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

August 2020
Edition 183

The Clay Research Group

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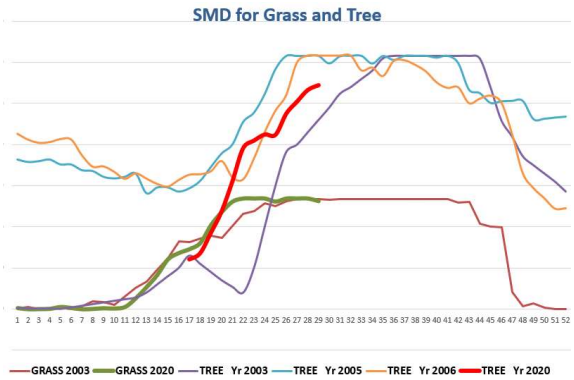
Issue 183, August 2020

SMD Update

Below, Soil Moisture Deficit data for both grass and trees for Tile 161 (SE England) of the Met Office grid.



For comparison purposes the current data (red for trees and green for grass) is plotted against two event years (2003 and 2006) and one normal year (2005).

Both profiles suggest cause for concern.

TDAG July Zoom Meeting

Interest and concerns were expressed relating to root barriers in the most recent TDAG Zoom meeting. There were concerns relating to the use of geopolymers both in relation to their engineering value and influence on soil biology. Andy Tipping queried the use of mesh barriers in the USA when combined with glyphosate. It was agreed that more research is needed on such approaches.

Next meeting is scheduled for 16th September via Zoom. Visit the TDAG web site at: http://www.tdag.org.uk/

I Love Claims Zoom Meeting

The I Love Claims discussions were delivered via Zoom on the 30th July. Speakers were Alan Milburn, Technical Claims Manager, Covea Insurance, Mike Lawson, CEO Property Risk Management Ltd and Richard Rollit, Engineering and Technical Director, Innovation Group.

The main topic was whether 2020 was likely to deliver a surge and how would everyone cope with the COVID-19 restrictions in place. The talk can viewed at: https://www.youtube.com/watch?v=CgQysTg1ois&feature=youtu.be

Contributions Welcome

Contributions welcome. Please Email us at:

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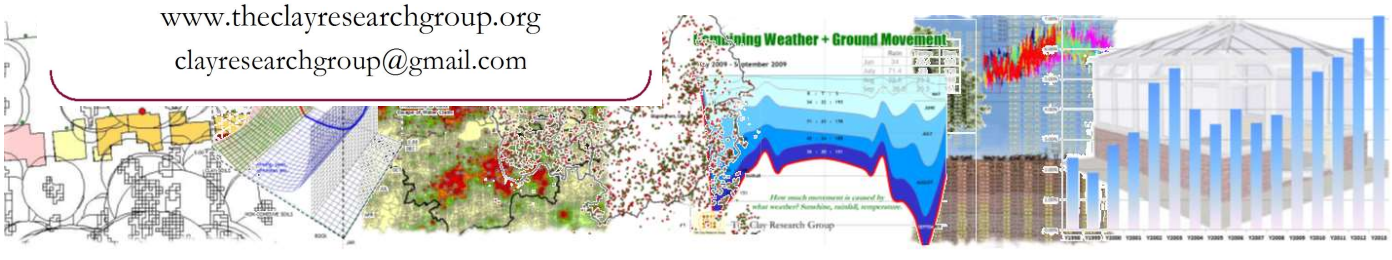

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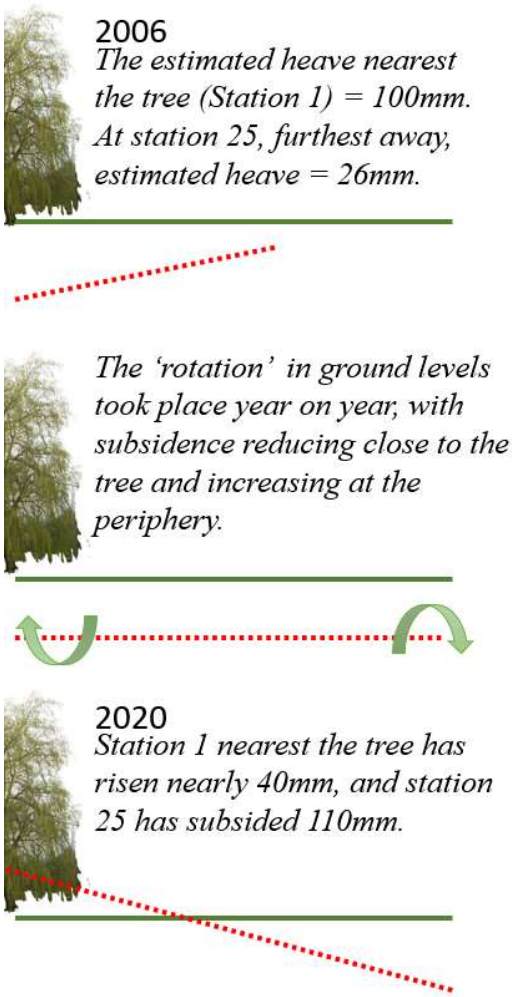
Dynamic Water Uptake of the Willow based on Level Data

Precise levelling over the last 14 years has provided an interesting insight into the dynamic nature of moisture abstraction by tree roots – at least, moisture abstraction by the Aldenham willow.



