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

December 2023
Issue 223

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CONTENTS

Issue 223, December 2023

Andrea Plucknett

Andrea tells us she will be leaving Welwyn Hatfield Borough Council on the 22nd December. She currently holds the position of Treasury Management & Insurance Officer and has been employed by the council for over 24years.

Andrea provided an article for the CRG newsletter (Issue 199, December 2021) where she made some very interesting points about the process of seeking recoveries on root induced clay shrinkage claims against local authorities - well worth a re-visit.

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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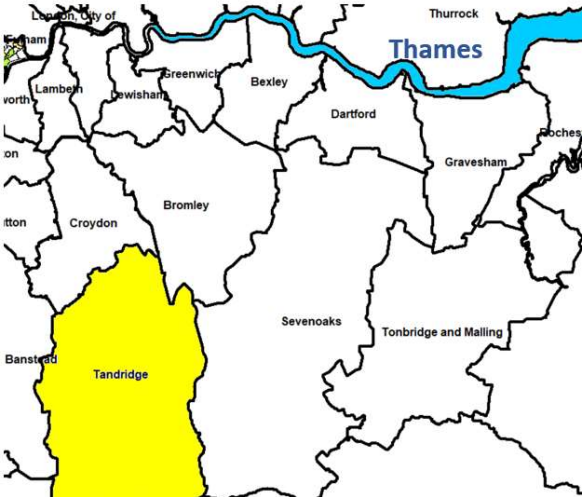
District and Sector Risk

Tandridge is the topic of the 'Risk by District' series in this month's edition. Situated in east Surrey, it has superficial deposits of clay with flints overlying variable bedrock deposits – see Page 9.



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

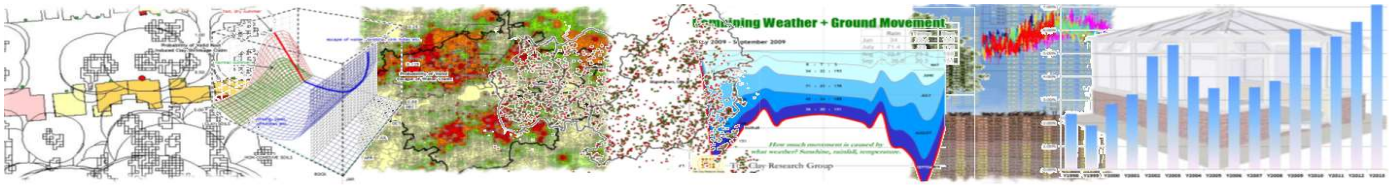
Satellite Data and Subsidence

There has been considerable interest recently in exploring whether satellite imagery might be useful when dealing with subsidence claims.

Reijo Pold, Founder of Value.Space, has been kind enough to provide an article outlining their approach – see pages 2 – 5.

The approach identifies areas of ground (page 4) and building (page 5) movement.

If you have any queries please Email us so that we can present them to Reijo and publish a response in a future edition.



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Detecting Subsidence with Satellites

Reijo Pold, Founder of Value.Space
reijo.pold@value.space

SUMMARY

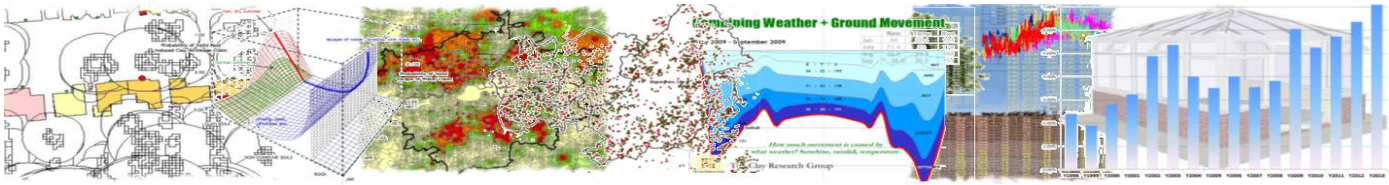
• Value.Space is an insurtech company that came out of Lloyd's Lab, it delivers satellite-based risk assessments for critical infrastructure and commercial properties to underwriters and risk engineers. Climate change is pushing the physics of brittle and aging assets to breaking points faster than ever before. Satellites detect millimetre-scale deformations whilst offering a cost effective, almost real-time monitoring solution to assess the structural health of assets across portfolios.
• Now we are seeing that climate change, particularly prolonged droughts, have caused a surge in subsidence levels in areas where there are clay soils. In 2022, this led to increased claims and losses for UK insurance companies because of property damage. Spaceborne monitoring can identify ground subsidence on a property and city level. Value. Space seeks to demonstrate its capabilities by overlaying a subset of claims data in areas that have been affected by property damage due to subsidence. Value.Space is looking to collaborate with insurers, academics and industry experts to methodically test practical use cases.

Overview

Value.Space is a UK-based global insurtech company that delivers structural health audits of assets such as dams, tailings storage facilities (TSFs), and property. The product utilises InSAR data from the European Space Agency, enriched with other data layers like climate information and input from engineering sciences, enabling up-to-date monitoring of critical objects.

Many of the world's large dams are quickly approaching their 'alert age', considered an average designed lifespan of 50 years. Mine TSFs face pressure due to increased demand for raw materials and they have to manage more mining waste. Climate change adds to the structural tensions of these assets. The severity and frequency of losses and claims for dams and TSFs are increasing, surpassing the capabilities of traditional insurance industry modelling tools. Responding to the heightened need for monitoring these assets with traditional land-based engineering surveys requires significant financial and manpower resources. Satellite-based assessments offer a more efficient solution, being up to 10 times faster and 25 times more cost-effective than land-based alternatives. They provide a way to evaluate risks and take swift action to prevent losses.

