

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



March 2025

Issue 238

The Clay Research Group

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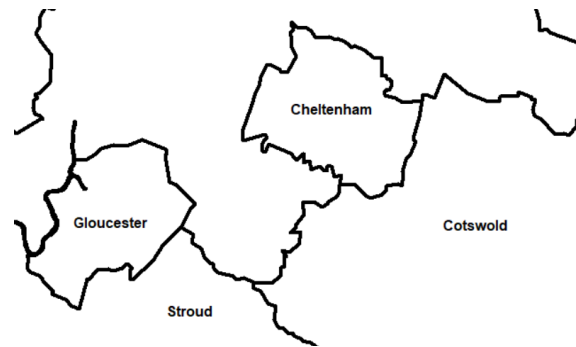
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Subsidence Risk Analysis by District

Cheltenham

District and Sector Risk

Cheltenham is situated to the south west of England. It has a population of around 118,500 and occupies an area of 46.6km². It is the subject of the ‘Risk by District’ series in this month’s edition. Its geology is predominantly River Terrace overlying the Lower Lias series – see Page 7.



Concrete and CO₂

An article in the journal Nature comments on the negative issues related to the use of concrete. *“Production of concrete is energy intensive and is responsible for more than 8% of anthropogenic carbon dioxide emissions — of which cement accounts for the vast majority.”*

<https://www.nature.com/articles/d41586-021-02612-5>

Claim Numbers

ABI data reports a low count of domestic subsidence claims in 2024 amounting to 8,500.

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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www.theclayresearchgroup.org

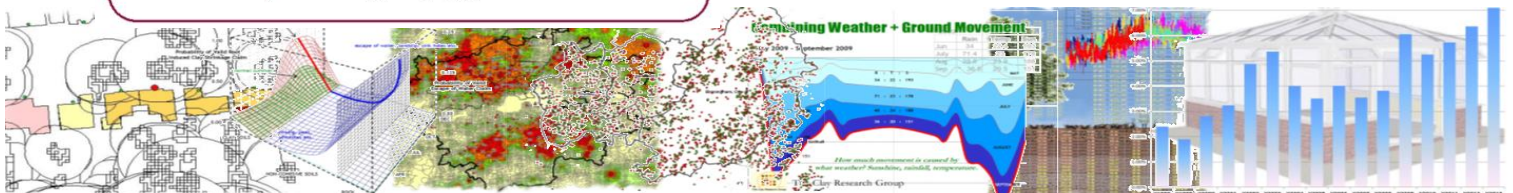
clayresearchgroup@gmail.com

Surrey Sinkhole

A 20mtrs long sinkhole appeared on 17th February in Godstone High Street, Surrey, leading to the evacuation of 30 nearby residences. 19th century maps reveal nearby sand pit quarries with entrance pits near to the sinkhole, with the problem exacerbated by leaking water service pipes.



Remedial works are underway including backfilling the void with concrete and drainage repairs.



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ChatGPT – Determining Subsidence



Question to ChatGPT

What is the best way to deal with a sinkhole that has caused subsidence damage to a domestic property?

ChatGPT Response

1. Ensure Immediate Safety

- Evacuate the property if necessary and avoid the affected area.
- Restrict access to prevent injury.
- Contact emergency services if there is a risk of collapse.

2. Assess the Situation

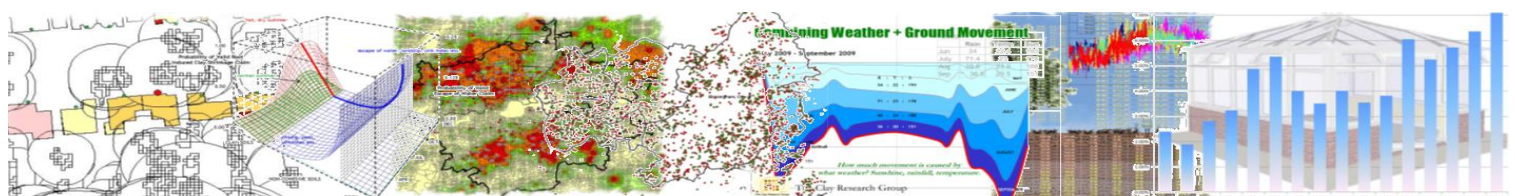
- Contact your local council or environmental agency to report the sinkhole.
- Engage a structural engineer or geotechnical specialist to assess the damage and determine the cause.
- Inform your home insurance provider, as many policies cover subsidence damage.

3. Determine the Cause

- Sinkholes can result from natural erosion, underground water movement, leaking pipes, or mining activity.
- A geotechnical investigation (using boreholes, ground-penetrating radar, or soil testing) will help understand the extent of the void.