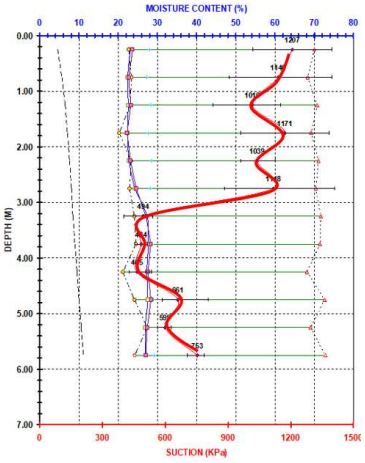
Diagrammatic plot of the changing profile of ground movement in the vicinity of the Aldenham willow, with ground close to the tree rising and towards the root periphery, subsiding. A reversal of the starting position. Total recovery near the tree = 40mm and furthest away, subsidence =110mm.

The first boreholes at the site of the Aldenham willow were sunk in May 2006 and soil tests at that time revealed a substantial moisture deficit 5mtrs away from the willow even though the tree had been out of leaf for the previous five months or so and following winter rainfall. That deficit was recorded as a negative porewater pressure exceeding 1,200kPa and extended to a depth of 3mtrs bGL. Towards the root periphery, 25mtrs away from the tree, the deficit was around 500kPa, peaking at 2m bGL.

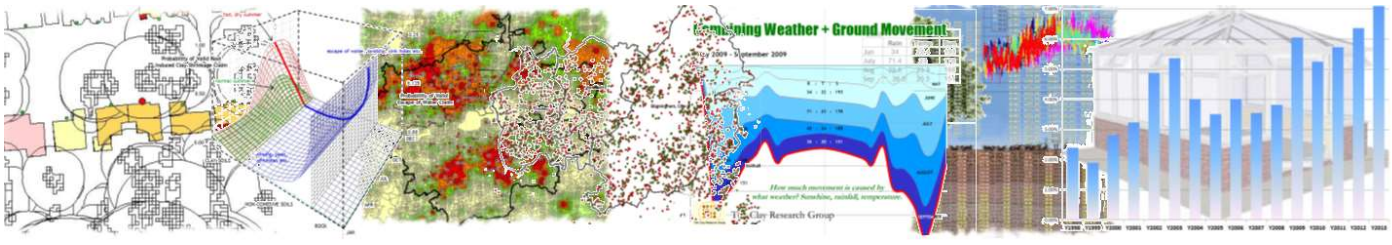
The results of the soil tests provided evidence of a persistent deficit across the root zone when precise levelling commenced in the same month.

It appears that soils close to the tree had reached a point where negative porewater pressure exceeded the uptake capacity of tree roots (the 'wilting point'), making roots further away work harder.

The tree handled the situation by increasing water uptake by the peripheral root system and precise levels have provided a useful means of visualising the change.



Above, soil suctions in BH1 (nearest the tree) reached 1,207 kPa in May 2006 and extend to a depth of 3mtrs bGL following winter rainfall and the absence of leaves



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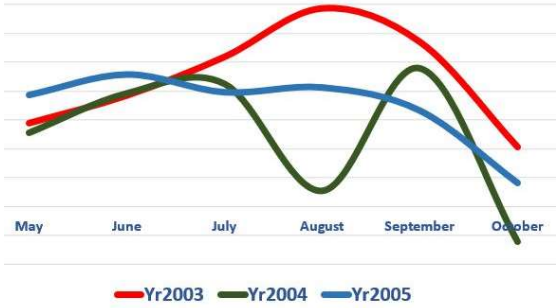
Surge - *Tmax-Rain?*

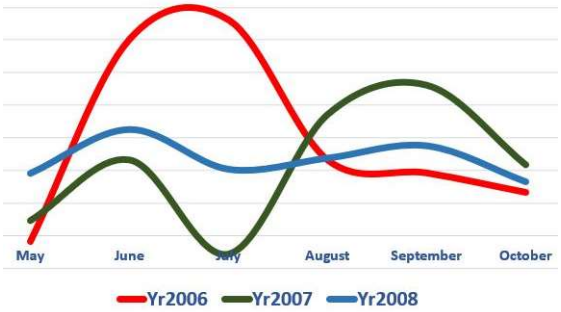
The proposed formula for linking weather to claim numbers, *Tmax-Rain*, is illustrated below in graphical form, associating recognised event years with normal years for the period May through to October, inclusive.

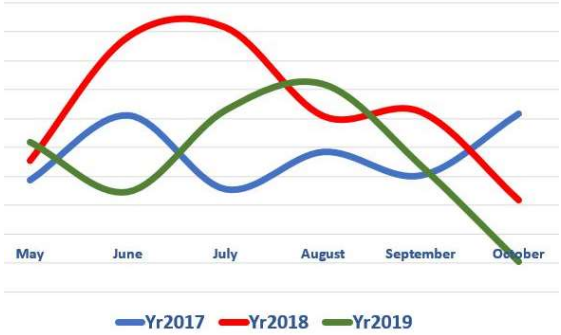
Top, 2003 is plotted against 2004 and 2005. Middle, 2006 is plotted against 2007 and 2008 and bottom, the surge in 2018 is plotted against 2017 and 2019. All data has been supplied by the Met Office from their Heathrow weather station.



