#### **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



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### **SMD Update**

Heavy and prolonged rainfall has resulted in a zero moisture deficit for both grass and tree cover until recently, as shown in the graph below.



### **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**

Bassetlaw is the subject of the 'Risk by District' series in this month's edition. It has superficial deposits of alluvium, sand, gravel, peat and Till overlying mudstone and sandstone – see Page 8.



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

### Subsidence as Percentage of Total Claim Spend

The latest ABI data reveals that domestic subsidence claims accounted for around 6% of total claim spend in 2023. The figure reached a high of 9.4% in 2006, and a low of 3.6% in 2017.

### AI - ChatGPT

The artificial intelligence application, ChatGPT, was launched in 2022. On page 3 we ask for the riskiest areas of the UK for domestic subsidence and on page 4, the best soil test to determine desiccation.



#### **Clay Shrinkage -v- Escape of Water Claims**

Below, graph showing the number of valid claims by cause, distinguishing between clay shrinkage and escape of water. The graph covers the period January 2018 to October 2022 from a sample of nearly 14,000 claims.

Clay shrinkage accounts for nearly twice the count of escape of water claims. Declinatures account for 53% of the sample.



2018 and 2022 are classed as surge years, and the graph illustrates the role played by clay shrinkage in dictating the difference between surge and normal years.

The risk rating is determined by taking claim frequency across the UK and the graph below illustrates the profile, delivering an average of 0.004. Nearly 20% of the postcodes across the UK have no claims recorded in the sample used.



The rapid increase to the right of the profile accounting for a very small number of postcodes is often the product of a few claims in an area with low housing density. The values in the 'Risk by District' series are recorded on a normalised 0 - 1 scale.



### **ChatGPT Application**



#### **Our Question**

Which is the riskiest part of the UK for domestic subsidence?

#### **ChatGPT Response**

"The risk of domestic subsidence in the UK can vary depending on several factors, including soil type, geological conditions, and local environmental factors. Generally, areas with clayey soils are more susceptible to subsidence due to changes in moisture levels.

Historically, some regions in the South East of England, particularly parts of London and the Home Counties, have been considered higher risk areas for subsidence due to the presence of shrinkable clay soils. Other areas with similar soil types, such as parts of East Anglia and the South West, can also be at risk.

However, it's important to note that subsidence risk can vary even within these regions, and individual properties can be affected differently based on their specific location, soil conditions, and other factors.

If you're concerned about subsidence risk for a specific property, it's advisable to consult with a structural engineer or a specialist surveyor who can assess the site and provide expert advice tailored to the property in question."

#### **Our Question**

Is a peat soil vulnerable to subsidence?

#### **ChatGPT Response**

"Yes, peat soils are indeed vulnerable to subsidence. Peat is organic matter that accumulates in waterlogged conditions over thousands of years. When peat is drained or disturbed, it can decompose and compact, leading to subsidence.

This process is often accelerated by human activities such as agriculture, forestry, or construction. Subsidence can have significant environmental and economic impacts, including land sinking, loss of habitat, and damage to infrastructure. Therefore, it's important to manage peatlands sustainably to minimize the risk of subsidence."



### **ChatGPT Interface**

#### **Our Question**

What is the best soil test to determine desiccation in a clay soil?

#### **ChatGPT Response**

"To determine desiccation in clay soil, you would typically want to assess its moisture content. One of the best soil tests for this purpose is the gravimetric method, also known as the ovendrying method. Here's how it works:

- 1. Collect Soil Samples: Collect soil samples from various locations within the area of interest. Ensure that the samples represent the depth and variability of the soil.
- 2. Preparation: Remove any visible debris or organic matter from the soil samples. Air-dry the samples at room temperature to prevent any moisture loss during transportation to the laboratory.
- 3. Weighing: Weigh each soil sample accurately using a balance.
- 4. Oven-Drying: Place the soil samples in a preheated oven at a specific temperature (usually around 105°C or 221°F) and leave them to dry for a predetermined period, typically 24 hours.
- 5. Weighing After Drying: After the drying period, remove the soil samples from the oven and allow them to cool in a desiccator to prevent moisture absorption from the air. Weigh the dried soil samples again.
- 6. Calculations: Calculate the moisture content of the soil using the formula:
  Moisture Content (%) = [(Initial weight Final weight) / Initial weight] x 100 Where:
  - Initial weight = Weight of the moist soil sample before drying (in grams).
  - Final weight = Weight of the dried soil sample after drying (in grams).
- 7. Interpretation: A higher moisture content indicates a wetter soil, while a lower moisture content suggests a drier soil. Desiccation in clay soil would be indicated by a relatively low moisture content compared to the soil's field capacity.

By conducting the gravimetric soil moisture test, you can accurately assess the moisture content of clay soil, which is essential for understanding its desiccation potential and making informed decisions regarding soil management and irrigation practices."





### Subsidence Claims 1992 - 2023

The number of claims continues to fall as the trendline illustrates, with occasional variations. Both claim numbers and settled costs follow a similar trend with figures rising significantly over the last 6 years.



### Met Office Anomaly Maps for April 2024

Anomaly maps from the Met Office web site for the month of April 2024 reproduced below. The month can be summed up as being wetter with a little less sunshine duration than the average for the month when compared with the 1991 – 2020 average. The Met Office report April to be the sixth wettest since records began in 1836.



htts://www.metoffice.gov.uk/research/climate/maps-and-data/uk-actual-and-anomaly-maps



### Subsidence Risk Analysis – Bassetlaw

Bassetlaw is located in north Nottinghamshire and occupies an area of 637.9km<sup>2</sup> with a population of around 117,000.



Postcode Sectors

Housing Distribution by Postcode

Distribution of housing stock using full postcode as a proxy. Each sector covers around 2,000 houses on average across the UK and full postcodes include around 15 - 20houses 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.

Bassetlaw is rated 231st out of 413 districts in the UK from the sample analysed and is around 0.796x the risk of the UK average, or 0.206 on a normalised 0 - 1 scale.

There is a varied risk across the borough as can be seen from the sector map, right. The varied geology across the district (see pages 8 and 9) comprises non-cohesive drift deposits (till, sand and gravel, peat, alluvium) overlying sandstone to the west and Triassic mudstone including Keuper Marl to the east. 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.



#### **Bassetlaw. 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.



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





### Subsidence Risk Analysis – Bassetlaw

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

See page 11 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 50% chance that the damage will have been caused by clay shrinkage or escape of water. In the winter, the likelihood of a claim being valid is around 70% and of the valid claims there is a 50% chance of the cause being clay shrinkage or escape of water.

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



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.



#### 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.



### District Risk. EoW and Council Tree Risk.



Below, left, mapping the frequency of escape of water claims confirms the presence of noncohesive 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. No council tree related claims are recorded in the sample we hold.



#### **Bassetlaw - 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.



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.

	valid summer	valid summer	Repudiation Rate	valid winter	valid winter	Repudiation Rate
District	clay	EoW	(summer)	clay	EoW	(winter)
Bassetlaw	0.278	0.321	0.401	0.32	0.37	0.302

#### Liability by Season - Bassetlaw



### 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.



**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.







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.