4. Stabilization & Remediation

- **Small Sinkholes:** May be filled with a stable material such as a cement-based grout or compacted soil.
- **Larger Sinkholes:** Require professional intervention, possibly including underpinning, grouting, or piling.
- **Ongoing Water Issues:** If caused by leaking pipes, these must be repaired to prevent further subsidence.



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5. Repairing the Property

- Foundation repairs may involve underpinning or structural reinforcement.
- Cracks in walls, floors, or ceilings will need assessment and repair.
- Re-levelling the structure may be necessary in severe cases.

6. Preventative Measures

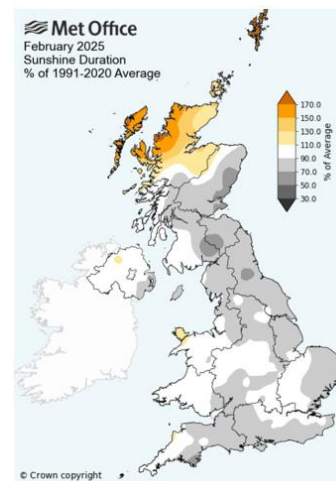
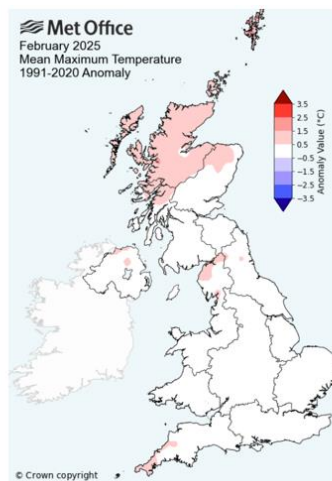
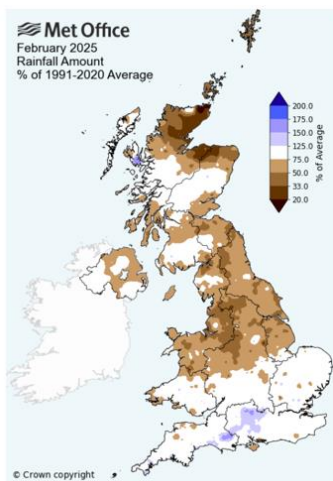
- Regularly inspect for warning signs such as cracks, doors/windows sticking, or depressions in the ground.
- Maintain proper drainage around the property.
- If in a sinkhole-prone area, consider geotechnical surveys before construction.

Would you like help finding professional services or insurance information specific to your location?

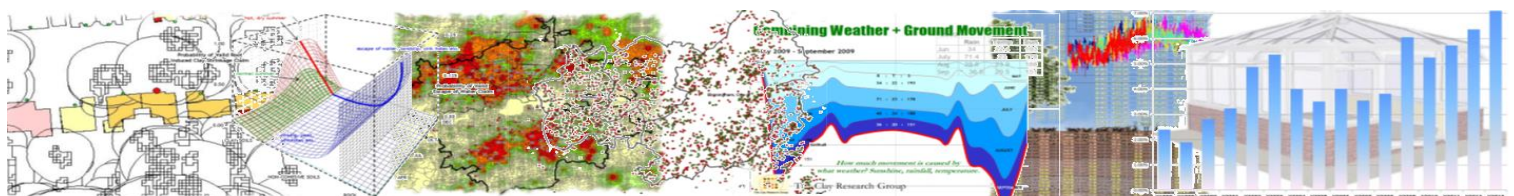
Met Office Anomaly Maps for February 2025

Anomaly maps from the Met Office web site for the month of February 2025 comparing data with average for the period 1991 – 2020 reproduced below.

The month can be summed up as having average temperatures for most of the UK with slightly reduced hours of sunshine. Drier in the midlands and northern parts of the UK.



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



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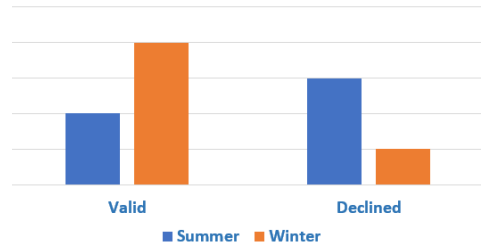
Cheltenham - Sector Level Sample Using Past Claims Data to Infer Geology and Derive Probability of Cause and Liability

GL52 6 – Housing is a mixture of predominantly semi-detached and detached housing in private ownership. Geology in the sector is outcropping Lower Lias clay.

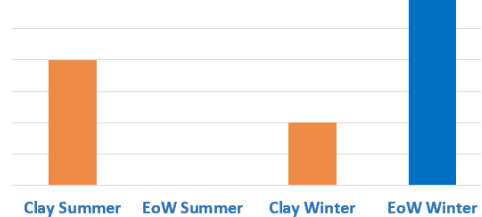
Clay shrinkage in the dominant cause of damage in the summer months and EoW in the winter, reflecting the likely presence of shallow superficial deposits of River Terrace.

Site investigations associated with the investigation of claims reveals a PI of around 36%.

