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 2020
Edition 181

The Clay Research Group

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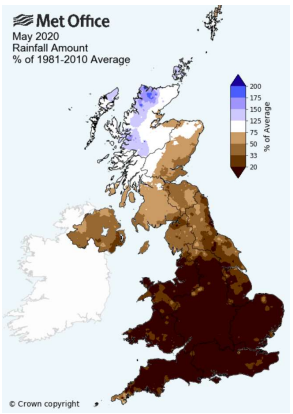
May - Driest and Sunniest

According to the Met Office, May has been both the sunniest and driest on record for England. "Spring 2020 recorded 696 hours of sunshine, exceeding the previous record of 594.3 hours."



Dr. Mark McCarthy of the Met Office said: "Exceeding the UK sunshine record is one thing, but exceeding by over 70 hours is truly exceptional." For more details, visit: https://www.metoffice.gov.uk/

Whether this persists and delivers high claim numbers in the summer is a concern given the Covid situation. Claim numbers have been increasing over the last two years, bucking the downward trend that started in 2012.

CV19 and Working Practice

The Coronovirus pandemic has changed the way subsidence claims are handled by many companies. With self-isolation and lockdown, more engineers and adjusters are carrying out remote assessments, talking to homeowners on the phone and, where possible, using video links to carry out surveys and assess damage. Some practices also have a range of applications to model ground movement and building vulnerabilities as well as viewing historical claims data to better understand the risk in the claim location.

TDAG took advantage of using a video link when their June conference had to be cancelled. Kieron Doick and Ian Lanchbury gave online presentations and slides can be downloaded from the web. The next conference, scheduled for July/August will be viewable via Zoom. Details will be available on the Eventbrite web site. Email Emma for further information:

E.Ferranti@bham.ac.uk

Aldenham Headmaster's House

This edition includes a review of data gathered over a 10yr term in connection with subsidence to the headmaster's house that occurred in 2009.

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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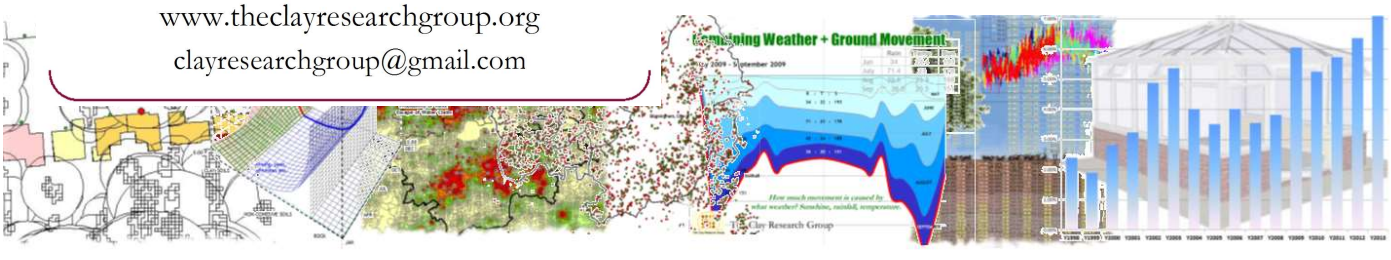

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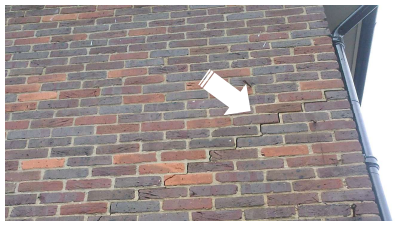
Aldenham Headmaster's House

In 2009 the Headmaster's house at Aldenham School research site developed cracks, the pattern of which indicated subsidence of the rear wall. See picture right showing the diagonal crack in the left (when viewed from rear garden) flank wall.

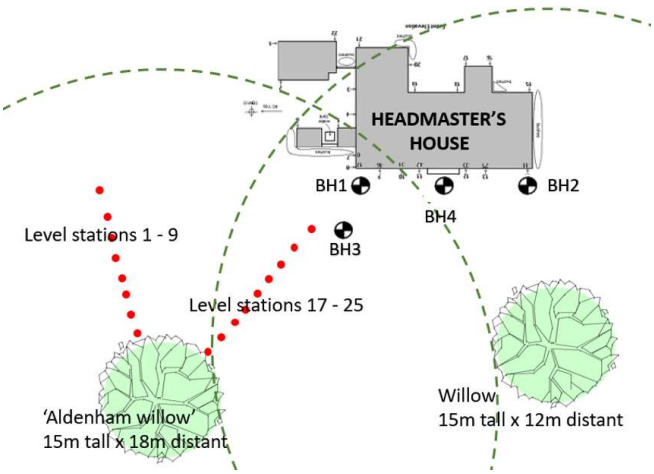


In October GeoServ set up levelling stations and MatLab Limited carried out investigations and a range of soil tests including penetrometer, suctions, moistures and oedometers etc.

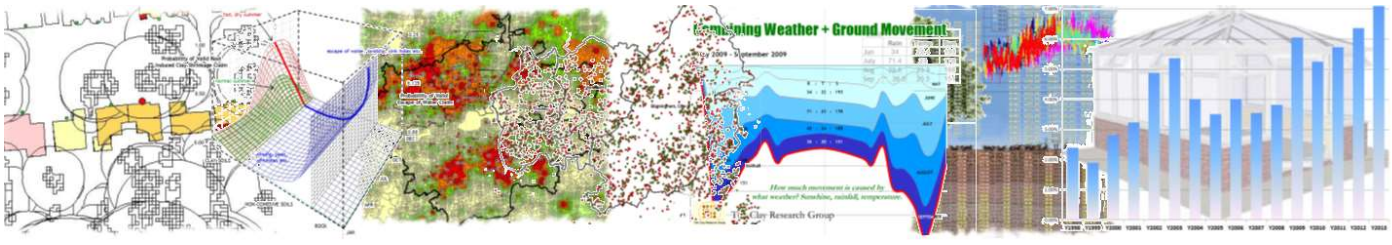
Left is a photograph of the rear elevation showing the location of relevant level stations and below, a site layout plan showing the location of level stations and boreholes. Several trees and shrubs have roots that would likely extend beneath the house foundations.

The geology is predominantly London clay with a Plasticity Index in the range of 40 – 50%.

Right, a plan of the property showing the location of boreholes and possible root zones of nearby trees. The Aldenham willow is 18m from the property and reviewing levelling results, its roots almost certainly encroach beneath the house foundations, as will those of the willow to the right of the plan which is 12mtrs away.



The objective of the investigations and monitoring was to determine causation - water leaking from nearby drains or root induced clay shrinkage – and record the outcome following reduction and/or removal of the nearby shrubs.