Value.Space has already conducted 4,000+ risk analyses for assets worth more than $25 billion in 70+ countries worldwide. We collaborate with global organisations, like the World Mine Tailings Failures (WMTF), providing evidence for major post-failure analysis, and work with UNECE (the United Nations Economic Commission for Europe) to strengthen risk governance in the sector.



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Our satellite monitoring technology is not limited to detecting movements in critical infrastructure but also measures ground deformation globally. The insurance sector's interest in deploying this technology to detect and quantify drought-related subsidence of clay soils is strong, especially in the UK and France, where property damage due to subsidence is covered by insurance.

In 2022, much of Southern and Western Europe experienced higher than average temperatures (the second hottest year on record for Europe, 1.4°C above average) and lower than average precipitation (4-10% less than average), leading to a spike in property damage claims caused by clay soil subsidence.

France's claims reached almost EUR 3 billion, a record, while the UK's costs were expected to reach £219 million, the highest annual payout since 2006.

France witnessed property damage claims due to drought-related subsidence totalling EUR 13.8 billion between 1989 and 2019. This total is projected to triple to EUR 43 billion between 2020 and 2050 due to changing climate patterns. PwC modelling indicates that UK insurers' subsidence costs could increase to £1.9 billion by 2030.

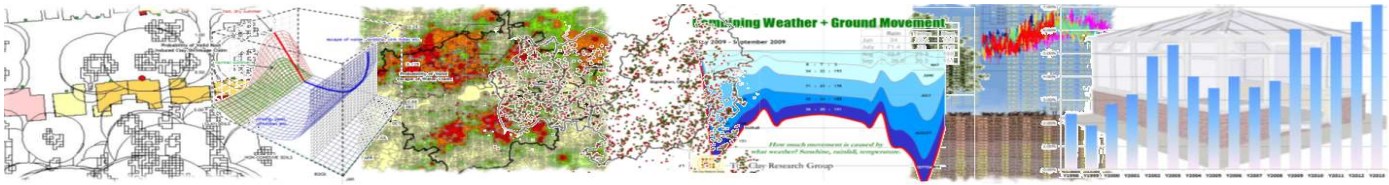
Currently, insurance companies find quantifying and verifying drought-related subsidence costs challenging, relying on soil exposure maps, climatic data, and historic claims.

Value.Space's sample subsidence assessments in the South of France (see Annex for details) demonstrated the limitations of solely relying on static soil maps to identify actual subsidence risks. Satellite-based assessments proved more effective in pinpointing subsidence hotspots and confirming reported clay soil deformations connected to property damage.

➢ Spaceborne surveys are conducted every 2 weeks with satellite overpasses.
➢ Subsidence/deformation measurements are taken with millimetre-scale accuracy.
➢ Properties can be surveyed, showing whether parts of buildings are moving differently.
➢ Movement thresholds can be dynamically adjusted according to construction design parameters.

We believe satellite-based subsidence monitoring could play a vital role in accurately detecting and quantifying existing and developing subsidence risks for property.

We are conducting research to understand the costs and damage of drought-related subsidence and the potential of applying satellite-based monitoring at a scale, especially in the UK. Our aim is to demonstrate the benefits that satellite-based monitoring could bring to quantifying, verifying or to pre-empting losses by analysing almost real-time data



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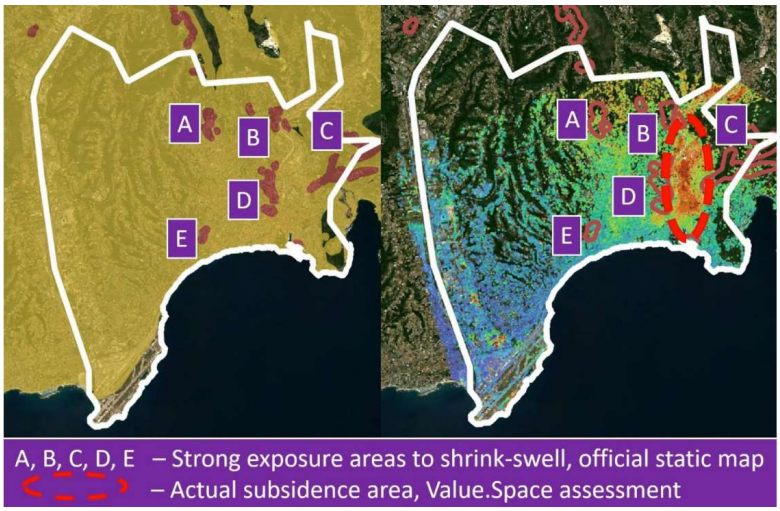
To achieve this, we are looking to bring together:

• Experts in drought-related subsidence of clay soils, such as geologists or subsidence engineers to create a picture of drought-related subsidence especially in the UK and the risks it poses to different types of properties.
• Representatives of insurance companies, who would be interested in testing the capabilities of satellite-based monitoring of drought-related subsidence and its effects on property on scale, against a sample claims database in the UK.

We're open to discussing our existing satellite-based risk assessment and monitoring capabilities and explore applying it to detecting and monitoring drought-related subsidence. Please reach out to reijo.pold@value.space for further information or to arrange a meeting.

ANNEX
Figure 1 - Nice City, Official Exposure Map and Value.Space's Assessment Comparison

Value.Space looked at Nice. On the left, the city is overlaid with a ground exposure map of shrink-swell exposure, as provided by the French Geological Survey. Media reports have conveyed an increase in property damage – doors stuck, cracks in houses – after the exceptionally dry year of 2022. Property insurance premiums in the region have followed suit, with reported increases averaging 33% in 2023 due to consequences of changing climate patterns.



• On the left side: most recent geological exposure map showing where medium (yellow areas) to strong (red areas) shrink-swell hotspots are.
• On the right side: Value.Space's up to date assessment (2023) shows an overview of actual subsidence hotspots.
• Exposure map published in 2021. Value.Space assessment dated 1st July 2023.

