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

May 2020
Edition 180

The Clay Research Group

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Issue 180, May 2020

Notes on Modelling Risk at District Level

This month's edition continues the assessment of risk by district with a visit to Sevenoaks, Kent. To model surge, the assessment uses data with losses amounting to nearly £400m, and for 'normal' years, just under £200m. To compare, recent years have delivered claims with an annual value of around £120m.

Restricting data from the last 10 years, a period of falling claim numbers, would deliver a misleading risk rating, missing the link to the major indicator – the geology.

The scales on some risk maps have been changed to allow comparisons between, for example, 'count of valid' and 'count of declinatures' images.

The exercise is in continual development and is hopefully of use to underwriters, claims handlers and engineers. Engineers visiting sites local to them will be aware of the geology and related risks but when travelling further afield (say in times or surge) some background data on risk, peril and liability can be useful.

CV19 - Global warming on hold?

Climate scientists report that the CV19 outbreak and subsequent lockdown around the world has resulted in a drop in CO_2 and NO_2. Pollution levels have fallen as traffic has reduced and commercial production comes to a virtual halt.

In effect, CV19 has delivered a reduction in greenhouse gases within a month or so, but at huge cost to the economy.

Perversely, subsidence numbers have been declining as global warming has been gradually increasing. Will this reduction in CO_2 and NO_2 deliver a cooler summer?

Contributions Welcome

We welcome articles, comments and thoughts from readers. Updates on current practice and procedures, suggestions on how risk can be managed, reports on interesting cases and input from experts in the various fields involved.

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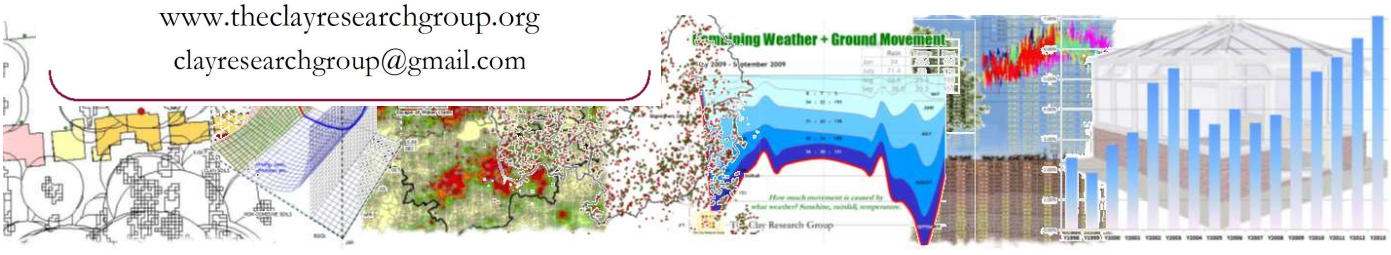

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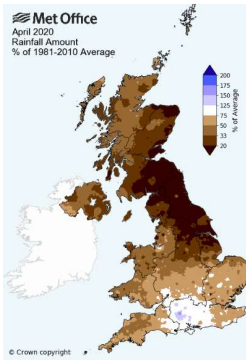
April 2020 – a dry, sunny month



The Met Office report that April was a warm, dry and sunny month.

"It was the sunniest April on record for the UK, according to a provisional analysis of the month's climate statistics. Rain in the last week of the month increased the rainfall totals in many places, but the UK overall still only received 40% of average April rainfall."

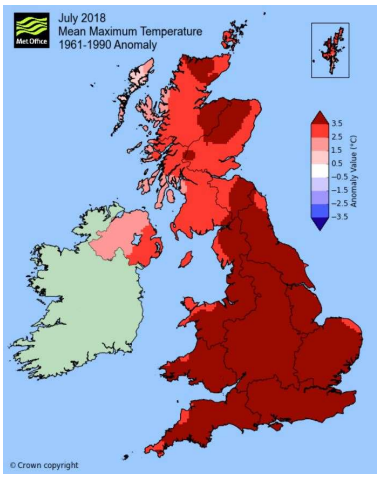
2019 – Europe's Hottest Year on Record

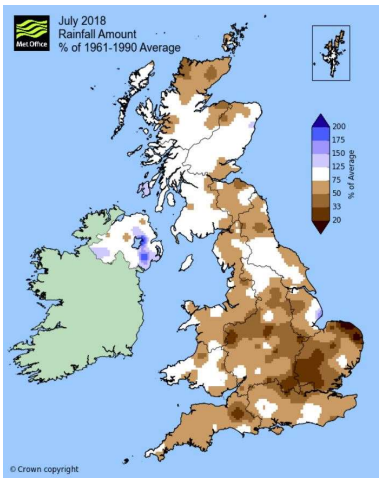
https://climate.copernicus.eu/

According to the European Union's Copernicus Climate Change Service, a series of summer heatwaves made 2019 Europe's hottest year on record, closely followed by 2014, 2015 and 2018. High temperatures caused drought in several countries over the summer months. They report "In Europe in March, average temperatures were almost two degrees Celsius above the 1981-2010 average".

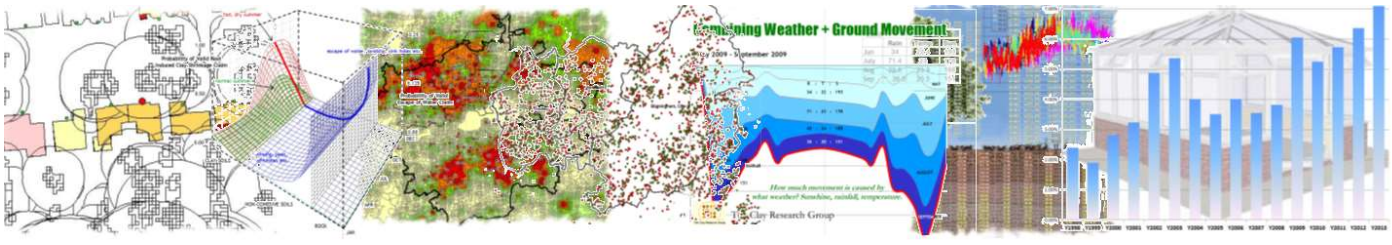
Met Office Anomaly Maps, July 2018

The third quarter of 2018 delivered a record surge in subsidence claims and the Met Office anomaly maps below throw some light on why this might have been.