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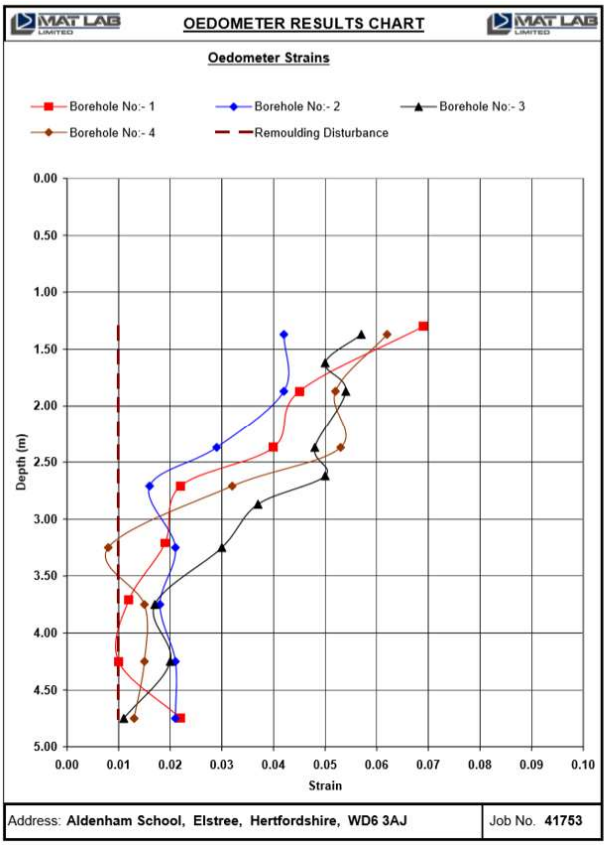
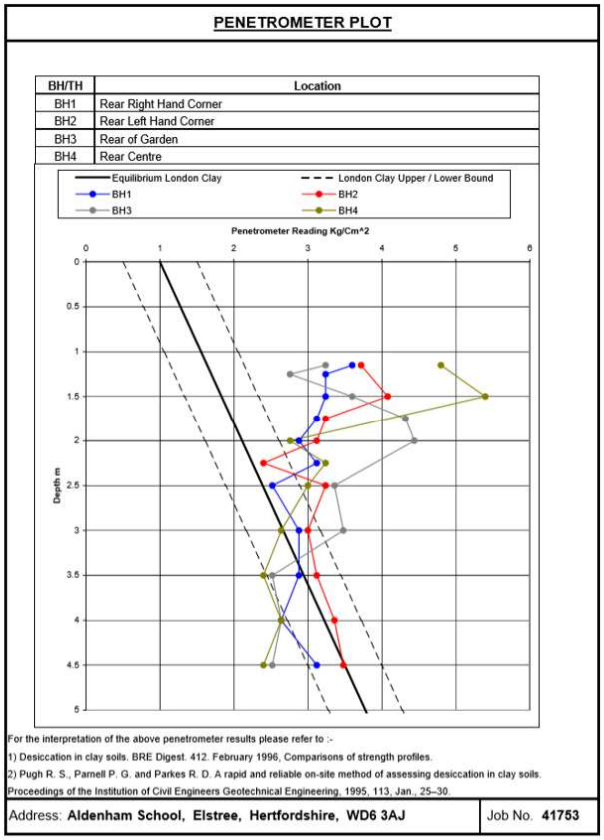
Soil Tests – Penetrometer -v- Oedometer.

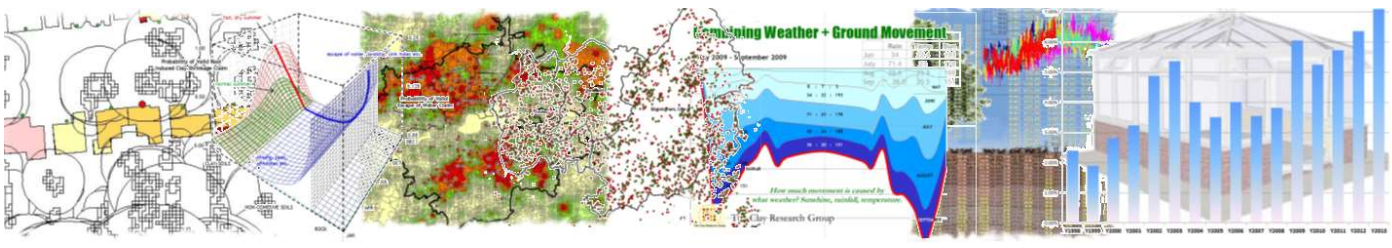
Site investigations revealed a desiccated clay and results using the penetrometer were similar to oedometer strains - see below. The profiles from all bores and tests (including suction profiles – see following page) delivered similar profiles. The clay soils were desiccated to depths of around 3mtrs.





Estimates of heave based on the oedometer tests are as follows: BH1 = 46mm, BH2 =34mm, BH3 = 53mm and BH4 = 47mm.

Further tests, including measuring soil suctions using the filter paper test, moistures etc., are shown on the following page.



