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

June 2023
Issue 217

The Clay Research Group

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Issue 217, June 2023

TDAG PRESENTATIONS

Presentations from the 9th and 19th May can be accessed on the TDAG web site at:

https://www.tdag.org.uk/past-events.html

Presentations from the 9th of May are perhaps more relevant from the subsidence viewpoint and strong views about how insurers and their agents deal with trees are expressed in the SHIFT presentation, **"Community Perspective"**.

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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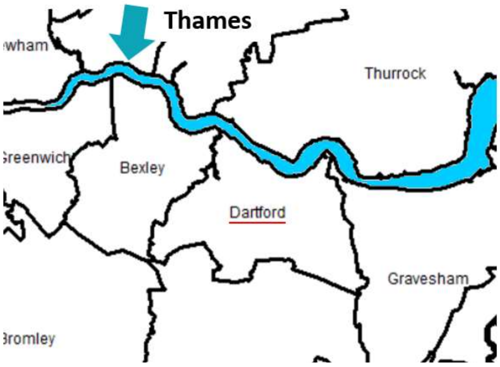
District and Sector Risk

Dartford is the topic of the 'Risk by District' series in this month's edition. Dartford is situated in Kent and has superficial deposits of Alluvium and River Terrace overlying chalk and Oldhaven, Blackheath, Woolwich, and Reading and Thanet beds.



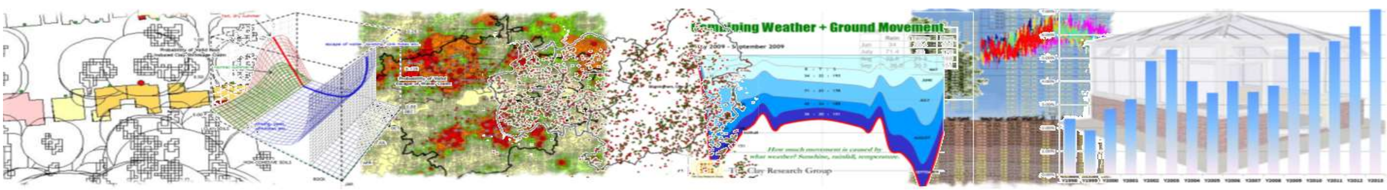
The maps are built from a data sample covering four claim years, including one surge and three 'normal' years.

Carbon Dioxide Levels

The Met Office web site records changes in carbon dioxide levels at the Mauna Loa site in Hawaii for 2023. Reports suggest that carbon dioxide will continue to build up in the atmosphere in 2023 due to ongoing emissions from fossil fuel burning, land use change and cement production.

This supports the views quoted in a recent article by Richard Rollit. Perversely perhaps, it seems that tree removal may be a significantly better option than underpinning from an environmental viewpoint due to carbon emission issues associated with cement production.

"One tonne of reinforced concrete can generate 180kg of CO2. In contrast a tree sequestrates about 22kg of CO2 a year. An underpinning scheme might use 25 m3 of concrete (which is approximately 60 tonnes = 10,800 kg of CO2), or about 2 acres of new forest for a year."



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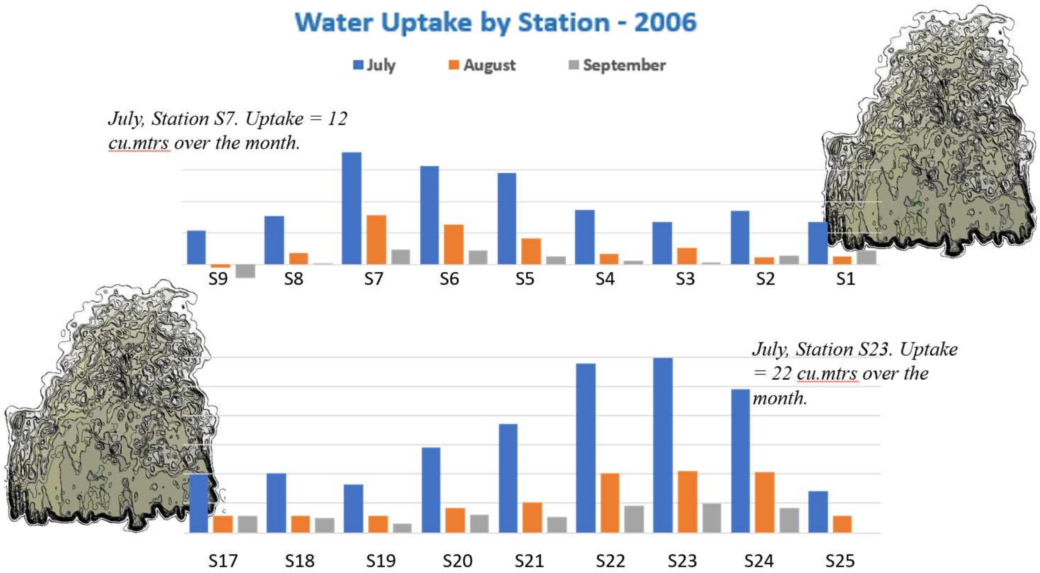
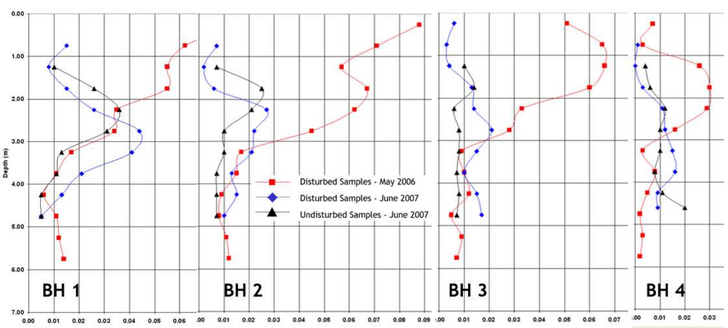
Water Uptake by Month, by Station
Aldenham Willow
Year 2006

