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

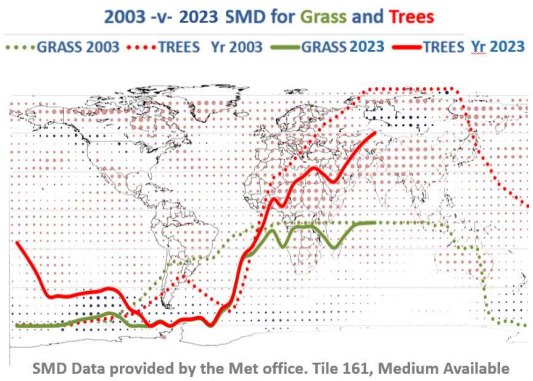
September 2023
Issue 220

The Clay Research Group

CONTENTS

Soil Moisture Deficit Update

Soil Moisture Deficit readings reflect the recent dry weather but possibly too late to deliver a surge.



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

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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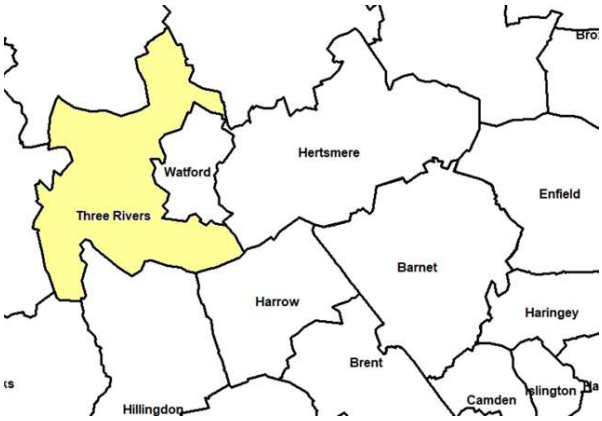
District and Sector Risk

Three Rivers is the topic of the 'Risk by District' series in this month's edition. It is a local government district in south-west Hertfordshire, and has superficial deposits of sand, gravel and alluvium overlying chalk beds.



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

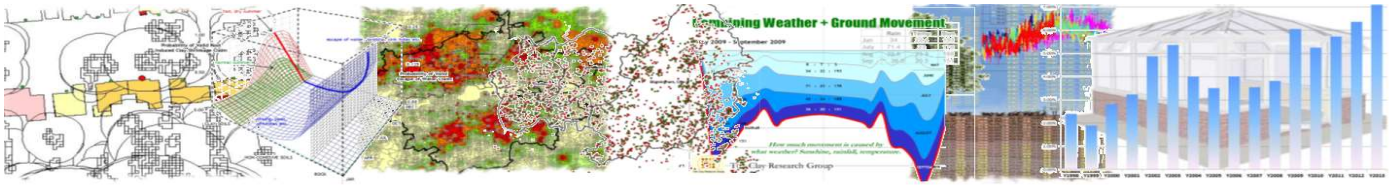
FORTHCOMING EVENTS

The Subsidence Forum are holding a training day on the 12th October, 2023. Visit their web site for more details:

https://www.subsidenceforum.org.uk/events-seminars/

The event is being held at Mythe Barn, Warwickshire

Their web site says *"An agenda will be announced nearer to the date, if you would like to register your interest or find out any further information, please email bookings@agmhouse.com"*



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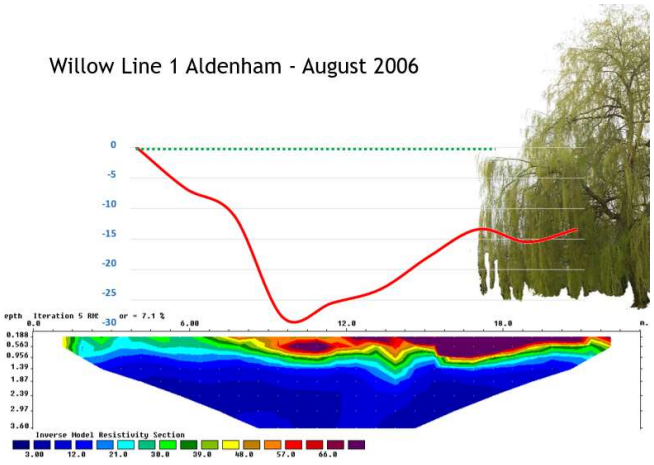
Electrical Resistivity and Ground Movement

Taken from the Research undertaken by Glenda Jones as part of her successful PhD at Keele University under the direction of Dr. Nigel Cassidy[1].

Glenda installed resistivity arrays at the sites of both the oak and willow at the Aldenham research site and took readings from April 2006 through to September 2008.

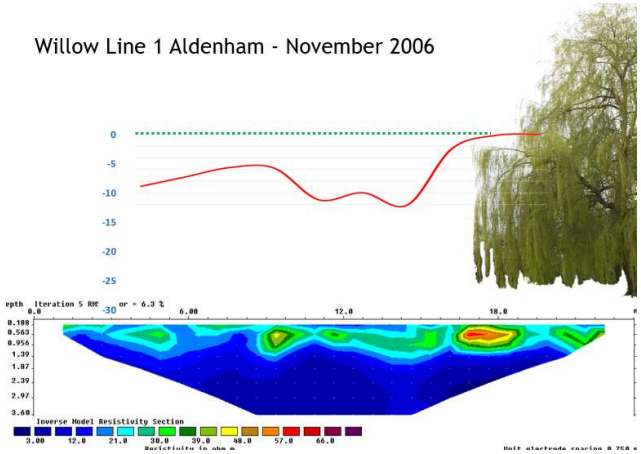
At the same time precise levels were being taken by GeoServ Ltd.