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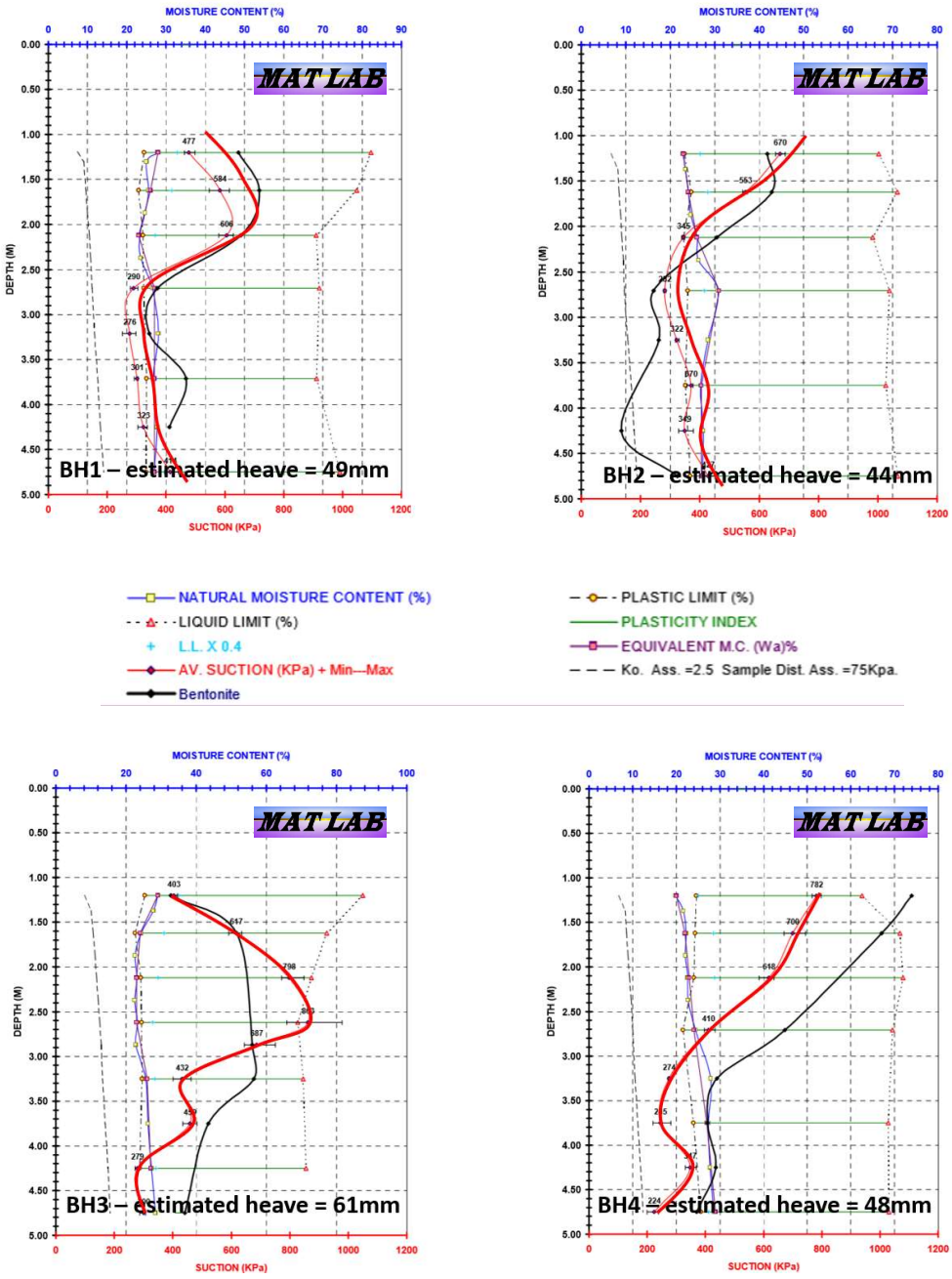
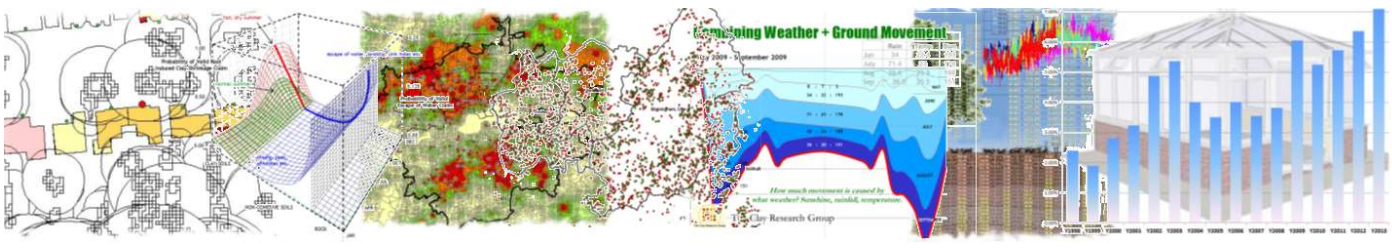
Soil Suctions

Below, suction profiles, moistures and PI values for the four boreholes shown on page 2. Those against the rear house wall indicated a potential swell in the range 44 – 49mm.



The bore sunk in the rear garden (BH3) had an estimated swell potential of 61mm, which is likely to include a significant contribution from the peripheral roots of the willow.



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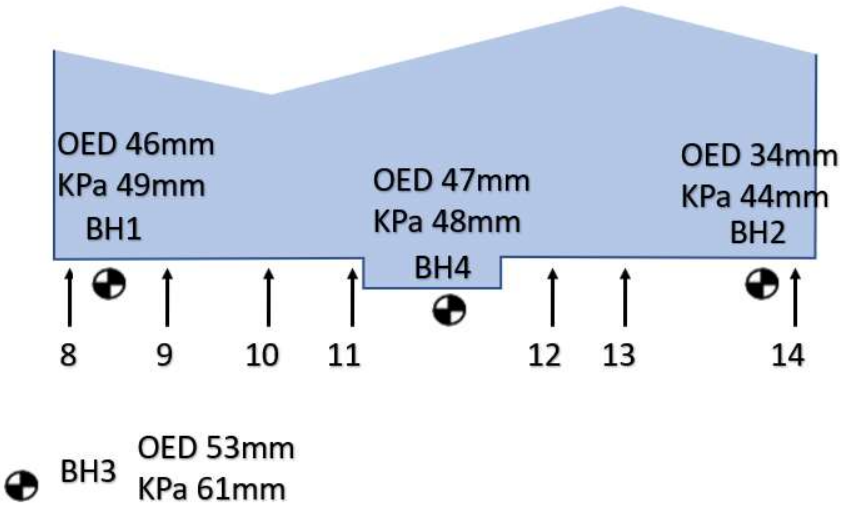
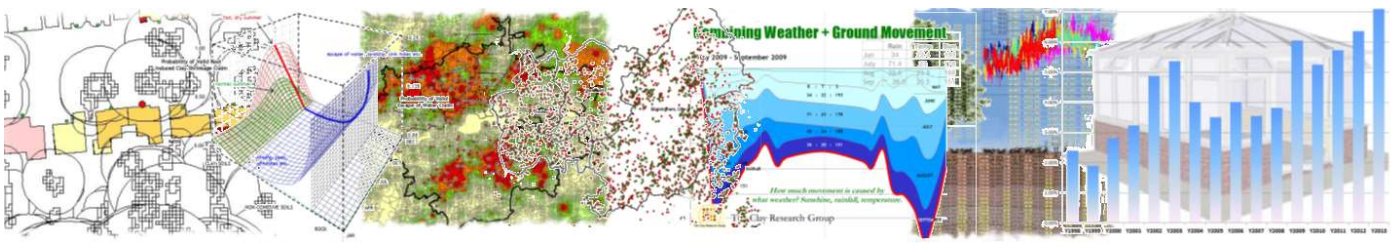
Do Estimates of Swell Match Measured Recovery?

Below, the rear elevation of the Headmaster's house showing upward movement at all levelling stations over a 10yr term, together with borehole locations. Recovery commenced almost immediately following trimming or removal of the shrubs growing against the wall (no action was taken with the willow trees) and has continued gradually over the monitoring term – see following page.



BH3 OED 53mm KPa 61mm

Above, estimates of swell derived from filter paper suction tests (KPa) and strains (OED) using the oedometer for each borehole. As can be seen, the two tests yielded similar results and matched the penetrometer profiles.



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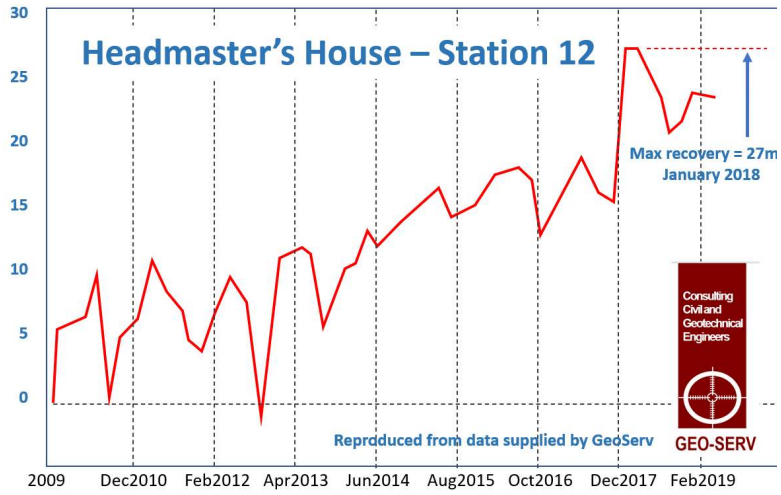
In Summary

In summary, the gradual upward movement of the rear wall following trimming or removal of shrubs growing against it appears to have had the desired effect with gradual recovery recorded over the monitoring term.