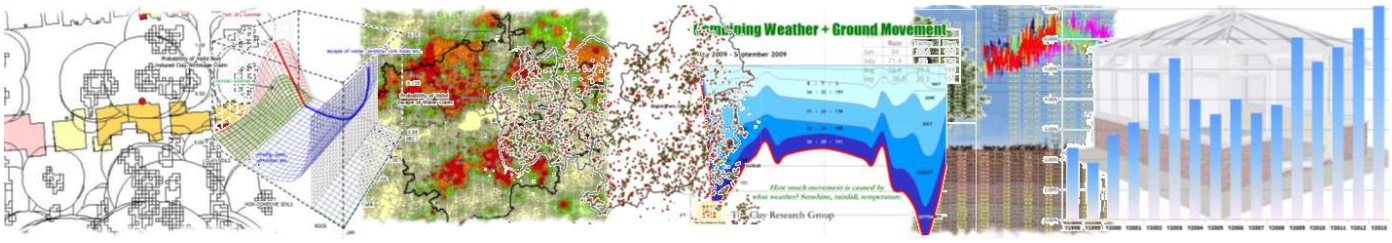
The 2003 surge peaked around August and delivered the highest number of claim = 54,000.

In 2006 the value of Tmax-Rain peaked much earlier – around June - and delivered 48,000 claims.





2018 is something of an anomaly, starting early (similar to 2006) but with a reduced peak and delivering an increase in third quarter claims. Previously, claim numbers had been declining steadily since 2006. 2018 delivered 23,000 claims in total.



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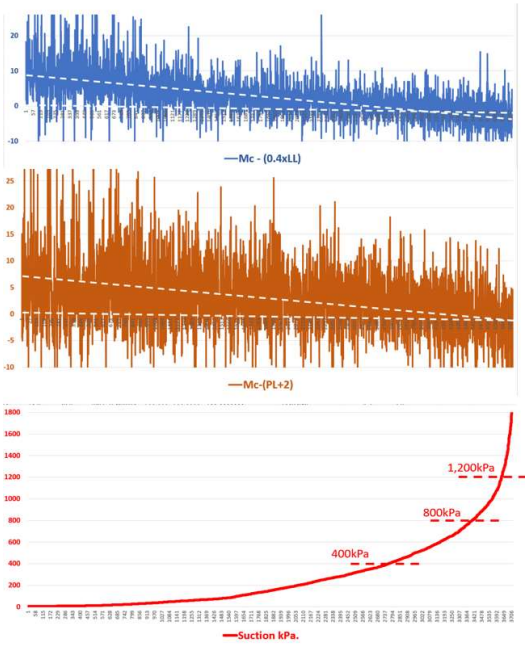
Index Properties -v- Suctions

Below, graphs comparing methods of determining desiccation comparing soil suctions (red line) with relationships between the moisture content (Mc) and plasticity indices. The sample consisted of over 3,700 test results.



It is acknowledged that use of the PI to determine desiccation isn't meant to deliver an accurate assessment and it is also recognised that values using the filter paper suction test are within +/- 25% so differences between the various methodologies isn't surprising.

See Edition 119 of the CRG newsletter for explanation of the PL and LL tests by Richard Driscoll.

Desiccation is suggested if the Mc is less than (a) 0.4 x LL – blue line - or (b) <2% above the PL (brown line).

Suctions (lower graph, red line) are plotted with values shown in the following ranges – 400, 800 and 1,200kPa.

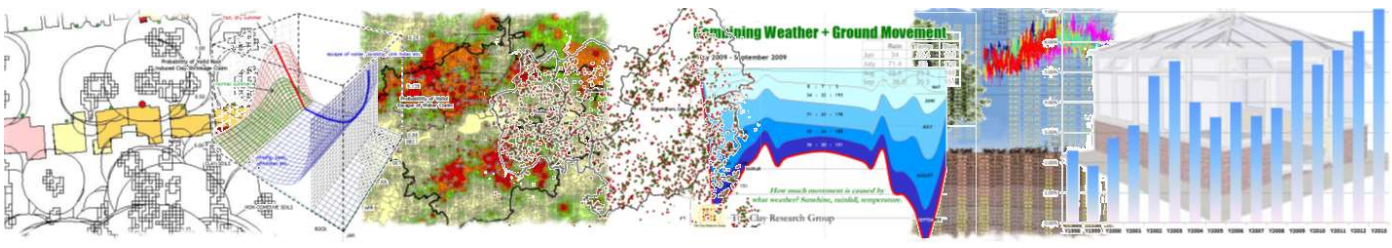
Although the general trend using the PI indicates soil drying, the rigid application of the values mentioned may result incorrect outcomes on individual cases.

Just under 30% claims were judged to be desiccated using the PI method, although the individual claims varied. That is to say, a result may reveal desiccation using the PL criteria, but not using the LL, or vice versa.

Using the soil suction method, over 50% of the claims were judged to be desiccated.

The correlation between LL and PL = 0.628, between suctions and LL = -0.47 and between suctions and PL = -0.299, suggesting the LL test to be the better of the two, using the suction test as the benchmark.

This analysis is based on a sample from the year 2000 and we welcome hearing from any laboratory willing to share their data.



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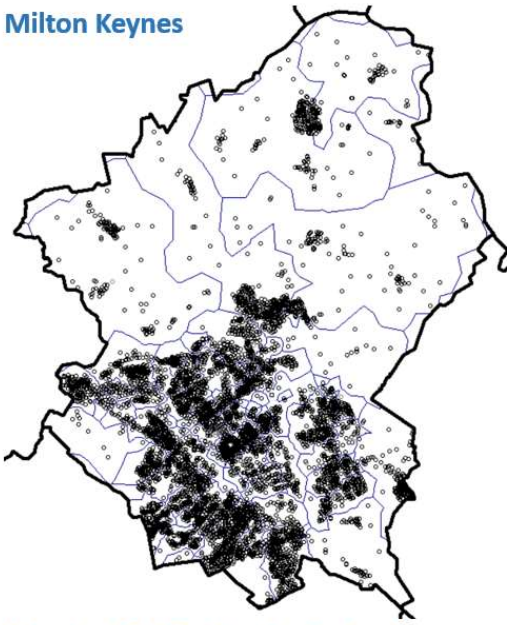
Subsidence Risk Analysis – MILTON KEYNES

Milton Keynes is situated in Buckinghamshire and occupies an area of around 89km^2 with a population of over 230,000.



