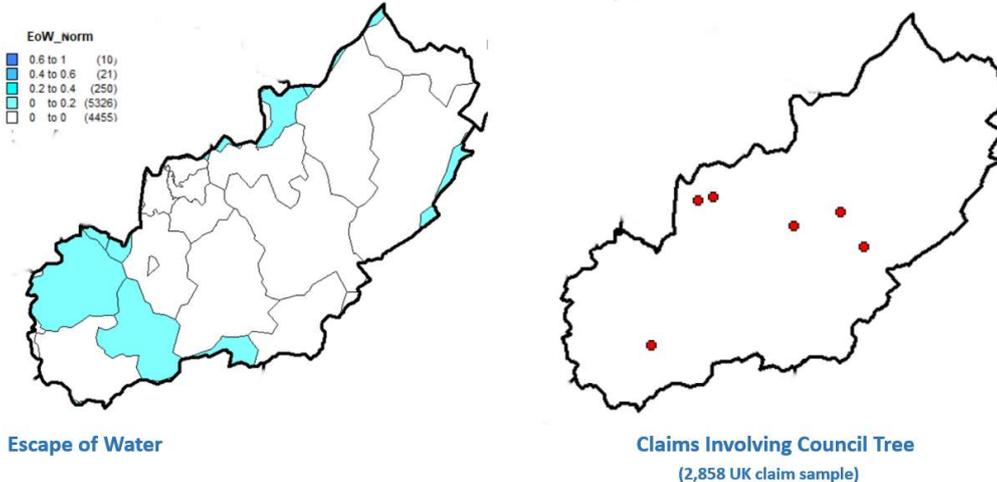
RUSHCLIFFE - Subsidence Risk Relative to UK



Below, left, mapping the frequency of escape of water claims confirms the presence of predominantly non-cohesive soils. The distribution on the map reflects the presence of non-cohesive drift deposits. As we would expect, the 50,000 scale BGS map provides a more detailed picture. The CRG 1:250 grid reflects claims experience.

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 claims coincide with the presence of shrinkable soils shown on the previous page from samples obtained from site investigations associated with claims.

RUSHCLIFFE

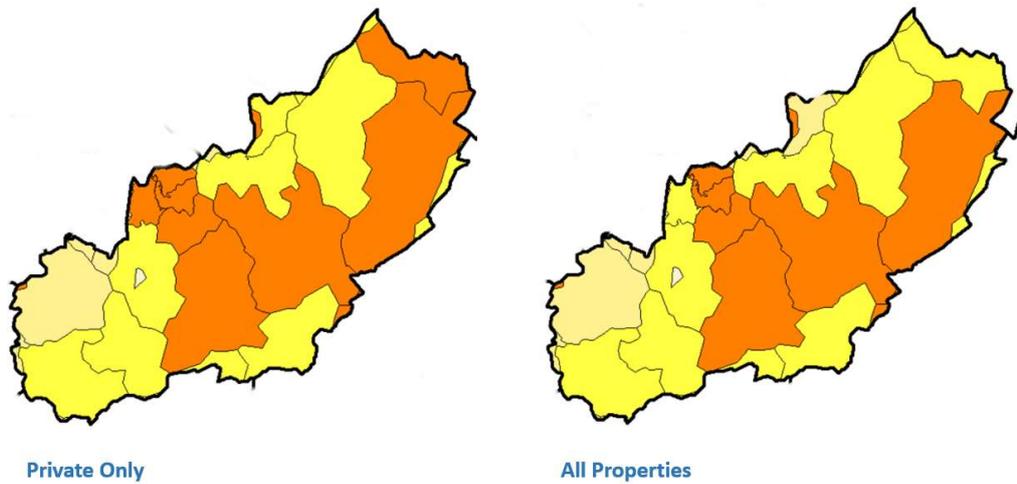


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Rushcliffe - Frequencies & Probabilities

Below, mapping the risk of subsidence by ownership. Claims frequency that includes council and housing association properties delivers a misleading value of risk as they tend to self-insure. The following show the normalised risk, taking account of the private housing population – that is, the rating compared with the average value for each category.

RUSHCLIFFE - Sector Risk Compared with UK Average



On a general note, a 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 usually low, and in the winter, it is high.

Valid claims in the summer have a higher probability of being 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 - RUSHCLIFFE

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Rushcliffe	0.572	0.161	0.267	0.12	0.44	0.44

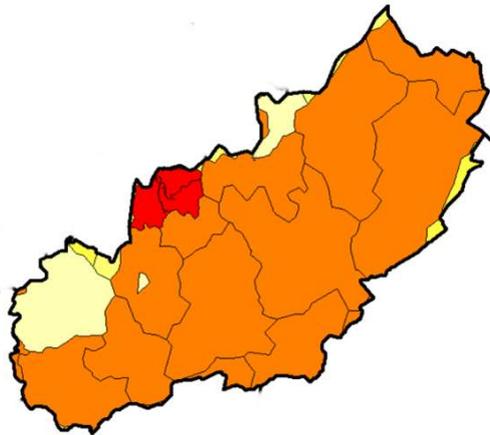


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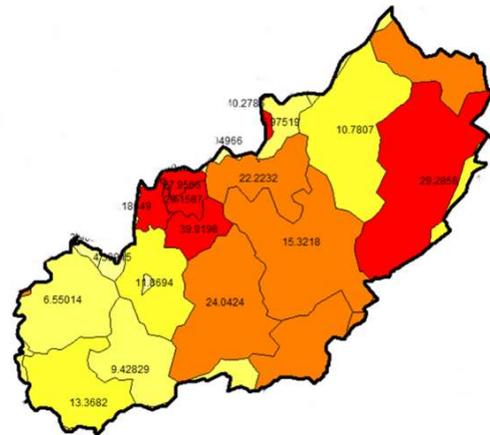
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Normal & Surge Years

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 of course.