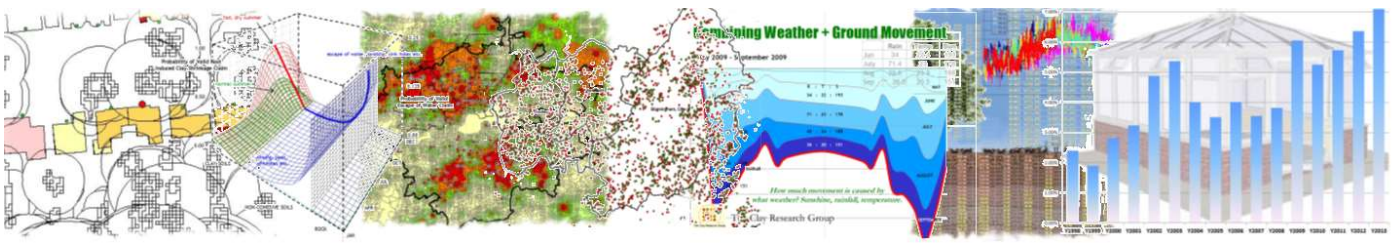
It does appear that the shrubs were the main cause of damage as peripheral root activity from monitoring of the Aldenham willow shows a persistent deficit and continued downward movement at the root periphery reaching 108mm in September 2019. Of course, this study has not ruled out some contribution from the willow but the suggestion is, action with the shrubs has delivered a satisfactory resolution.

There was no evidence that the minor leakage from nearby drains was an influencing factor. First, the ground was dry when trial holes were excavated and second, the evidence of desiccation down to 3mtrs or so suggests otherwise – as does the recovery profile. See monitoring graph for station 12 below.



Estimates of swell from soil testing suggests a potential recovery of over 40 – 50mm. Actual recovery over a 10 year term has been 27mm maximum at station 12 (above).

The potential influence of peripheral roots from the willow confound a conclusive answer as to whether the estimate of swell is 'accurate' and particularly as we know there is a persistent moisture deficit at the root periphery of the willow and 108mm subsidence was recorded at station 25 in September 2019. Perhaps the potential for a further 20mm or so of recovery remains due to the moisture uptake of the trees but for the time being, action with the shrubs has resolved the problem.



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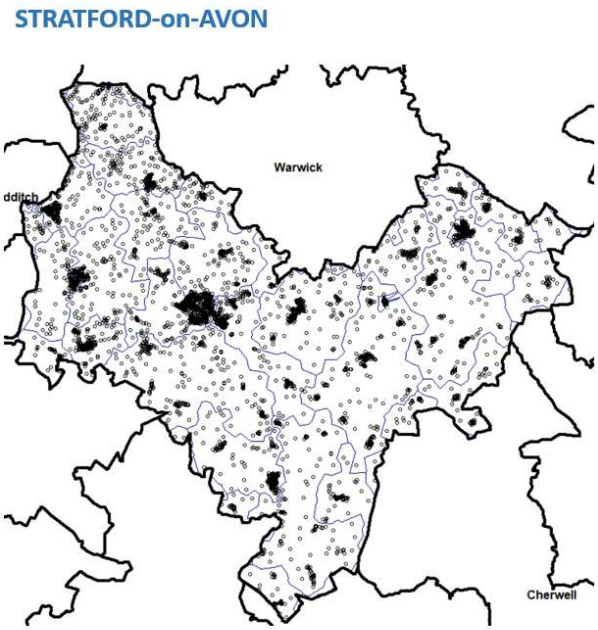
Subsidence Risk Analysis – STRATFORD-on-AVON

Stratford occupies an area of nearly 980km^2 with a population of around 28,000.



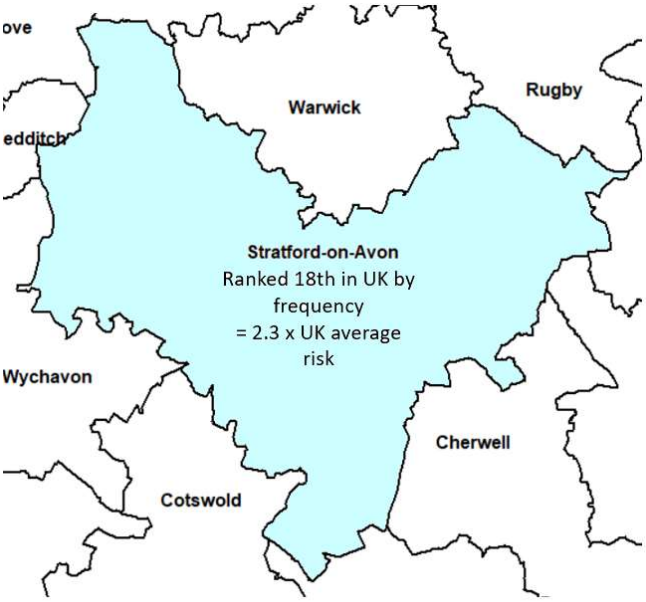
Distribution of housing stock using full postcode as a proxy. Each postcode in the UK covers on average 15 – 20 houses, although there are large variations.

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

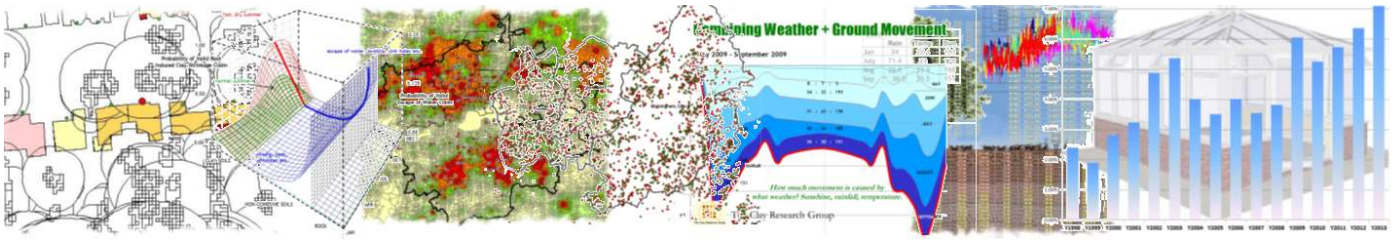
The highest risk rating is a value of 4 and Stratford is rated as being 2.3 times the UK average risk, ranked in 18th place.

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.



Layout of the district used for risk analysis above. Stratford has an estimated population of around 28,000 and an area of 980km^2.