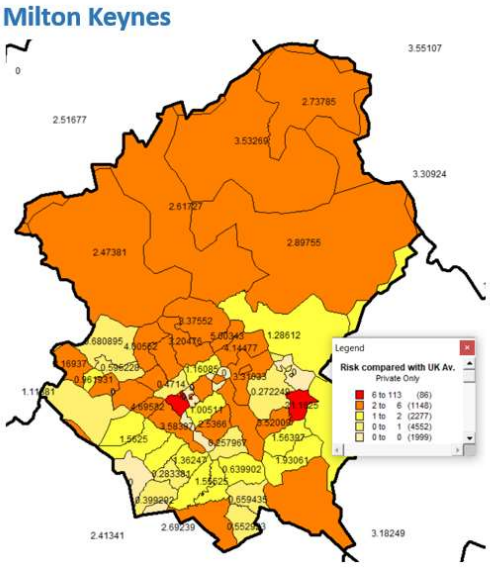
Distribution of housing stock using full postcode as a proxy. Each postcode in the UK covers on average 15 – 20 houses, although there are large variations.

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

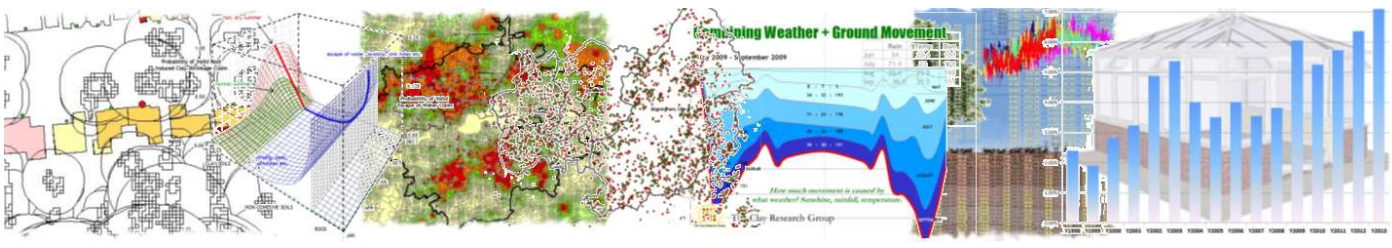
The highest risk rating is a value of 4 and Milton Keynes is rated as being 1.6 times the UK average risk, putting it in 54th place.

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.



Milton Keynes is ranked 54th in the UK in terms of 'risk by district' and rated 1.669 x the UK average risk for domestic subsidence claims from the sample analysed.



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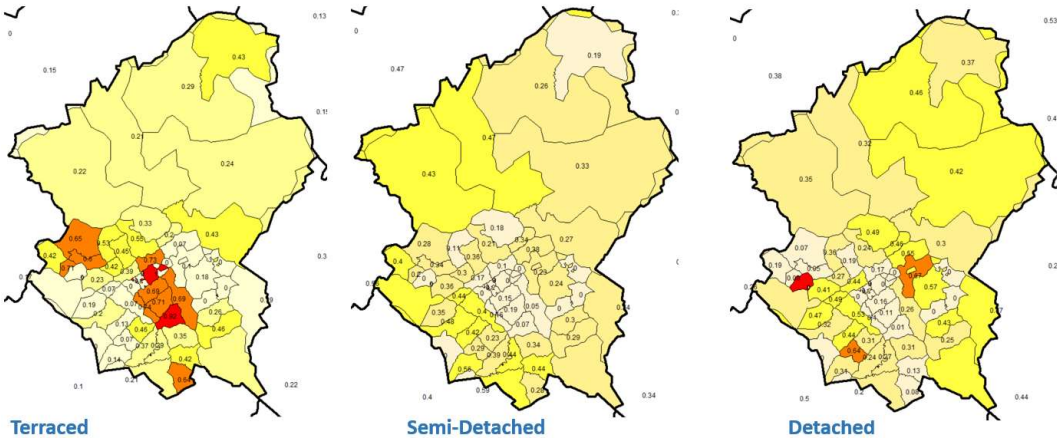
MILTON KEYNES - Properties by Style and Ownership

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 Milton Keynes district at around 0.27 (variable across the district) on a scale of 0 – 1. This assessment could be refined using insurer's portfolio data.

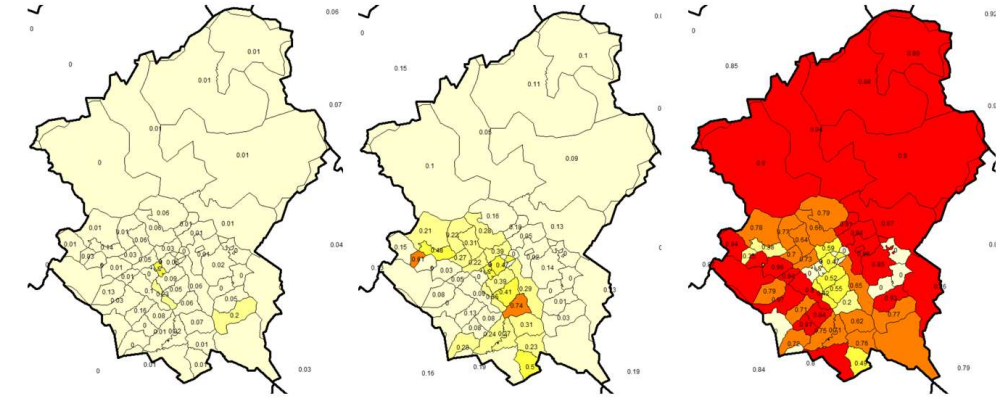
Milton Keynes - Distribution by House Type



