

# The Clay Research Group

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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



November 2024

Issue 234

# The Clay Research Group

## CONTENTS

Issue 234, November 2024

### Page 2

ChatGPT – Soil tests to determine if a clay soil is desiccated.

### Page 3

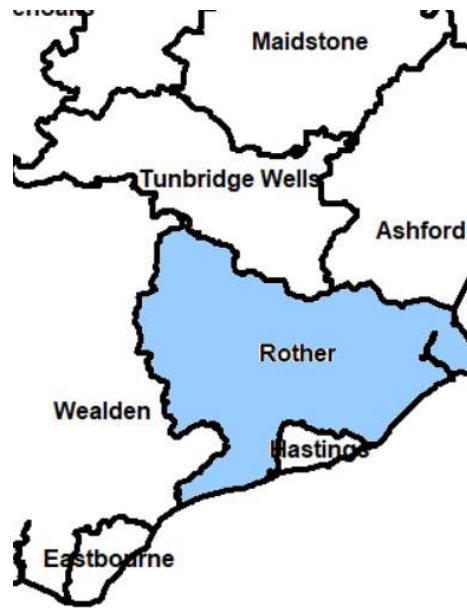
UK Met Office Anomaly Maps, October

### Pages 4 - 11

Subsidence Risk Analysis by District  
**Rother**

## District and Sector Risk

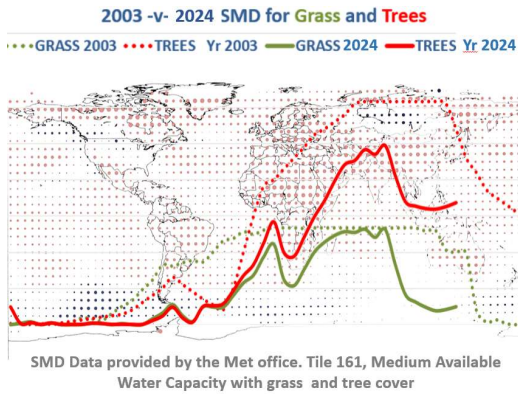
Rother, East Sussex is the subject of the ‘Risk by District’ series in this month’s edition. Its geology is predominantly outcropping Hastings beds – see Page 7.



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

## SMD

The SMD for both trees and grass remains well below values recorded in a surge year (2003 in this example) suggesting a late surge is unlikely.



## Contributions Welcome

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

## Warm October

The Met Office report that October was the joint 8th warmest on record matching 2011 in records going back to 1910.

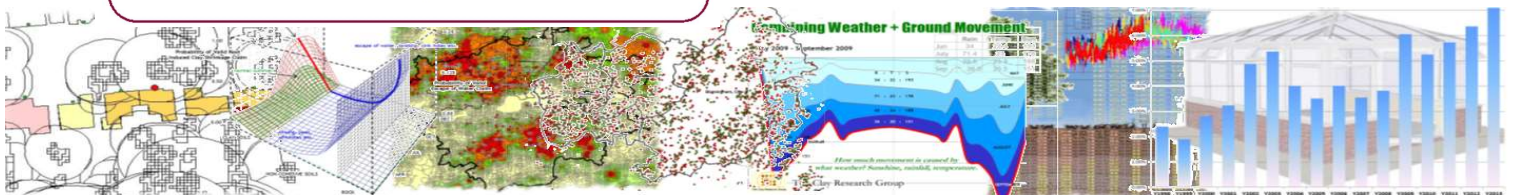
The warmest October on record was 2001 (12.2°C).

“Overall, October saw above average temperatures, with the UK 0.7°C above the long-term average.”

## THE CLAY RESEARCH GROUP

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## ChatGPT – Soil Testing



### QUESTION to ChatGPT:

What is the best test to determine if a clay soil is desiccated?

### ChatGPT RESPONSE:

To determine if clay soil is desiccated (dried out and shrunken), a few tests can be particularly effective, as they allow for the assessment of soil moisture content, structure, and shrinkage properties. Here are the best methods:

#### 1. Moisture Content Test

- **Purpose:** This is a basic yet direct test to determine the amount of moisture present in the soil.
- **Method:** Take a soil sample, weigh it, and dry it in an oven at 105-110°C for 24 hours. Weigh it again after drying. The difference in weight before and after drying provides the moisture content.
- **Interpretation:** Low moisture content relative to the expected field moisture capacity suggests desiccation.