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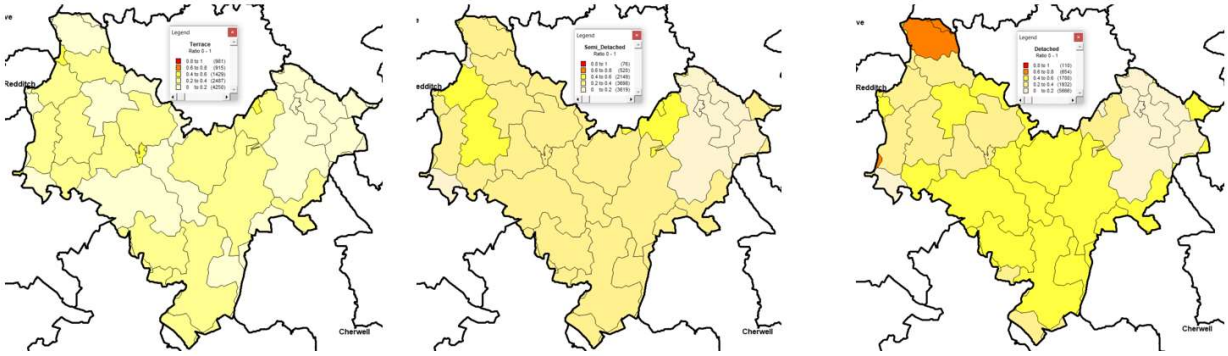
STRATFORD-on-AVON - Properties by Style and Ownership

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 from a visual assessment using Google Street View, we rate Stratford district at around 0.45 on a scale of 0 – 1. This assessment could be refined using insurer's portfolio data.

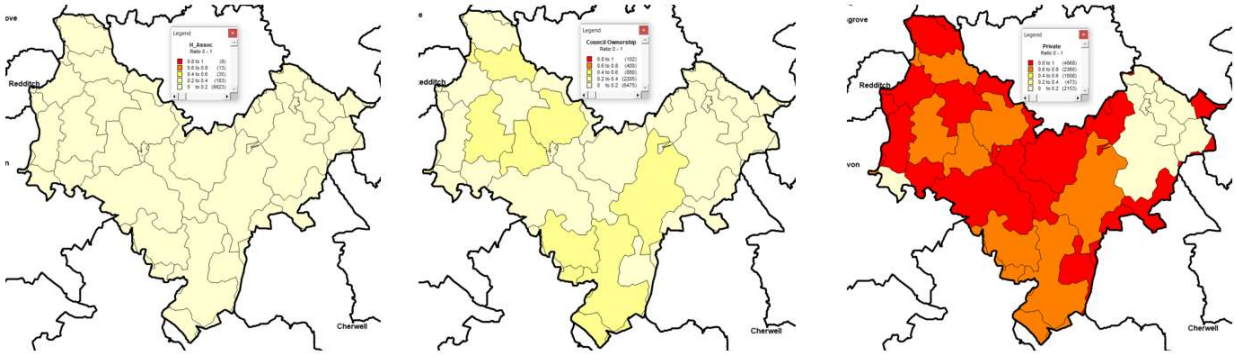
STRATFORD - Distribution by House Type



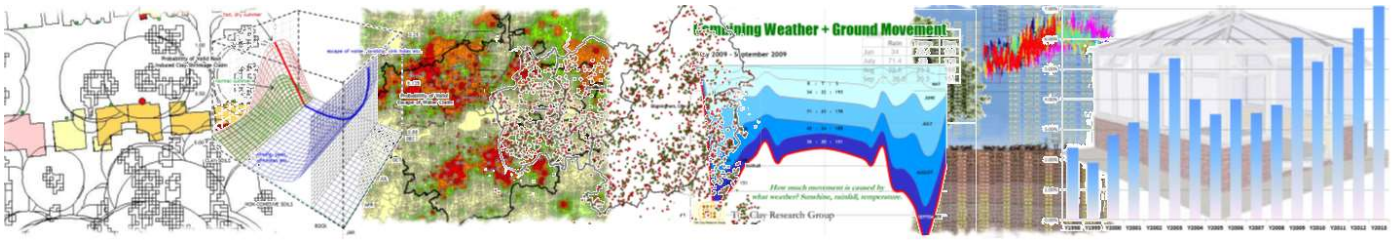
Terraced | Semi-Detached | Detached

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

STRATFORD - Distribution by Ownership



Housing Association | Council Ownership | Private Ownership



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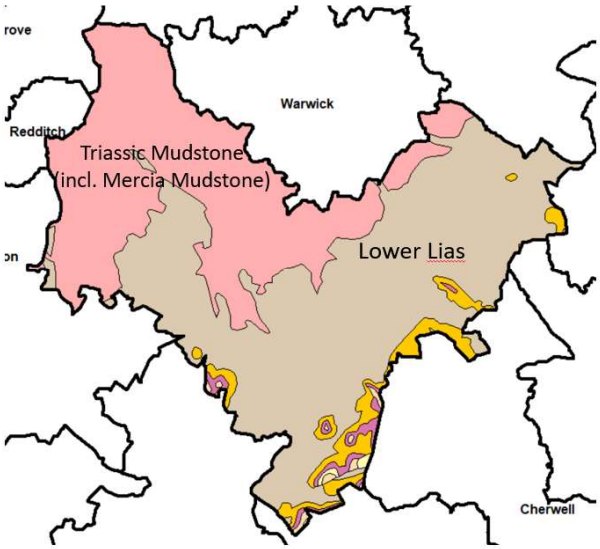
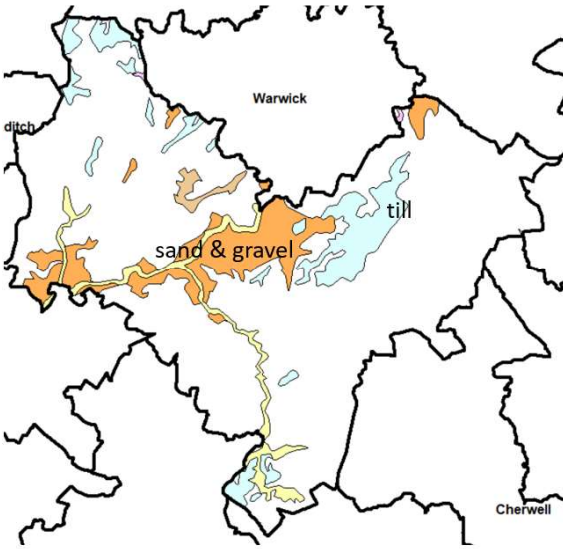
Subsidence Risk Analysis – STRATFORD

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

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



SOLID

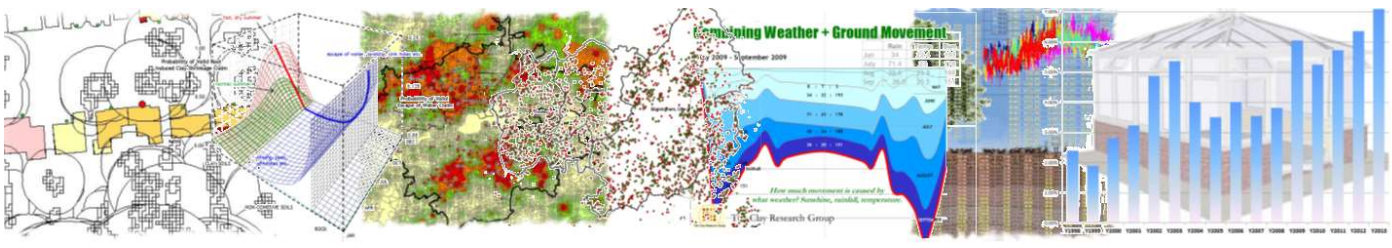


DRIFT

See page 10 for a seasonal analysis, which reveals that, in the summer there is a greater than 80% probability of a claim being valid, and of the valid claims, there is a greater than 70% probability that the cause will be due to clay shrinkage.

