

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



April 2024
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The Clay Research Group

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Subsidence Risk Analysis by District

Newcastle-upon-Tyne

District and Sector Risk

Newcastle-upon-Tyne (Newcastle) is the subject of the 'Risk by District' series in this month's edition. It has superficial deposits of sand, gravel and Till overlying coal measure – see Page 8.



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

Cliff Fall at Norfolk

Due to a failing cliff face at The Old Farmhouse in Trimingham, Norfolk the property is to be demolished by the council to prevent debris falling onto the beach.



The cost to stabilise the cliff is estimated to be around £20m and is unlikely to go ahead.

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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Artificial Intelligence Applications

ChatBot and ChatGPT

Ai applications are becoming increasingly popular. We posed some simple questions on the ChatGPT site asking 'What is the major cause of domestic subsidence in England?' and 'Can trees cause subsidence?' – see page 2.

Bob Walker, Soils Laboratory Manager at Environmental Services, Innovation Group, spent some time exploring the ChatBot application on the web, asking the challenging question "explain how rehydration channels work with clay soils, allowing for the introduction of lime to dissuade tree root activity".

We posed the same question to ChatGPT and responses are listed on pages 3 and 4.



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ChatGPT and Subsidence

Question to ChatGPT

What is the major cause of domestic subsidence in England?

ChatGPT Response

In England, one of the major causes of domestic subsidence is related to the geology of the region. Many areas in England are built on clay soils, which are susceptible to shrinkage and swelling depending on moisture levels. During dry periods, clay soils can shrink, causing the ground to settle and leading to subsidence under buildings. Conversely, during wet periods, clay soils can expand, exerting pressure on foundations and causing structural damage. This cycle of shrinkage and expansion can result in subsidence issues for buildings constructed on such soils. Additionally, factors such as leaking drains or poor construction practices can exacerbate the problem.

Question to ChatGPT

Can trees cause subsidence?

ChatGPT Response

Yes, trees can indeed contribute to subsidence under certain circumstances. Subsidence occurs when the ground sinks or collapses, often due to the underlying soil or rock compressing or shifting. Trees can exacerbate this process in several ways:

1. **Water Uptake:** *Trees absorb water from the soil through their roots. In areas with clay-rich soils, excessive water extraction by trees can cause the soil to shrink, leading to subsidence.*
2. **Desiccation:** *Large trees can draw moisture from the soil, causing it to dry out and shrink. This shrinkage can result in the ground settling and potentially causing subsidence.*
3. **Root Growth:** *Tree roots can penetrate and exert pressure on underground structures such as pipes, drains, and foundations. Over time, this pressure can lead to damage and instability, contributing to subsidence.*
4. **Change in Soil Composition:** *As tree roots grow and expand, they can alter the composition and structure of the soil, potentially leading to differential settlement and subsidence.*

While trees are not the sole cause of subsidence, they can be a contributing factor, especially when combined with other geological or environmental conditions. Proper management of trees, including regular inspection, pruning, and monitoring of their impact on the surrounding soil, can help mitigate the risk of subsidence.



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ChatBot and Rehydration Channels

Bob Walker, Soils Laboratory Manager at Environmental Services, Innovation Group provided the following example of a ChatBot response to the question: “Explain how rehydration channels work with clay soils, allowing for the introduction of lime to dissuade tree root activity”

“Rehydration channels combined with lime introduction can effectively manage soil moisture, improve soil structure, and discourage tree root activity in clay soils. Here’s a detailed explanation of how this approach works:

