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

May 2021
Issue 192

The Clay Research Group

CONTENTS

Issue 192, May 2021

TDAG Meeting

Sue James from TDAG confirms that a zoom meeting is being held on Tuesday the 18th May 2021, starting at 15.00 and continuing to 16.30. Item 4 of the meeting is entitled ''subsidence, foundations and trees''.

BGS Risk Model

The British Geological Survey are holding a Webinar at 1pm on Thursday, 20th May to reveal their new product, GeoClimate UKCP18 data. The model deals with "potential change in subsidence due to changes in climate, identifying areas projected to experience the largest increases in susceptibility to subsidence over the next century."

UKCRIC Update

Professor Anastasios Sextos hosted a webinar on the 19th April outlining the work undertaken at Bristol University as part of the UKCRIC funded research project. This included the construction of a soil testing facility incorporating a shake table to emulate earthquake conditions and a soil tank plus other equipment. Unfortunately, clay soils are the most difficult to model in the soil tank given their cohesive properties.

The date for applications for collaboration with the new UKCRIC National Facility for Soil-Foundation-structure interaction has now passed and further details will be available shortly.

Cranfield is a founder member of UKCRIC and invite you to join them to learn more about UKCRIC's vision and the various facilities which are available to support your research and are hosting a talk on the 19th May from mid-day and scheduled to last an hour. To learn more about UKCRIC's vision register at:

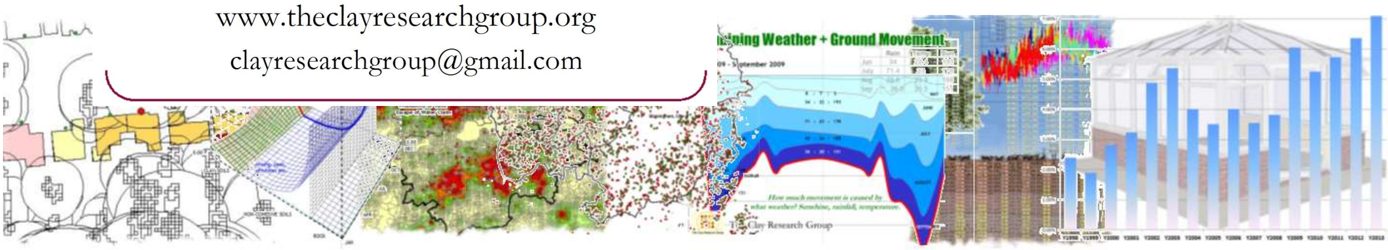
https://www.ukcric.com/events/ukcric-roadshow-at-cranfield/

Contributions Welcome

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

clayresearchgroup@gmail.com

THE CLAY RESEARCH GROUP
www.theclayresearchgroup.org
clayresearchgroup@gmail.com

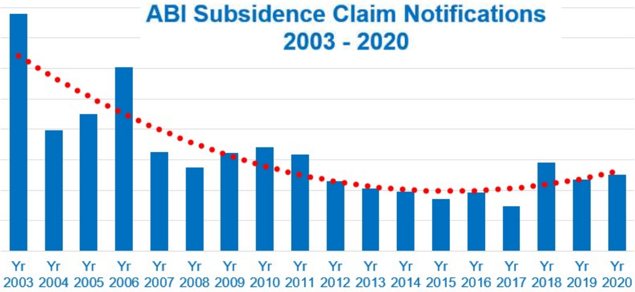


The Clay Research Group

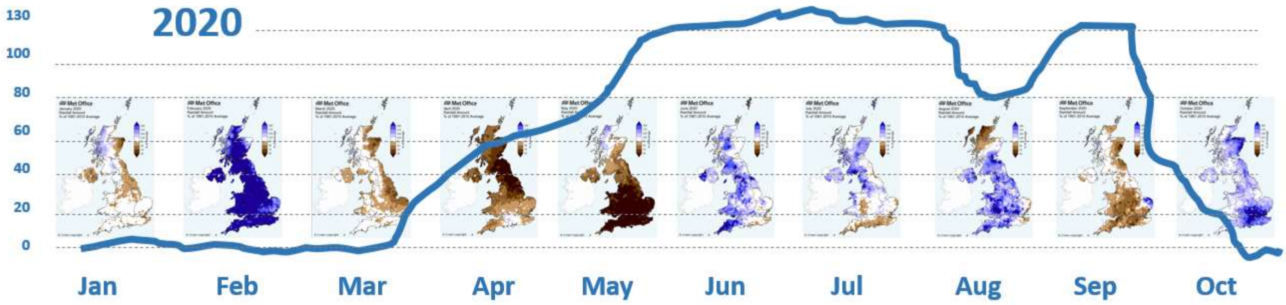
Claim Numbers, SMD and Anomaly Mapping

Following a steady decline in claim numbers since 2006, the last three years have perhaps shown some stabilisation, albeit at a much lower level.