Ground movement following installation in May 2006 is shown as a red line on the ER graphs along Array 1 of the willow tree.



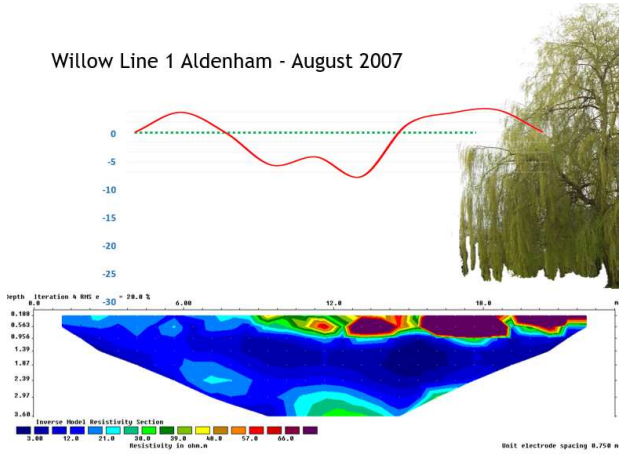
The zone of desiccation is identified by the precise levels, and maximum movement coincides with the red/yellow/green zones shown on the ERT plot.

2006 was a surge year and some rehydration would be expected towards the winter months as can be seen in the image at the head of the column, right.



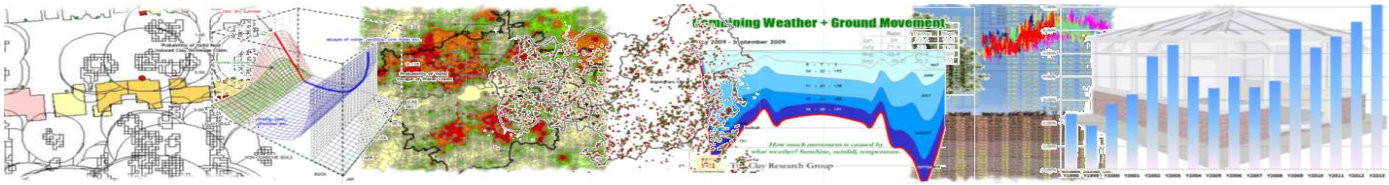
Recovery of around 20mm was recorded at the station where maximum subsidence had taken place, and the ERT image shows a reduction in resistivity.

Below, further recovery along Array 1 with station 2 (5mtrs from the tree) 4.4mm and station 9, 3.9mm above the initial reading taken in May 2006.



The depth of desiccation recorded using ERT varies from that of soil testing as we shall see in next month's edition, and interpretation requires a degree of expertise that would perhaps make it difficult to use as evidence.

[1] *Dr Cassidy is now Emeritus Professor of Geotechnical Infrastructure Engineering at Birmingham University.*



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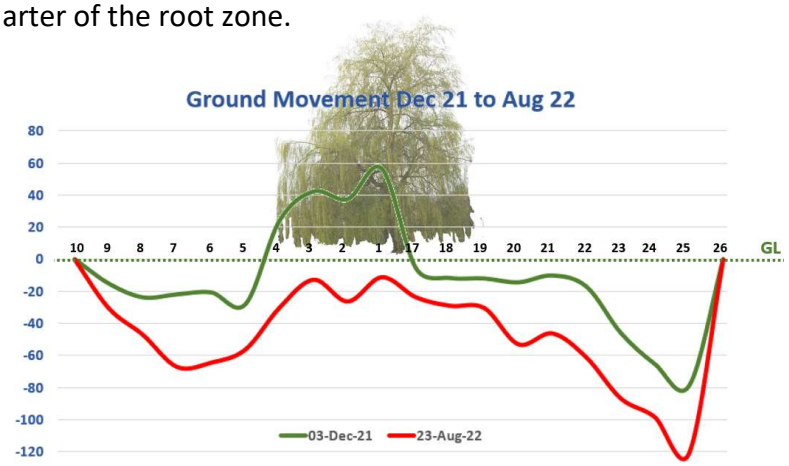
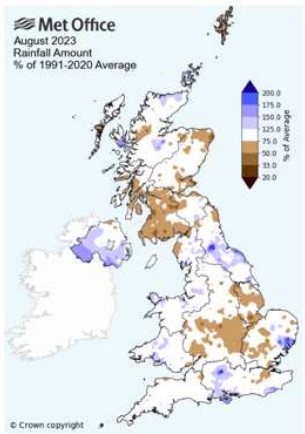
Seasonal Ground Movement Profiles
Aldenham Willow

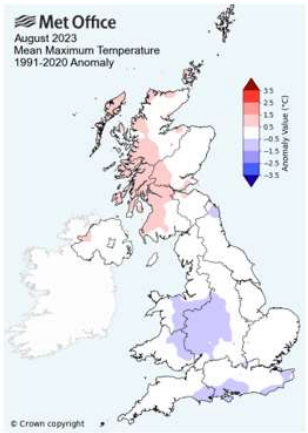
Below, the difference in ground levels between December 2021 (green line) and August 2022 (red line), a surge year. Station 1 (nearest the tree) exhibits the greatest degree of movement (recovery) amounting to 45mm. It is interesting to see the difference between array 1 (stations 1 – 9), and array 2 (stations 17 – 25), illustrating the difficulty in modelling risk. Not only does ground movement vary by species, but also by location around the circumference. Both arrays are in the same quarter of the root zone.