- Channel Installation:** Rehydration channels, also known as subsurface irrigation or drainage systems, are installed beneath the surface of the clay soil. These channels are designed to distribute water and other substances, such as lime, at a specific depth within the soil.
- Water Source:** A controlled water source, such as an irrigation system or a water supply line, is connected to the rehydration channels. This water source provides a consistent supply of water for the soil.
- Lime Introduction:** Lime is introduced into the rehydration channels along with the water. Lime is typically in the form of crushed or powdered agricultural lime (calcium carbonate). As water flows through the channels, it carries the lime particles with it, dispersing them into the clay soil.
- pH Modification:** Lime is an alkaline substance. When introduced into the clay soil, it raises the soil's pH level, making it less favourable for root growth. Tree roots typically prefer slightly acidic to neutral pH conditions, and the elevated pH discourages their activity in the treated areas.
- Moisture Distribution:** Water is distributed through the rehydration channels simultaneously with the lime application. This controlled watering helps maintain soil moisture levels at the desired depth, ensuring that plants receive adequate water for their growth.
- Improved Soil Structure:** The rehydration channels, by delivering water and lime at depth, promote better soil structure and reduce compaction. Lime also aids in soil aggregation and flocculation, which can enhance the soil's porosity and reduce its plasticity.
- Discouraging Tree Root Activity:** Over time, as tree roots encounter the modified pH environment created by the lime, they are less likely to grow extensively into the treated areas. The less favourable pH conditions act as a deterrent to root intrusion, helping to protect the rehydration system from root damage or blockages.



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“Combining rehydration channels with lime introduction provides a comprehensive solution to address soil moisture, soil structure, and tree root management in clay soils. This approach fosters healthier plant growth, discourages excessive root activity in specific areas, and ensures the long-term effectiveness of the rehydration system. Consulting with a soil scientist or arborist familiar with local soil conditions and tree species is advisable to determine the optimal lime application rates and practices for your specific situation.”

ChatGPT and Rehydration Channels

Question to ChatGPT

The same question - “Explain how rehydration channels work with clay soils, allowing for the introduction of lime to dissuade tree root activity” - was posted on the ChatGPT site, which delivered the following reply:

ChatGPT Response

Rehydration channels are pathways in the soil that allow water to penetrate and move through. In clay soils, which are composed of very fine particles, these channels are especially important because clay tends to compact easily, reducing the movement of water and air.

When lime is introduced to clay soils, it can help improve soil structure by increasing aggregation, which means that soil particles clump together, creating larger pore spaces.

This, in turn, facilitates the movement of water and air through the soil.

In the context of dissuading tree root activity, the introduction of lime can help create an environment that is less conducive to root growth. By improving soil structure, lime can make it more difficult for roots to penetrate deeply into the soil. Additionally, lime can raise the pH of the soil, making it less hospitable for certain types of plants, including trees.

Overall, the combination of rehydration channels in clay soils and the introduction of lime can help improve soil structure and create conditions that discourage tree root activity in specific areas.”

The rehydration channels play a crucial role in this process by ensuring that the lime is able to penetrate into the soil effectively. As water moves through the soil, it carries the lime particles with it, allowing them to reach deeper layers where tree roots may be active. This can help inhibit root growth and prevent trees from encroaching on undesired areas.



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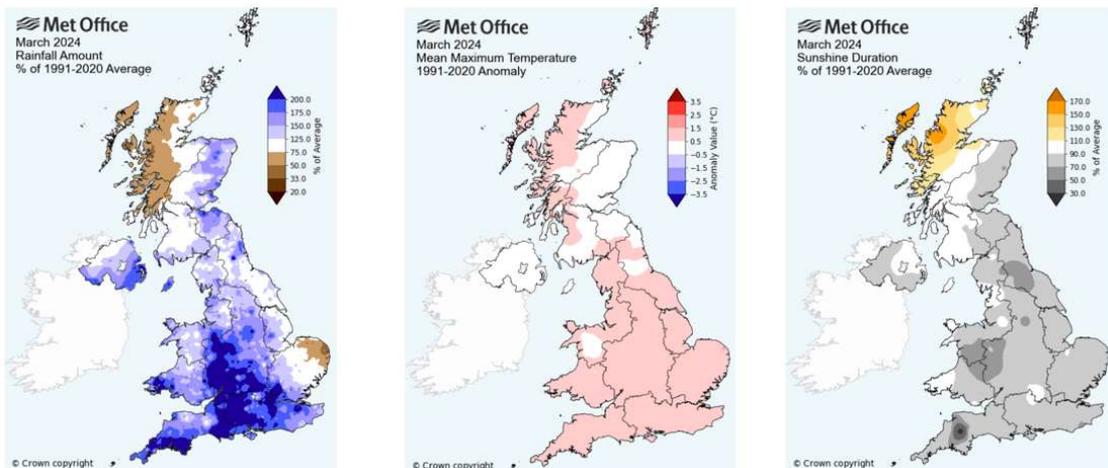
GPT and Rehydration Channels ... *continued*

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Met Office March 2024 Update. Anomaly Data, 1991 – 2020

Anomaly maps from the Met Office web site for the month of March 2024 reproduced below. The month can be summed up as being wetter and slightly warmer than the average for March when compared with the 1991 – 2020 average.