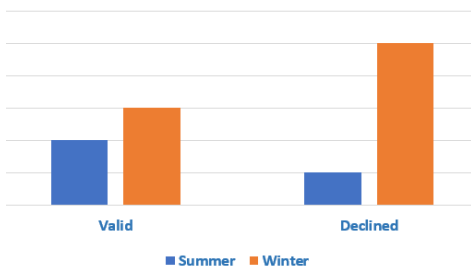
Liability Analysis



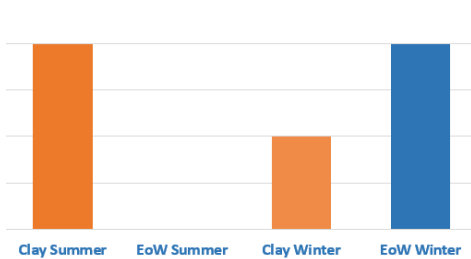
Cause Analysis (valid)



Liability Analysis



Cause Analysis (valid)

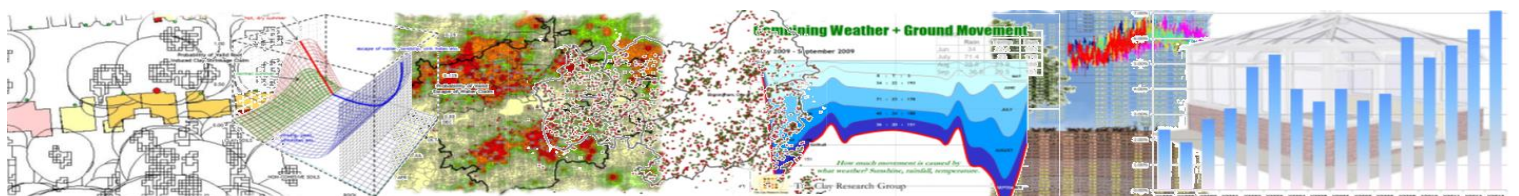


GL50 3 – Geology is River Terrace overlying Lower Lias - see page 7 for extract from BGS 625,000 scale maps and page 8 for the results of investigations related to subsidence claims.

The shrinkable clay soils have a PI of around 44% from records relating to results from site investigations undertaken.

Reflecting the geology, the dominant cause of subsidence in the summer is clay shrinkage and, in the winter, escape of water. Valid claim numbers are slightly lower in the summer, with higher number of declinatures in the winter.

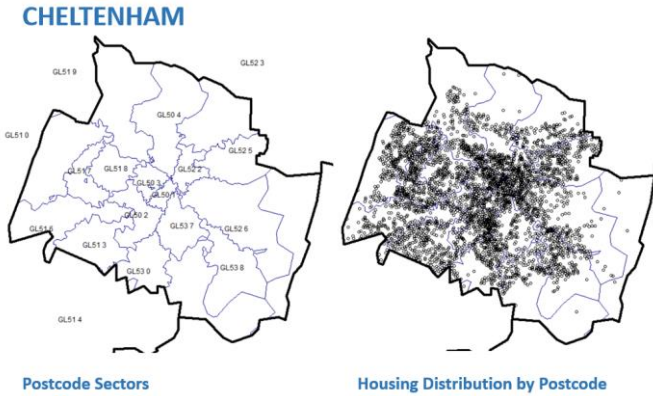
The sector has predominantly terraced properties in private ownership.



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Subsidence Risk Analysis – Cheltenham

Cheltenham is situated in Gloucestershire, to the south west of England, and occupies an area of around 46.6km² with a population approaching 119,000.



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.

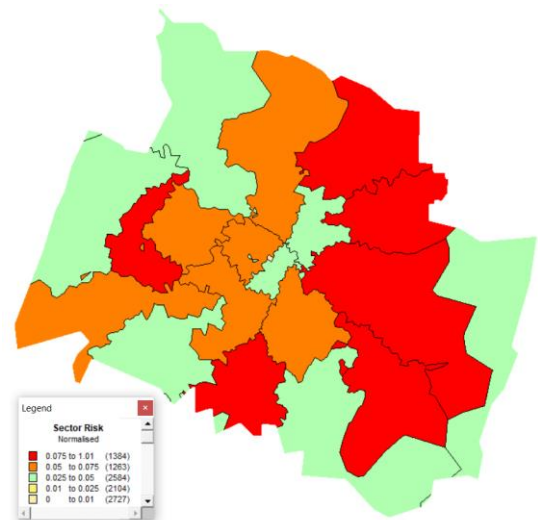
Sector and housing distribution across the district (left, using full postcode as a proxy) helps to clarify the significance of the risk maps on the following pages. Are there simply more claims in a sector because there are more houses?

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.