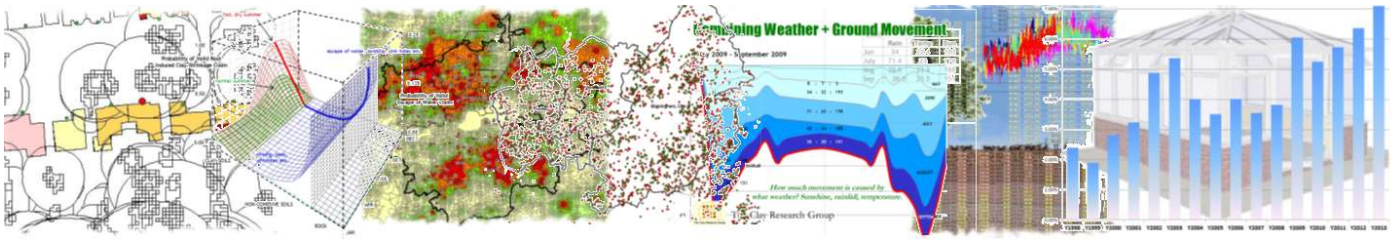
Terraced | Semi-Detached | Detached

Distribution by ownership is shown below. The maps reveal predominantly privately-owned properties across the borough.

Milton Keynes - Distribution by Ownership



Housing Association | Council Ownership | Private Ownership



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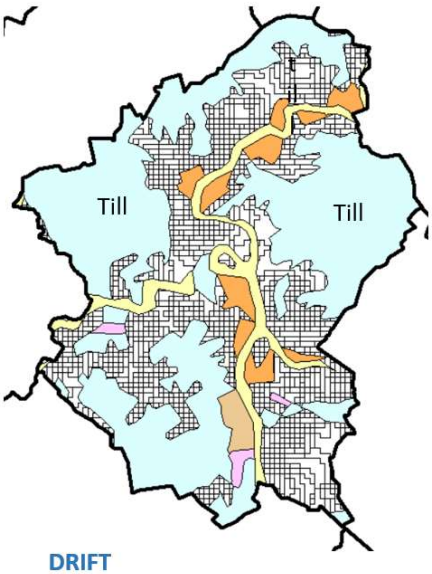
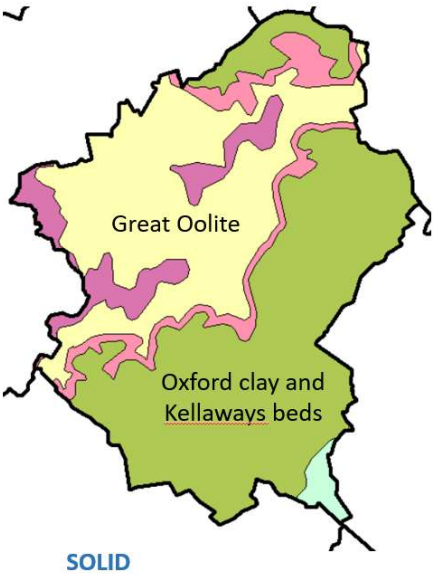
Subsidence Risk Analysis – MILTON KEYNES

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.

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



DRIFT

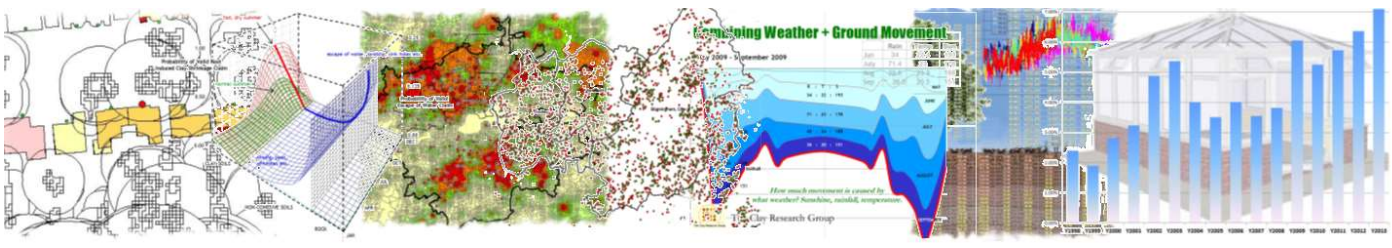


SOLID

See page 10 for a seasonal analysis which reveals that in the summer there is slightly less than 75% probability of a claim being valid, and of the valid claims, there is a high 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 influence of the underlying clay series and the apparent shallow thickness of the superficial deposits.