The maps show July 2018 values as a percentage of the 1961-1990 averages, revealing higher temperatures and lower rainfall. There was a 3.5% increase in temperature and less than 30% of average rainfall in parts of the SE.



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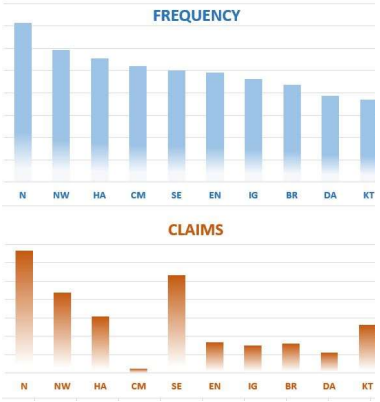
Rehydration of Desiccated Clay Soil using Electrokinesis

A paper in this month's Geotechnique journal entitled "Electrokinetic Treatment of Expansive Desiccated Clays" explores a different approach to using electrokinesis – that is, rehydration rather than dehydration. The authors explain - "this study explores a system that could be operated during prolonged drought periods to rehydrate and neutralise the negative pore pressures of expansive clay"

Researchers Omar Hamza (University of Derby, College of Engineering and Technology) and Jamie Ikin (C2C Consulting Engineers, Stoke on Trent) publish their findings in Geotechnique, Volume 70, May 2020.

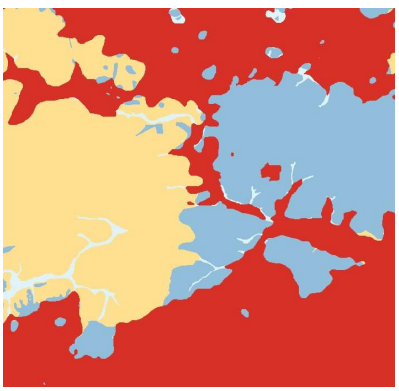
Frequency -v- Count

Most of the analysis we undertake uses frequency data, rather than count, which may seem perverse. Surely we want to know where there are lots of claims? The reason is to provide the underwriter with some idea of the premiums per household to meet the risk and whilst 1 claim in a sector might appear to indicate it is safe, if there are only 5 houses, the risk escalates (frequency = 0.2). On the other hand, if there are say 100 claims, it may be a safe sector if there are 2,000 houses (frequency = 0.05). The difference between the two approaches is shown right.



BGS GeoClimate Shrink/Swell GeoHazard Risk Model

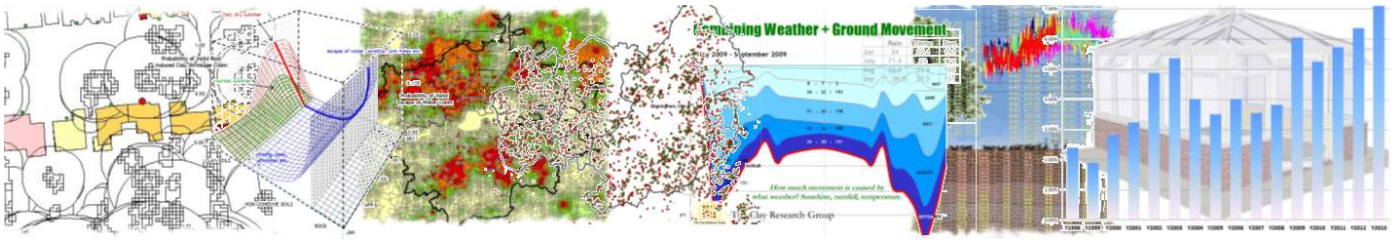
The British Geological Survey (BGS) have developed a risk model that takes into account the possible effects of climate change up to 60 years into the future using UKCP09 data.



The BGS data can be downloaded in both ESRI and MapInfo GIS formats with an 'open access' (1:200,000 scale) and a premium version (1:50,000 scale) available.

For further information and costs go to:

https://www.bgs.ac.uk/products/geohazards/geoclimate/home.html



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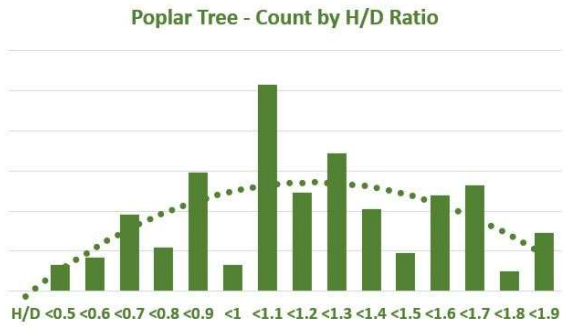
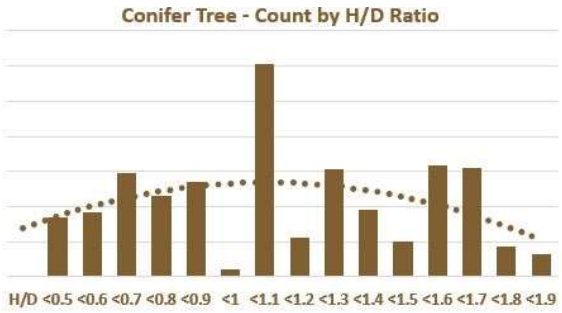
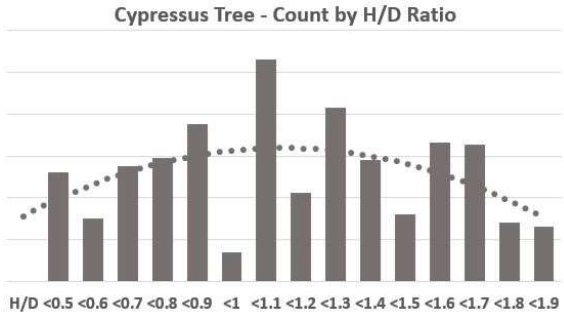
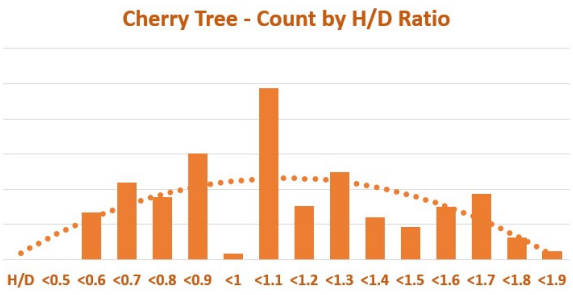
Revisiting Tree Risk Metrics