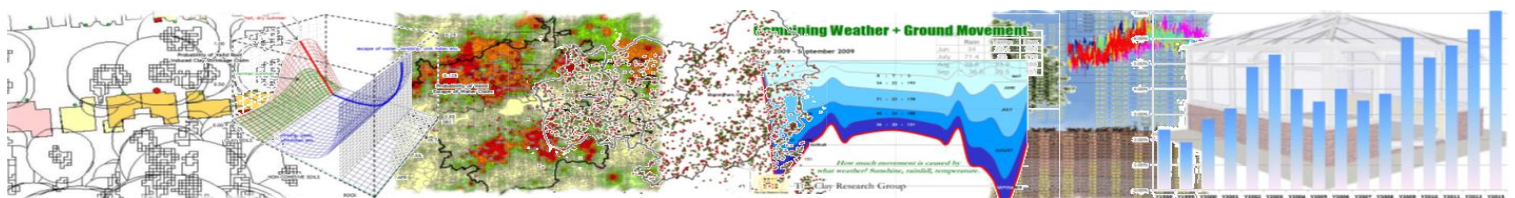
From the sample we hold, sectors are rated for the risk of domestic subsidence compared with the UK average – see map, right.

Cheltenham is rated 41st out of 413 districts in the UK from the sample analysed and is around 1.823x the risk of the UK average, or 0.472 on a normalised 0 - 1 scale.

There is a greater than average risk to the east of the district associated with outcropping Lias clay as can be seen from the sector map, right.



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



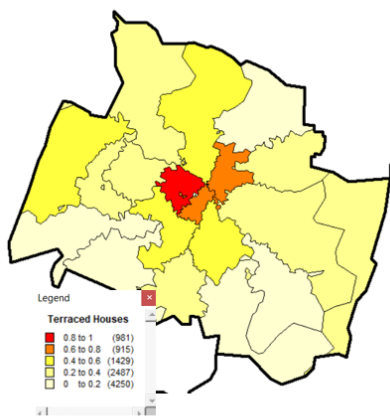
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Cheltenham - Properties by Style and Ownership

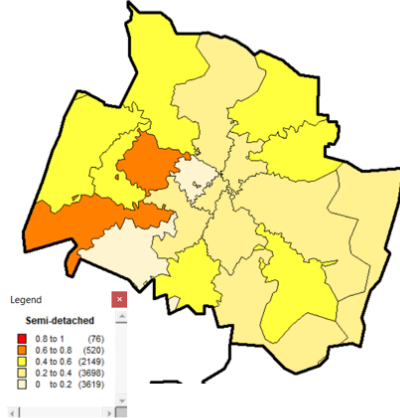
Below, the general distribution of properties by style of construction, distinguishing between terraced, semi-detached and detached. Unfortunately, the more useful data is missing at sector level – property age.

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.