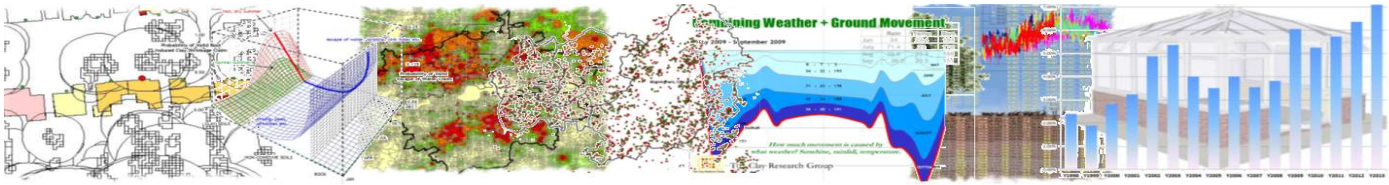


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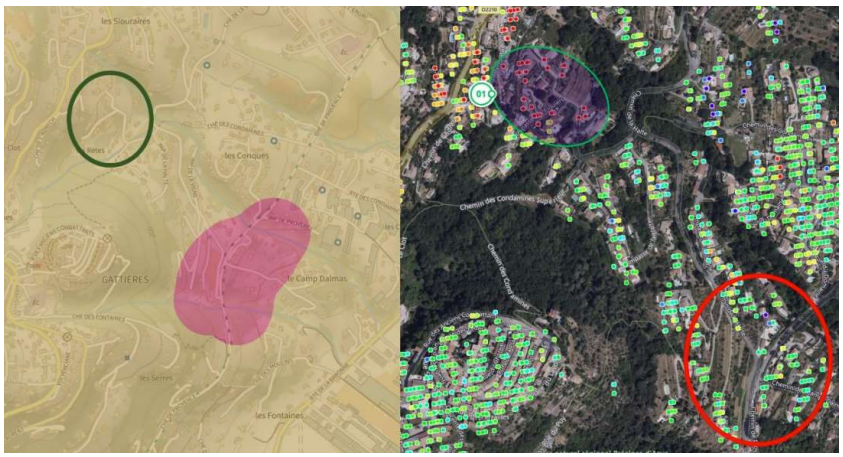
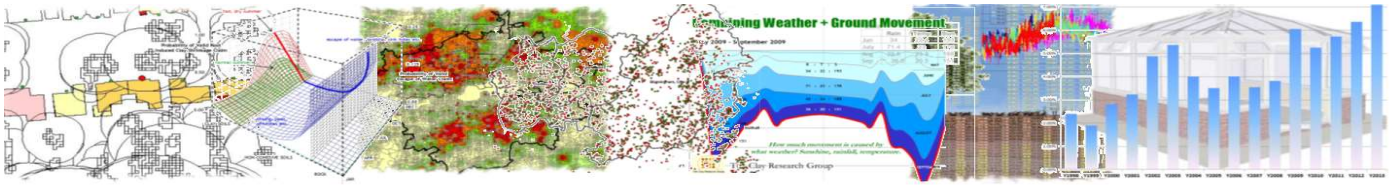
Figure 2 - Building Level Subsidence Analysis

Value.Space also allows zooming in and visualising deformation to the property level. The example below shows building level subsidence in Nice for the Palais des Expositions from July 2020 to July 2023 which shows various levels of deformation on the building. • The picture shows Value.Space's assessment of the building subsidence between July 2020 and July 2023. • The cluster of red dots on the eastern side of the building indicate cumulative deformation/subsidence of 15 mm over the period, with a velocity of up to 6 mm/y. The orange and green dotted area on the western side of the building indicates deformation/subsidence with half of the values compared to the other side of the building

Figure 3 – Verifying Street-Level Subsidence in Gattières, France

Residents of Impasse de Figuiers street in the municipality of Gattières just north of Nice reported damage to at least 11 properties in the area from drought-related subsidence of clay soils. Value.Space conducted a satellite-based assessment to verify the report of subsidence.





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• On the left is the most recent official geological exposure map showing where the medium (yellow) and strong (in red) clay soils shrink-swell hotspots are at the target area in Gattières.

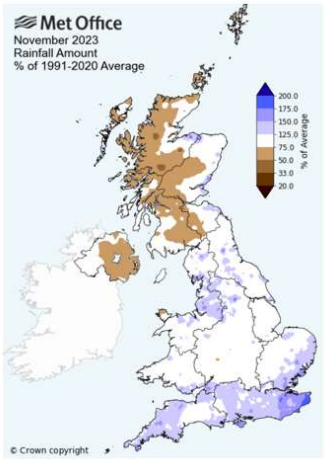
• On the right side is up to date Value.Space assessment (August 2018-August 2023) with subsidence confirmed (red dots indicating subsidence, encircled in green). Cumulative subsidence over the period of up to 65 mm, with a velocity of up to 16 mm/y.

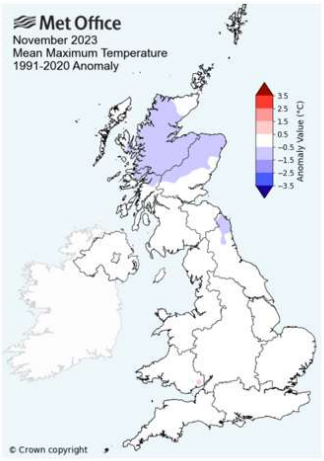
• Value.Space assessment does not show noticeable subsidence in the area of strong exposure to drought-related subsidence on the static map but confirms ground deformation at a medium exposure area, where residents reported subsidence damage to their houses.

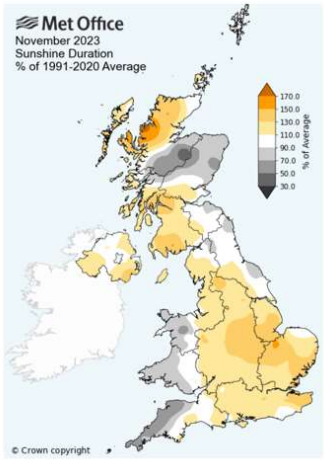
Contact reijo.pold@value.space for further information.