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

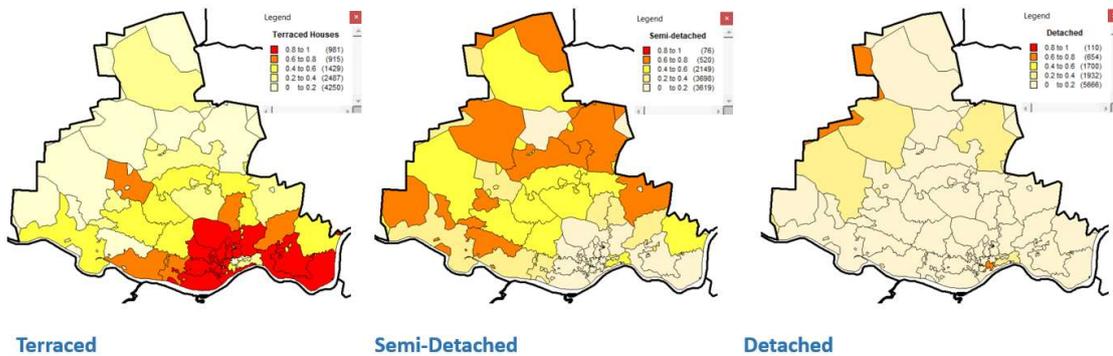


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Newcastle-upon-Tyne. Properties by Style and Ownership

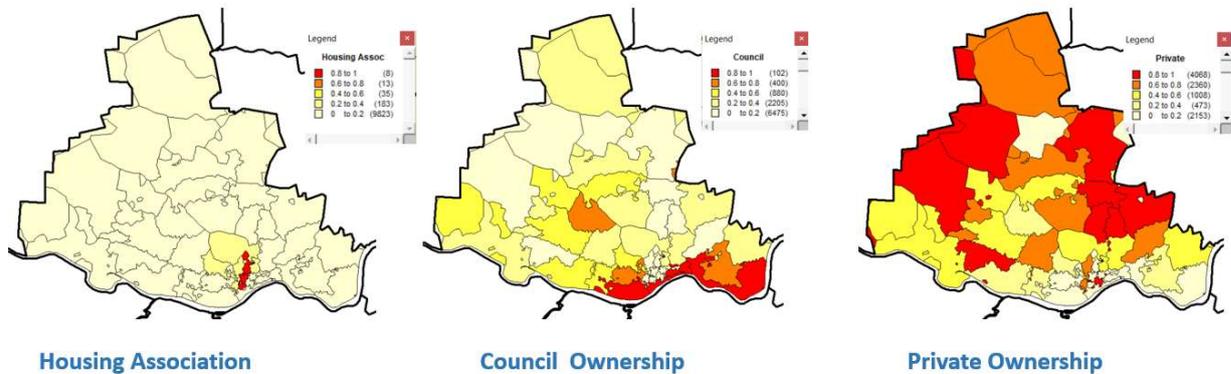
Below, the general distribution of properties by style of construction, distinguishing between terraced, semi-detached and detached. Unfortunately, the more useful data is missing at sector level – property age. Risk increases with age of property and the model can be further refined if this information is provided by the homeowner at the time of taking out the policy.

Newcastle-upon-Tyne - Distribution by House Type



Distribution by ownership is shown below. Semi-detached and terraced, private properties are the dominant class ownership across the borough.