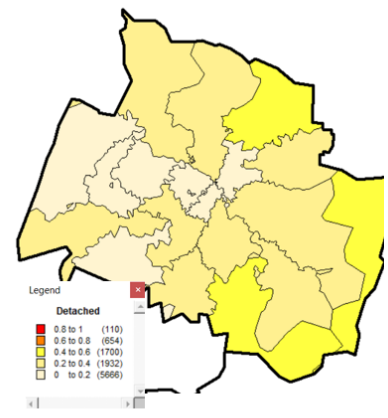
CHELTENHAM - Distribution by House Type



Terraced



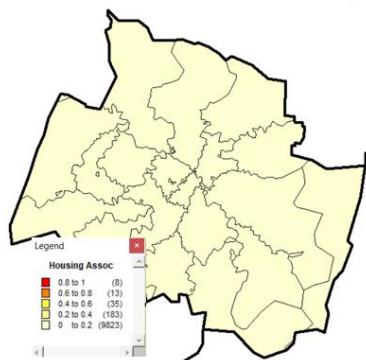
Semi-Detached



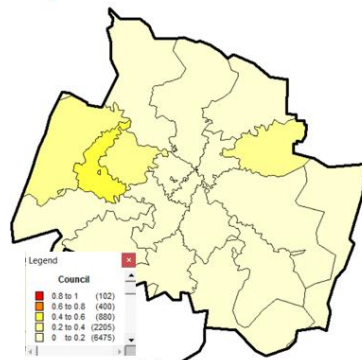
Detached

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

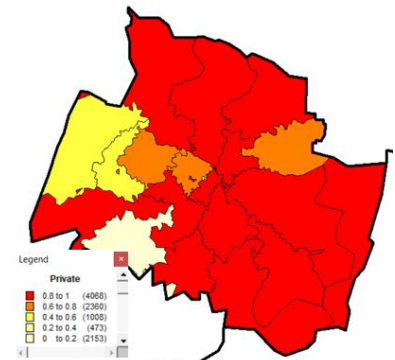
CHELTENHAM - Distribution by Ownership



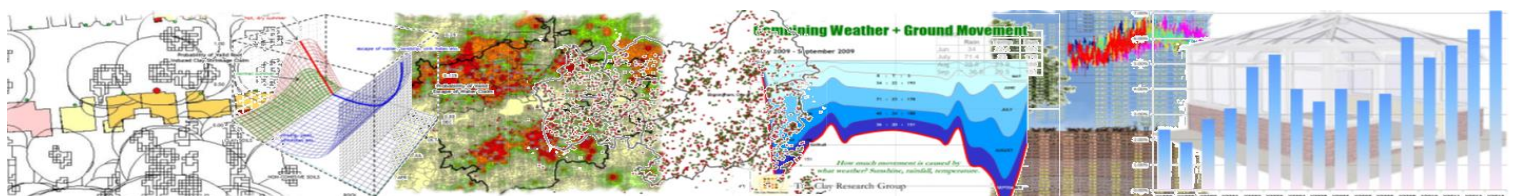
Housing Association



Council Ownership



Private Ownership



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Subsidence Risk Analysis – Cheltenham

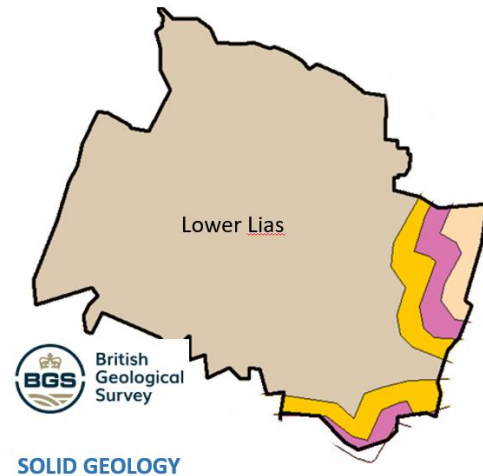
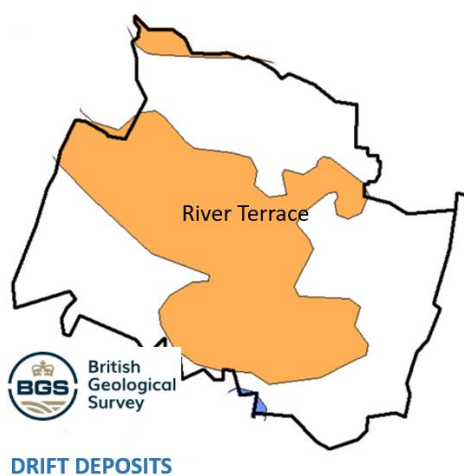
Below, extracts from the British Geological Survey low resolution 1:625,000 scale geological maps showing the solid and drift series. View at: <http://mapapps.bgs.ac.uk/geologyofbritain/home.html> for more detail.

See page 10 for a seasonal analysis of the sample which reveals that, at district level, there is around a 75% probability of a claim being valid in the summer and, of the valid claims, there is a 80% probability that the damage will have been caused by clay shrinkage.

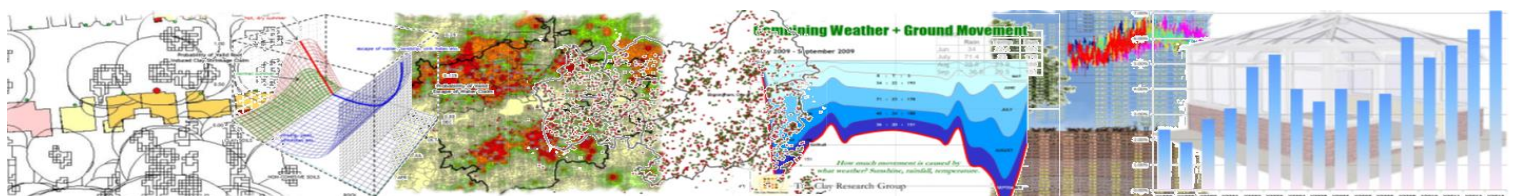
In the winter, the likelihood of a claim being valid drops to around 45% and of the valid claims, escape of water is the most likely cause – around 80%.

A postcode sector map on the following page records the PI of soils retrieved following site investigations from actual claims.

CHELTEMHAM : 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.

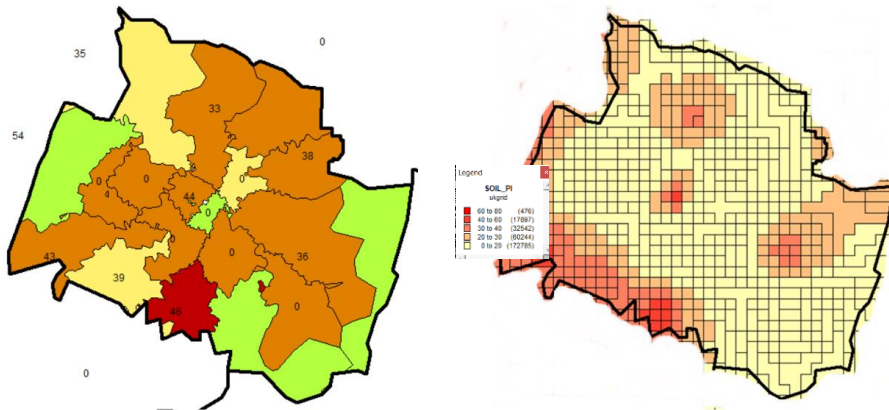


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Liability by Geology and Season

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.