#### 2. Shrinkage Limit Test

- **Purpose:** This test is highly effective for clay soils, as it measures the moisture content at which soil no longer shrinks as it dries.
- **Method:** Form a small, pat-shaped soil sample and allow it to dry completely. The volume reduction upon drying is measured and compared to the soil's initial volume. A high shrinkage rate indicates potential desiccation, as clay particles pull tightly together in the absence of water.
- **Interpretation:** If the shrinkage limit is significantly lower than the field moisture content, the soil is likely desiccated.

#### 3. Visual and Structural Assessment

- **Purpose:** Desiccated clay soils often show visible cracks and hard clods.
- **Method:** Observe the soil structure at the surface and deeper layers. Desiccated clay soils typically develop cracks (sometimes deep) due to shrinking as they dry out. This cracking is more prominent in clay than in other soil types.
- **Interpretation:** Visible deep cracks and a brittle texture are indicators of desiccation.

#### 4. Penetrometer Test (Field Test)

- **Purpose:** Desiccated clay is often very hard, so measuring soil resistance can help identify dryness.
- **Method:** Use a handheld or electronic penetrometer to measure the resistance of the soil to penetration. This test can be done at various depths.
- **Interpretation:** High resistance, especially compared to moist conditions, is a sign of desiccation.



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## 5. X-Ray Diffraction (Advanced Lab Test)

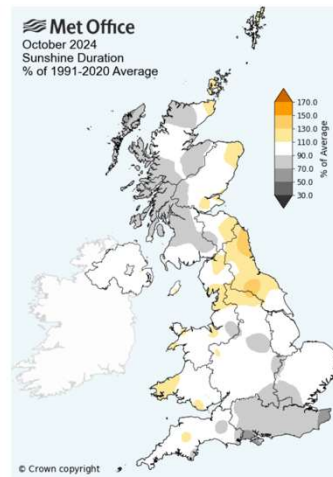
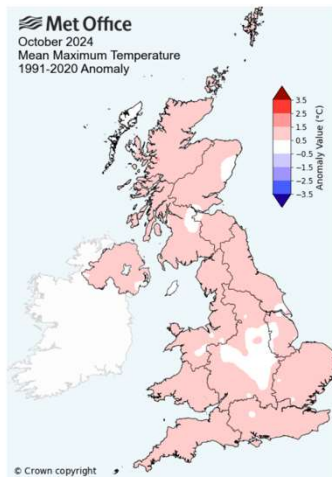
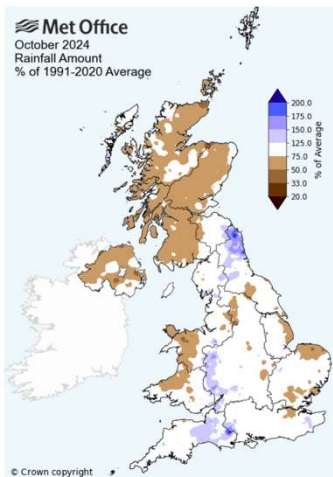
- **Purpose:** This technique helps understand the clay mineral structure and can indicate changes due to desiccation.
- **Method:** In a lab setting, X-ray diffraction can reveal whether water is present within the clay mineral structure. Some clay minerals shrink significantly when desiccated.
- **Interpretation:** Structural changes in the clay mineral layers are characteristic of desiccation.

In field applications, **moisture content tests, shrinkage limit tests, and visual inspection** are generally the most practical and informative for identifying desiccation in clay soils.

## Met Office Anomaly Maps for October 2024

Anomaly maps from the Met Office web site for the month of October 2024 reproduced below.

The month can be summed up as being similar to the 1991 – 2020 average. Slightly drier to the north in Scotland, slightly warmer across the UK with variable sunshine duration – fewer hours to the north west and south east, and slightly more to upper east coast.