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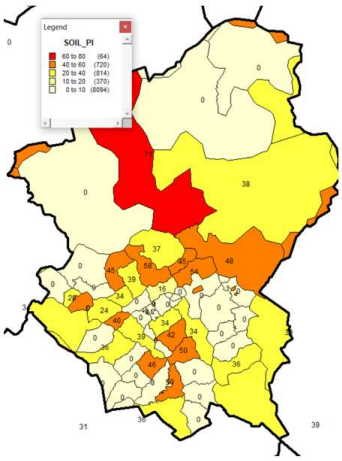
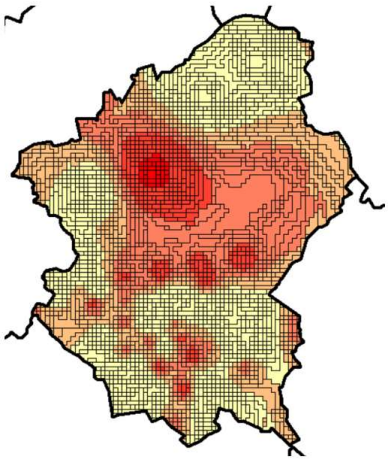
Liability by Season and Geology

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 is at variance with the BGS maps on the previous page with clay having an average PI of around 40% where it exists. The higher the PI values, the darker red the CRG grid.

Milton Keynes – Soil Plasticity Index



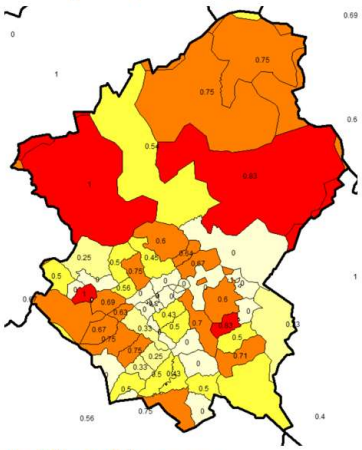
Soil PI Averaged by Sector



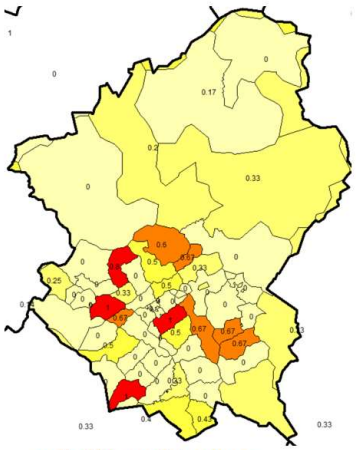
PI Interpolated on 250m CRG grid

Zero values for PI in some sectors may reflect the absence of site investigation data - not necessarily the absence of shrinkable clay. The widespread influence of the shrinkable clay plays an important role in determining 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.

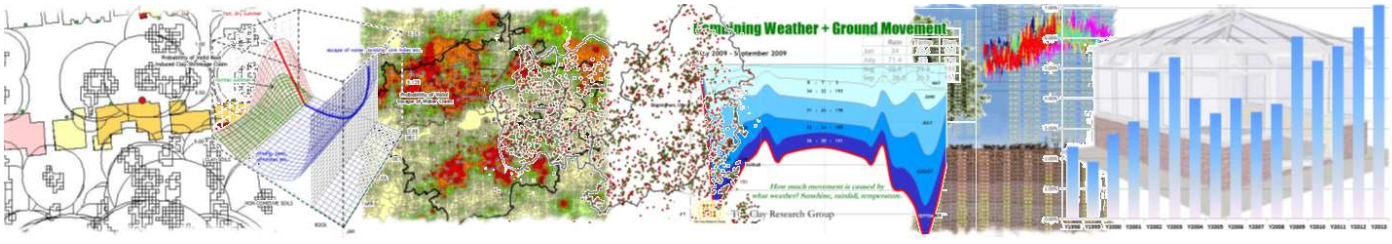
Milton Keynes – probability of valid claim by season



Probability Valid, Summer



Probability Valid, Winter



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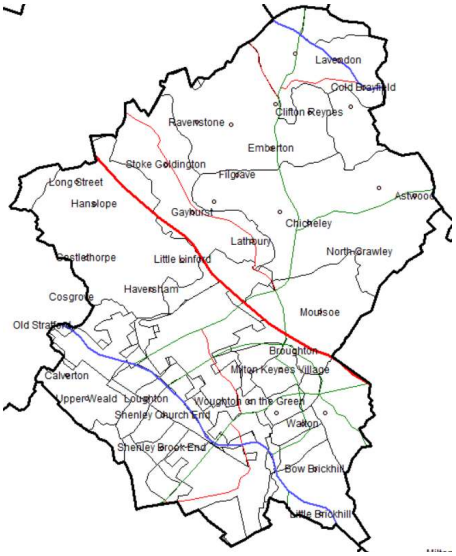
District Layout. EoW and Council Tree Risk.

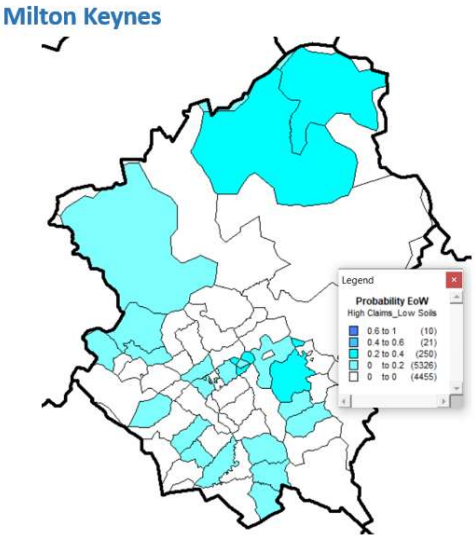


Milton Keynes covers quite a large area and consists of many small villages (see map, left) in contrast to previous studies.

