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

July 2022
Issue 206

The Clay Research Group

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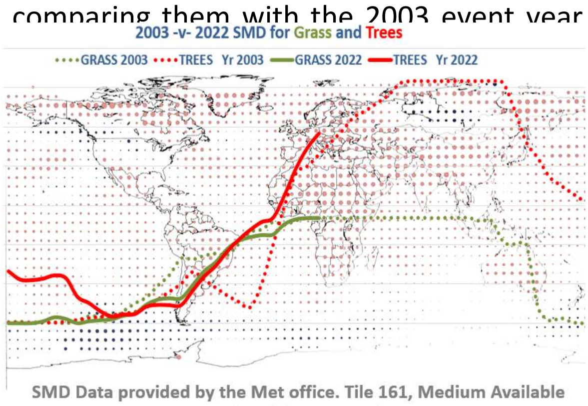
Issue 206, July 2022

Soil Moisture Deficit

Below, current SMD values provided by the Met Office from the Heathrow weather station, for both grass and tree cover, comparing them with the 2003 event year



SMD Data provided by the Met office. Tile 161, Medium Available Water Capacity with grass and tree cover

The profiles for both tree and grass cover continue to follow the 2003 event year.

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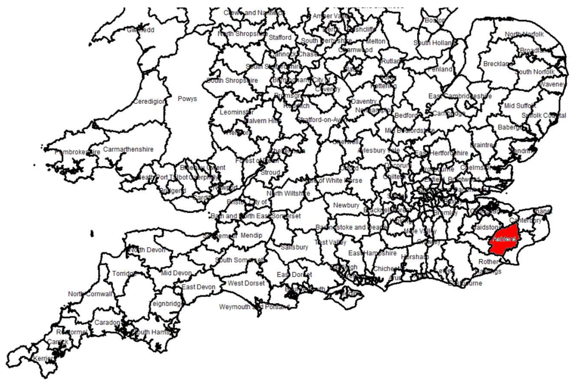
District and Sector Risk

Ashford is the topic of the District Risk series in this month's edition and increased resolution is provided with examples at postcode sector level.

The study includes a review of cause and liability by season, providing a useful reference for underwriters, engineers and claim handlers.



Predicting which trees will cause damage, where and when

How difficult can it be? There are numerous tables by leading authorities (NHBC, Giles Biddle etc) listing the risk posed by various species, providing height to distance ratios all supplemented by claims experience. Of course, the weather makes matters more difficult but models assuming hot, dry years must help surely? See page 2 for the answer.

Contributions Welcome

We welcome articles and comments from readers. If you have a contribution, please Email us at:

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Predicting Which Trees Will Cause Damage, Where and When

A survey of Haringey collected some time ago (2006), suggests 7,527 trees in council ownership and 52,611 privately owned trees within influencing distance of a property built on shrinkable clay. Just over 12% of trees with a potential to cause damage using the above criteria were under the control of the council – a figure reflected in claims data. By far the biggest risk is posed by privately owned trees.

The likelihood of determining which house will suffer what damage as a result of which tree, and when, are ridiculously small. There is no realistic prospect. Instead, we have been looking at combined probabilities not based on 'what is the chance of 'x' tree causing damage', but 'when there is damage, what is the probability of the tree being involved?' This changes the odds and simplifies the calculation. We want to understand that when a diagonal crack appears directed towards the tree, and that crack is wider at the top than the bottom, what are the odds knowing the tree species, height, distance, soil properties and weather at the time of damage that the tree is the cause?

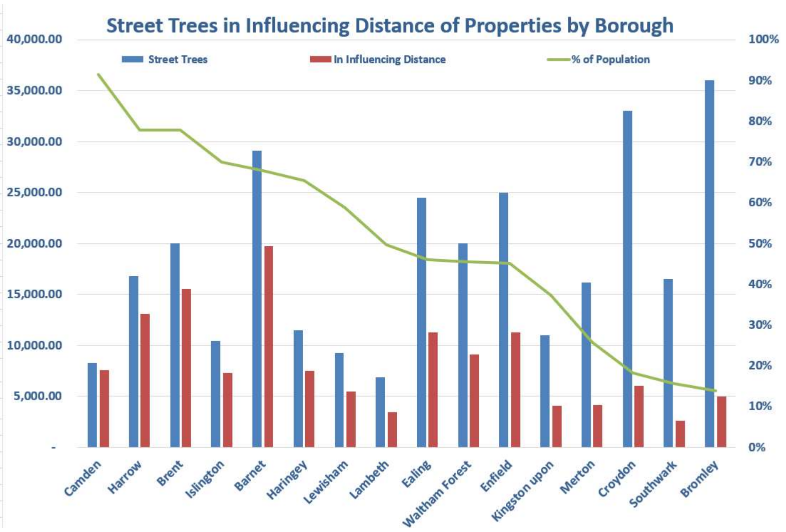
Examples of valid claims not associated with vegetation might be houses with shallow foundations bearing onto fill where damage is caused by a leaking drain. This isn't an unusual situation even when outcropping clay is shown on the geological maps.