The graphs below illustrate ground movement for the months indicated using data gathered from the precise level stations of both arrays in 2006 and by inference, moisture uptake.

Water uptake increases gradually with distance from the tree, peaking at stations 7 (array 1) and 23 (array 2) in July. Both stations are around 15mtrs from the tree – a distance approximately equal to its height at the time readings were taken.





Oedometer test results from boreholes sunk in May 2006 (red) and June 2007. BH 3 is nearest level station 7 in the top graph.

Soil tests undertaken in May 2006 (left) reveal the presence of a persistent moisture deficit carried over from the previous year.

Desiccation is evident in all boreholes to a depth of around 3mtrs bGL.

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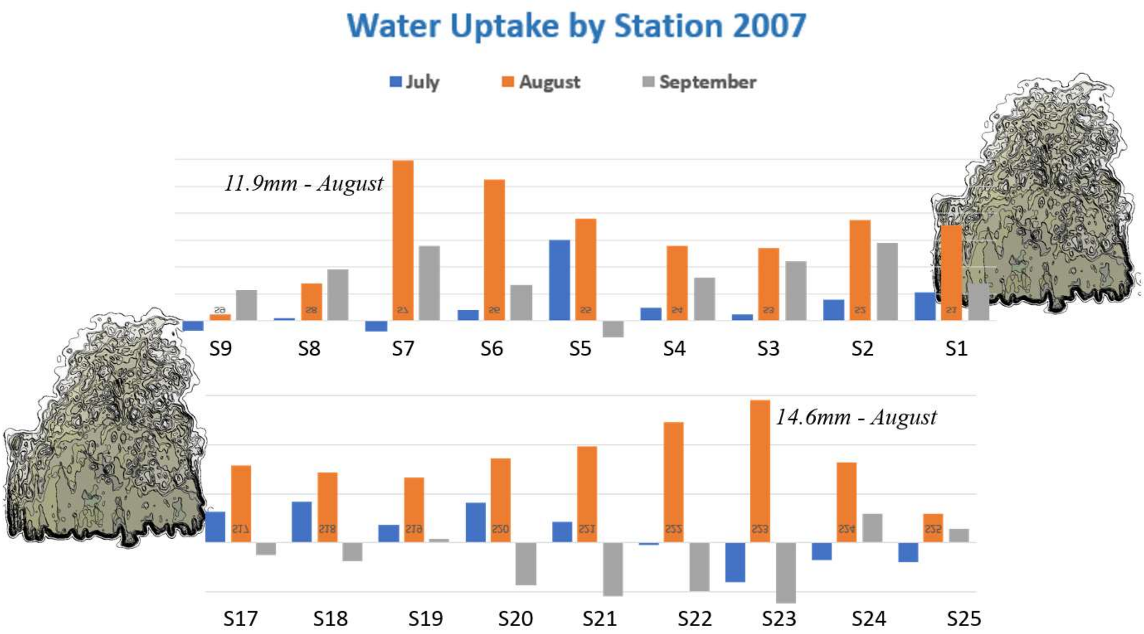
Water Uptake by Month, by Station
Aldenham Willow
Year 2007

In 2007, a milder year with fewer claims, both arrays peake in August, interestingly at the same locations - stations S7 and S23.

The Met Office data shows an early dry spell in 2006 compared with 2007, explaining the difference between the years.



Soil test results on the previous page show the recovery that took place between May 2006 and June 2007. Although the dates of the levels and soil tests do not correspond, they help to provide some idea of root activity by month and by season.

At BH3, nearest levelling station 7, oedometer results show an almost complete recovery with desiccation reducing from a peak measured strain of 0.07 to 0.01. The estimated heave in May 2006 was around 80mm and in June of the following year, 25mm, a recovery of 55mm.

A very approximate estimate of water uptake by the willow suggests an amazing 700 gallons a day in July, reducing to 250 in August and around 100 in September. This estimate uses an average ground movement value from the levelling stations, multiplied by the root area (assuming a 25m radius) and a water shrinkage factor of 4.