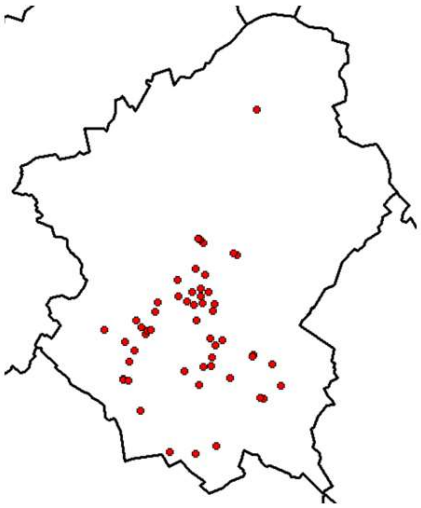
A review using Google Earth is useful in providing context and exploring the differences in property ages and styles of construction across the district.

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

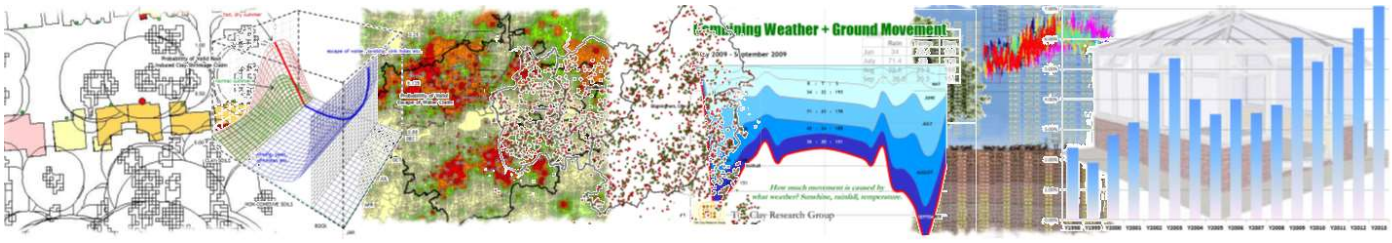
Below, left, mapping the frequency of escape of water claims from the sample reflects the presence of the non-cohesive drift deposits or shallow foundations on backfill given the age of some of the housing stock. Below, right, dots on the 'Council Tree Claims' map represent properties where damage has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



Escape of Water Frequency Distribution



Local Authority Street Tree Claims



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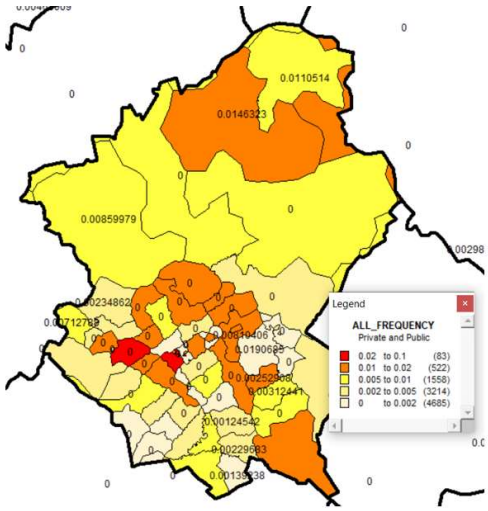
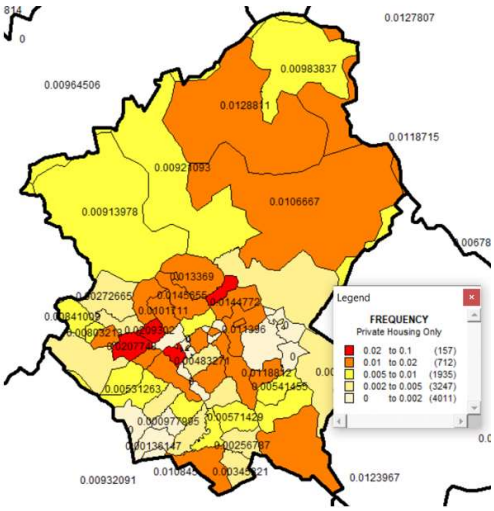
MILTON KEYNES - Frequencies & Probabilities

Milton Keynes - Postcode Sector Subsidence Risk (frequency) by Ownership



Combined Public and Private Frequency



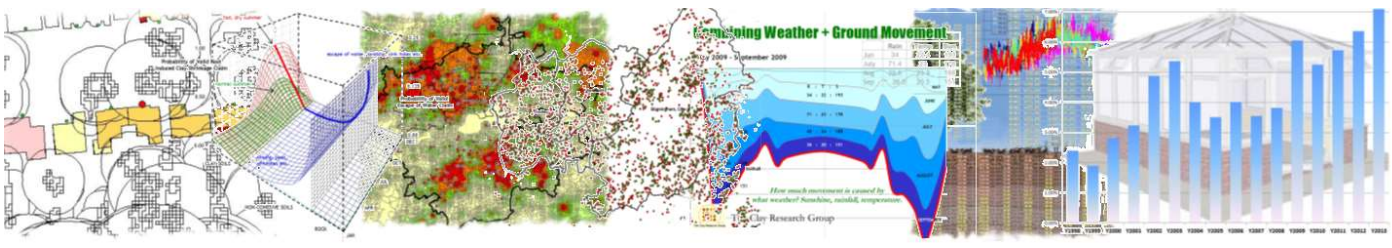
Private Only

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 (greater than 90%) that the cause will be clay shrinkage.