Met Office November 2023 Update.
Anomaly Data, 1991 – 2020

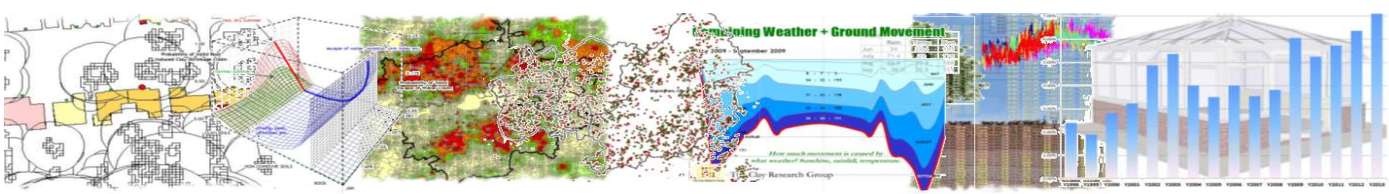
Anomaly maps from the Met Office web site reproduced below. November 2023 was warmer than the 1991-2020 average, with increased rainfall along the south coast, drier in Scotland and slightly longer hours of sunshine to the south east.







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



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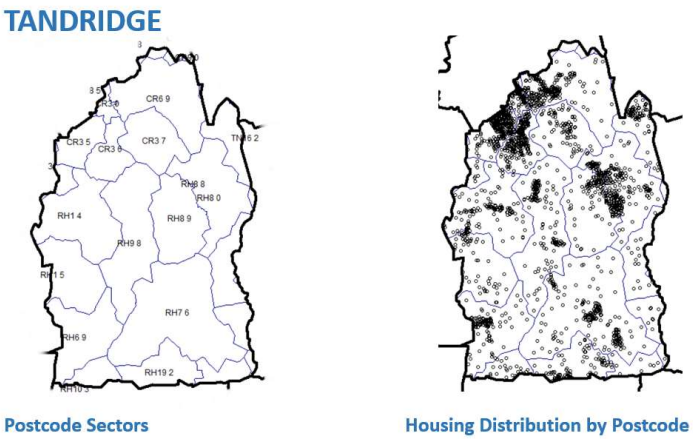
Subsidence Risk Analysis – TANDRIDGE

Tandridge is located in east Surrey, occupying an area of 248km^2 with a population of around 87,500.



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 – 20 houses on average, although there are large variations.

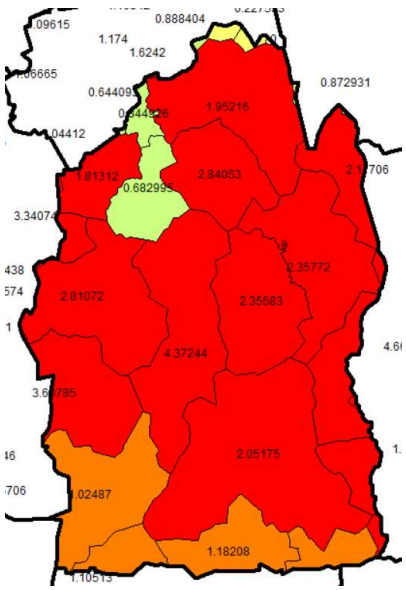
From the sample we hold, sectors are rated for the risk of domestic subsidence compared with the UK average – see map, right.

Tandridge is rated 22nd out of 413 districts in the UK from the sample analysed and is around 2.2x the risk of the UK average, or 0.57 on a normalised 0 - 1 scale.

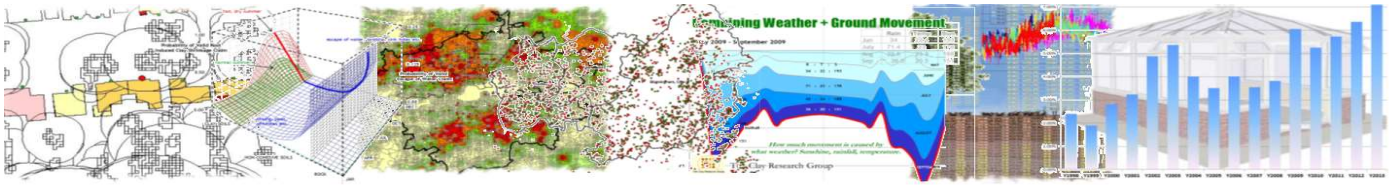
There is a varied risk across the borough as can be seen from the sector map, right, which reflects the varied geology.

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.



Risk of domestic subsidence claims rated against average across the UK from the sample analysed.



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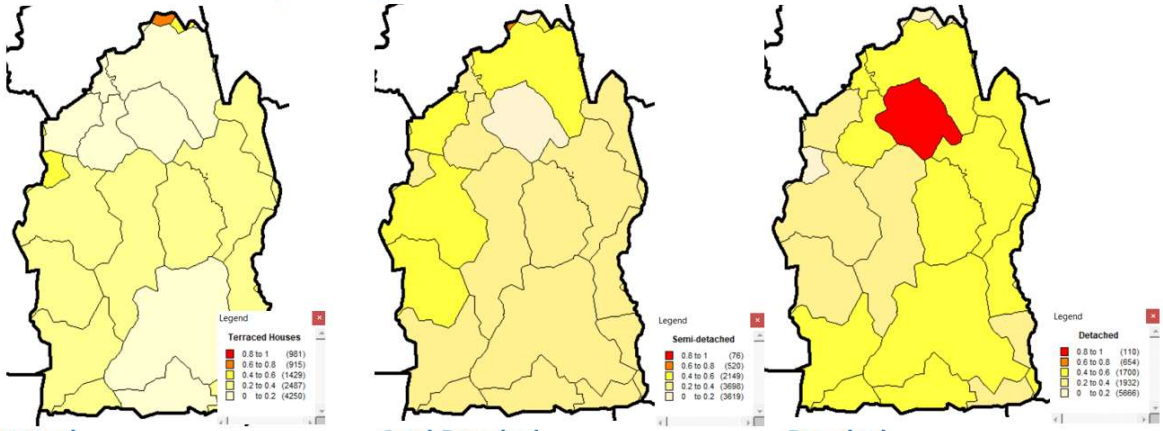
TANDRIDGE - Properties by Style and Ownership

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.