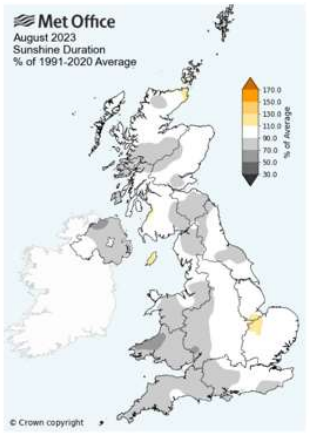


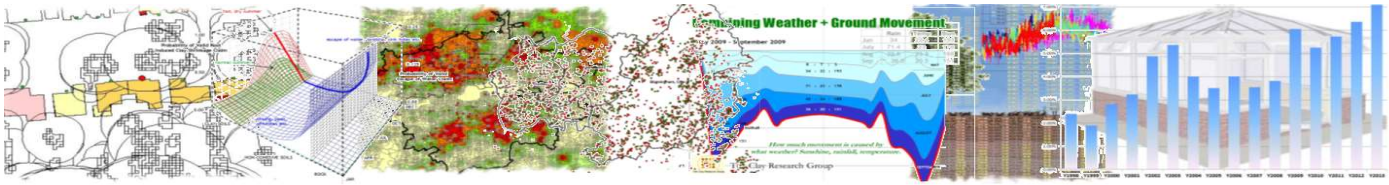
Met Office August 2023 Update.
Anomaly Data, 1991 – 2020

Anomaly maps from the Met Office web site reproduced below. August 2023 delivered little change when averaged across the UK with some areas recording increased rainfall, temperature and sunshine and others less but within 'normal' seasonal averages compared with the period 1991 – 2020. Based on the figures, we would not anticipate a subsidence surge this year.









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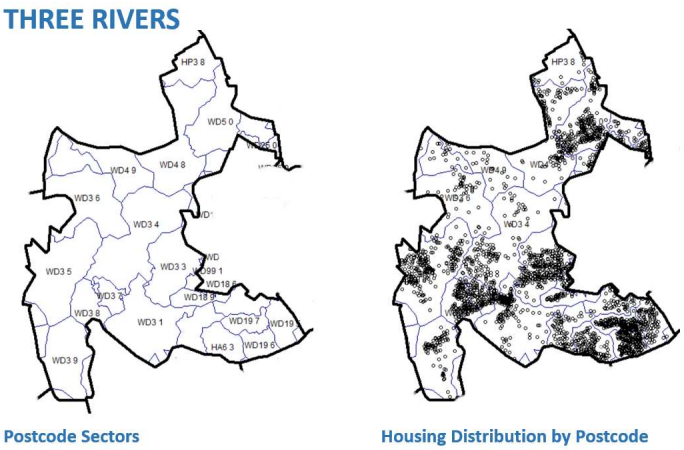
Subsidence Risk Analysis – THREE RIVERS

Three Rivers is a district in south-west Hertfordshire occupying an area of 88.84km^2 with a population of around 94,000.



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.

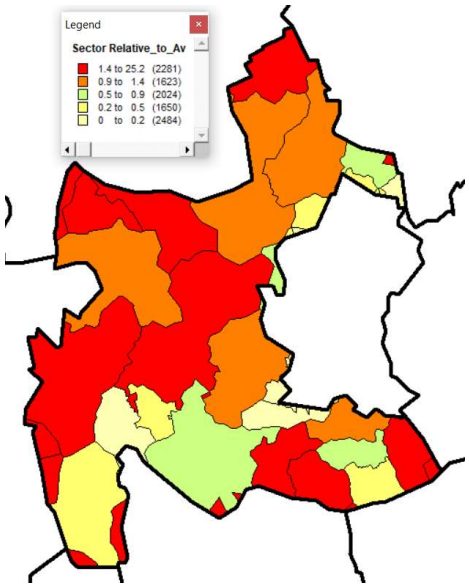
Sector and housing distribution across the district (left, using full postcode as a proxy) helps to clarify the significance of the risk maps on the following pages. Are there simply more claims in a sector because there are more houses?

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.

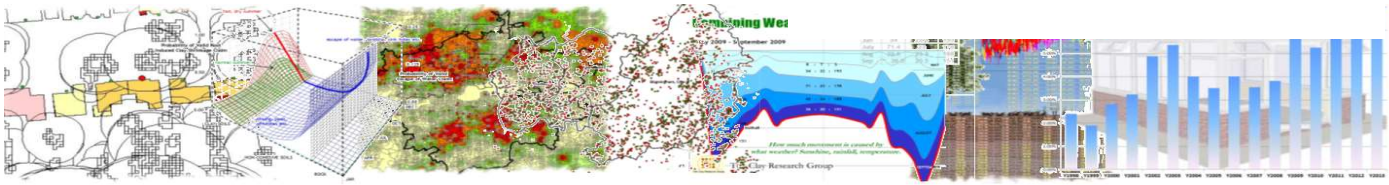
From the sample we hold, sectors are rated for the risk of domestic subsidence compared with the UK average – see map, right.