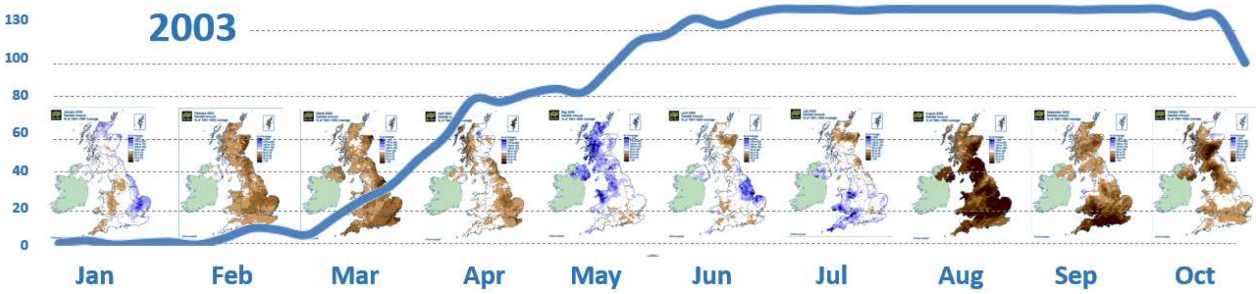
The 'y' axis shows claim numbers in thousands with a value in 2020 of 125,000.

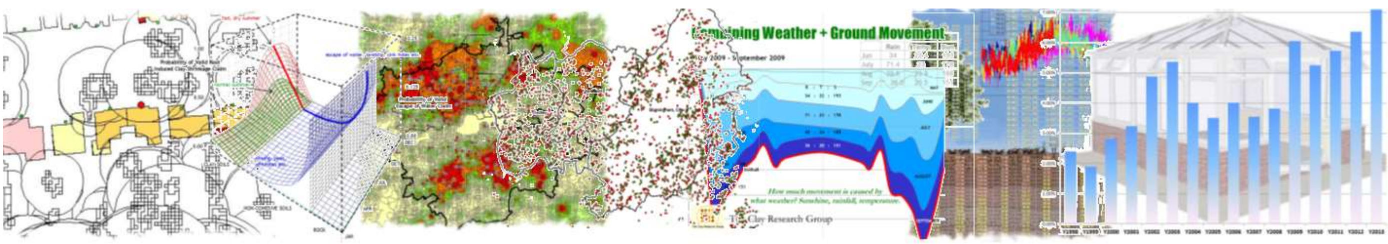


Below, average monthly rainfall maps for January to October comparing 2020 and 2003 with anomaly maps for the period 1981 – 2010. The SMD values (blue line for grass) have been superimposed. SMD data has been gathered by the Met Office from the Heathrow weather station.



In 2020 (above), SMD shows soil drying started in April and reached around 70mm by the end of the month, increasing to 117mm by the end of May, a particularly dry month increasing to the south of the UK. June and July remained steady with a deficit reaching the maximum value of 134mm. Rainfall in August delivered some respite as revealed by the dip in the SMD graph and was followed by a dry spell in September before returning to around 10mm at the end of October. 2003 (surge year, below) anomaly mapping reveals moderate drying early in the year followed by an average period from May to July before quite severe drying in August.