In last month's edition we reviewed tree metrics that, independent of species, might give an indication of the risk in terms of root induced clay shrinkage and arrived at a figure of H/D = 1.1 for sycamore, plane, willow, ash, oak and lime trees. This value has proven robust across all species reviewed, including 'all trees' examining over 42,000 records – see below.

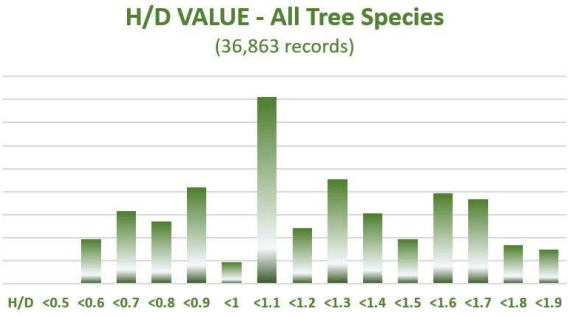




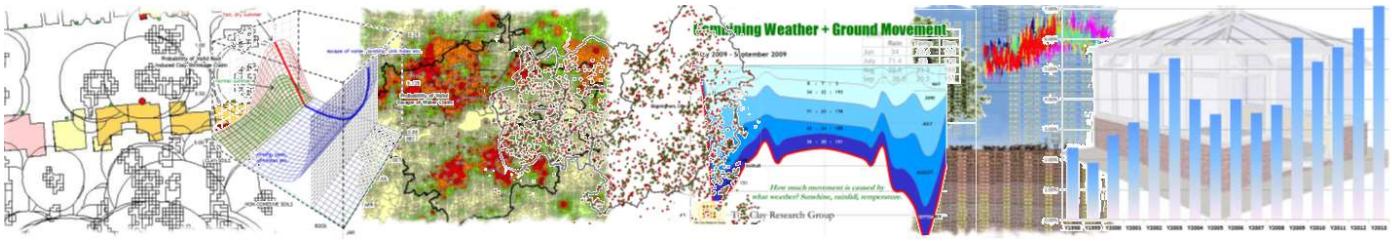




By comparing height with maximum claims incidence in terms of H/D, we can see that the ash for example is riskiest (in terms of count) when it is 11mtrs tall, the conifer at 5mtrs, willow at 14mtrs, the plane between 13 – 16mtrs, cherry tree between 5 – 7mtrs and the poplar when it is around 20mtrs tall.



Of course, measurements are based on site assessments of height and distance, the accuracy of which will vary dependent on the circumstances. The measurements are likely to be more accurate in cases where Third Party trees are involved and perhaps less where damage has been caused by the homeowner's own tree but hopefully the output will be useful to local authority tree officers and others responsible for maintaining vegetation.



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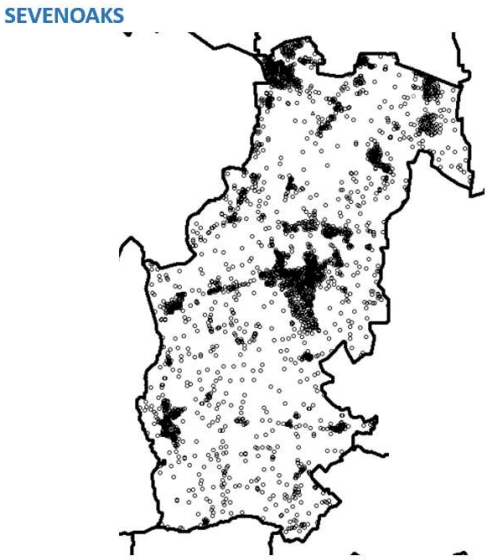
Subsidence Risk Analysis – Sevenoaks

Sevenoaks occupies an area of nearly 370km^2 with a population of around 29,500.



Housing Distribution by Postcode

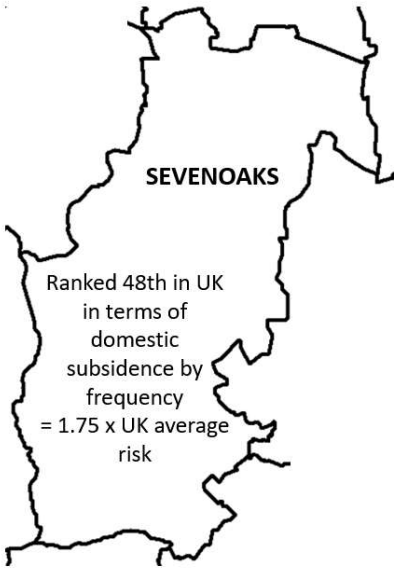
Distribution of housing stock using full postcode as a proxy. Each postcode in the UK covers on average 15 houses, although there are large variations.

Districts are rated for the risk of domestic subsidence compared with the UK average – see map, right.