Three Rivers is rated 82nd out of 413 districts in the UK from the sample analysed and is around 1.46x the risk of the UK average, or 0.378 on a normalised 0 - 1 scale.

There is a varied risk across the borough as can be seen from the sector map, right, which reflects the varied geology with non-cohesive drift deposits overlying predominantly chalk.



Three Rivers district is rated around 1.46 times the UK average risk for domestic subsidence claims from the sample analysed.



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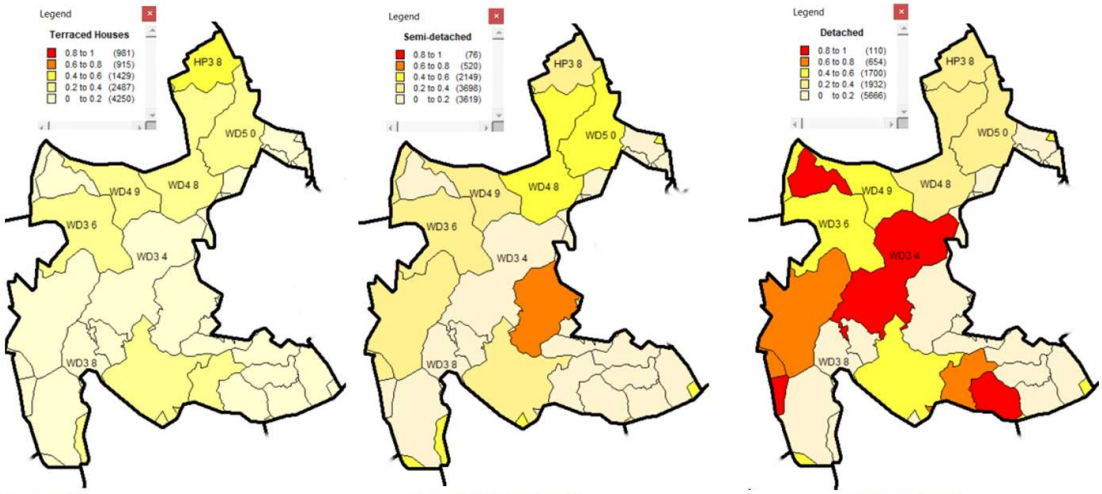
THREE RIVERS - Properties by Style and Ownership

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.

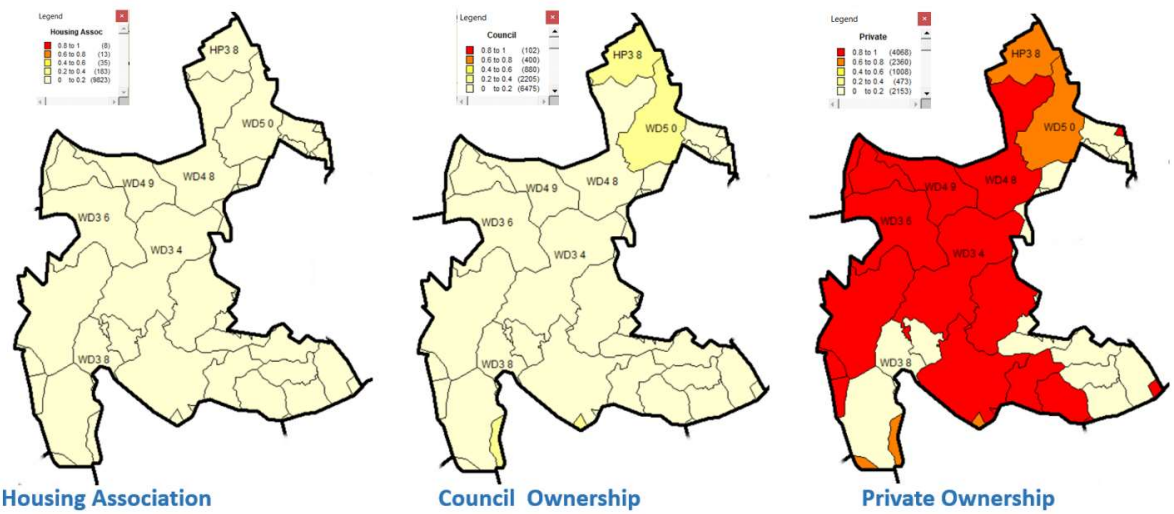
THREE RIVERS - Distribution by House Type



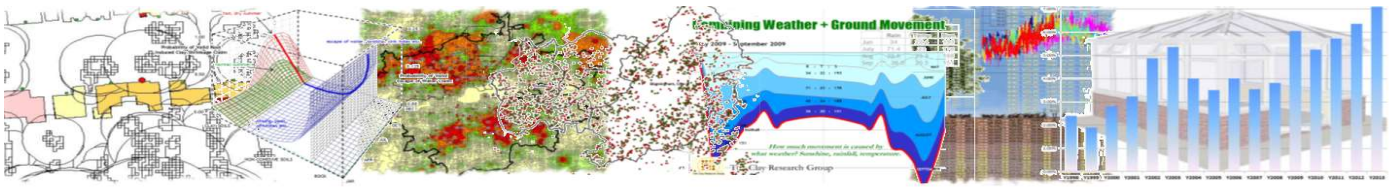
Terraced Semi-Detached Detached

Distribution by ownership is shown below. Detached properties are the dominant class in private ownership across the borough.