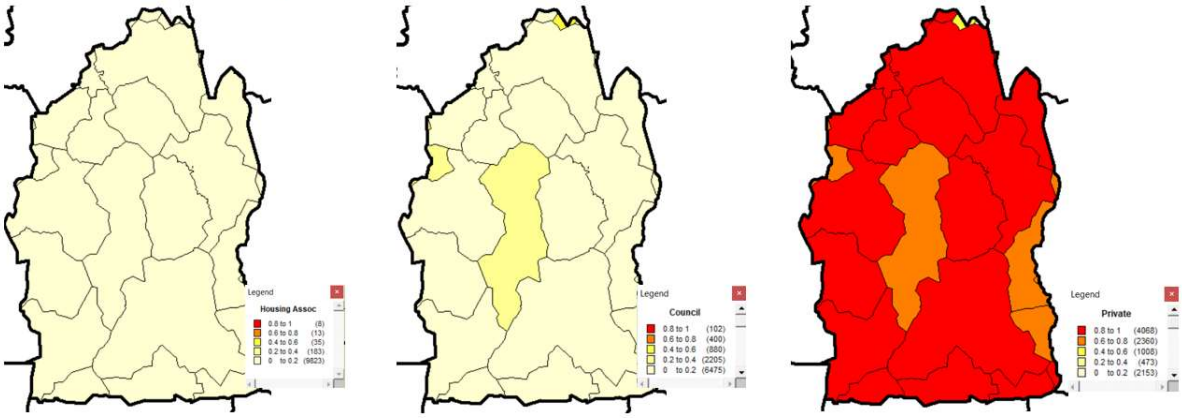
TANDRIDGE - Distribution by House Type



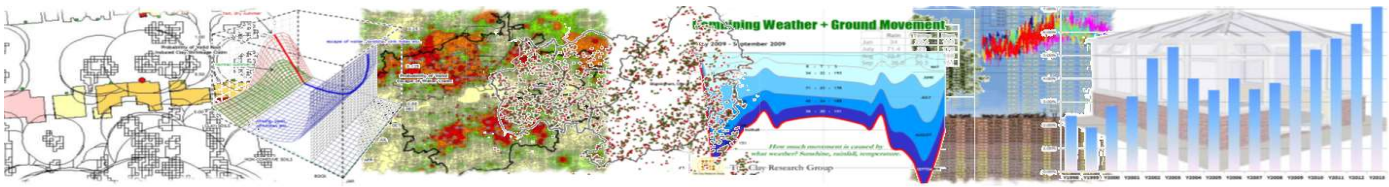
Terraced Semi-Detached Detached

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

TANDRIDGE - Distribution by Ownership



Housing Association Council Ownership Private Ownership



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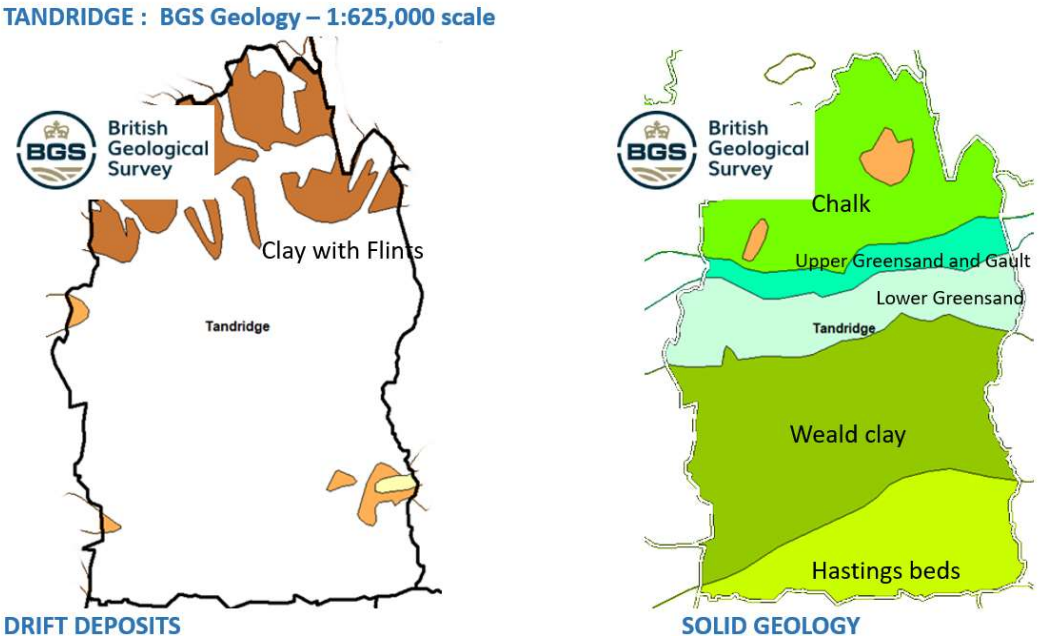
Subsidence Risk Analysis – TANDRIDGE

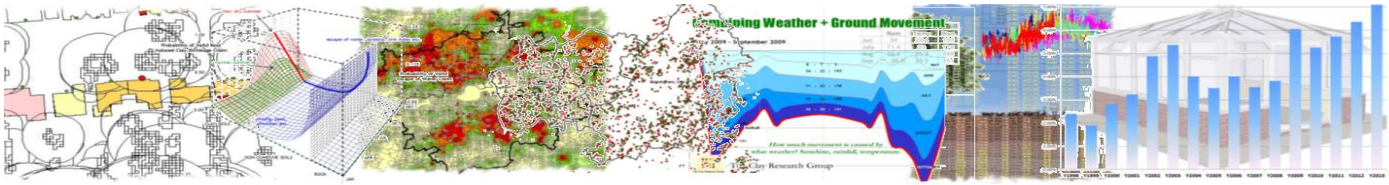
Below, extracts from the British Geological Survey low resolution 1:625,000 scale geological maps showing the solid and drift series. View at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html for more detail.