The highest risk rating is a value of 4 and Sevenoaks is rated as being 1.75 times the UK average risk, ranked in 48th place.

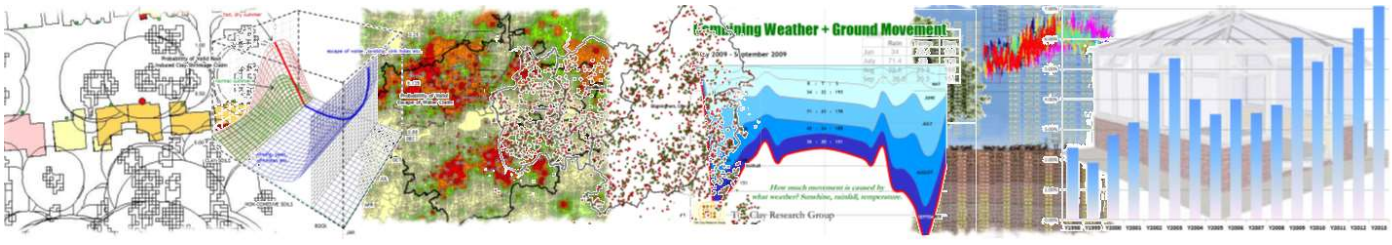
Housing distribution across the district (left, using full postcode as a proxy) helps to clarify the significance of the risk maps on the following pages. Are there simply more claims because there are more houses?

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 Compared with UK Average

Layout of the district used for risk analysis above. Northampton has an estimated population of around 29,500 and an area of 370km^2.



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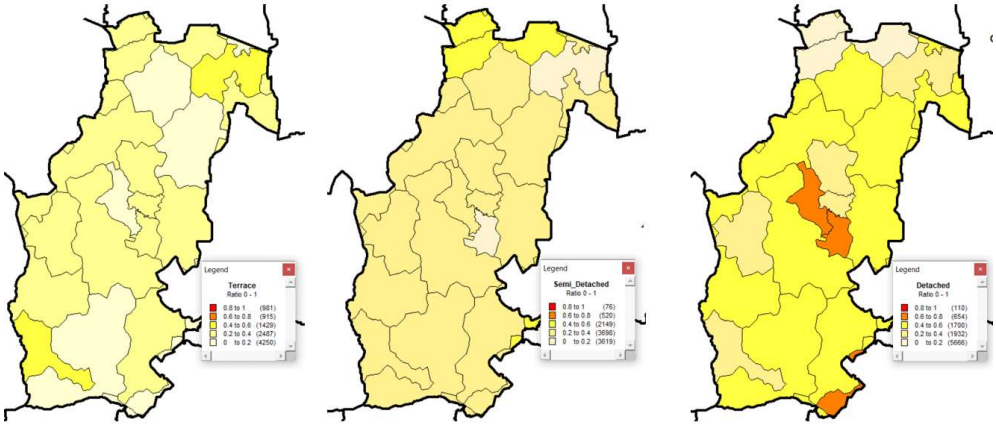
Sevenoaks - Properties by Style and Ownership

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 – the age of the property. Risk increases with age of property and from a visual assessment using Google Street View, we rate Sevenoaks district at around 0.5 on a scale of 0 – 1. This assessment could be refined using insurer's portfolio data.

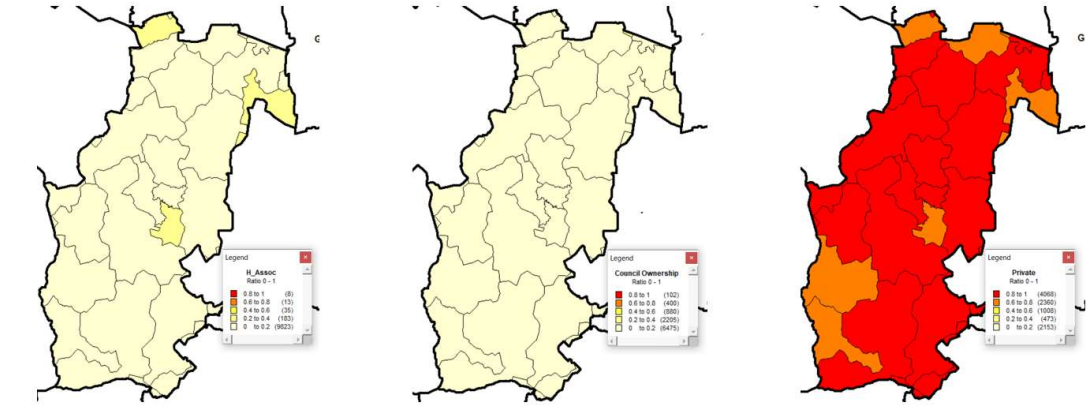
SEVENOAKS - Distribution by House Type



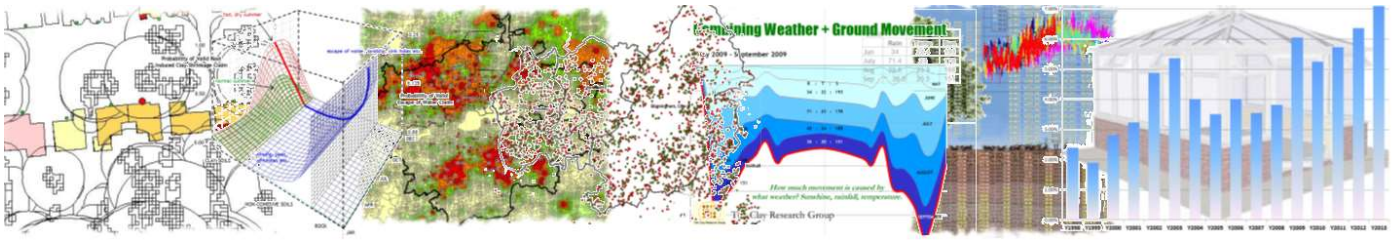
Terraced | Semi-Detached | Detached

Distribution by ownership is shown below. The maps reveal predominantly privately-owned properties across the borough, which will influence the risk rating.