The average height of trees in the borough was around 8mtrs, irrespective of ownership. Private and council trees delivered the same figure. Both had a figure of 30mtrs for maximum tree height and soils had a PI of just over 46% - fairly typical for London clay. Of the 23 postcode sectors with centroids contained by the district boundary, 5 did not have a shrinkable soil. 78% of the postcode sectors presented a potential risk of clay shrinkage.

Risk Potential
- Street Trees-

Right, a graph showing the count of street trees with a modelled root zone (based on 1.2x the tree height) extending beneath the building footprint, by borough. The green line plots the risk potential.

Adding tree species and age of property would increase the usefulness.



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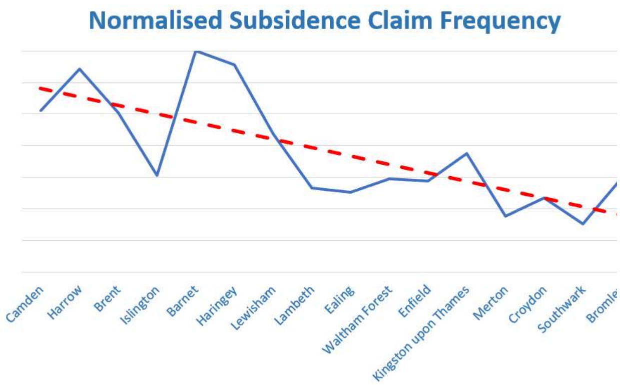
Risk Potential – Street Trees *... continued*

Plotting the risk by borough using claim data delivers the profile, right. The data has been plotted on a normalised 0 – 1 scale adding a linear trendline (red).



The trendline broadly follows the one on the previous page taking into account the fact we do not identify tree species and the use of a generic '1.2 x tree height' algorithm to assess root encroachment beneath the building.

In the News

A 600 year old Oak tree in Barnard Way, Bretton, Peterborough was thought to be causing damage to a nearby property and an application seeking its removal was challenged by local residents. Following investigations and recognising the cost of a claim (legal fees, further investigations and repairs to damaged property should the case against it be proven), the council decided that allowing its removal was the appropriate course of action. The tree has now been felled.

A five-bedroom house near Ely, Cambridgeshire, has been demolished due to what was thought to be heave damage.

Although only five years old, cracks started appearing throughout the house, many wider at the base and diminishing with heave – supporting the diagnosis. See photograph right.

Investigations revealed the foundations were between 1.5 – 2mtrs deep. Fortunately, the property was covered by a 10yr insurance policy and is now being demolished and re-built on deeper foundations.

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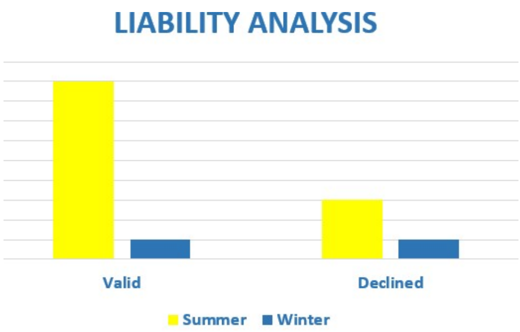
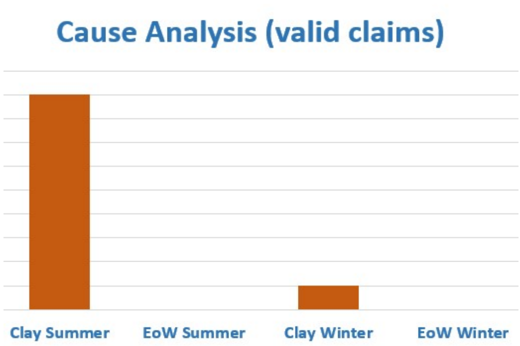
Using Past Claims Data to Infer Geology and Derive Probability of Cause and Liability – Sector Level Analysis