Newcastle-upon-Tyne - Distribution by Ownership



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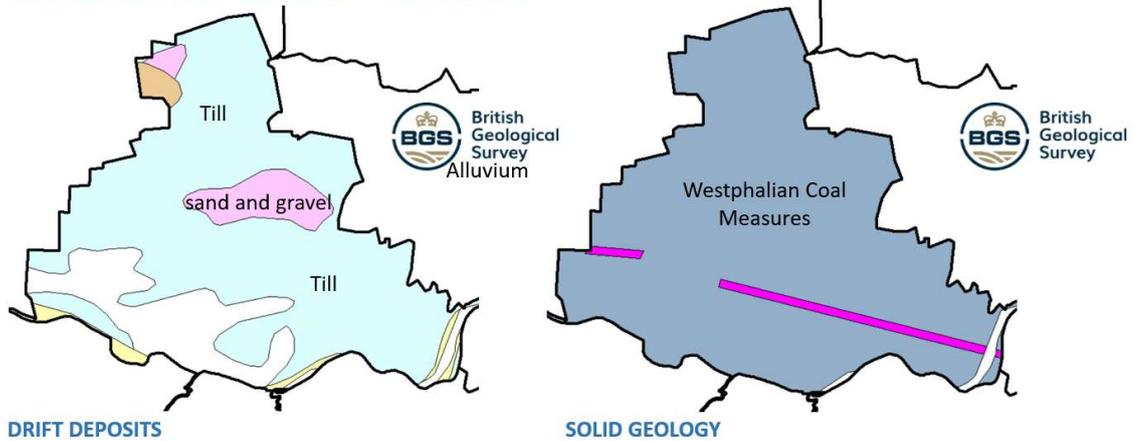
Subsidence Risk Analysis – Newcastle-upon-Tyne

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 a 60% probability of a claim being valid in the summer and, of the valid claims, there is around a 60% chance that the damage will have been caused by clay shrinkage, with escape of water accounting for the remaining 40%. In the winter the likelihood of a claim being valid remains at around 60%. Of the valid claims there is a 40% chance of the cause being clay shrinkage and 60% chance of the cause being an escape of water.

Maps at the foot of the following page plot the seasonal distribution and provide an indication of risk by geological series.

Newcastle-upon-Tyne : BGS Geology – 1:625,000 scale



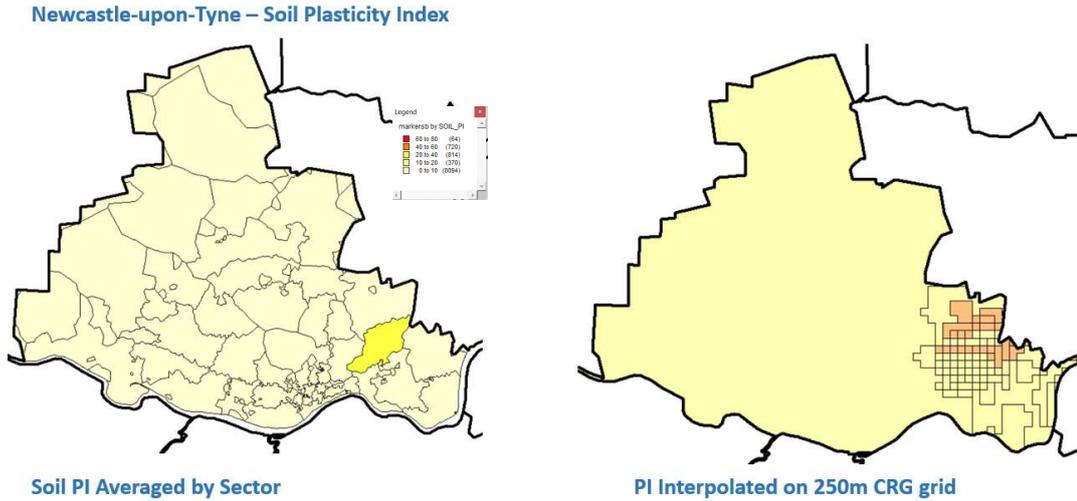
Above, extracts from the 1:625,000 series British Geological Survey maps. Working at postcode sector level and referring to the 1:50,000 series delivers far greater benefit when assessing risk.