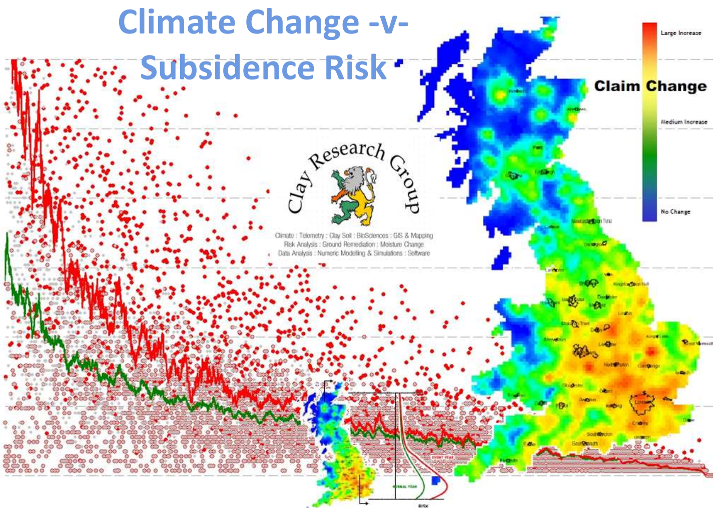




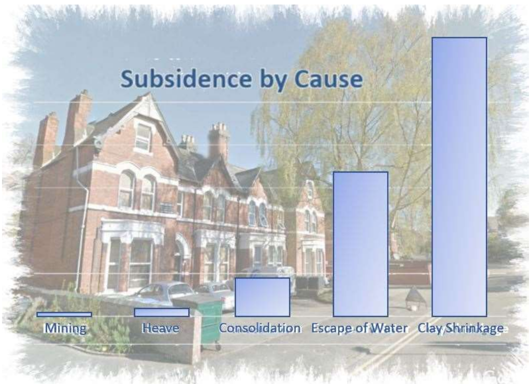
The Clay Research Group

Graphs from the Past

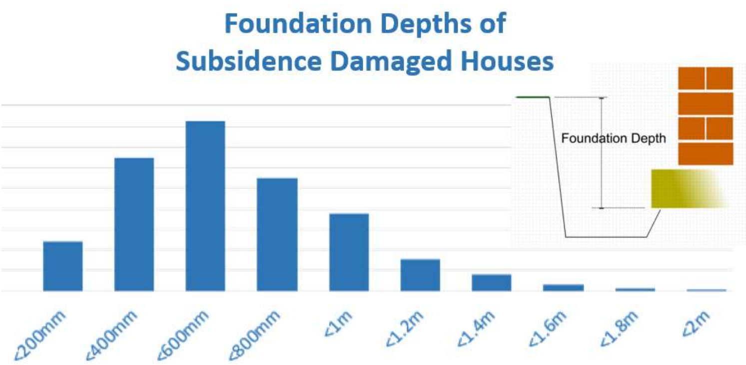
Well, the not-too-distant past. Given the ‘working from home’ environment we have been given the opportunity to review what we have learnt from analysing the data and reviewing some of the graphs that have appeared since the launch of the CRG.



Graph showing count and distribution of claims in surge (red) and normal (green) years and mapping subsidence risk distribution associated with climate change. Distribution increases significantly to the left of the ‘x’ axis associated with the presence of clay soils, which cover around 20% of the UK, with high density housing in the south east.

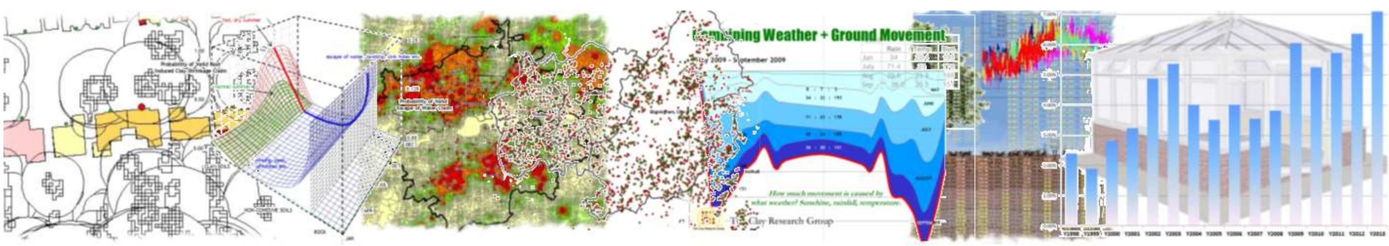


Right, a bar graph indicating the distribution of claims by cause, with clay shrinkage the most common (variable by year – surge or normal years) followed by Escape of Water, consolidation, heave and mining.



Left, existing foundation depths from large sample of site investigations undertaken following a claim for subsidence on a domestic property.