CHELTENHAM – Soil Plasticity Index



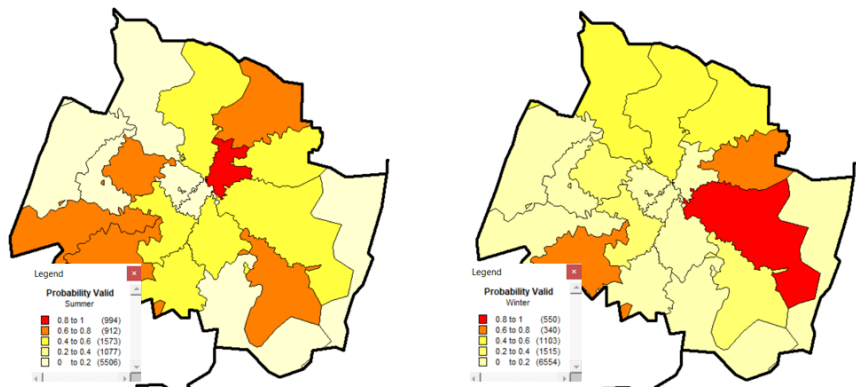
Soil PI Averaged by Sector

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.

The maps below 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.

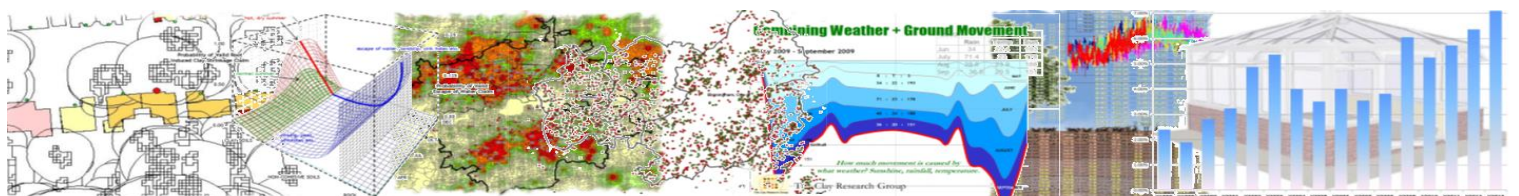
CHELTENHAM – by season



Probability Valid, Summer

Probability Valid, Winter

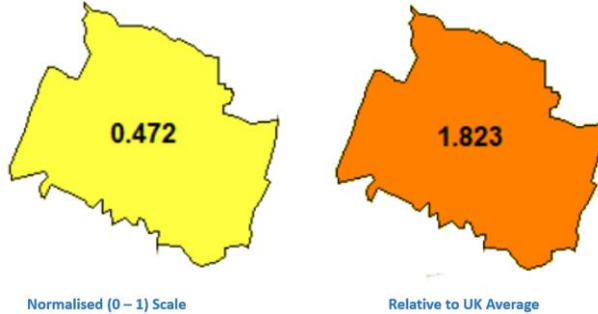
The 'claim by cause' distribution and the risk posed by the soil types is illustrated at the foot of the following page. A high frequency risk can be the product of just a few claims in an area with a low housing density of course and claim count should be used to identify such anomalies.



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District Risk. EoW and Council Tree Risk.