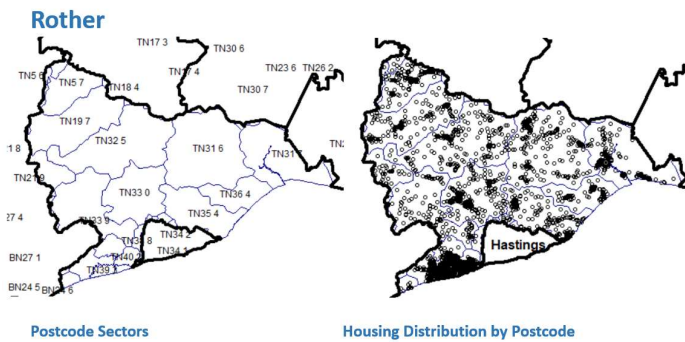
<https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-actual-and-anomaly-maps>



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## Subsidence Risk Analysis – Rother

Rother is located in East Sussex and occupies an area of 512km<sup>2</sup> with a population of around 96,000.



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?

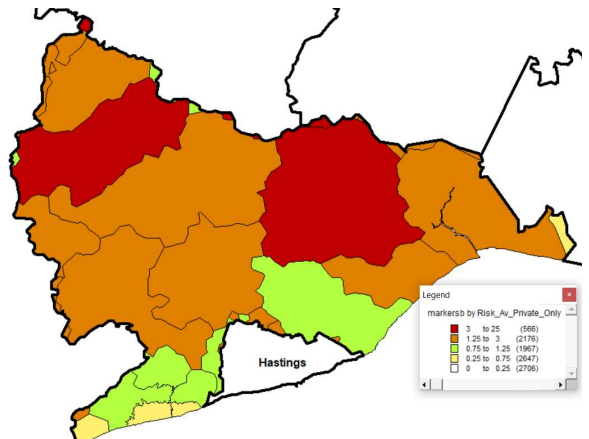
Using a frequency calculation (number of claims divided by private housing population) the relative risk across the borough at postcode sector level is revealed, rather than a 'claim count' value.

*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.*

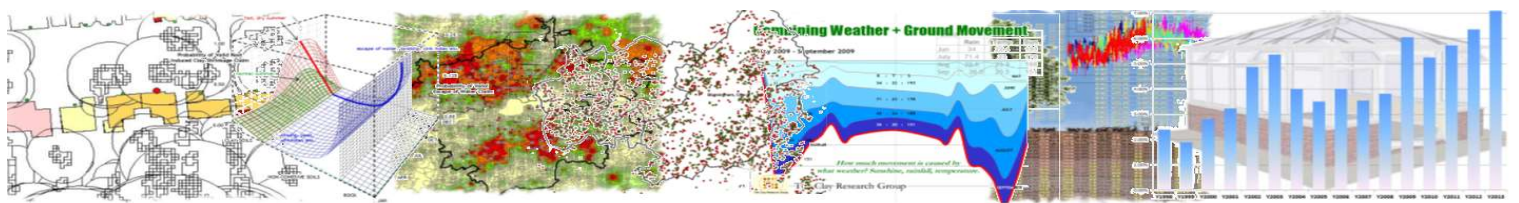
From the sample we hold sectors are rated for the risk of domestic subsidence compared with the UK average – see map, right.

Rother is rated 70th out of 413 districts in the UK from the sample analysed and is around 1.55x the risk of the UK average, or 0.403 on a normalised 0 - 1 scale.