THREE RIVERS - Distribution by Ownership



Housing Association Council Ownership Private Ownership



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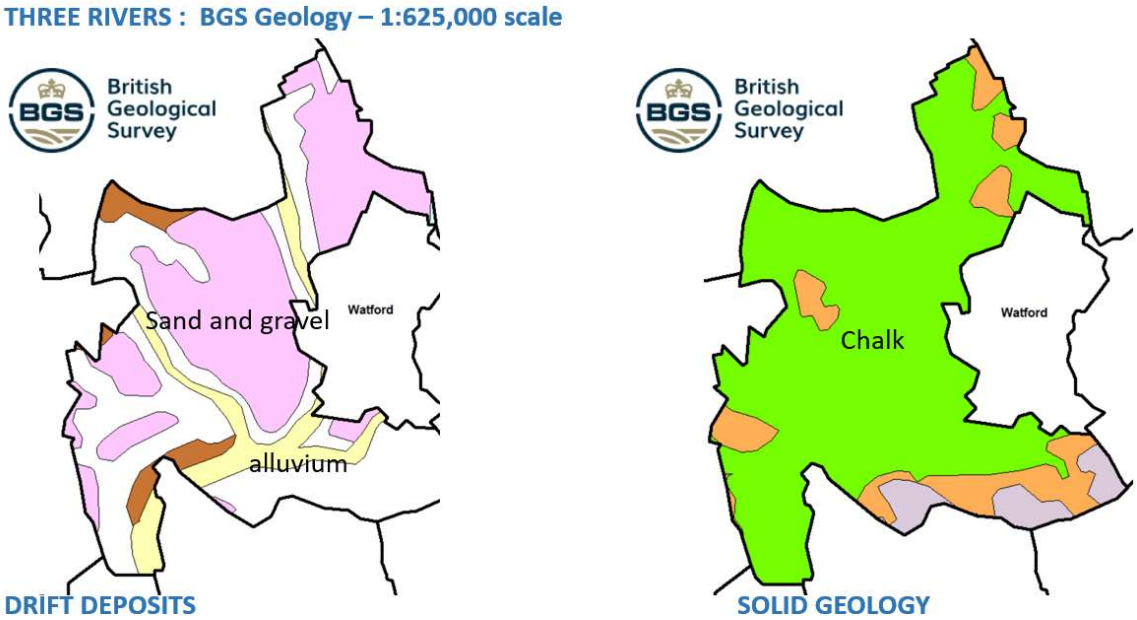
Subsidence Risk Analysis – THREE RIVERS

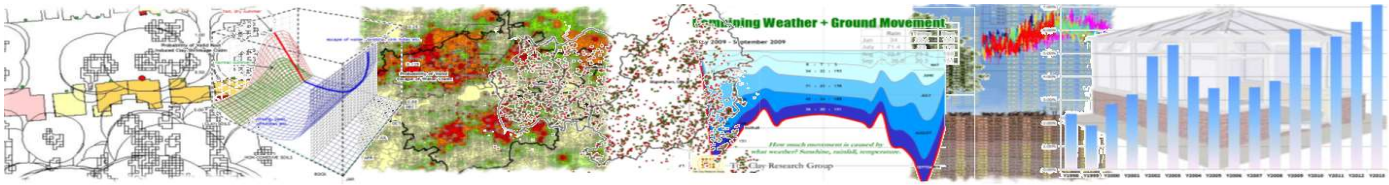
Below, extracts from the British Geological Survey low resolution 1:625,000 scale geological maps showing the solid and drift series. View at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html for more detail.

See page 9 for a seasonal analysis of the sample which reveals that, at district level, there is around a 70% probability of a claim being valid in the summer and, of the valid claims, there is around a 80% chance that the damage will have been caused by clay shrinkage, with escape of water accounting for the remaining 20%. This appears contradictory when looking at the geological maps. In the winter the likelihood of a claim being valid is around 40% - and if valid, there is a greater chance of the cause being an escape of water.

Maps at the foot of the following page plot the seasonal distribution with shrinkable deposits encountered following investigations associated with claims.



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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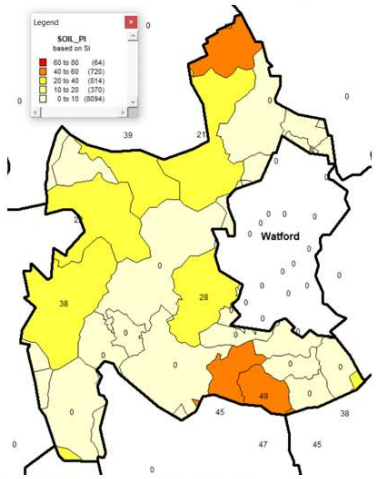
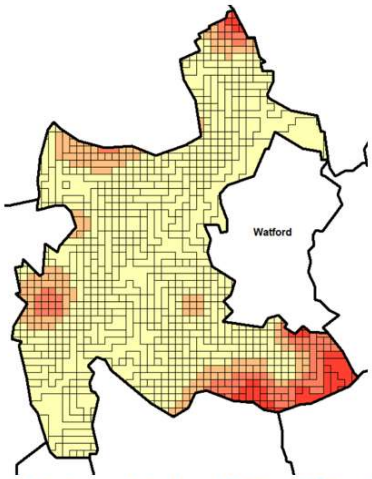
Liability by Geology and Season

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.