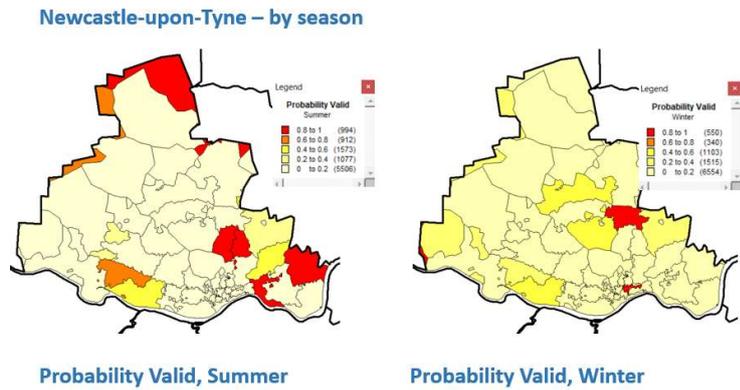
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Liability by Geology and Season

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.



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.



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

Combining the risk maps by season and reviewing the table on page 11 is perhaps the most useful way of assessing the potential liability, likely cause and geology using the values listed.

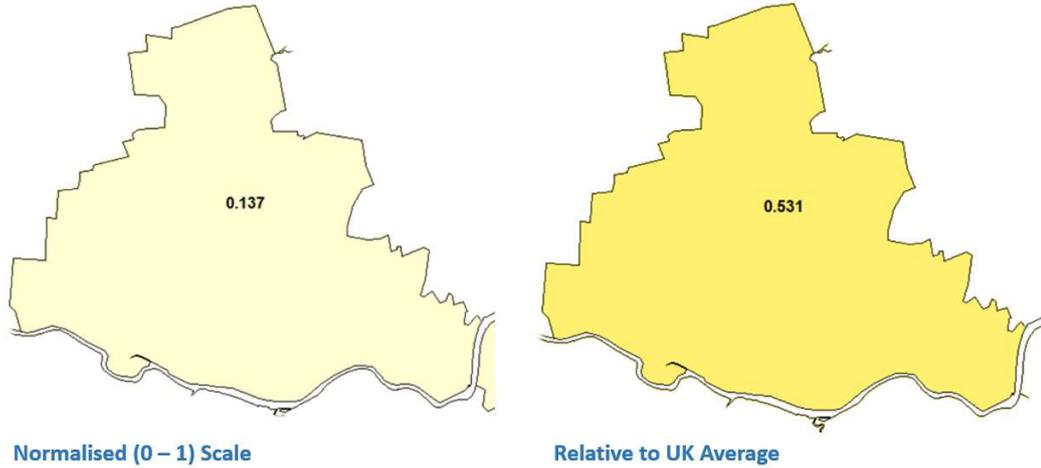
The 'claim by cause' distribution and the risk posed by the soil types is illustrated at the foot of the following page. A high frequency risk can be the product of just a few claims in an area with a low housing density of course and claim count should be used to identify such anomalies.



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District Risk. EoW and Council Tree Risk.

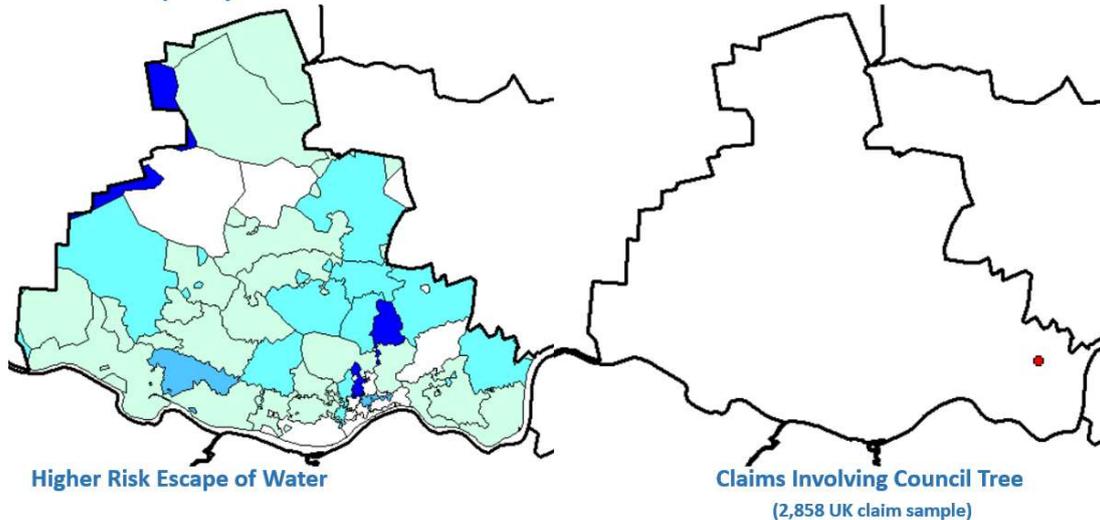
Newcastle-upon-Tyne - Subsidence Risk Relative to UK