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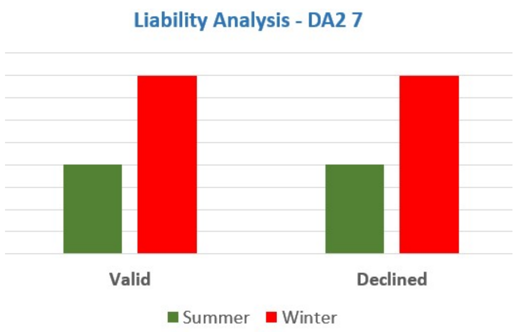
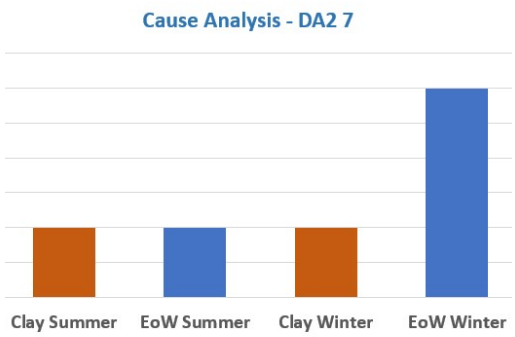
DARTFORD Area Sector Level Sample.
Using Past Claims Data to Infer Geology and Derive Probability of Cause and Liability





DA2 7 – The table below lists the probability of both causation and liability by season, which reflects the underlying geology, at postcode sector level. There is an even probability that valid subsidence claim will be due to either clay shrinkage or escape of water in the summer and a 50% chance of a declinature.

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
DA2 7	0.25	0.25	0.5	0.13	0.38	0.5

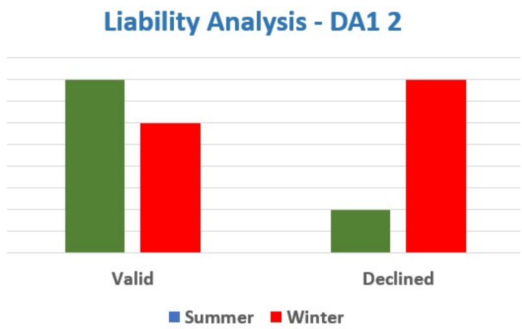
In the winter a valid claim is most likely due to an escape of water and again, with a 50% probability of a declinature, reflecting the primarily non-cohesive nature of the solid and drift geology.

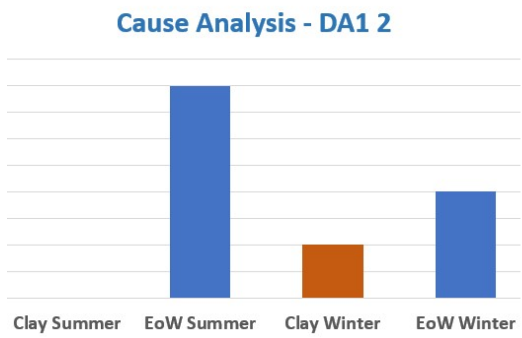
DA1 2 – As above, and again reflecting the geology, escape of water is the dominant cause when handling valid subsidence claims in both the summer and winter.

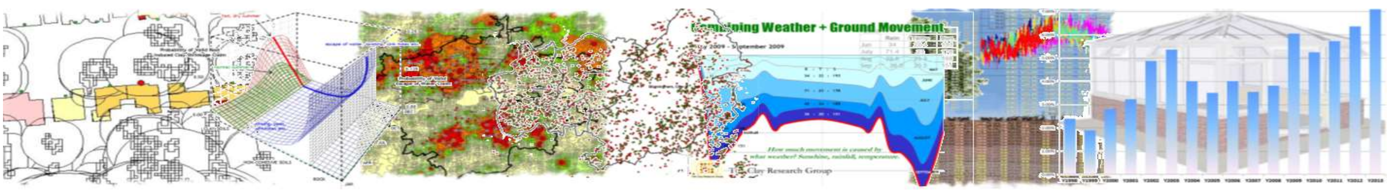
District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
DA1 2	0.00	0.80	0.2	0.14	0.28	0.57

There is a 20% chance that a claim with be declined in the summer and nearly 60% chance of a declinature in the winter. These rates will vary with rainfall volume.

The sector contains around 5,000 houses with a population of around 12,000. Sector DA2 7 has around 4,500 houses and a population of around 11,000.







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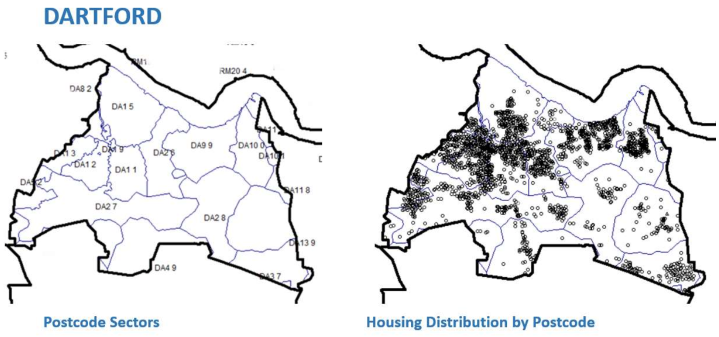
Subsidence Risk Analysis – DARTFORD

Dartford is situated in Kent and occupies an area of 70km^2 with around 38,400 households and a population of around 118,000.