THREE RIVERS – Soil Plasticity Index



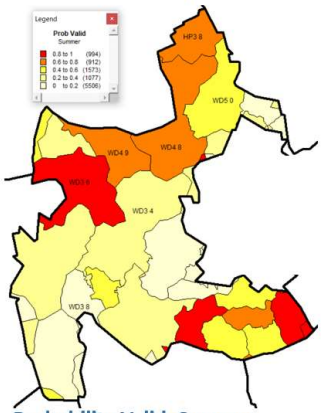
Soil PI Averaged by Sector



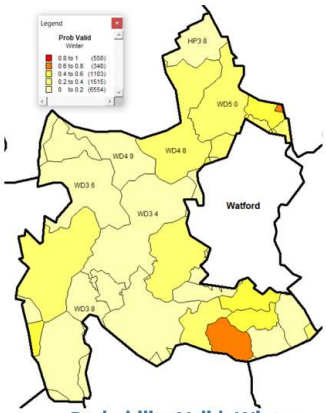
PI Interpolated on 250m CRG grid

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.

THREE RIVERS – by season



Probability Valid, Summer



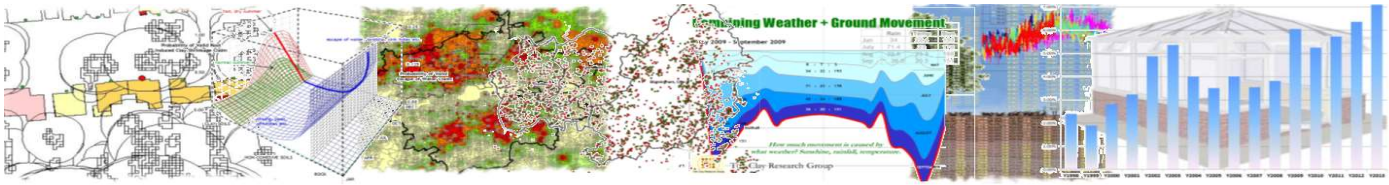
Probability Valid, Winter

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

Combining the risk maps by season and reviewing the table on page 9 is perhaps the most useful way of assessing the potential liability, likely cause and geology using the values listed.

This approach seems less useful in this instance as clay is recorded as a prime cause of subsidence in the summer months and yet the geological series are, in the main, non-shrinkable.

The 'claim by cause' distribution and the risk posed by the soil types is illustrated at the foot of the following page. 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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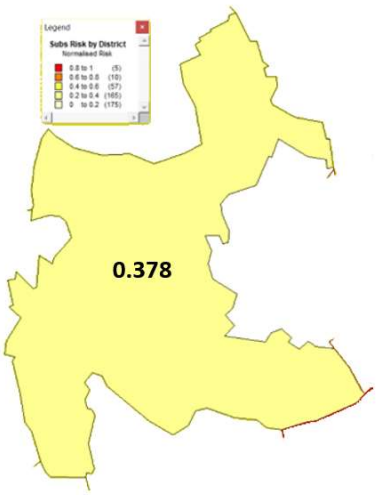
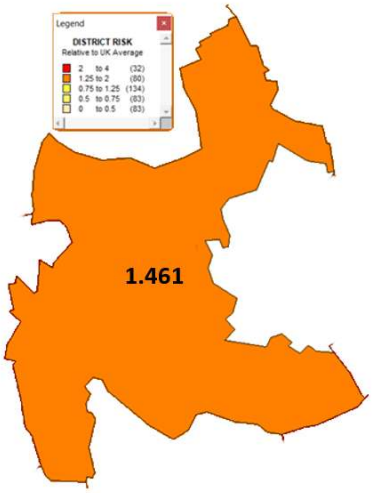
District Risk -v- UK Average. EoW and Council Tree Risk.

THREE RIVERS - Subsidence Risk Relative to UK



Normalised (0 – 1) Scale



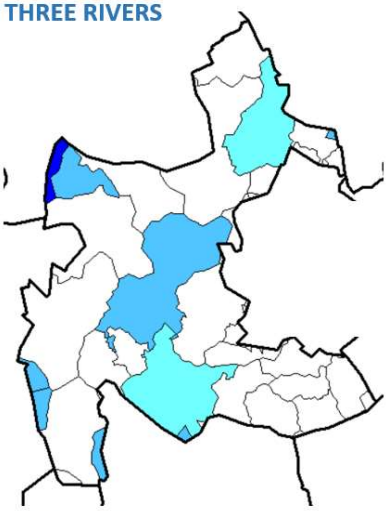
Relative to UK Average

Below, left, mapping the frequency of escape of water claims confirms the presence of non-cohesive soils. As we would expect, the 50,000 scale BGS map provides a more detailed picture.