See page 9 for a seasonal analysis of the sample which reveals that, at district level, there is around a 77% probability of a claim being valid in the summer and, of the valid claims, there is around a 86% chance that the damage will have been caused by clay shrinkage, with escape of water accounting for the remaining 13%. In the winter the likelihood of a claim being valid is lower at around 31%. Of the valid claims there is a 14% chance of the cause being clay shrinkage and 87% chance of the cause being an escape of water, a reversal of the summer values.

Maps at the foot of the following page plot the seasonal distribution with shrinkable deposits encountered following investigations associated with claims.



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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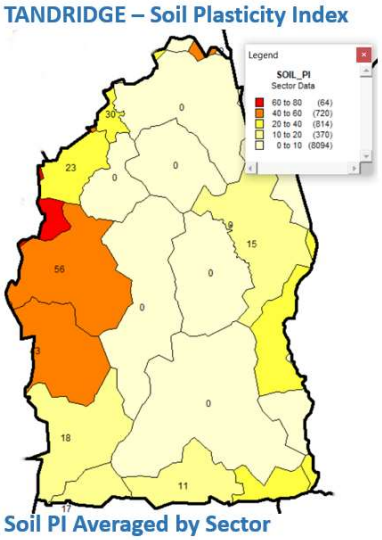
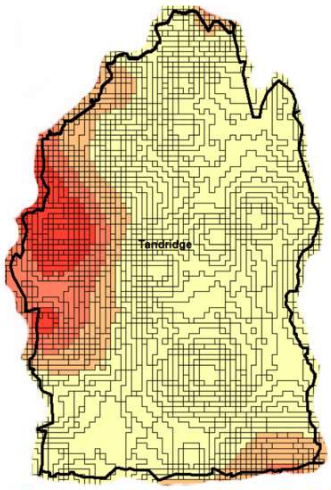
Liability by Geology and Season

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.



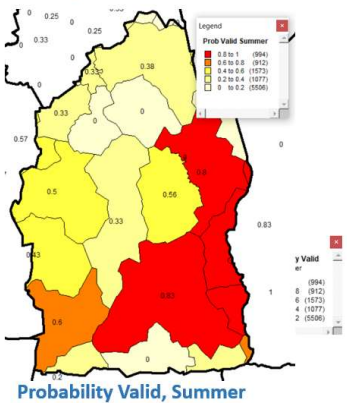
Soil PI Averaged by Sector



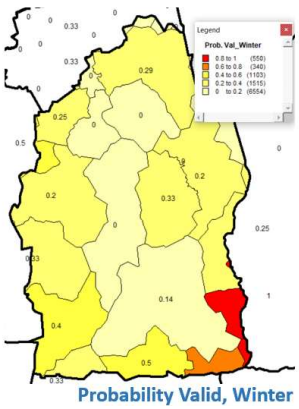
PI Interpolated on 250m CRG grid

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.

TANDRIDGE – by season



Probability Valid, Summer



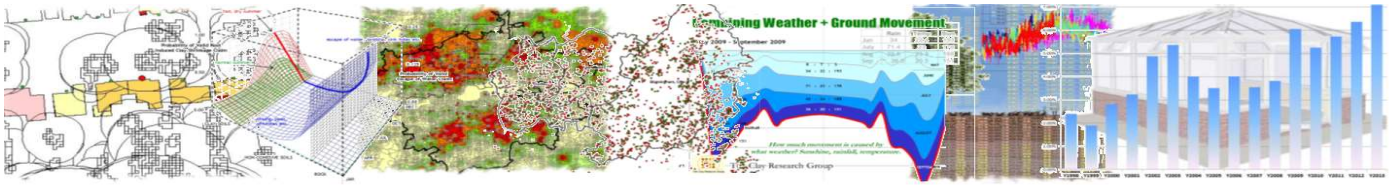
Probability Valid, Winter

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

Combining the risk maps by season and reviewing the table on page 12 is perhaps the most useful way of assessing the potential liability, likely cause and geology using the values listed.

This approach seems less useful in this instance as clay is recorded as a significant cause of subsidence in the summer months and yet the geological series are, in the main, non-shrinkable.

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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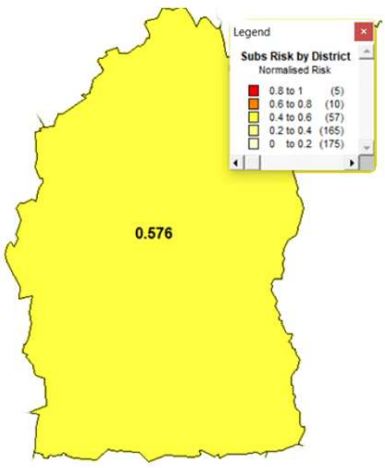
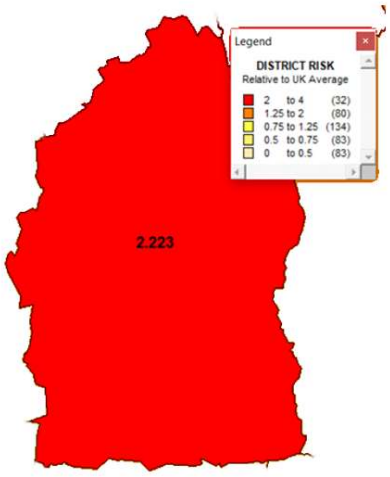
District Risk -v- UK Average. EoW and Council Tree Risk.