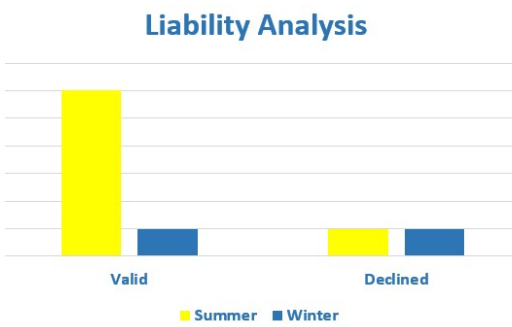


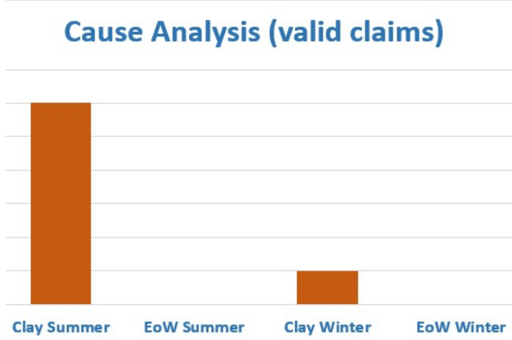


TN26 3 – This is one of the higher risk postcode sectors in Ashford from the sample, with nearly 75% of claims accepted in the summer and 50% in the winter months.

The primary cause of subsidence in the sector is clay shrinkage both in the summer and winter months. No claims resulting from an escape of water are recorded in the sample.

Both the 1:50,000 and the 1:625,000 scale BGS maps suggest outcropping Weald clay, with no superficial deposits, which explains the risk profile.





TN27 8 – Situated to the west of the district and adjoining TN26 3, this is another high-risk sector with predominantly clay shrinkage claims throughout the year.

As with the sector above, no claims resulting from an escape of water are recorded in the sample.

The geology is the same as the above postcode – i.e. outcropping Weald clay with no superficial deposits.

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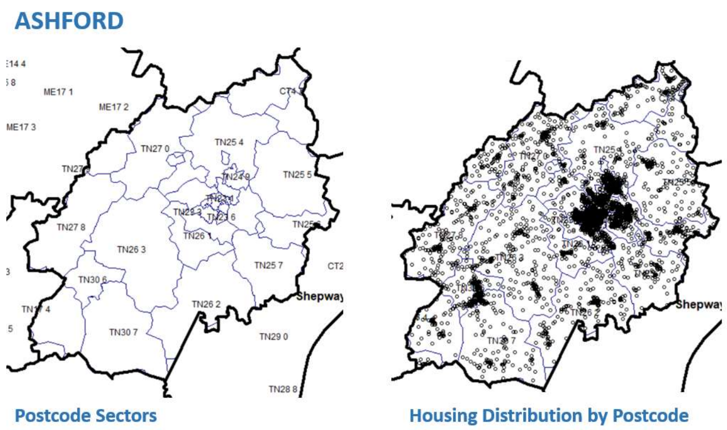
Subsidence Risk Analysis – ASHFORD

Ashford is situated in Kent and occupies an area of 239km^2 with a population exceeding 130,000.



Distribution of housing stock using full postcode as a proxy. Each sector covers around 2,000 houses and full postcodes include around 15 – 20 houses on average, although there are large variations.

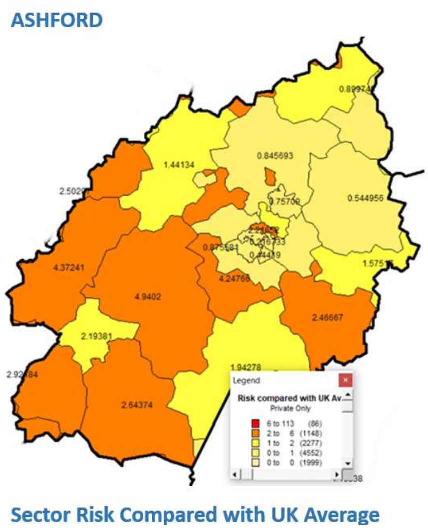
Housing distribution across the district (left, using full postcode as a proxy) helps to clarify the significance of the risk maps on the following pages. Are there simply more claims in a sector because there are more houses?

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

Ashford is rated 113th out of 413 districts in the UK from the sample analysed and is around 1.2x the risk of the UK average, or 0.3 on a normalised scale.

There is an increased risk to the south west of the borough as can be seen from the sector map, right. This corresponds with the presence of outcropping clay soils as shown on page 8.



Ashford district is rated around 1.2 times the UK average risk for domestic subsidence claims from the sample analysed. Above, risk by sector.