In 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 - MILTON KEYNES

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Milton Keynes	0.749	0.036	0.215	0.01	0.16	0.83



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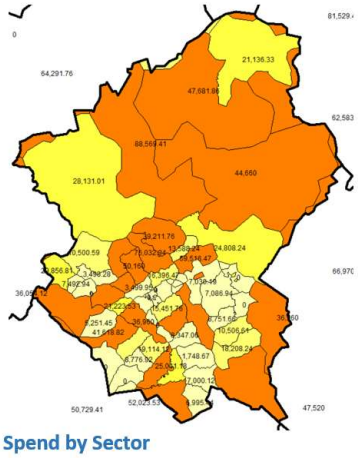
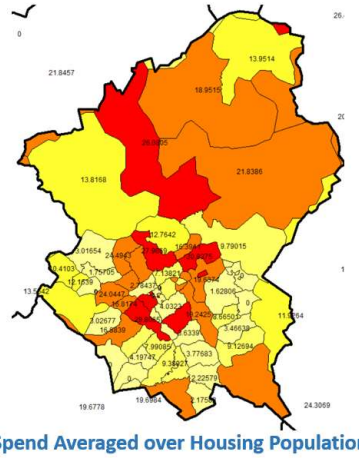
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

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 – Milton Keynes



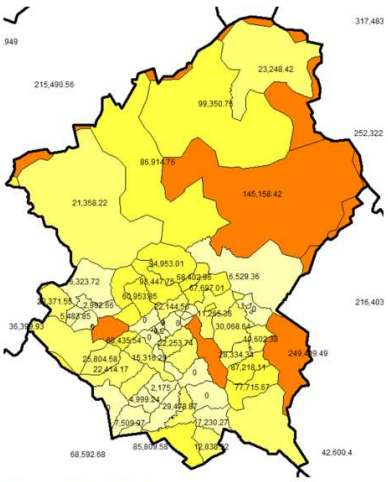
Spend by Sector



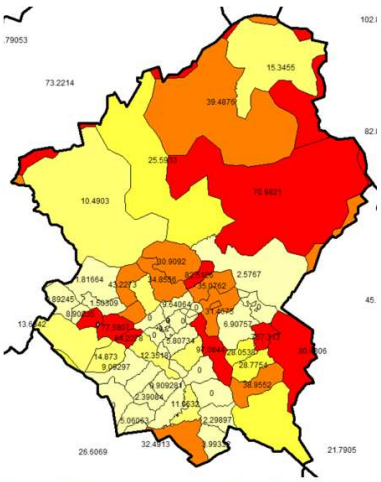
Spend Averaged over Housing Population

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.

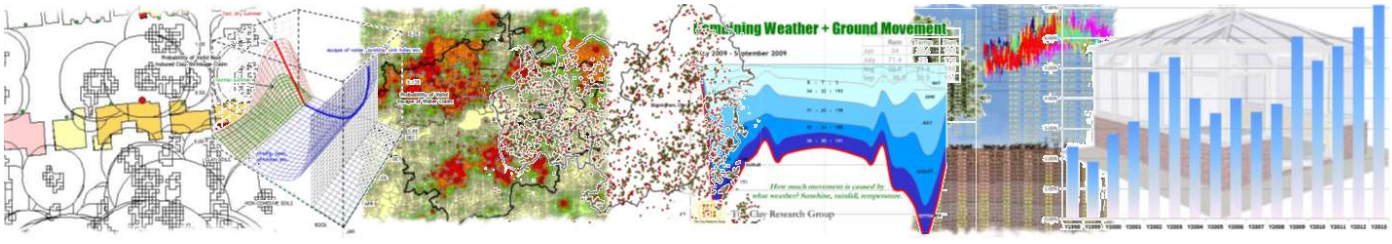
SPEND in SURGE – Milton Keynes



Spend by Sector



Spend Averaged over Housing Population



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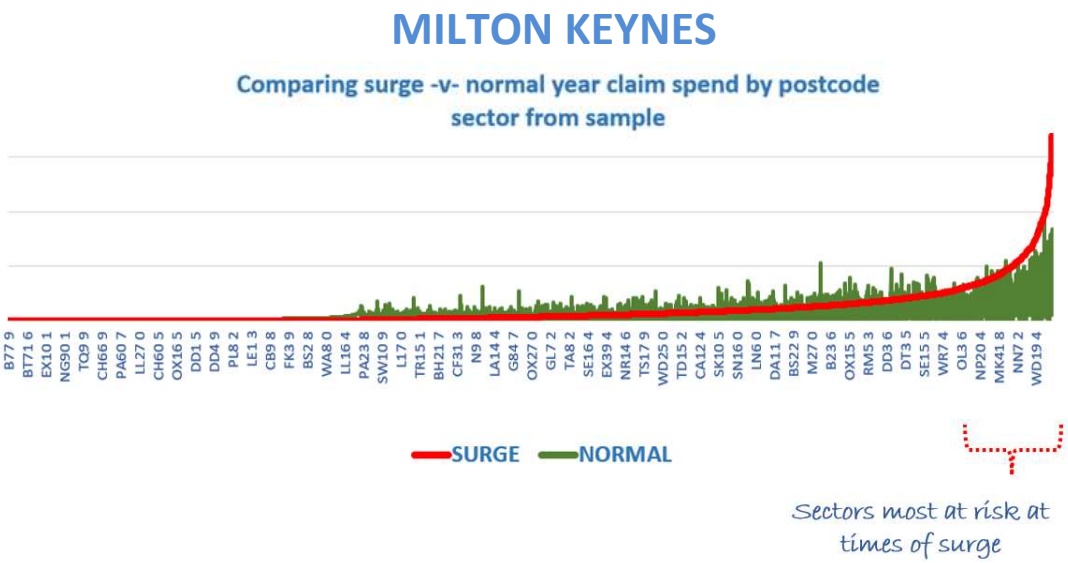

The above graph identifies the variable risk across the district distinguishing between normal and surge years by postcode sector. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

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.