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



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

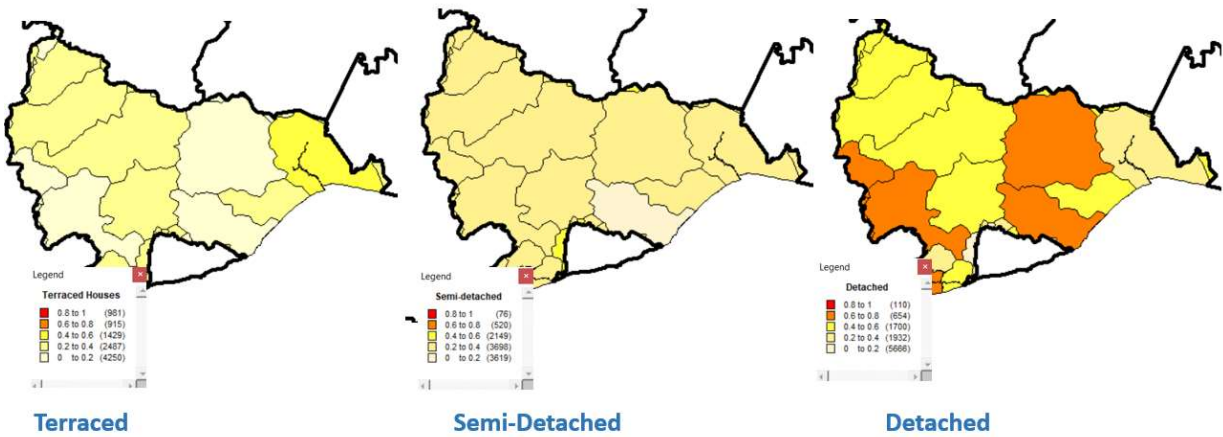


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## Rother - Properties by Style and Ownership

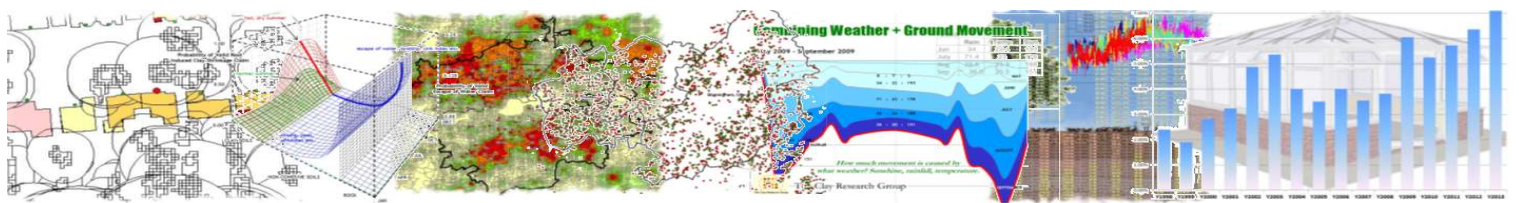
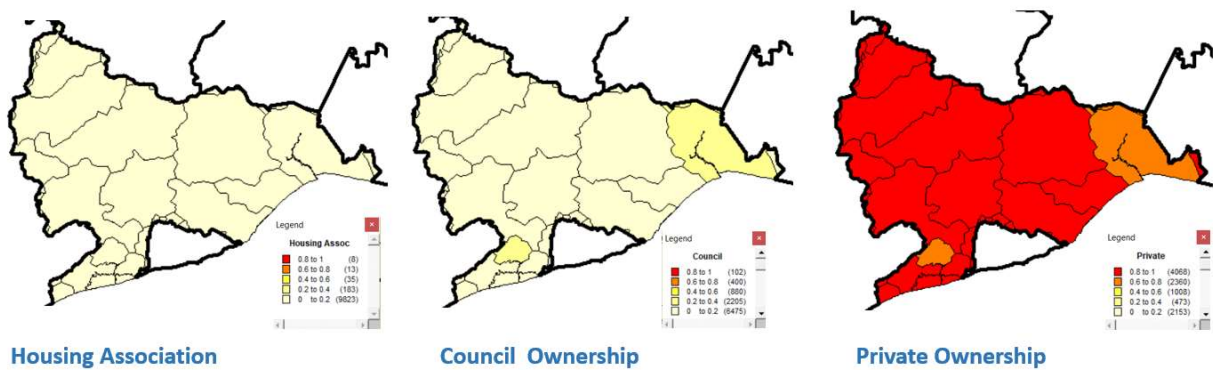
Below, the general distribution of properties by style of construction, distinguishing between terraced, semi-detached and detached. Unfortunately, the more useful data is missing at sector level – property age. Risk increases with age of property and the model can be further refined if this information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

Rother - Distribution by House Type



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

Rother - Distribution by Ownership



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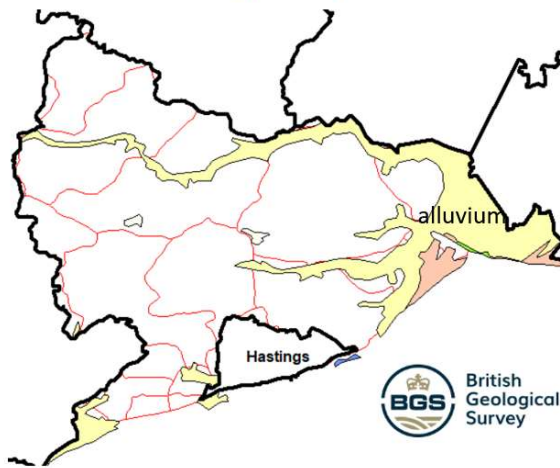
## Subsidence Risk Analysis – Rother

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 80% probability of a claim being valid in the summer and, of the valid claims, there is a 90% (from the data sample) probability that the damage will have been caused by clay shrinkage. In the winter, the likelihood of a claim being valid drops to less than 20% 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.