NORMAL YEAR SPEND – RUSHCLIFFE



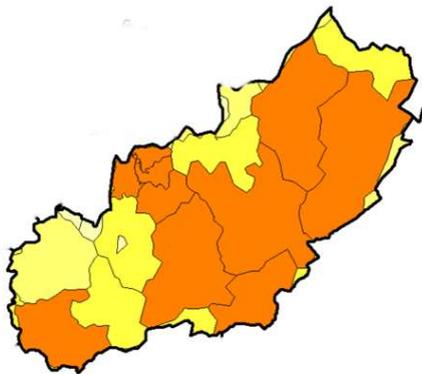
Spend by Sector



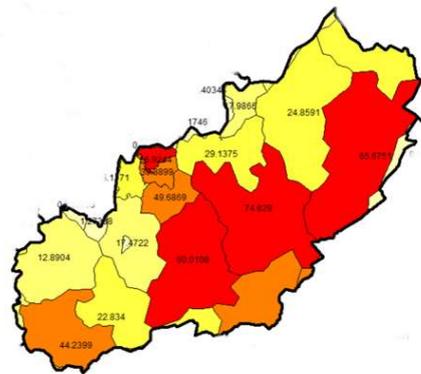
Spend Averaged Over Private Housing Population

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 private 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. The absence of any distinct difference between surge and normal years reflects the geology.

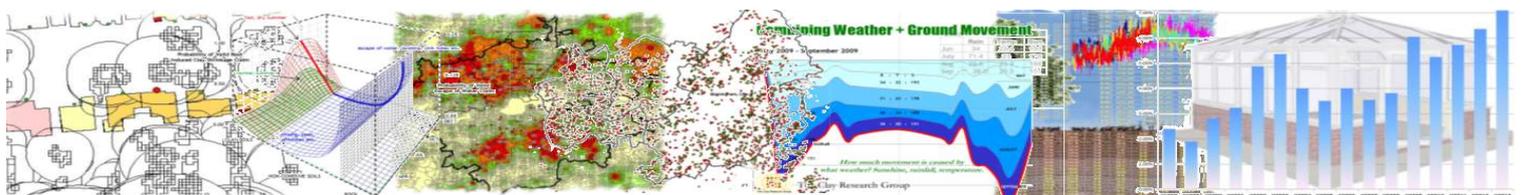
SPEND in SURGE – RUSHCLIFFE



Spend by Sector



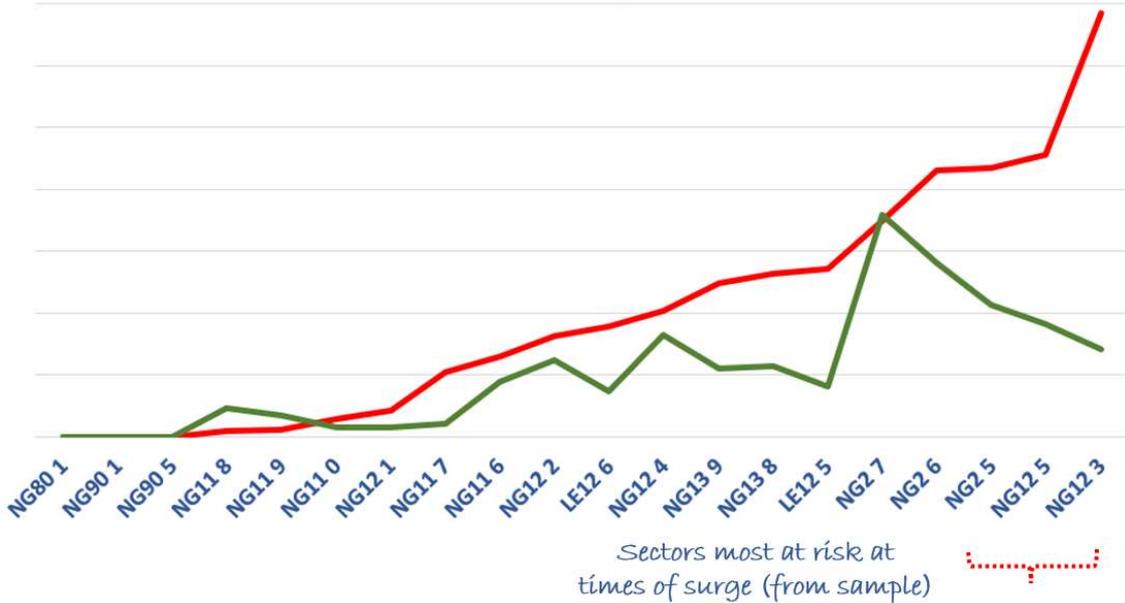
Spend Averaged over Private Housing Population



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RUSHCLIFFE

Comparing Surge -v- Normal Year Claim Spend by Postcode Sector from Sample



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 are based on losses for surge of just over £400m, and for normal years, £200m.