SEVENOAKS - Distribution by Ownership



Housing Association | Council Ownership | Private Ownership



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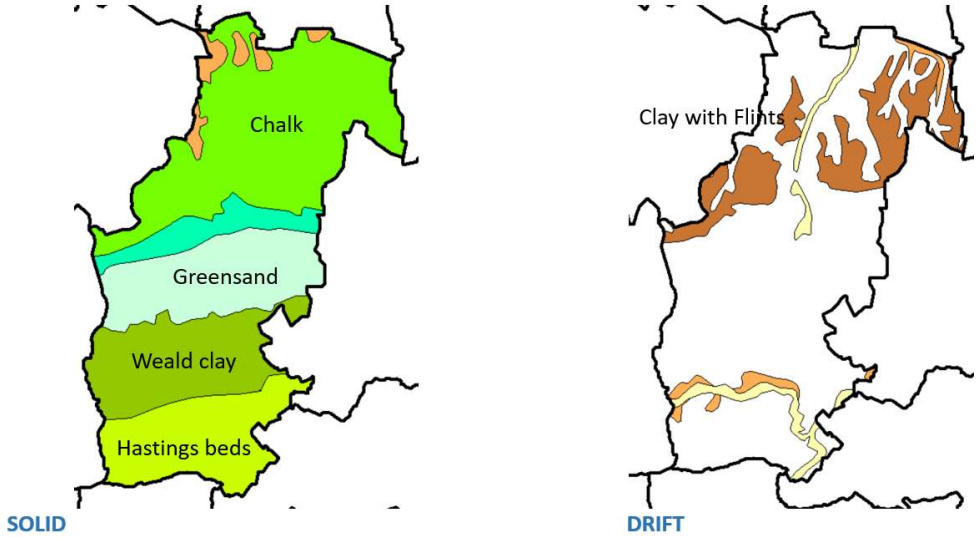
Subsidence Risk Analysis - Sevenoaks

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

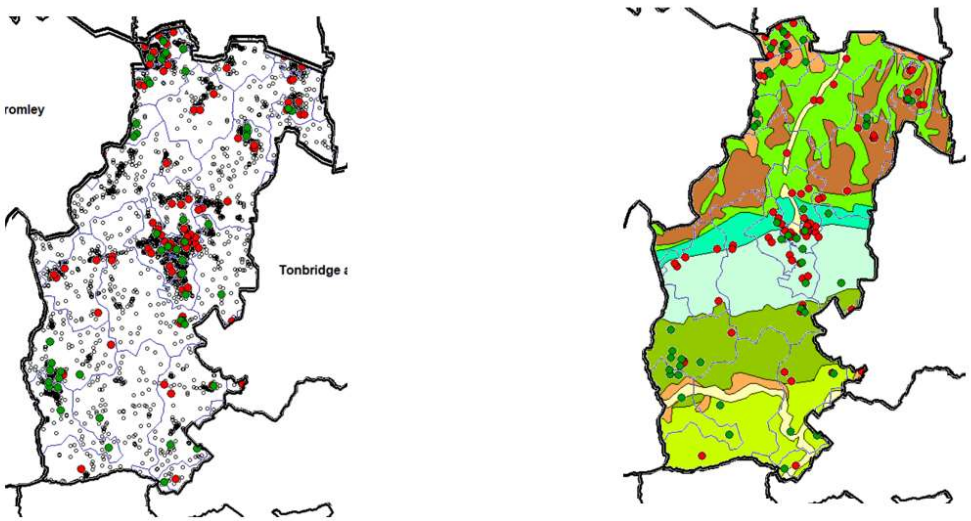
SEVENOAKS : BGS Geology – 1:625,000 scale low resolution mapping



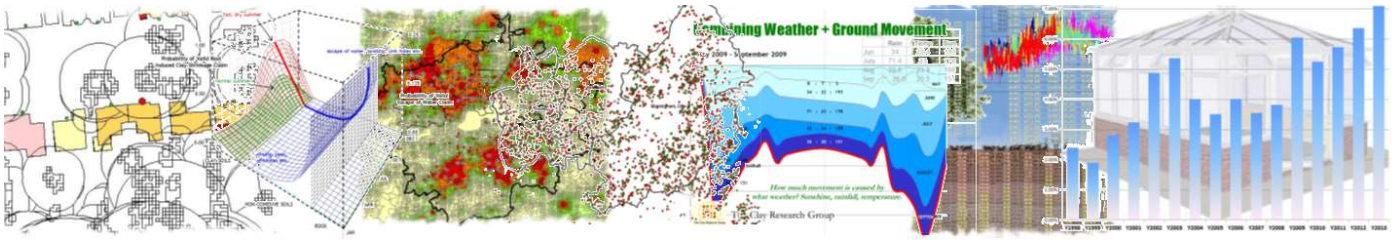
SOLID DRIFT

See page 10 for a seasonal analysis, which reveals a fairly balanced number of valid claims in the summer (clay shrinkage related) and winter (predominantly associated with escape of water), reflecting the variable geology.