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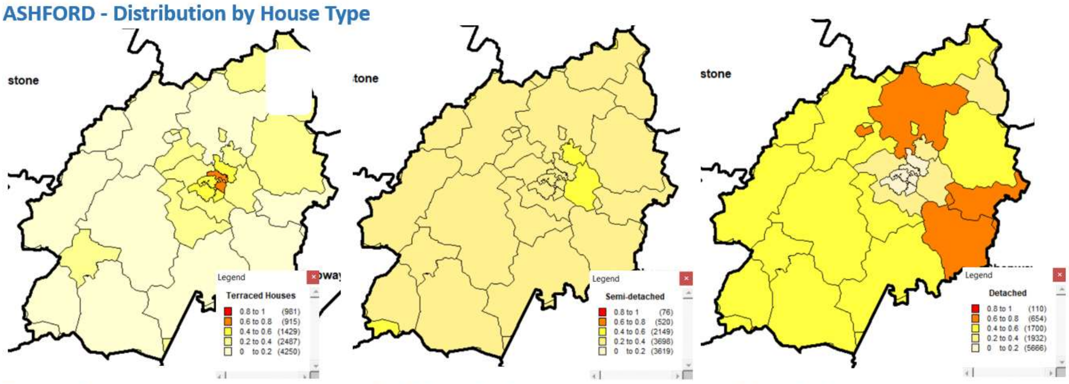
ASHFORD - Properties by Style and Ownership

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 application.

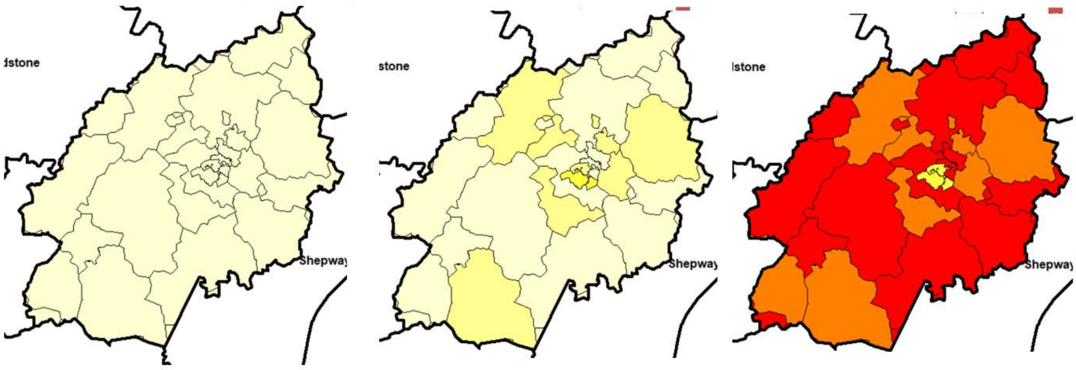
ASHFORD - Distribution by House Type



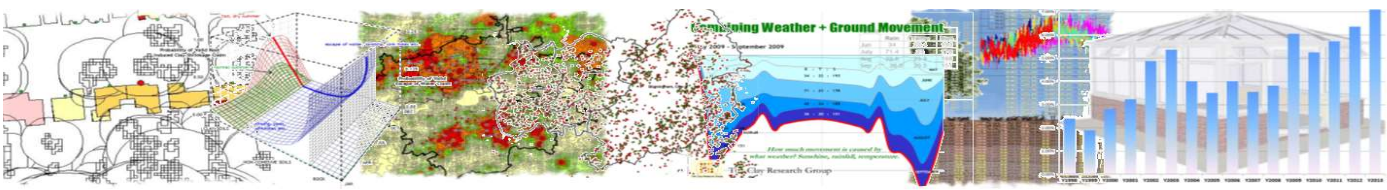
Terraced Semi-Detached Detached

Distribution by ownership is shown below. Privately owned properties are the dominant class and are spread across the borough. See page 10 for distribution of risk by ownership.