Below, left, mapping the frequency of escape of water claims confirms the presence of non-cohesive soils. The distribution on the map reflects the presence of drift deposits of till, sand and gravel. 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. Unsurprisingly given the largely non-cohesive nature of the soils there is only one council tree related claim recorded.

Newcastle-upon-Tyne

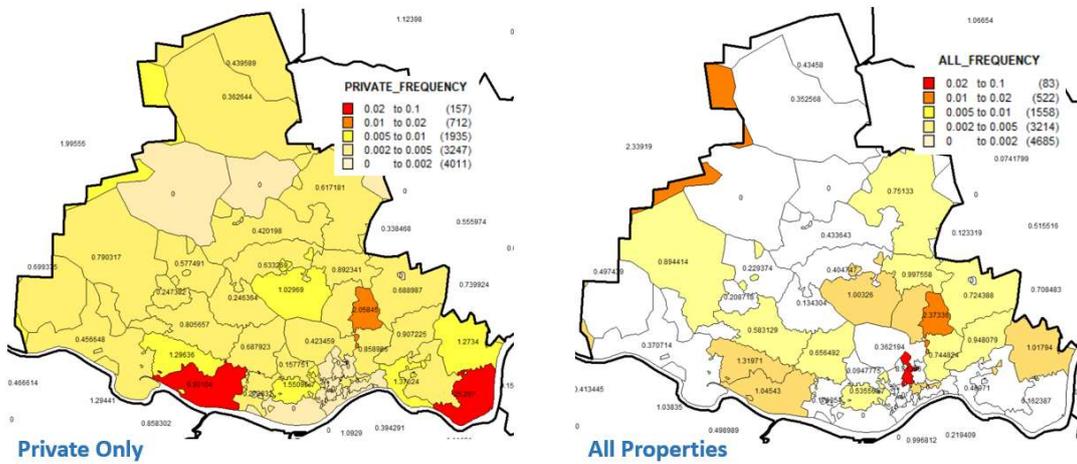


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Newcastle-upon-Tyne - Frequencies & Probabilities

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.

Newcastle-upon-Tyne - 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 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 - Newcastle-upon-Tyne

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Newcastle upon Tyne	0.353	0.265	0.382	0.27	0.36	0.37

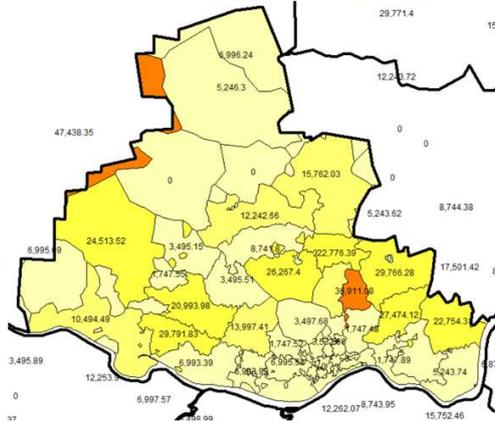


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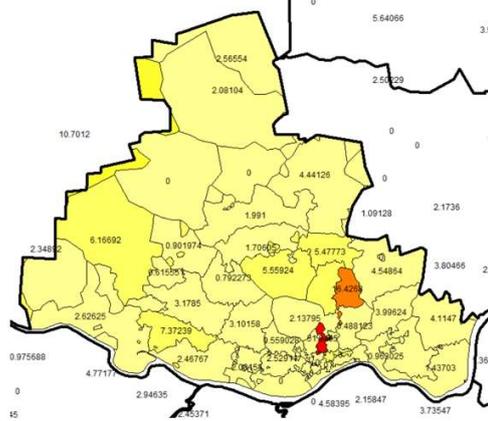
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

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 of course.