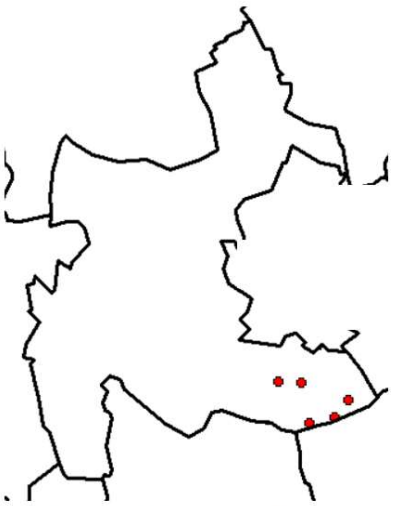
The CRG 1:250 grid reflects claims experience.

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. Although the superficial geology is largely non-cohesive, claims suggest the presence of shrinkable deposits in these locations.

THREE RIVERS

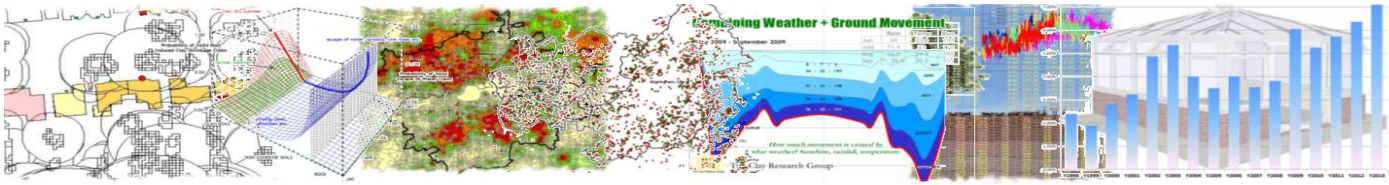


Higher Risk Escape of Water



Claims Involving Council Tree

(2,858 UK claim sample)



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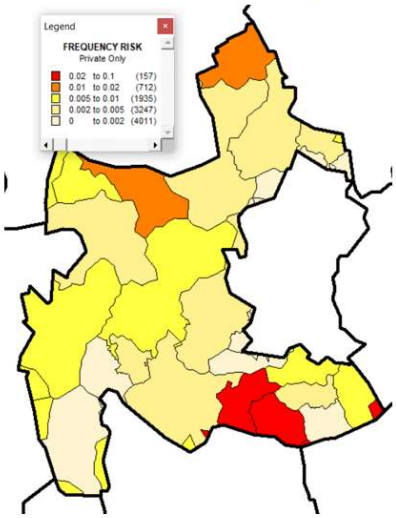
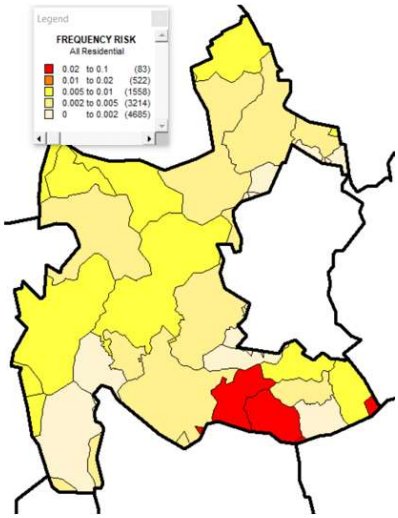
THREE RIVERS - Frequencies & Probabilities

Below, mapping the risk of subsidence by ownership. Claims frequency including council and housing association properties delivers a misleading value of risk as they tend to self-insure. The following show the normalised risk, taking account of the private housing population.

THREE RIVERS - Sector Risk by Home Ownership



Private Only



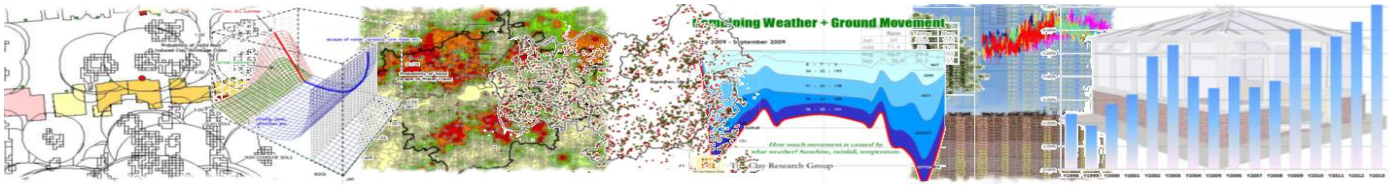
All Properties

On a general note, a 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 - THREE RIVERS

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Three Rivers	0.632	0.130	0.238	0.08	0.37	0.55



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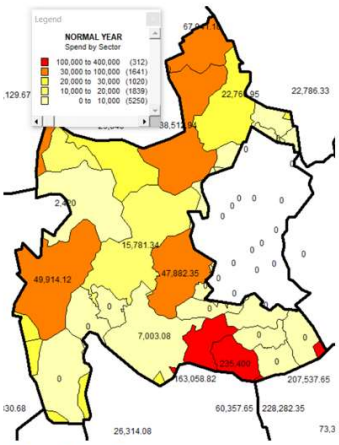
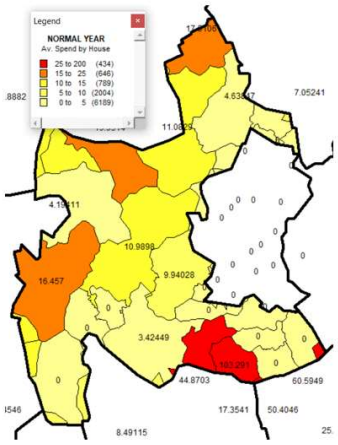
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