ASHFORD - Distribution by Ownership



Housing Association Council Ownership Private Ownership



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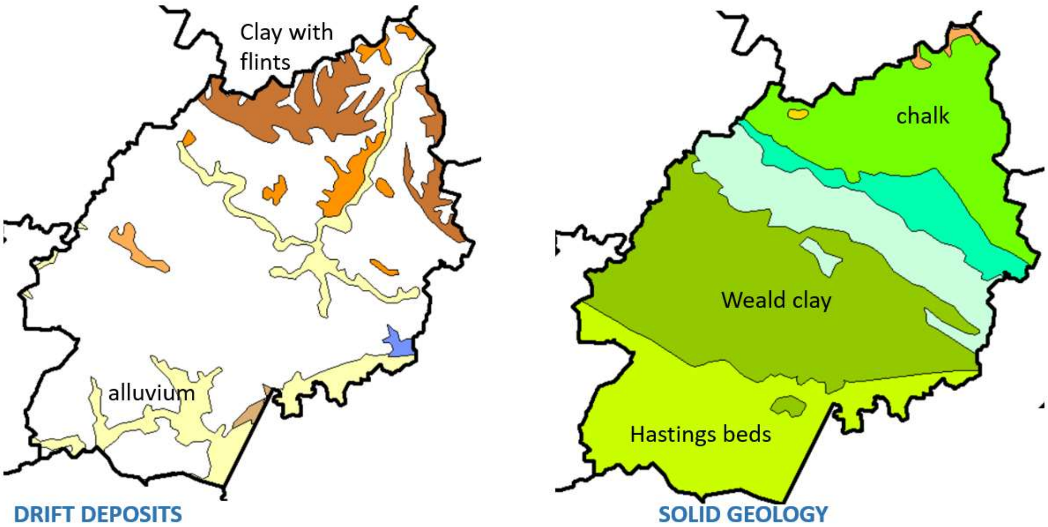
Subsidence Risk Analysis – ASHFORD

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 we hold which reveals that in the summer there is slightly less than 80% probability of a claim being valid, and of the valid claims, there is a high probability (around 90% in the sample) that the cause will be clay shrinkage.

In the winter the likelihood of a claim being valid is around 20% - and if valid, there is around an 90% probability the cause will be due to an escape of water. Maps at the foot of the following page plot the seasonal distribution.

ASHFORD : BGS Geology – 1:625,000 scale



1:625,000 series British Geological Survey maps. Working at postcode sector level and referring to the 1:50,000 series maps deliver far greater benefit when assessing risk. Clay shrinkage is the dominant cause in the summer, and escape of water in the winter months.

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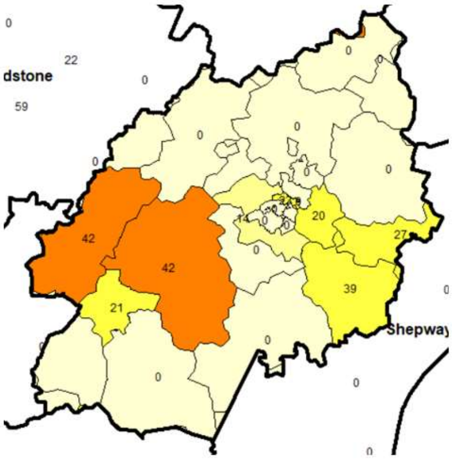
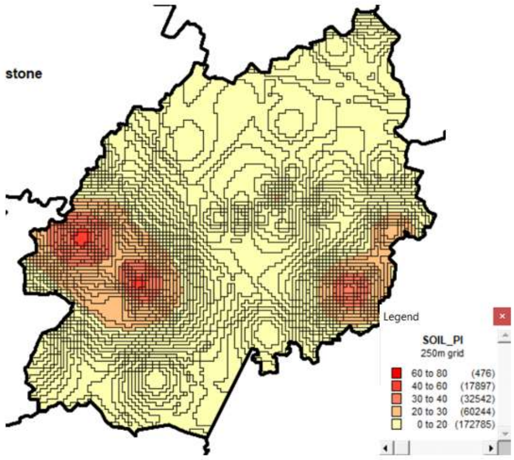
Liability by Geology and Season

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. The general pattern agrees with the BGS maps on the previous page.

ASHFORD – Soil Plasticity Index



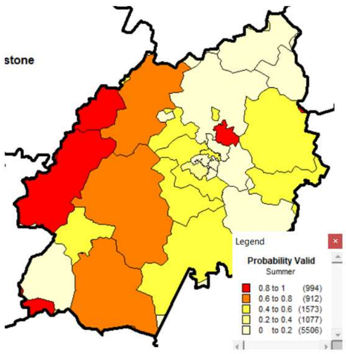
Soil PI Averaged by Sector



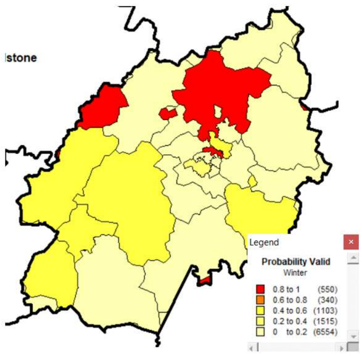
PI Interpolated on 250m CRG grid

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.