NORMAL YEAR SPEND – Newcastle-upon-Tyne



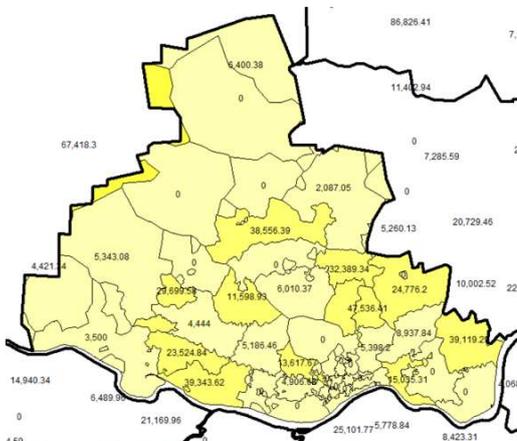
Spend by Sector



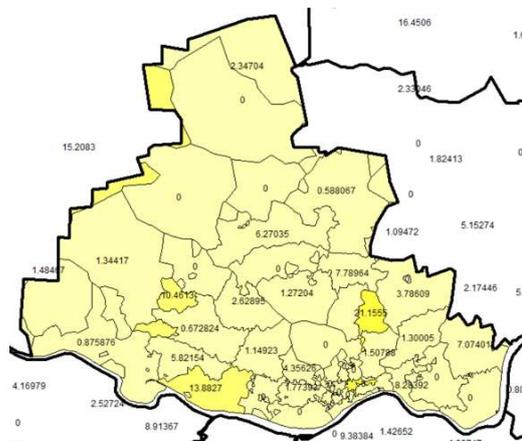
Spend Averaged Over Housing Population

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 – Newcastle-upon-Tyne



Spend by Sector



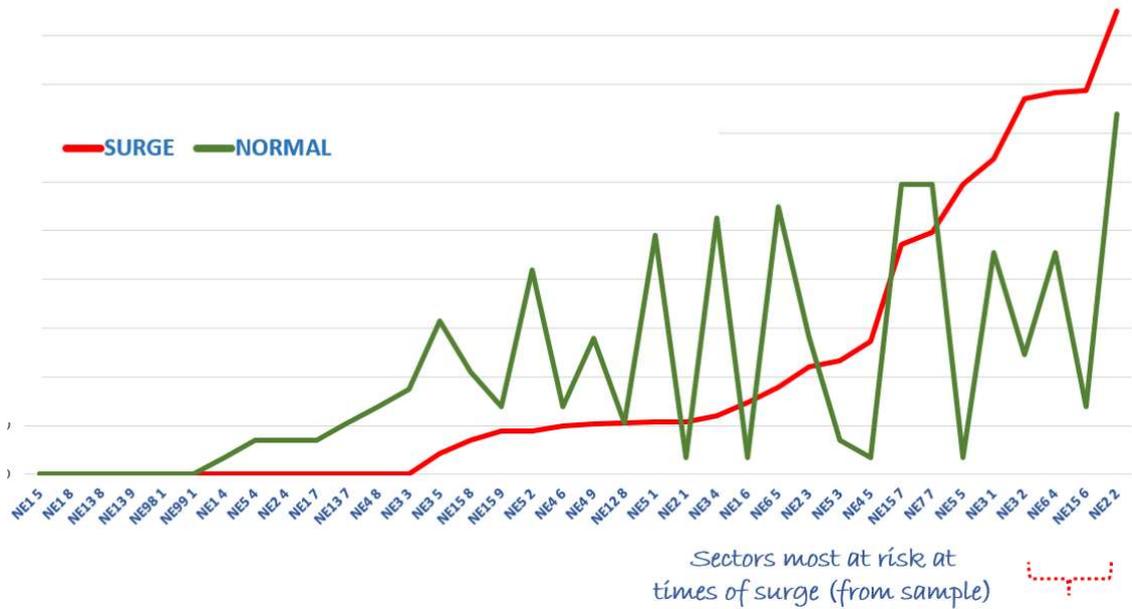
Spend Averaged Over Housing Population



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Newcastle-upon-Tyne

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.