In the winter the situation reverses. The likelihood of a claim being declined exceeds 80%, and the most likely cause is an escape of water – a leaking drain most likely or water service.

The analysis reflects the clay content of the underlying soils.



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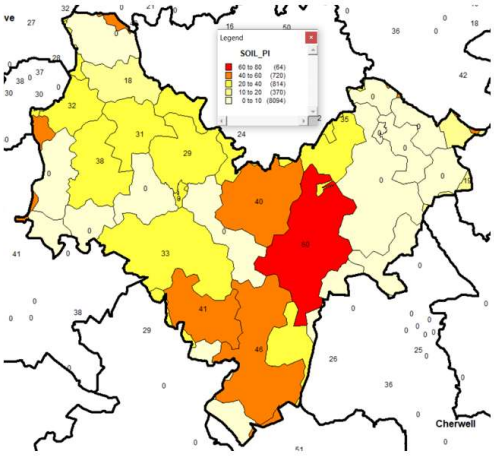
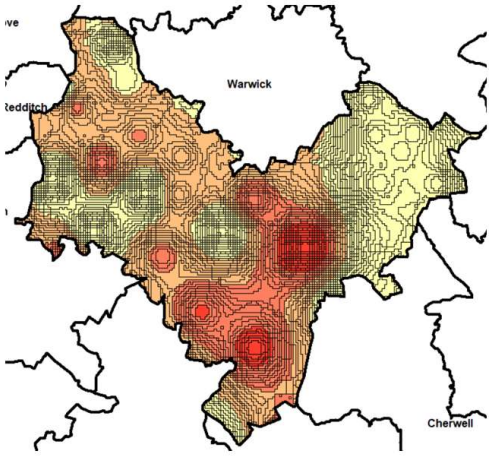
Liability by Season and Geology

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 models reflects the solid geology indicated by the BGS maps, with Mercia Mudstone to the north (average PI of around 30%) and the Lower Lias series to the south (average PI of around 40%). The higher the PI values, the darker red the CRG grid.

STRATFORD – Soil Plasticity Index



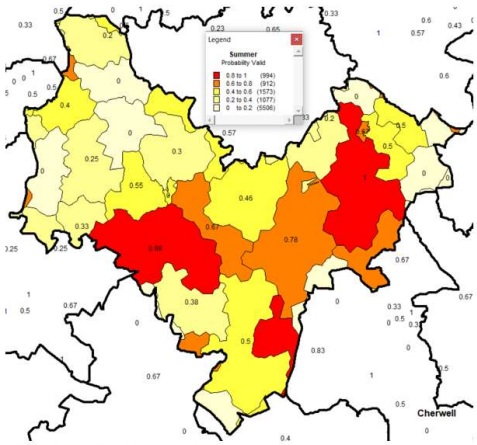
Soil PI Averaged by Sector



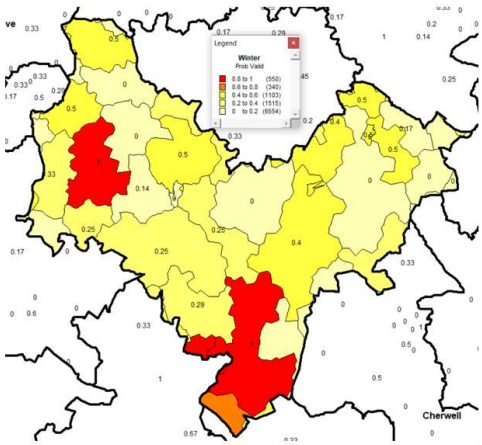
PI Interpolated on 250m CRG grid

Zero values for PI in some sectors reflects the absence of site investigation data, not necessarily the absence of shrinkable clay as comparisons between the images above, below and on page 7 reveal. Below, the probability of whether a claim is likely to be valid or declined by season. A single claim in an area with low population can raise the risk as a result of using frequency estimates.

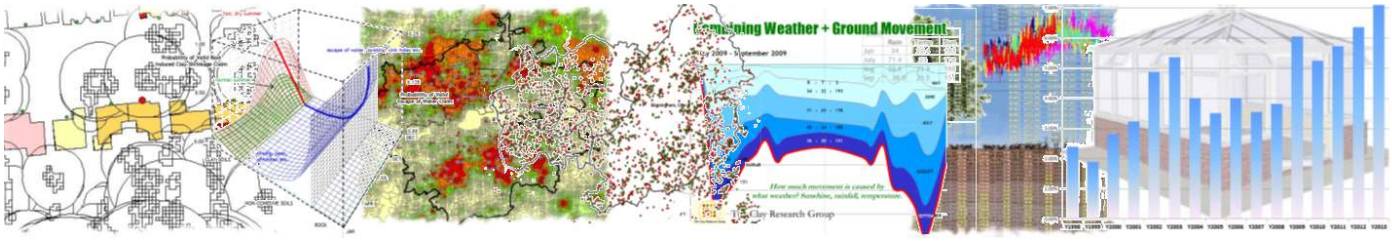
STRATFORD – probability of valid claim by season



Probability Valid, Summer



Probability Valid, Winter



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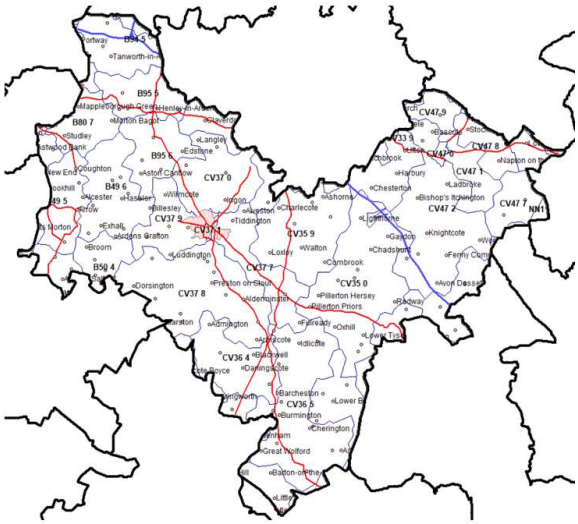
District Layout. EoW and Council Tree Risk.