ASHFORD



Probability Valid, Summer

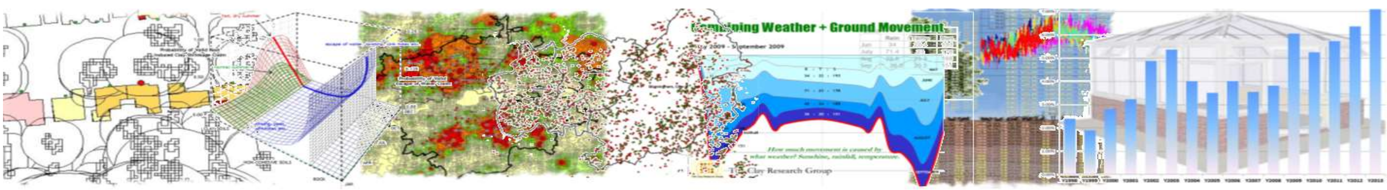


Probability Valid, Winter

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

Combining the risk maps by season combined with the table on page 10 is perhaps the most useful way of assessing the likely cause, potential liability and geology using the values listed.

The claim distribution and the risk posed by the soil types is illustrated at the foot of the following page. Escape of water related claims are associated with the superficial deposits or simply shallow foundations on poor ground and the dominant clay shrinkage claim, the outcropping clay. 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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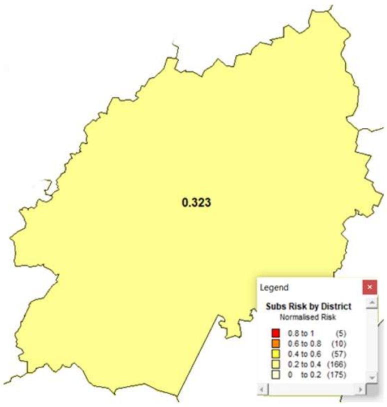
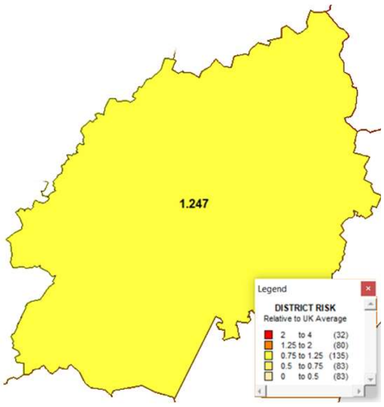
District Risk -v- UK Average. EoW and Council Tree Risk.

ASHFORD - Subsidence Risk



Normalised (0 – 1) Scale

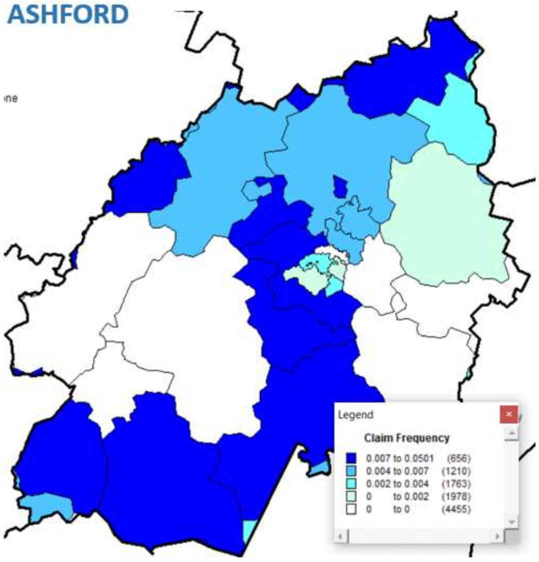


Relative to UK Average

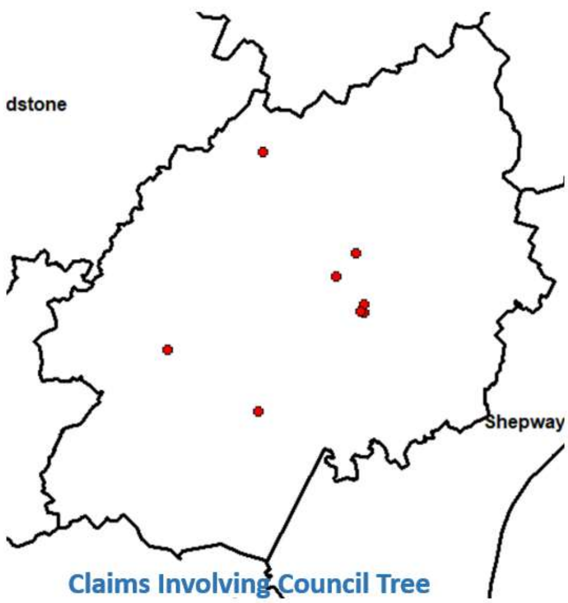
Below, left, mapping the frequency of escape of water claims reflects the presence of, non-cohesive soils – alluvium, sands and gravels etc., with chalk to the north of the district. The absence of shading can indicate a low frequency rather than the absence of claims.