CHELTENHAM - Subsidence Risk Relative to UK

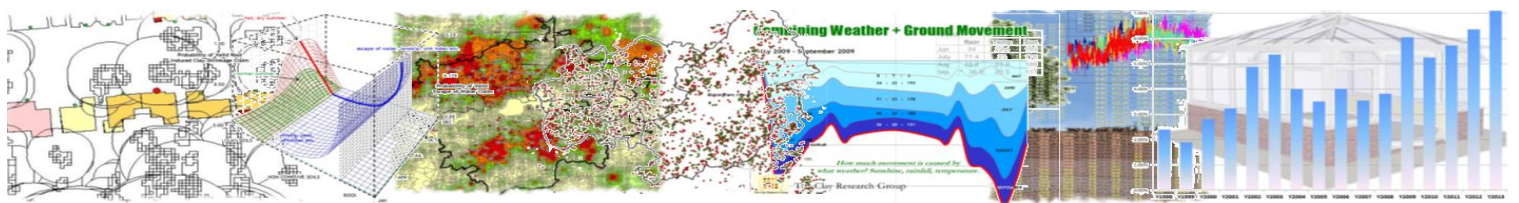
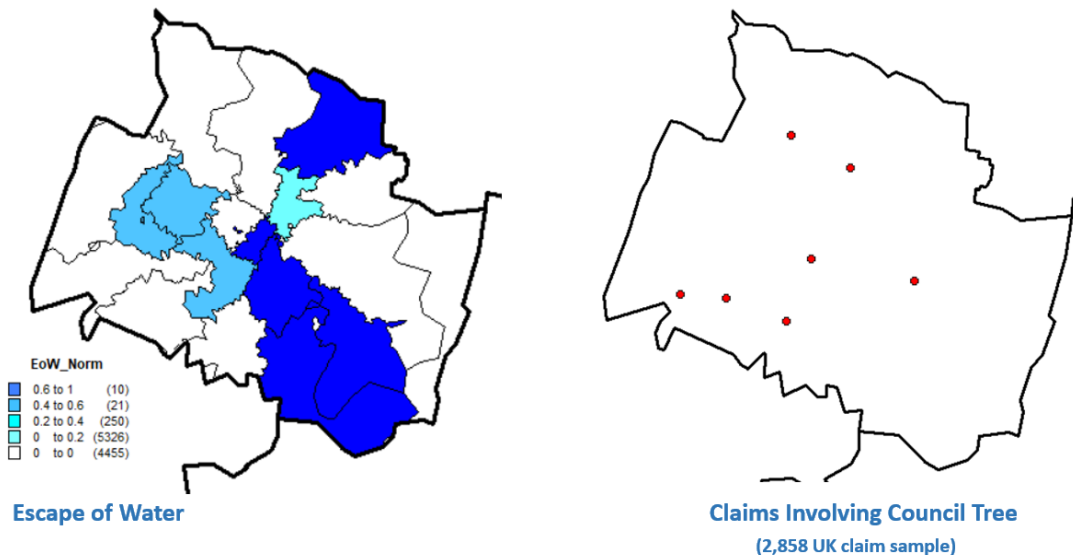


Below, left, mapping the frequency of escape of water claims confirms the presence of predominantly non-cohesive soils. The distribution on the map reflects the presence of non-cohesive River Terrace deposits.

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 usually coincide with the presence of shrinkable soils and the map below suggests the superficial deposits may be shallow.

CHELTENHAM

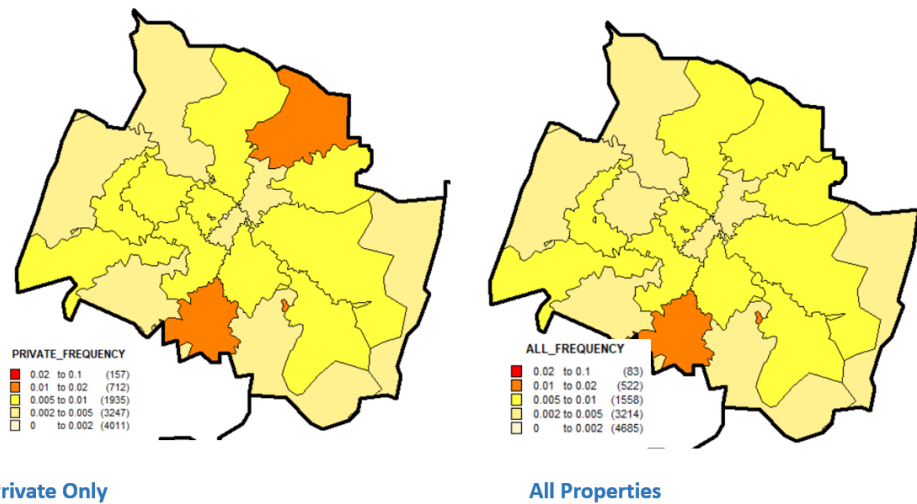


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Cheltenham - Frequencies & Probabilities

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.

CHELTENHAM - Sector Risk Compared with UK Average

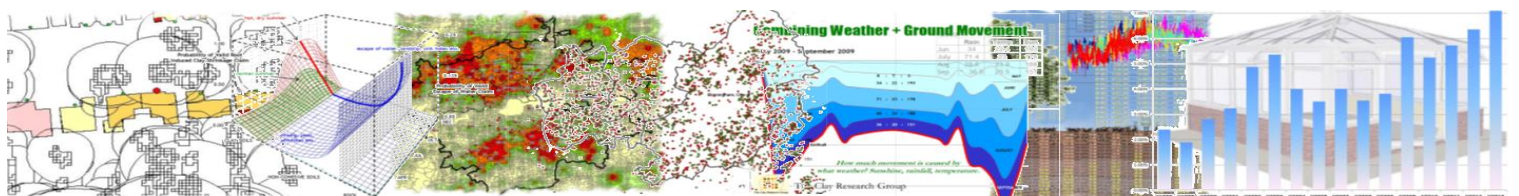


On a general note, a reversal of rates for valid-v-declined by season is a characteristic of the underlying geology. For clay soils, the probability of a claim being declined in the summer is usually low, and in the winter, it is high.