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.

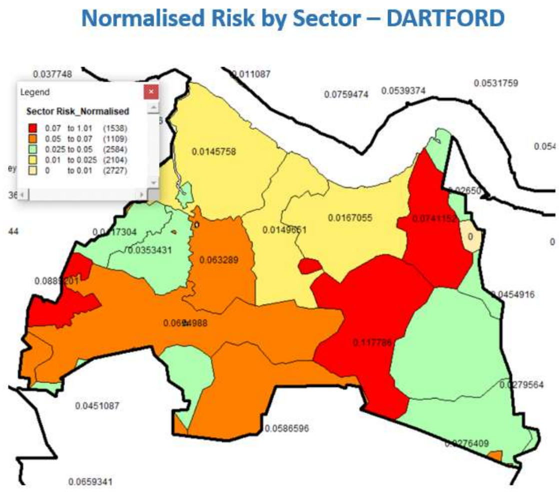
Sector and housing distribution across the district (left, using full postcode as a proxy) helps to clarify the significance of the risk maps on the following pages. Are there simply more claims in a sector because there are more houses?

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.

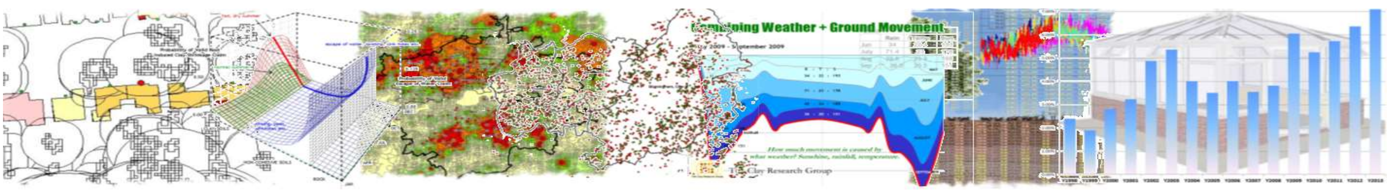
From the sample we hold, sectors are rated for the risk of domestic subsidence compared with the UK average – see map, right.

Dartford is rated 204th out of 413 districts in the UK from the sample analysed and is around 0.875x the risk of the UK average, or 0.227 on a normalised 0 - 1 scale.

There is an increased risk to the south of the borough as can be seen from the sector map, right, which corresponds with outcropping London clay.



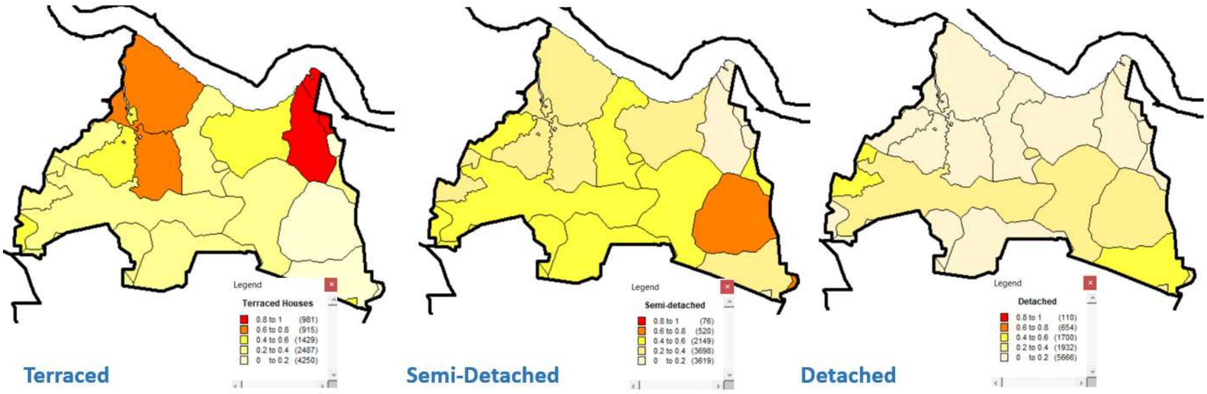
Dartford district is rated around 0.875 times the UK average risk for domestic subsidence claims from the sample analysed. Above, normalised risk by sector.