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 - THREE RIVERS



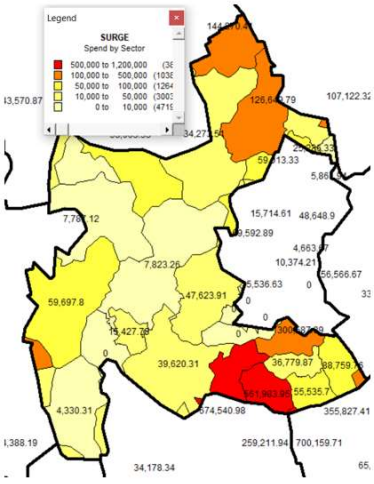
Spend by Sector



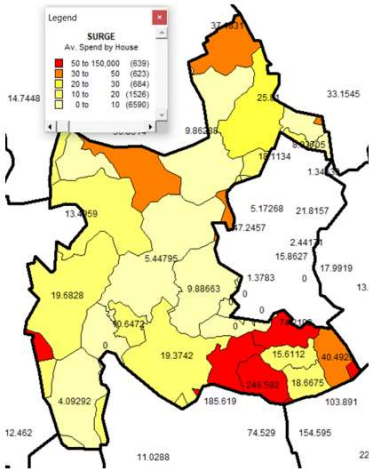
Spend Averaged over Housing Population

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.

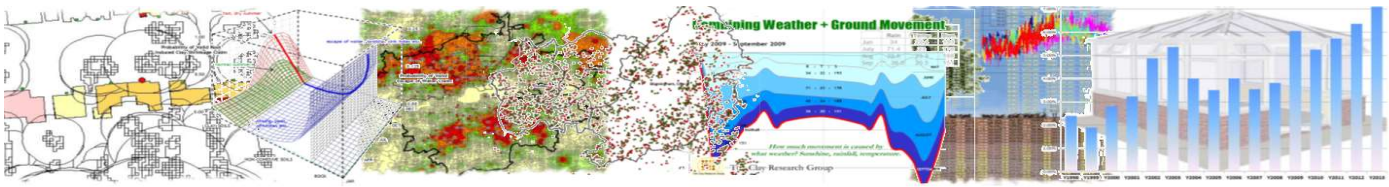
SURGE YEAR SPEND – THREE RIVERS



Spend by Sector



Spend Averaged over Housing Population



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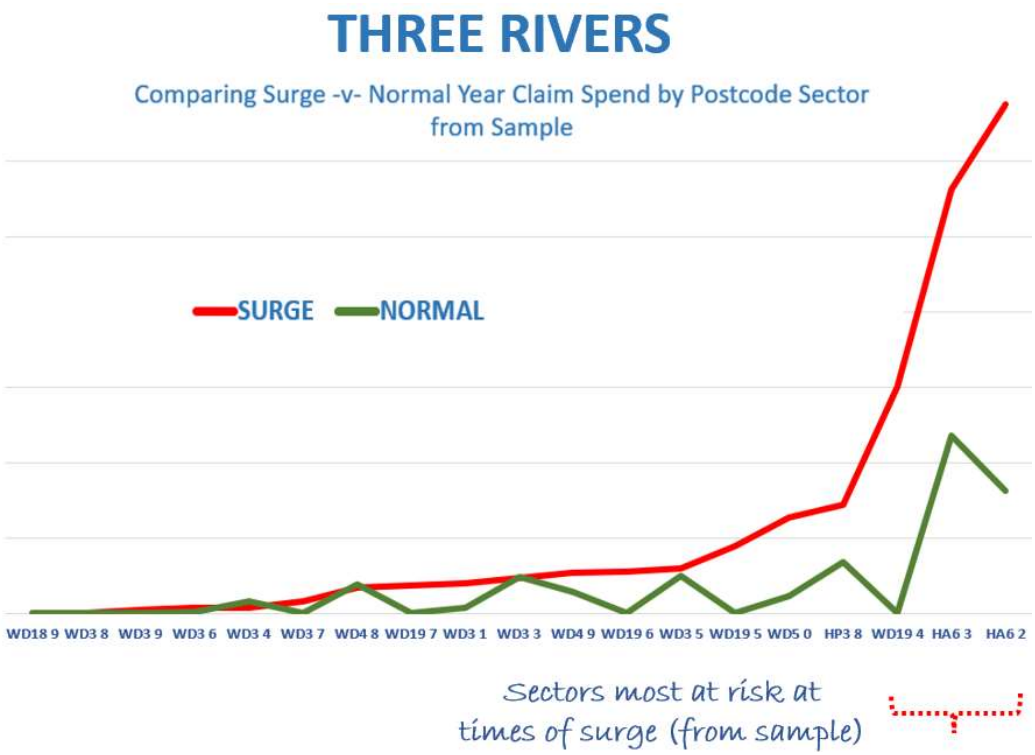

The above graph identifies the variable risk across the district at postcode sector level from the sample, distinguishing between normal and surge years. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

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