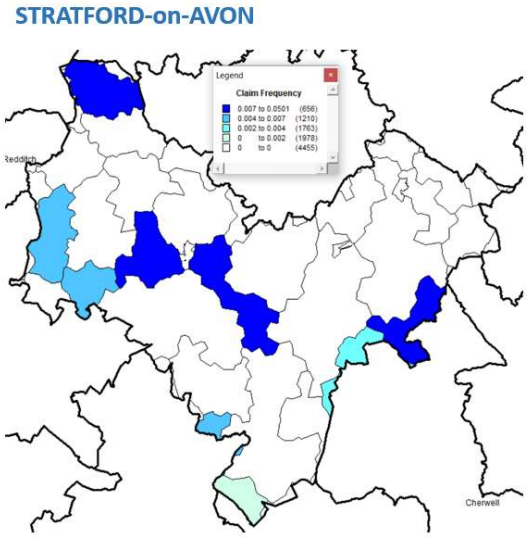


The district of Stratford covers quite a large area and consists of many small villages (see map, left) in contrast to previous studies.

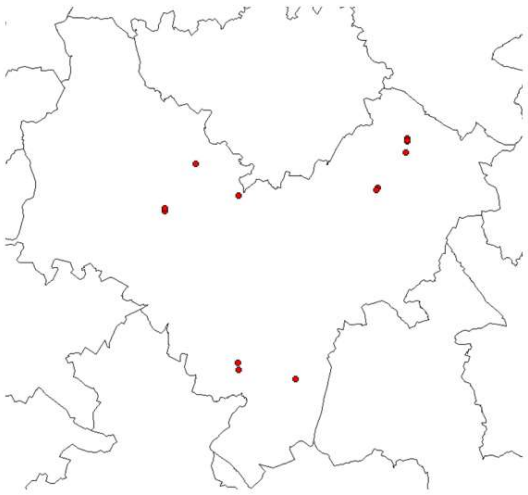
A review using Google Earth is useful in providing context and exploring the differences in property ages and styles of construction across the district.

In this study, risk values are often based on small housing population densities.

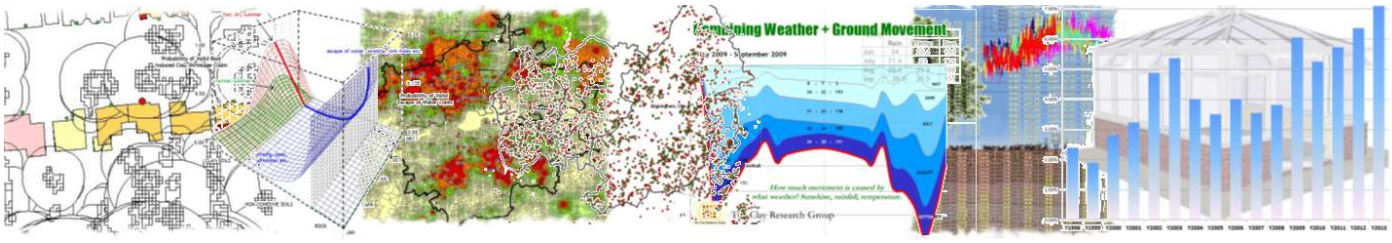
Below, left, mapping the frequency of escape of water claims from the sample reflects the presence of shallow, non-cohesive drift deposits or even shallow foundations on backfill given the age of some of the housing stock. Below, right, dots on the 'Council Tree Claims' map represent properties where damage has been attributable to vegetation in the ownership of the local authority which coincide with the clay formation.



Escape of Water Frequency Distribution



Local Authority Street Tree Claims



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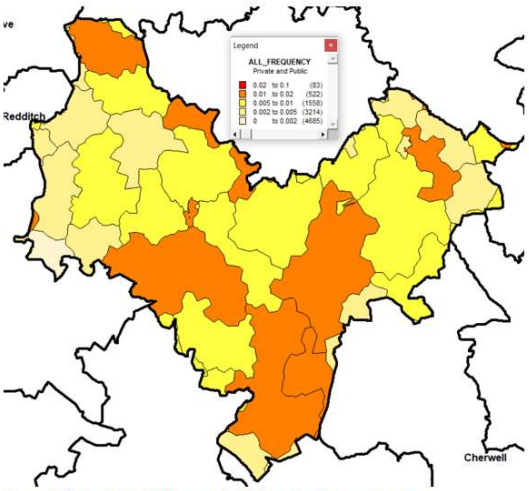
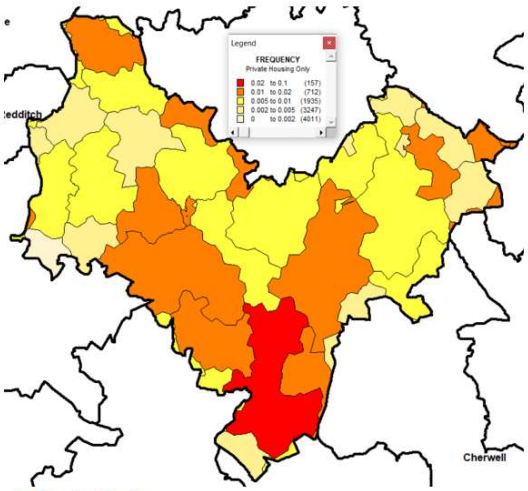
STRATFORD - Frequencies & Probabilities

STRATFORD - Postcode Sector Subsidence Risk (frequency) by Ownership



Combined Public and Private Frequency



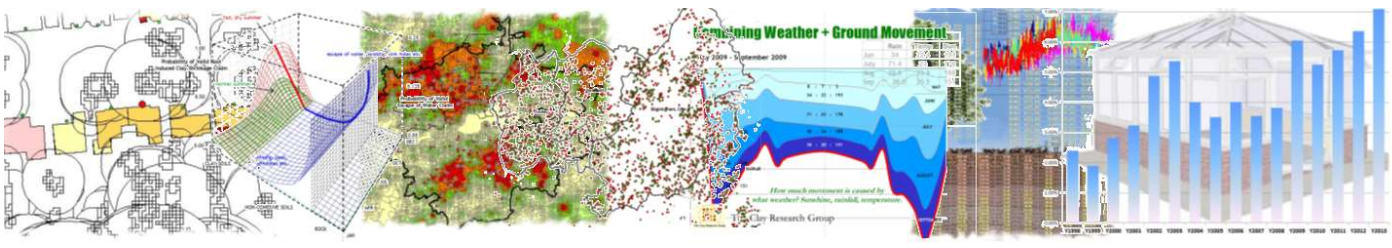
Private Only

The maps and figures reveal a borough with a clear seasonal signature, reflecting the geology – i.e. the presence of shrinkable clay soils.

The chances of a claim being declined in the summer are relatively low – just over 20% and if the claim is valid, there is a high probability (over 70%) that the cause will be clay shrinkage. In the winter, the repudiation rate exceeds 80% - and if the claim is valid, it is likely that the cause will be water related. The probabilities of causation reverse between the seasons.