DARTFORD - Properties by Style and Ownership

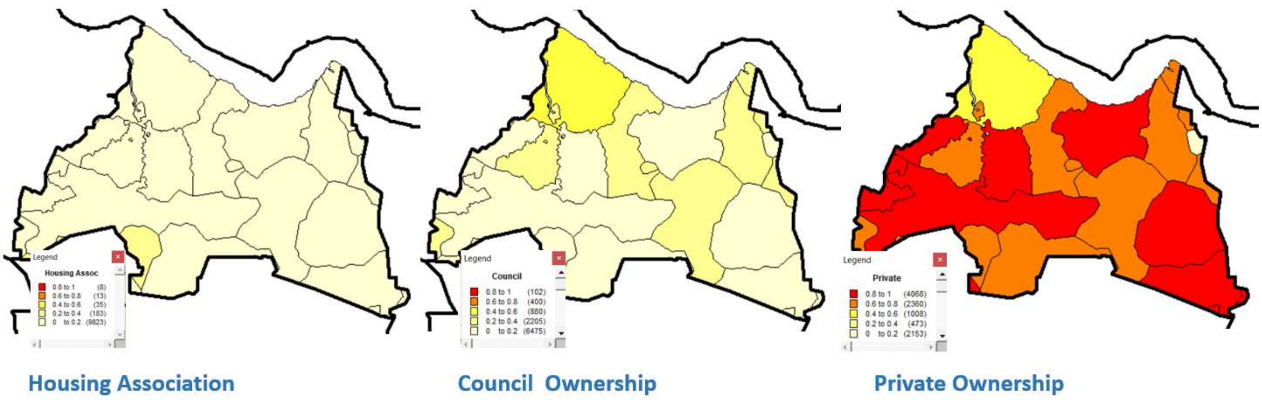
Below, the general distribution of properties by style of construction, distinguishing between terraced, semi-detached and detached. Unfortunately, the more useful data is missing at sector level – property age. Risk increases with age of property and the model can be further refined if this information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

DARTFORD - Distribution by House Type



Distribution by ownership is shown below. Terraced properties are the dominant class with private ownership increasing to the south of the borough. See page 10 for distribution of risk by ownership.

DARTFORD - Distribution by Ownership



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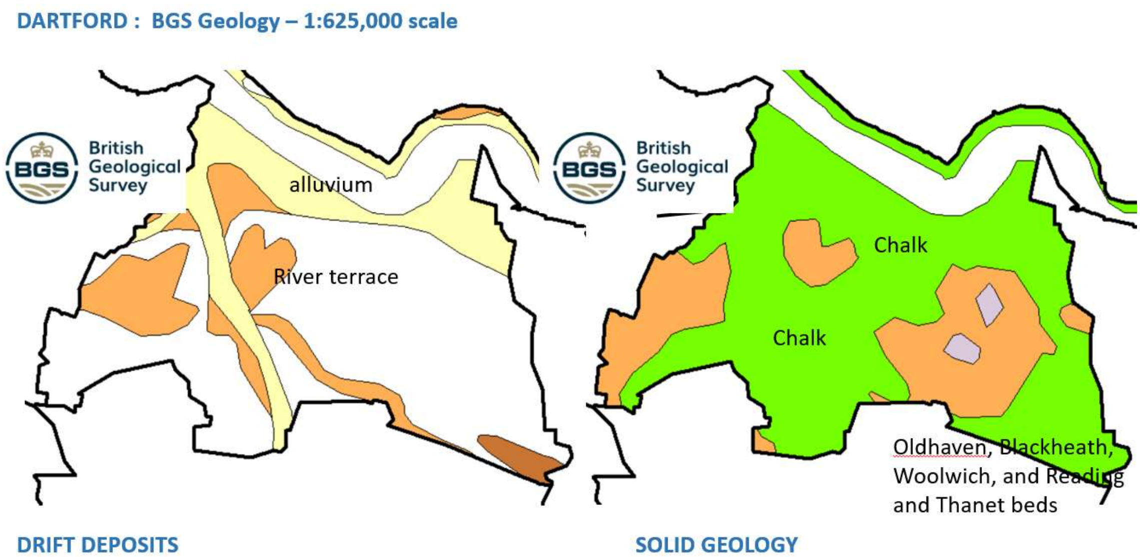
Subsidence Risk Analysis – DARTFORD

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 a greater than 50% probability of a claim being valid in the summer and of the valid claims, there is around a 60% chance the damage will have been caused by an escape of water – leaking drains etc., with clay shrinkage accounting for the balance. In the winter the likelihood of a claim being valid is higher at around 70% - and if valid, there is a higher than 60% probability the cause will be due to an escape of water. This reflects the geology – alluvium and outcropping chalk.

Maps at the foot of the following page plot the seasonal distribution.