Rother : BGS Geology – 1:625,000 scale

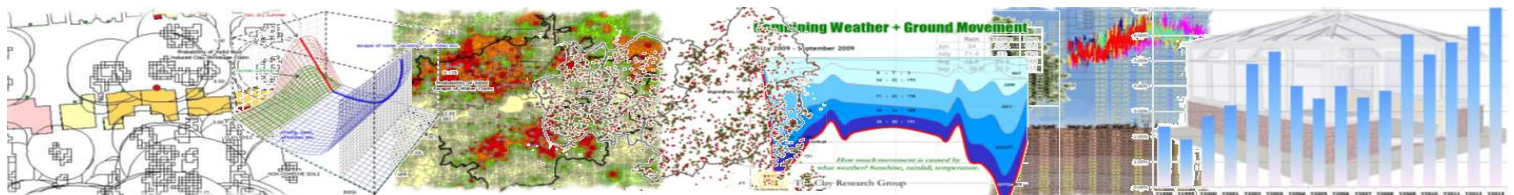


DRIFT DEPOSITS



SOLID GEOLOGY

*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.*

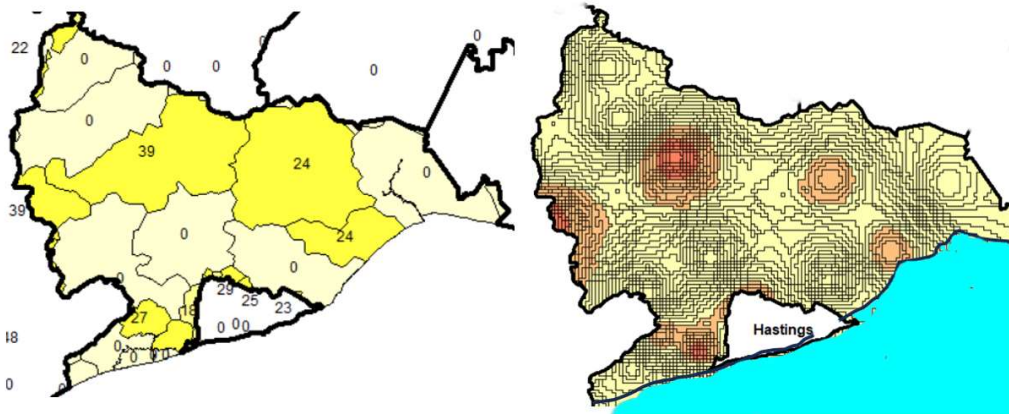


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## Liability by Geology and Season

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.

Rother – Soil Plasticity Index

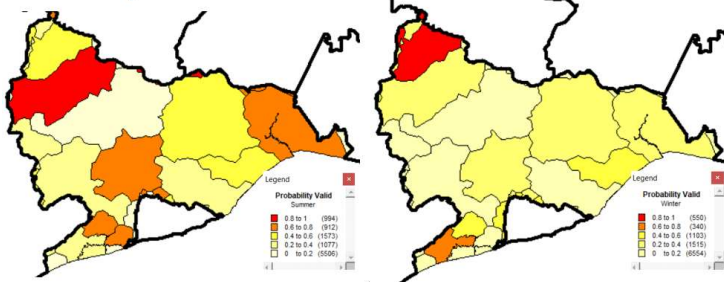


Soil PI Averaged by Sector

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.

Rother – 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 9 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.