Liability by Season - STRATFORD

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Stratford-on-Avon	0.719	0.065	0.216	0.01	0.16	0.83



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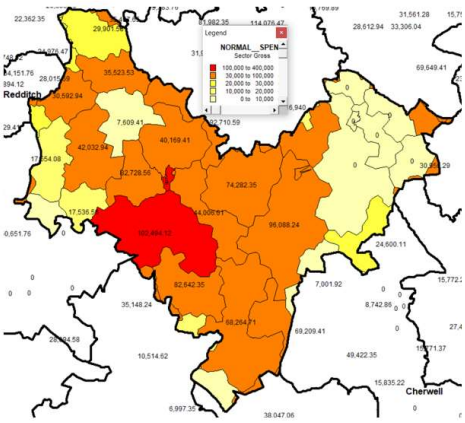
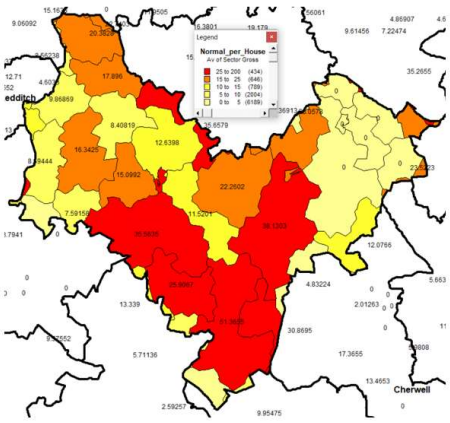
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

The maps below show the aggregated claim cost from the 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 – STRATFORD



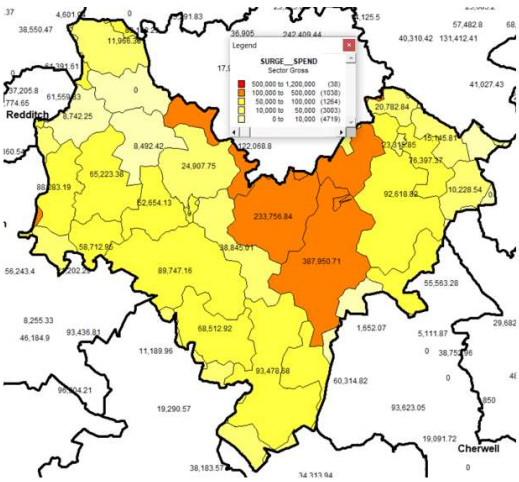
Spend by Sector



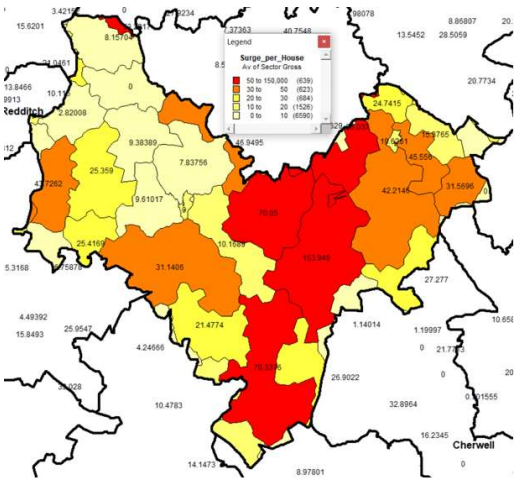
Spend Averaged over Housing Population

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.

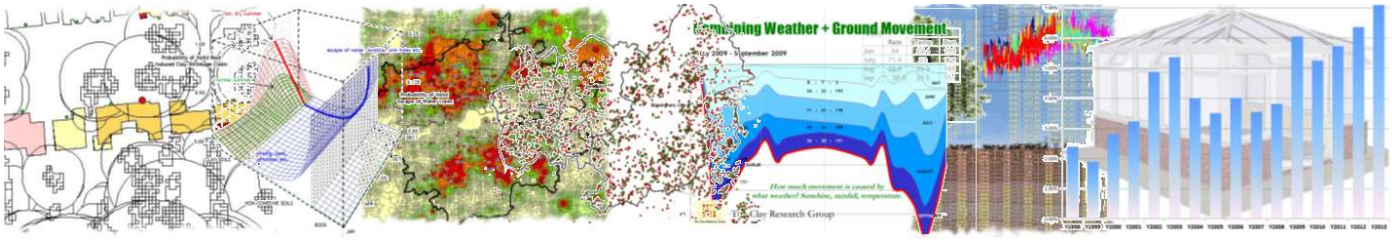
SPEND in SURGE – STRATFORD



Spend by Sector



Spend Averaged over Housing Population



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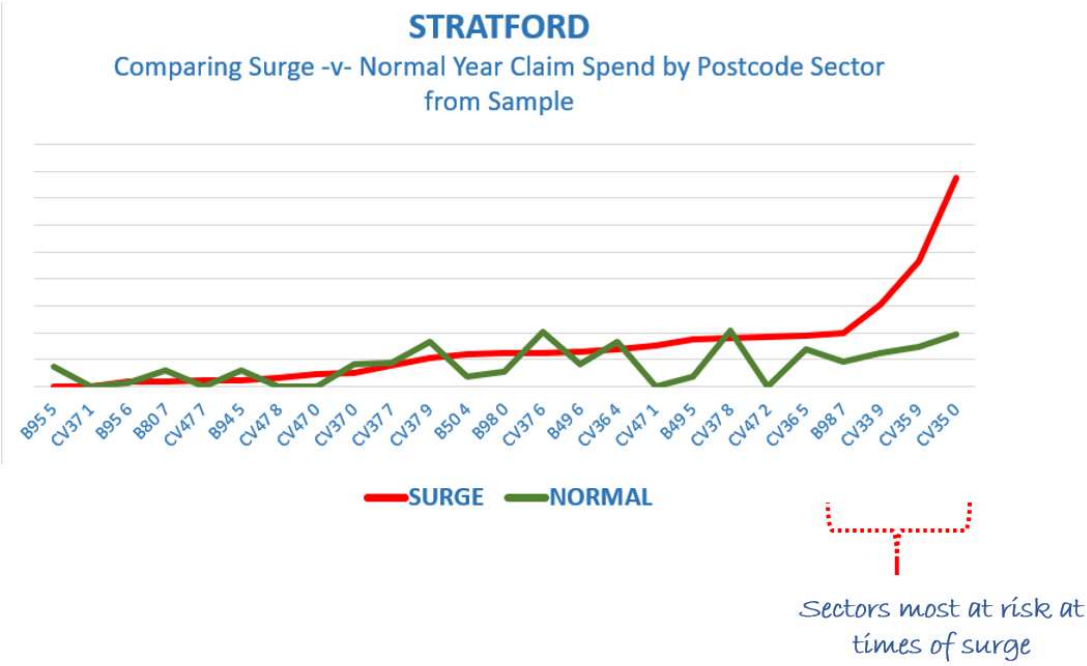

Identifying the variable risk across the district distinguishing between normal and surge years by postcode sector. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

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.

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.