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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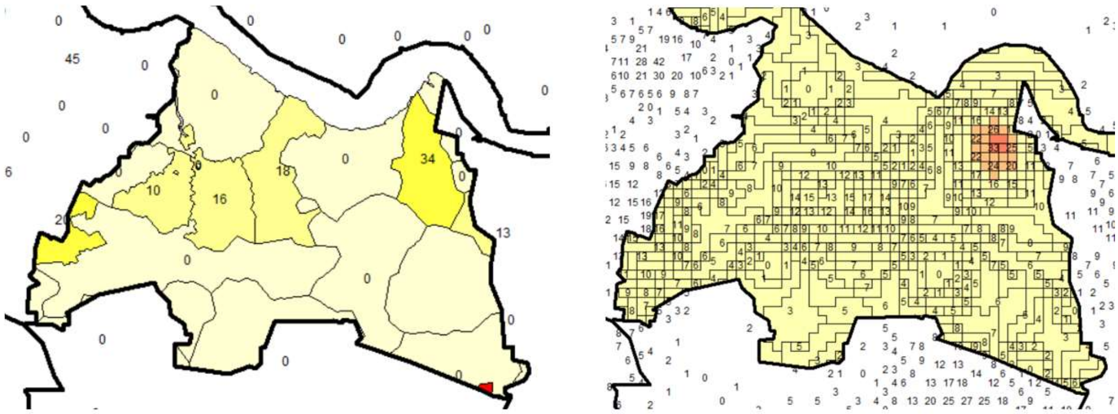
Liability by Geology and Season

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.

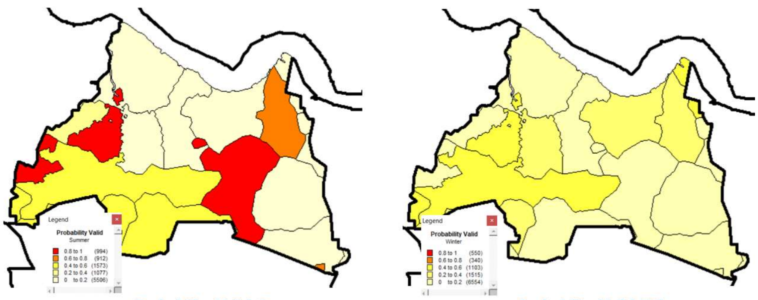
DARTFORD – Soil Plasticity Index



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.

DARTFORD – 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 10 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.

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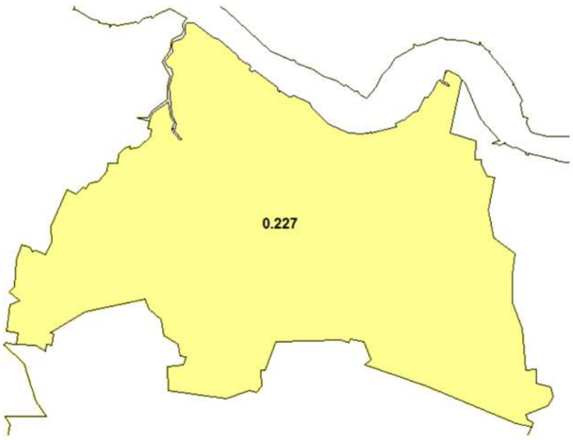
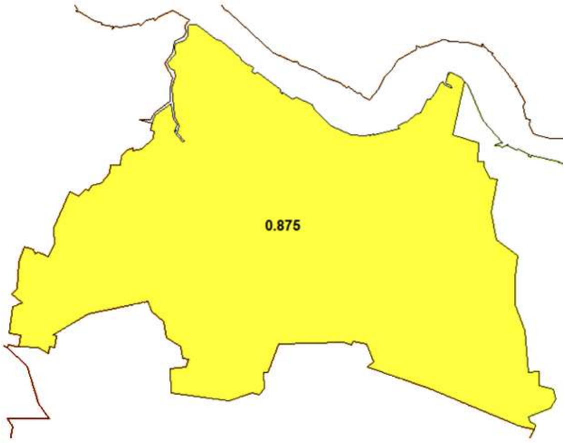
District Risk -v- UK Average. EoW and Council Tree Risk.

DARTFORD - Subsidence Risk Relative to UK



Normalised (0 – 1) Scale

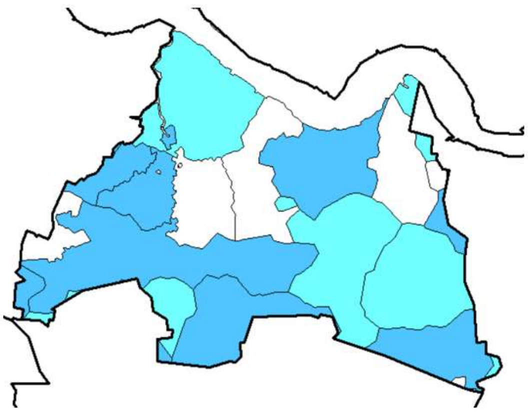


Relative to UK Average

Below, left, mapping the frequency of escape of water claims confirms the presence of non-cohesive soils bordering the Thames - deposits of River Terrace and alluvium overlying chalk beds etc. As we would expect, the 50,000 scale BGS map provides a more detailed picture. The CRG 1:250 grid reflects soil results gained from the investigation 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. A single claim reflects the presence of predominantly non-shrinkable soils. The tree location matches the position of the shrinkable soils to the NE of the CRG map on page 8.