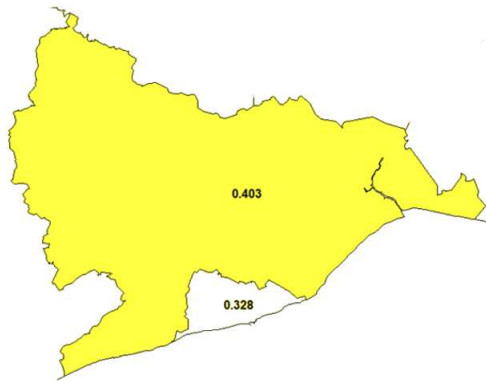




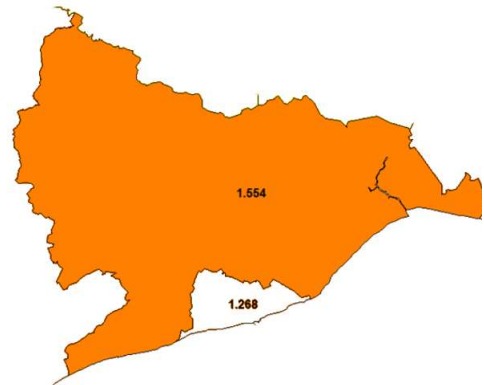
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## District Risk. EoW and Council Tree Risk.

Rother - Subsidence Risk Relative to UK



Normalised (0 – 1) Scale

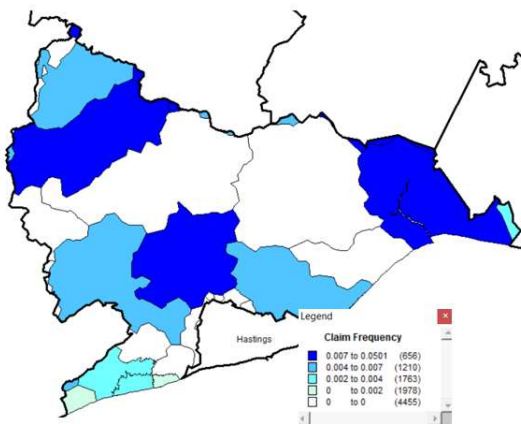


Relative to UK Average

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 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.

Rother



Escape of Water



Claims Involving Council Tree  
(2,858 UK claim sample)

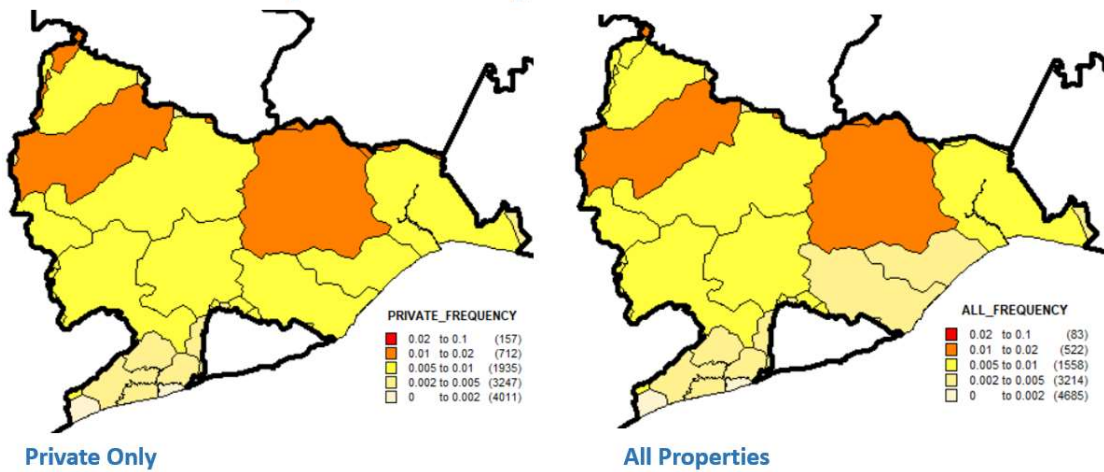


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## Rother - Frequencies & Probabilities

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.