SEVENOAKS : Mapping claims by peril by population and geology



Claims on Population Map Claims on Geological Map



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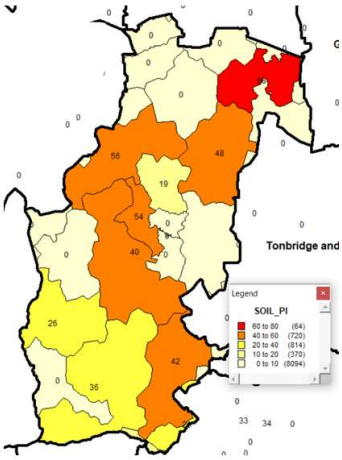
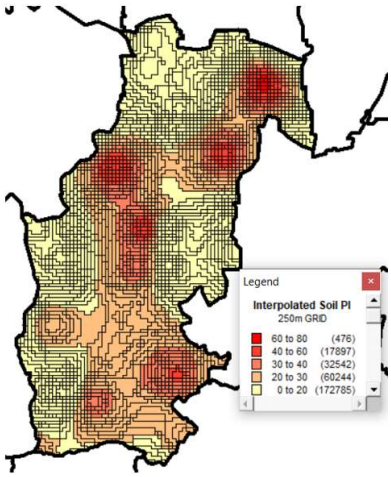
Liability by Season and Geology

Below, the average PI by postcode sector (left) derived from site investigations and interpolated to develop the CRG 250m model grid (right). The presence of a shrinkable clay in the CRG model reflects the highly shrinkable nature of the Clay with Flints drift deposits to the north and the underlying Weald series to the south. The higher the PI values, the darker red the CRG grid and the more likely the values are linked to actual results from claims.

SEVENOAKS – Soil Plasticity Index



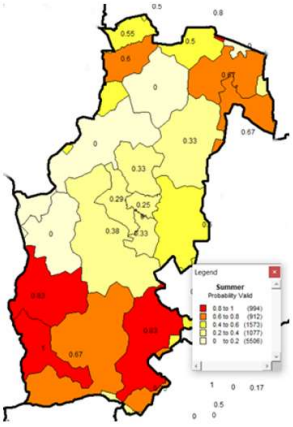
Soil PI Averaged by Sector



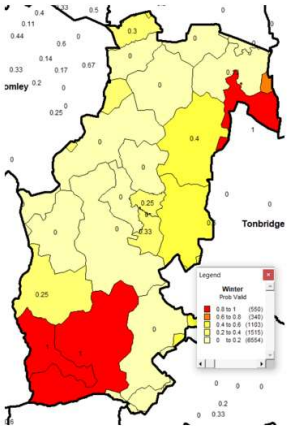
PI Interpolated on 250m CRG grid

Below, the probability of whether a claim is likely to be valid or declined by season. The high-risk sector to the south east corner reflects an issue with using frequency data. A single claim in an area with low population can raise the risk as a result of using frequency estimates – note low density housing in this sector from map on previous page.

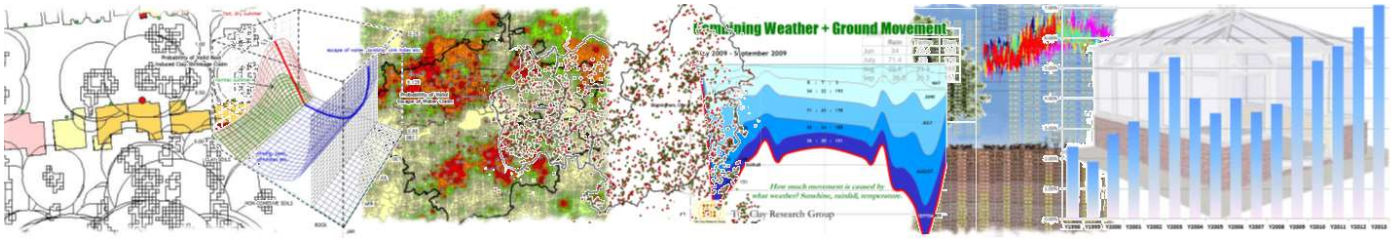
SEVENOAKS



Probability Valid, Summer



Probability Valid, Winter



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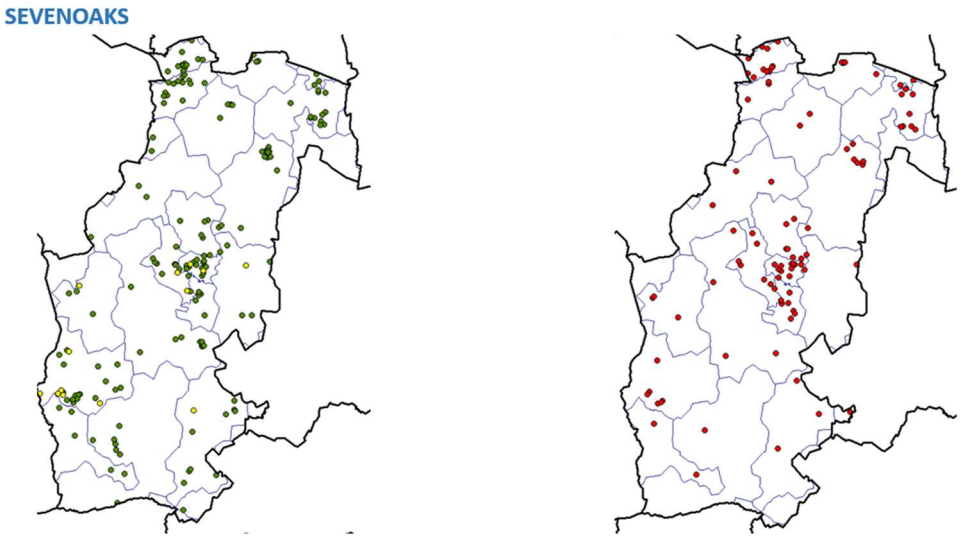
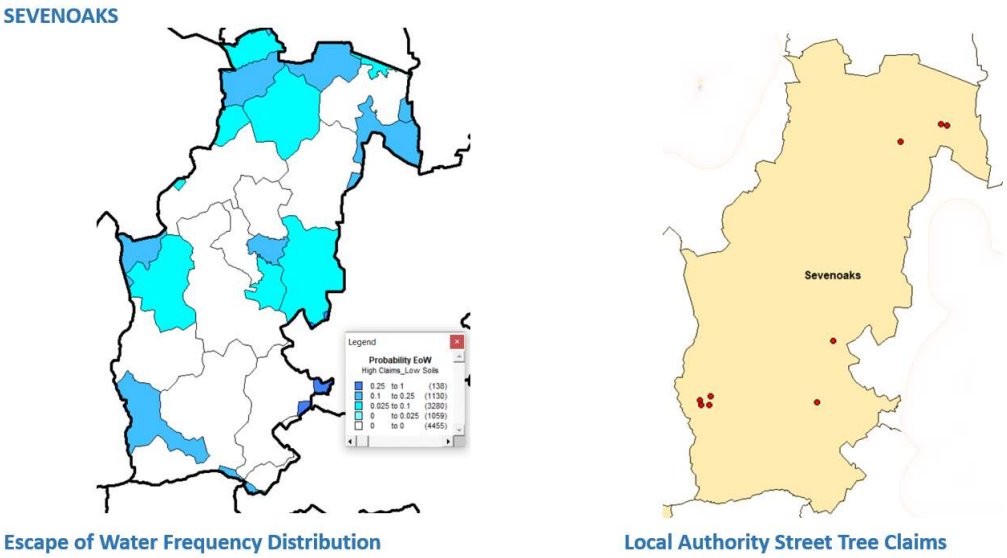
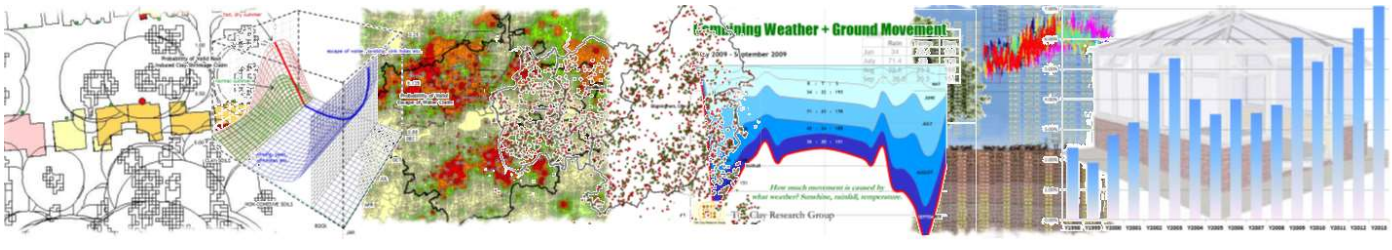
Liability by Sector. All Perils