DARTFORD



Higher Risk Escape of Water

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

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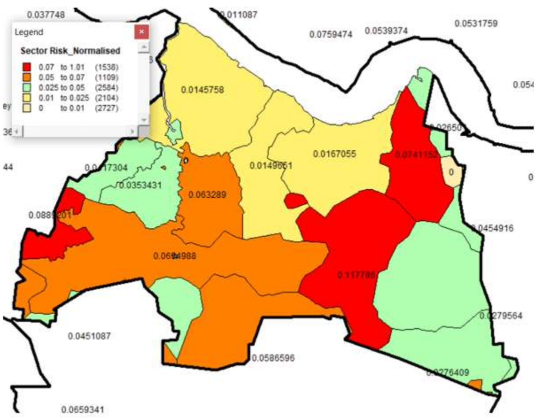
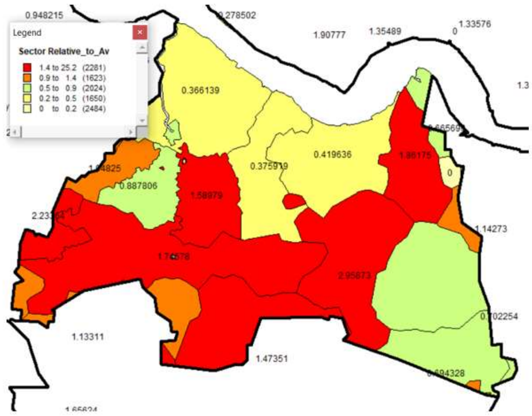
DARTFORD - Frequencies & Probabilities

Below, mapping the total housing stock by ownership. Claims frequency including council and housing association properties delivers a misleading value of risk as they tend to self-insure.

Risk by Sector – DARTFORD



Normalised Subsidence Risk – scale 0 – 1



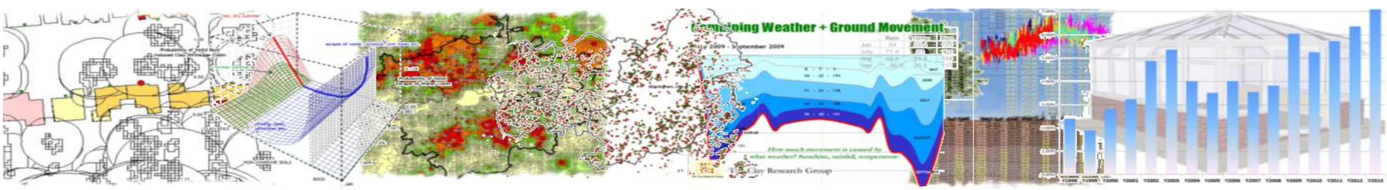
Subsidence Risk Compared to UK Average

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 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 - DARTFORD

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Dartford	0.198	0.362	0.44	0.26	0.47	0.267



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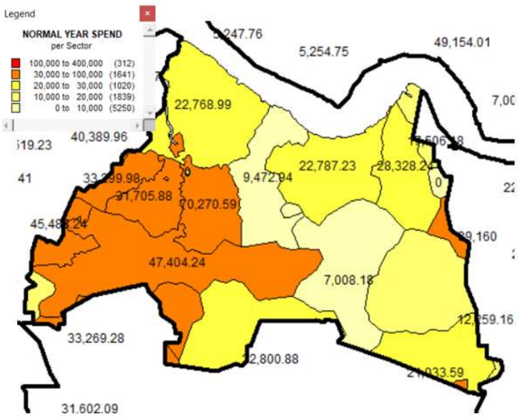
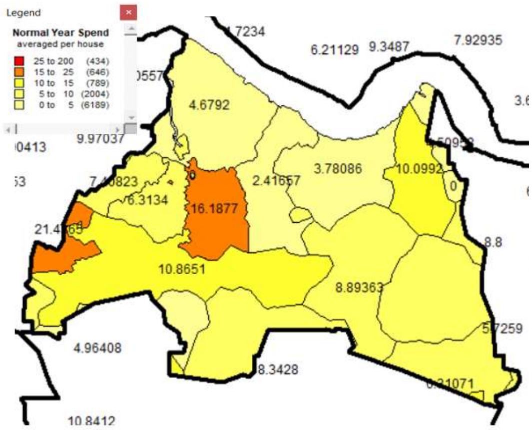
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