Rother - 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 - Rother

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Rother	0.691	0.089	0.22	0.02	0.15	0.83

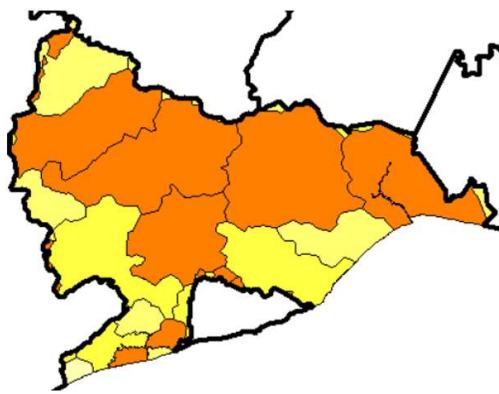


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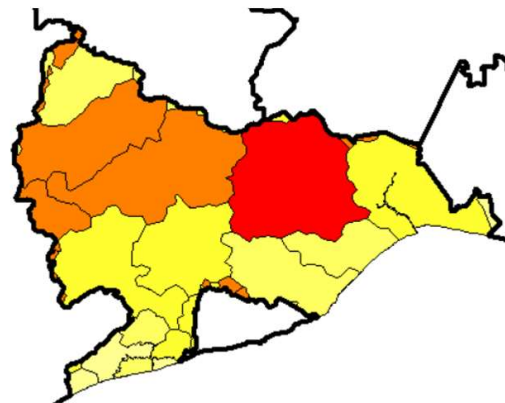
## Aggregate Subsidence Claim Spend by Postcode Sector and Household in Normal & Surge Years

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 – Rother**



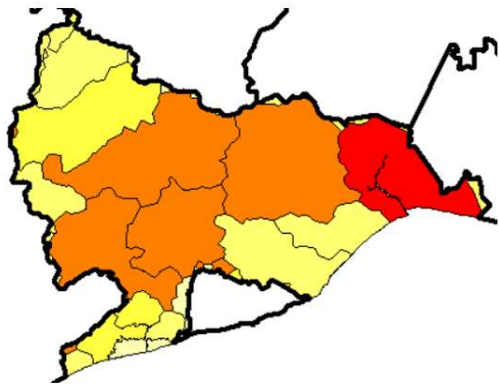
**Spend by Sector**



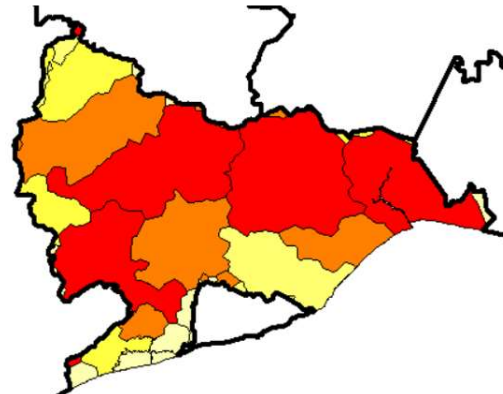
**Spend Averaged Over Private Housing Population**

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.

**SPEND in SURGE – Rother**



**Spend by Sector**



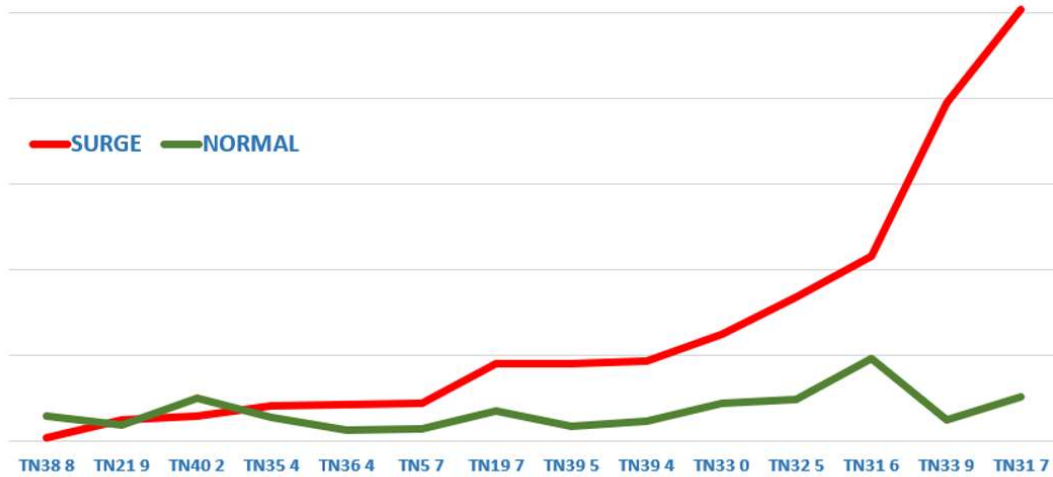
**Spend Averaged Over Private Housing Population**



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## Rother

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.