Above, mapping liability and plotting count of valid and declined claims at full postcode from the sample and bearing in mind one dot can represent one or more claims. Below, left, mapping the frequency of escape of water claims from the sample reflects the presence of shallow, non-cohesive drift deposits to the south east of the district. Below, right, dots on the 'Council Tree Claims' map, represent properties where damage has been attributable to vegetation in the ownership of the local authority which coincide with the clay formation.





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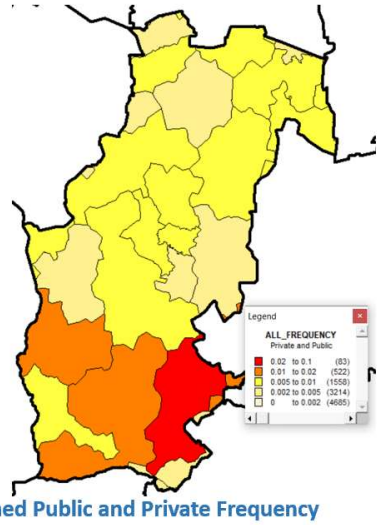
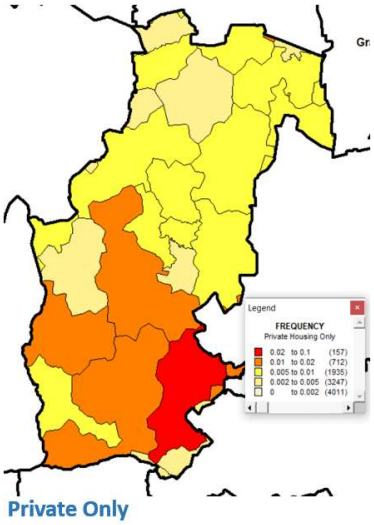
Sevenoaks - Frequencies & Probabilities

SEVENOAKS - Postcode Sector Subsidence Risk (frequency) by Ownership



Combined Public and Private Frequency



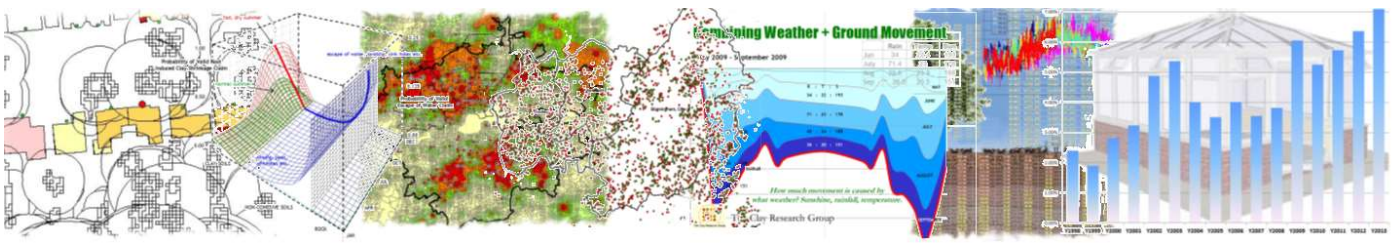
Private Only

The maps and figures reveal a borough with a fairly balanced seasonal risk, reflecting the variable geology. The chances of a claim being declined in the summer are just over 25% and if it is valid, there is a higher probability that the cause will be clay shrinkage. In the winter, the repudiation rate increase - around 44% for our sample - and if the claim is valid, there is a higher probability the cause will be water related. The probabilities of causation reverse between the seasons.

To improve our understanding a postcode sector analysis is far more useful.