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 location coincides the presence of shrinkable clay soils – see both BGS (page 7) and CRG (page 8).

ASHFORD



Higher Risk Escape of Water



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

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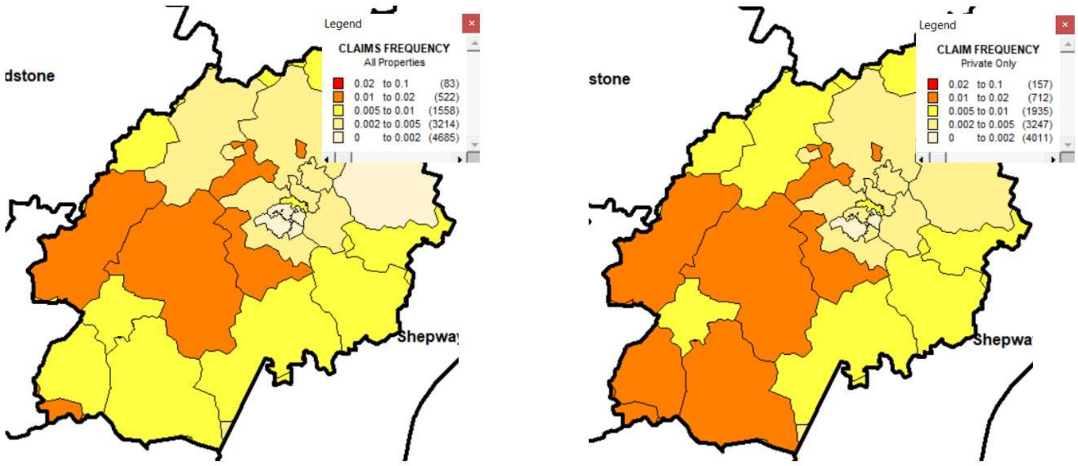
ASHFORD - Frequencies & Probabilities

Mapping claims frequency against the total housing stock by ownership (left, private council and housing association combined and right, private ownership only revealing an increased risk), the importance of understanding properties at risk by portfolio.

ASHFORD - Postcode Sector Subsidence Risk (frequency) by Ownership



Combined Public and Private Frequency | Private Only

On a general note, the 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 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 steady throughout the year.

Liability by Season - ASHFORD

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Ashford	0.713	0.070	0.217	0.02	0.15	0.83

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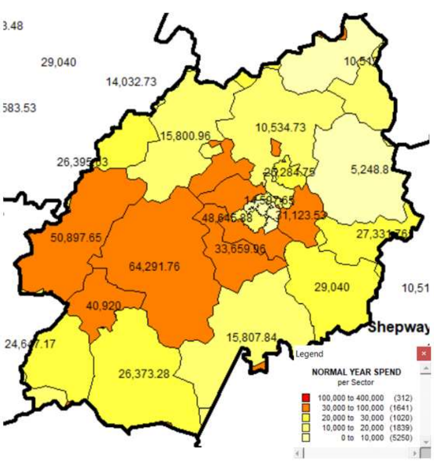
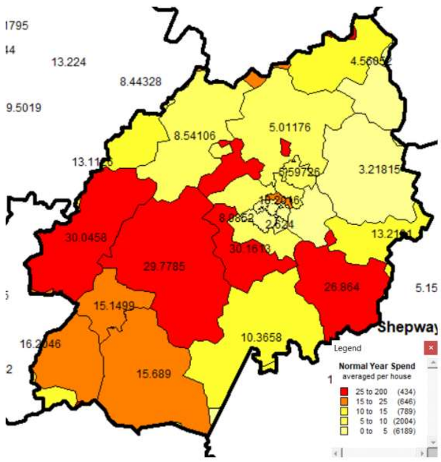
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

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.