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 - CHELTENHAM

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Cheltenham	0.622	0.140	0.238	0.08	0.37	0.55

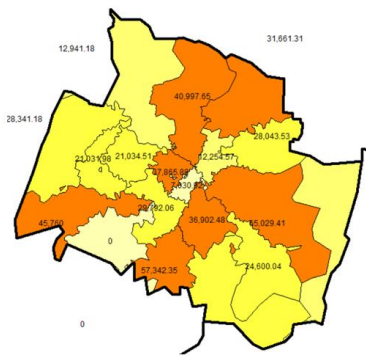


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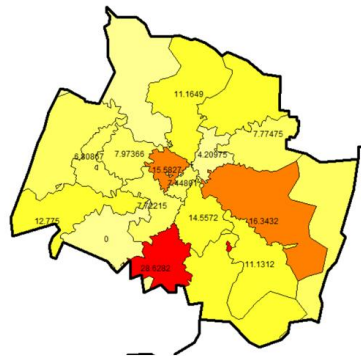
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Normal & Surge Years

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 – CHELTENHAM



Spend by Sector



Spend Averaged Over Private Housing Population

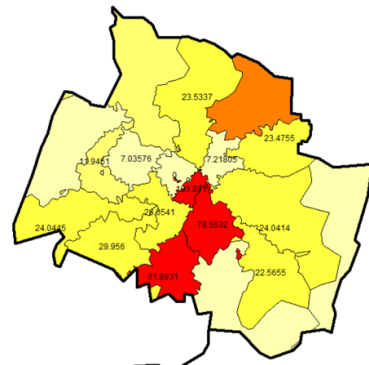
It will also be a function of the distribution of vegetation and age and style of construction of the housing stock. The images to the left in both examples (above and below) represent gross sector spend and those to the right, sector spend averaged across private housing population to derive a notional 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.

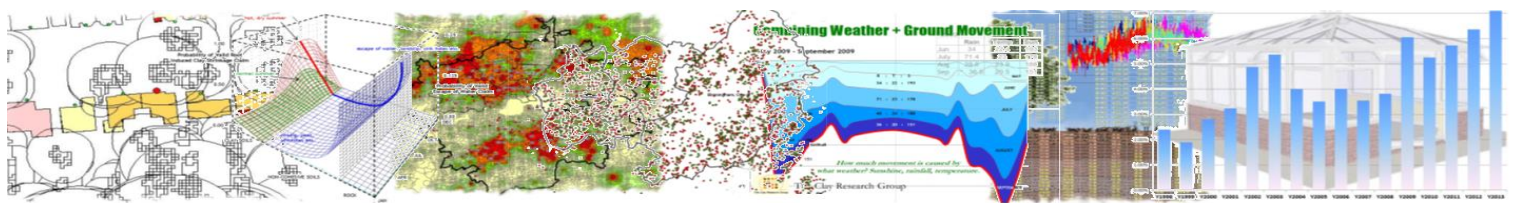
SPEND in SURGE – CHELTENHAM



Spend by Sector



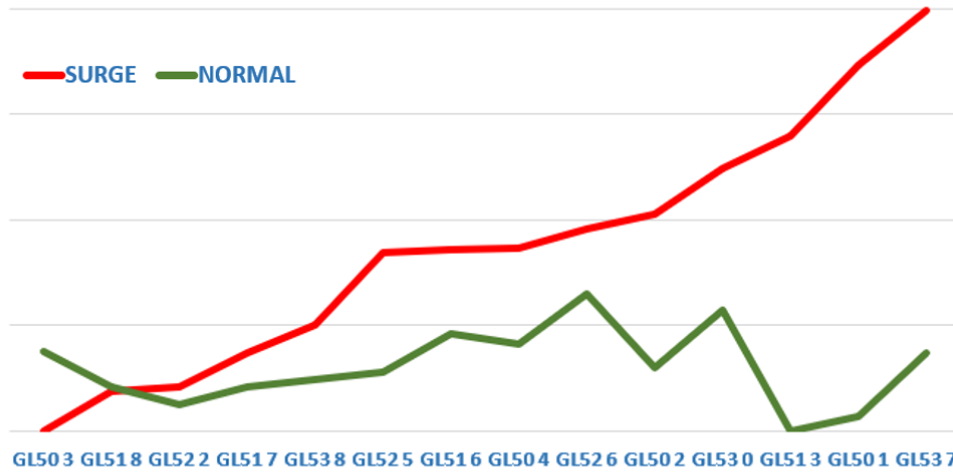
Spend Averaged Over Private Housing Population



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CHELTENHAM

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



Sectors most at risk at times of surge (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.