Liability by Season - SEVENOAKS

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Sevenoaks	0.568	0.165	0.267	0.13	0.43	0.44



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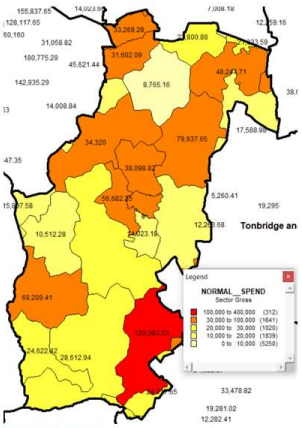
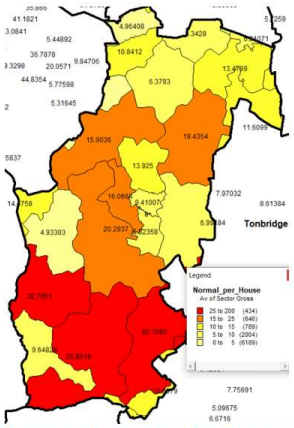
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

The maps below show the aggregated claim cost from the claim 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.

NORMAL YEAR SPEND – SEVENOAKS



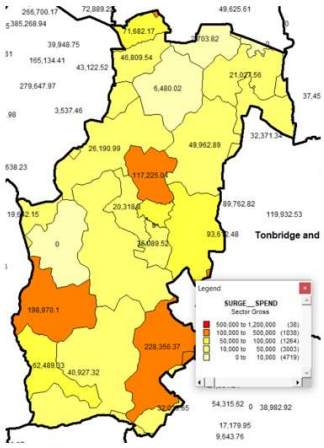
Spend by Sector



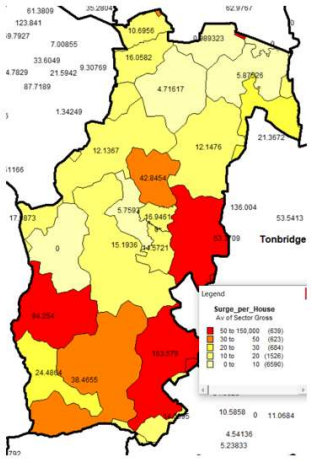
Spend Averaged over Housing Population

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 cost per house. The figures can also be distorted by the odd, single high value claim.

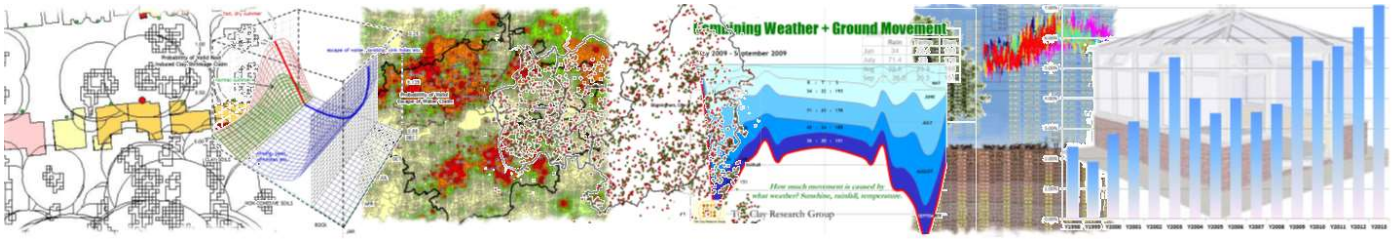
SPEND in SURGE – SEVENOAKS



Spend by Sector



Spend Averaged over Housing Population



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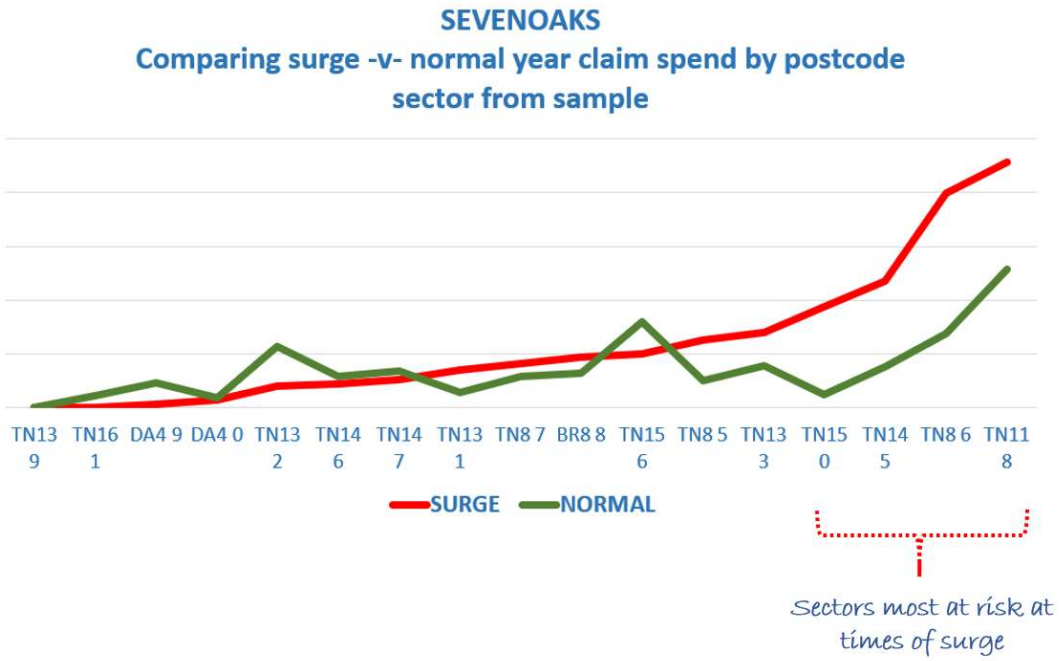

Identifying the variable risk across the district distinguishing between normal and surge years by postcode sector. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

It is of course the case that a single expensive claim (a sinkhole for example) can distort the outcome using the above approach.

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 can 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.