NORMAL YEAR SPEND – ASHFORD



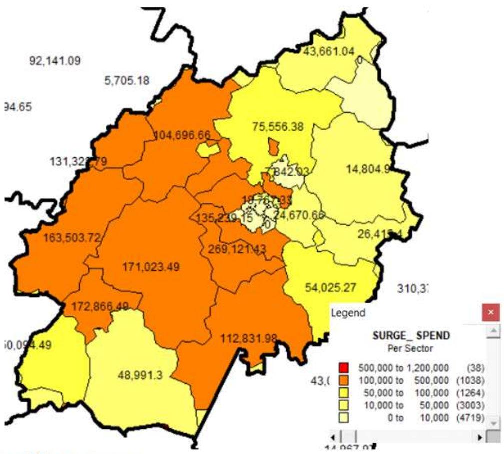
Spend by Sector



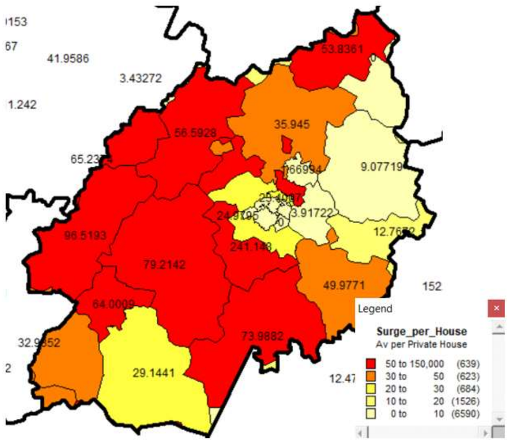
Spend Averaged over Housing Population

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.

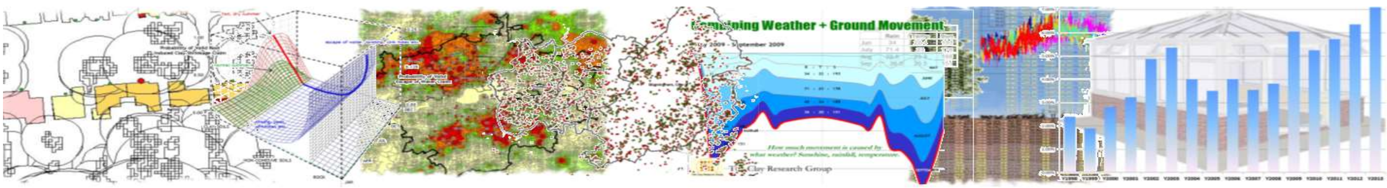
SPEND in SURGE – ASHFORD



Spend by Sector



Spend Averaged over Housing Population



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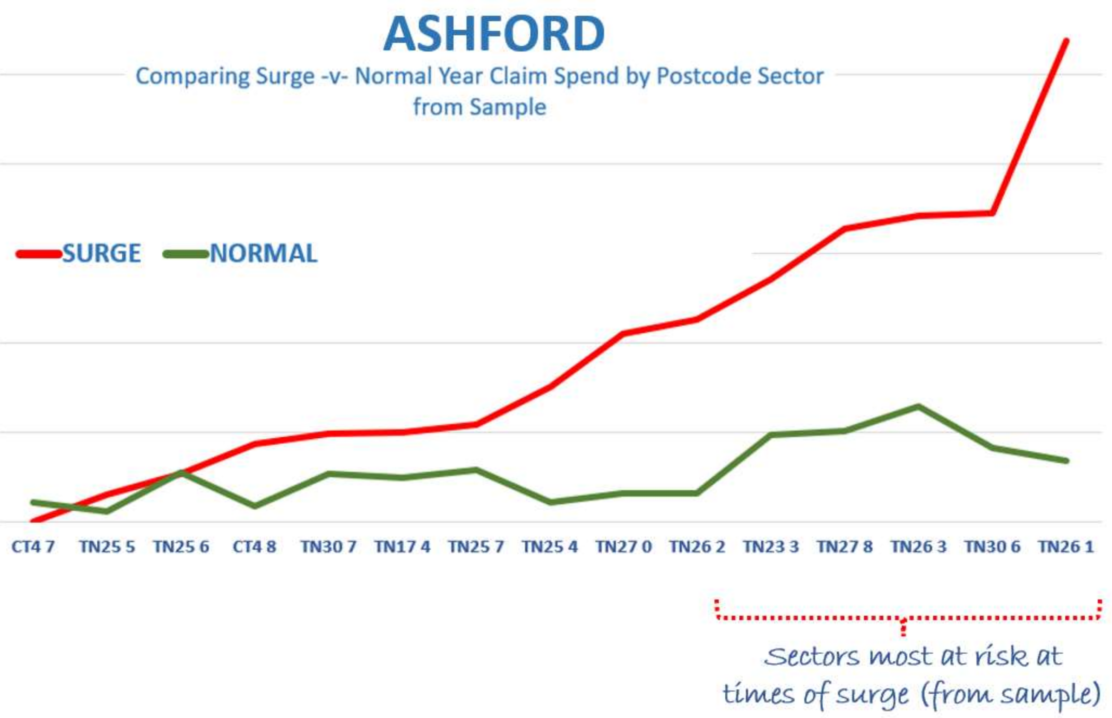

The above graph identifies the variable risk across the district at postcode sector level from the sample, distinguishing between normal and surge years. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

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 is based on losses for surge of just over £400m, and for normal years, £200m.