TANDRIDGE - Subsidence Risk Relative to UK



Normalised (0 – 1) Scale



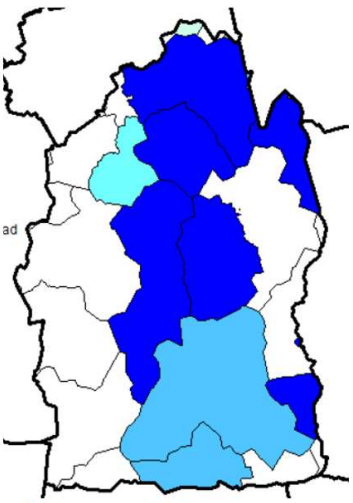
Relative to UK Average

Below, left, mapping the frequency of escape of water claims confirms the presence of non-cohesive soils. As we would expect, the 50,000 scale BGS map provides a more detailed picture.

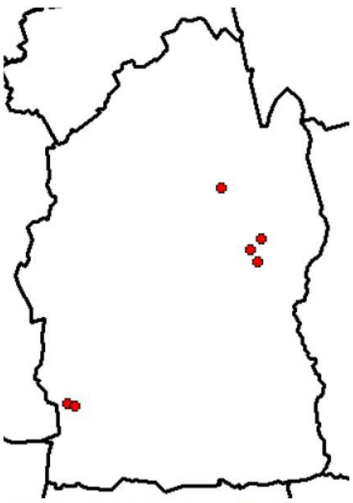
The CRG 1:250 grid reflects claims experience.

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 low numbers are attributable to the superficial geology being largely non-cohesive.

TANDRIDGE

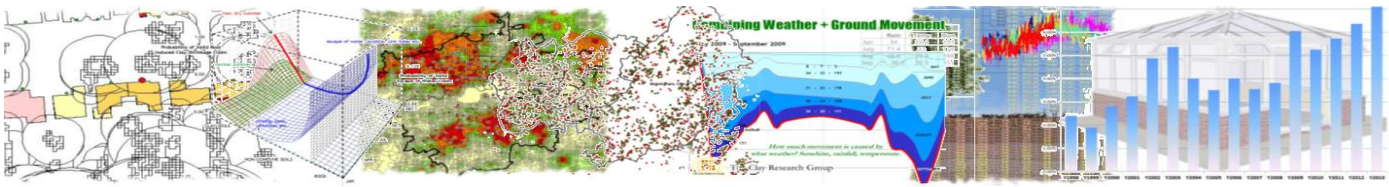


Higher Risk Escape of Water



Claims Involving Council Tree

(2,858 UK claim sample)



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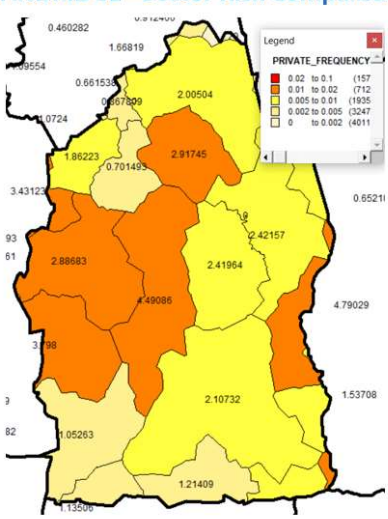
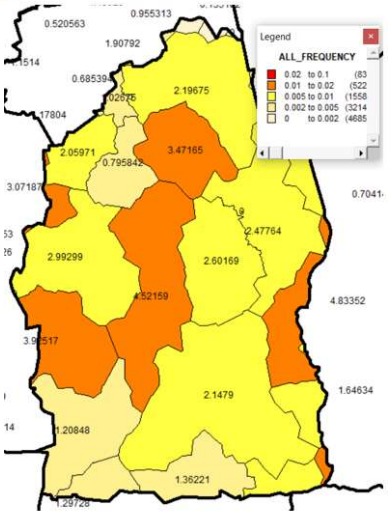
TANDRIDGE - Frequencies & Probabilities

Below, mapping the risk of subsidence by ownership. Claims frequency including 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.

TANDRIDGE - Sector Risk Compared with UK Average



Private Only



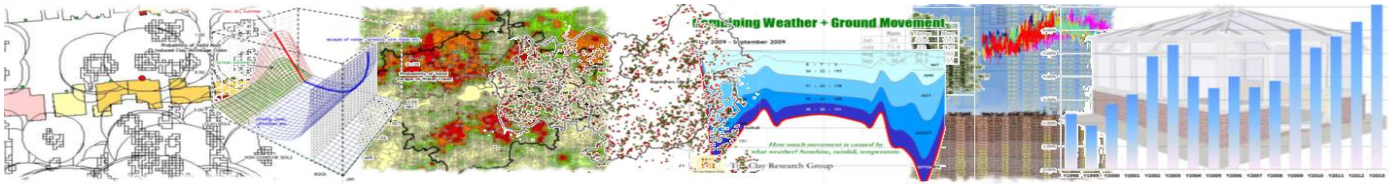
All Properties

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 - TANDRIDGE

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Tandridge	0.662	0.106	0.232	0.04	0.27	0.69