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 – DARTFORD

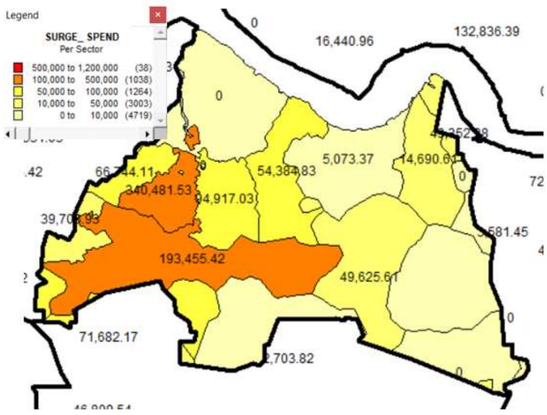


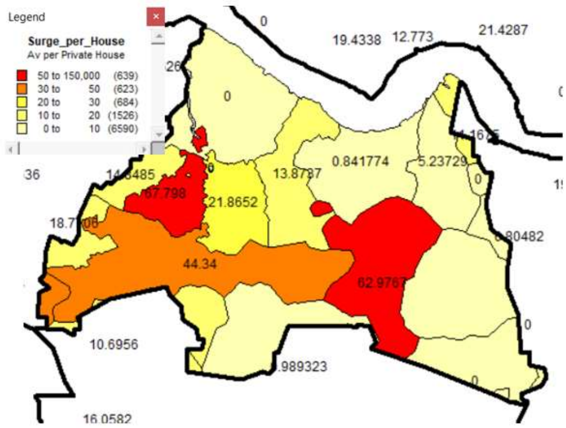


Spend by Sector | **Spend Averaged over Housing Population**

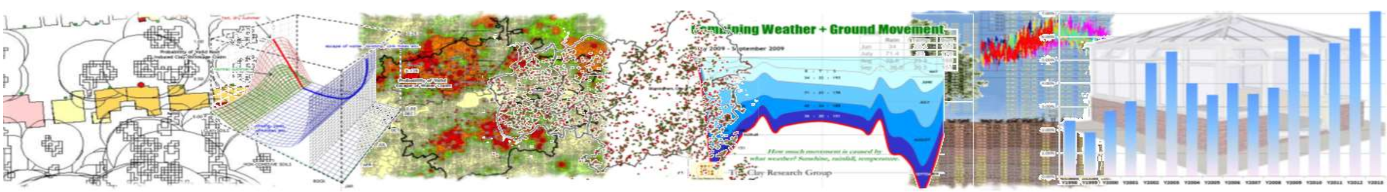
It will also be a function of the distribution of vegetation and age and style of construction of the housing stock. The images to the left in both examples (above and below) represent gross sector spend and those to the right, sector spend averaged across housing population to derive a notional premium per house for the subsidence peril. The figures can be distorted by a small number of high value claims.

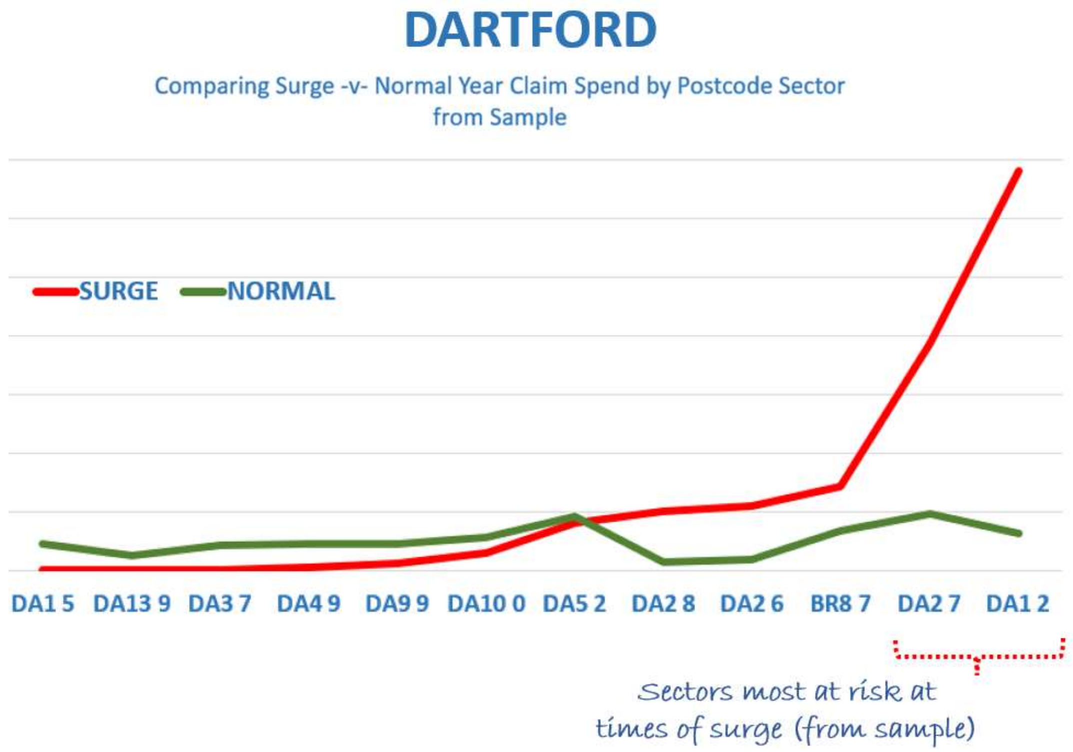
SPEND in SURGE – DARTFORD





Spend by Sector | **Spend Averaged over Private Housing Population**





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.