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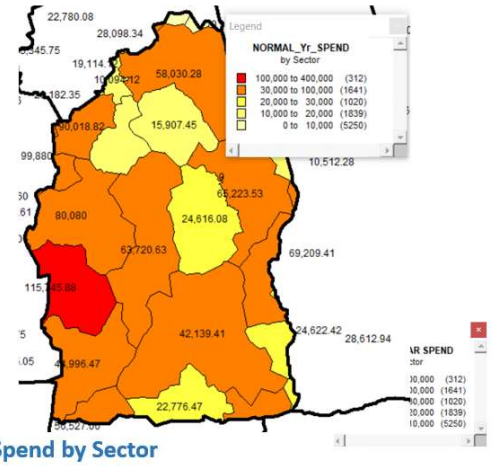
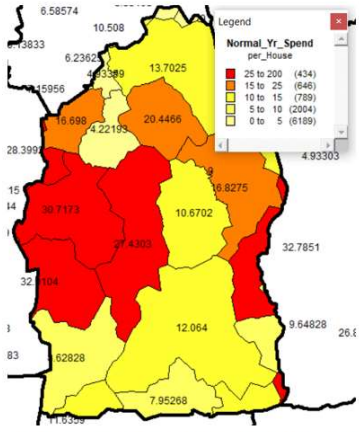
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

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 – TANDRIDGE



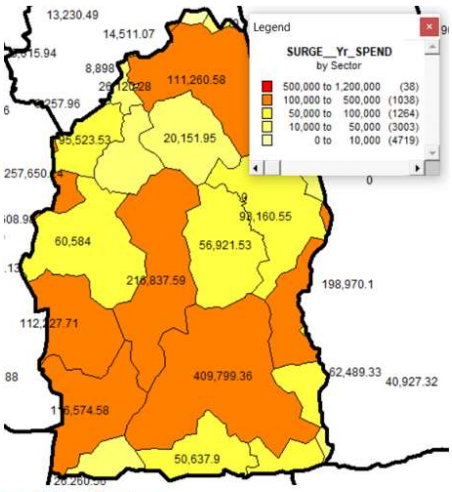
Spend by Sector



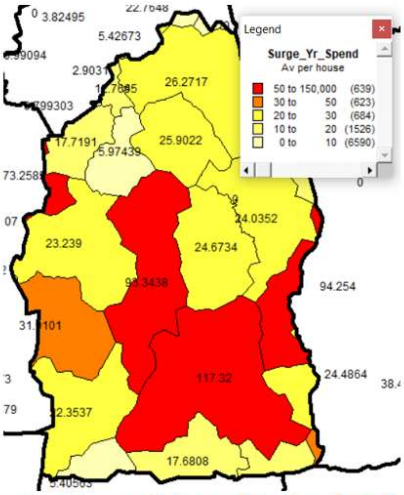
Spend Averaged Over Housing Population

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.

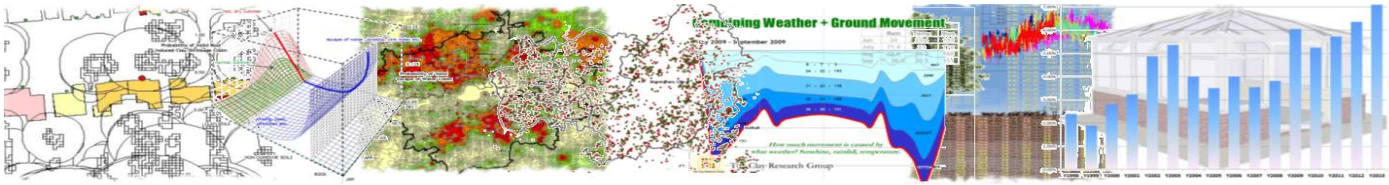
SPEND in SURGE – TANDRIDGE



Spend by Sector



Spend Averaged over Private Housing Population



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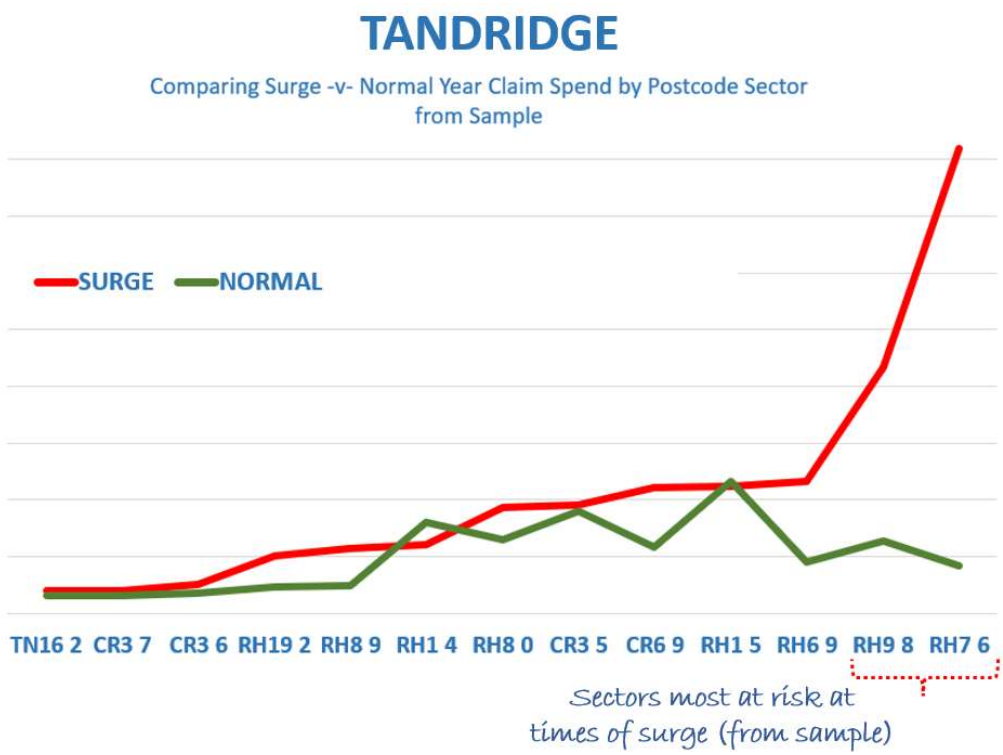

The above graph identifies the variable risk across the district at postcode sector level from the sample, distinguishing between normal and surge years. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

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.