As might be expected, the majority have a depth to the underside of 600mm or less.



The Clay Research Group

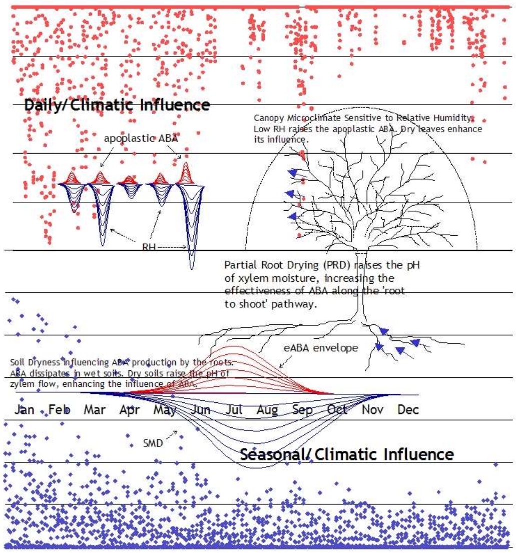
Graphs from the Past ... *continued*

The graph, right, plots the relationship between relative humidity and production of eABA, the plant hormone controlling stomatal aperture.

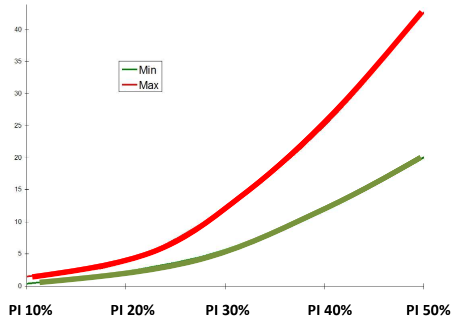
ABA provides protection to vegetation in drought conditions by reducing transpiration.

Providing water to part of the root zone raises the pH of the xylem, increasing the effectiveness of this stress hormone and provides an effective medium to transport it to the canopy.

Relative Humidity and ABA Production



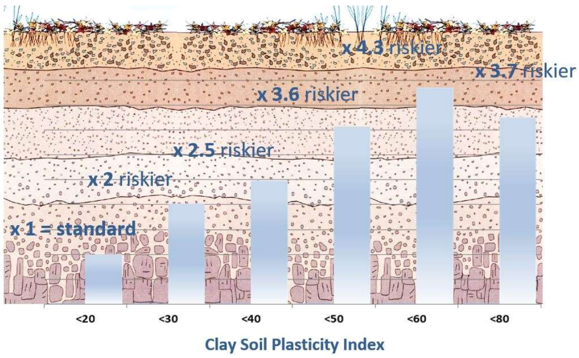
Relationship Between Swell Potential and Soil Plasticity Index

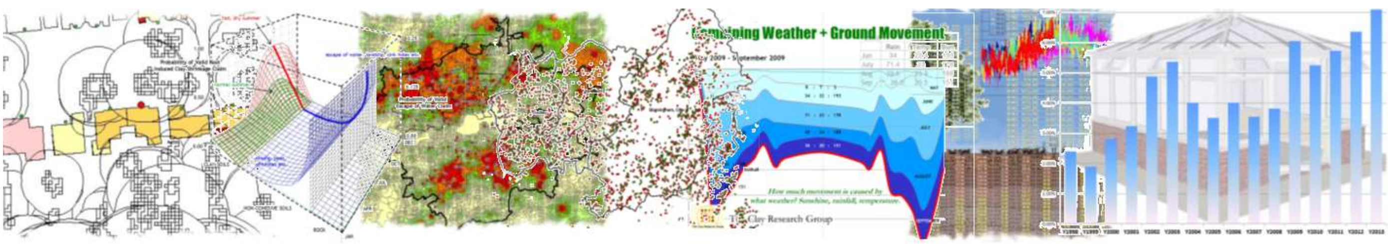


Left, graph taken from a paper by Seed *et al,* entitled "Prediction of Swelling Potential for Compacted Clays" published in the Journal of Soil Mechanics, Foundation Division, ASCE in 1962 showing the relationship between the soil plasticity index and swell potential.

Putting the Risk of Subsidence into Perspective. Variation in Risk by PI

The bar graph, right, plots the risk of subsidence from a sample of over 100,000 claims based on the soil plasticity index, confirming the higher the PI, the greater the risk.



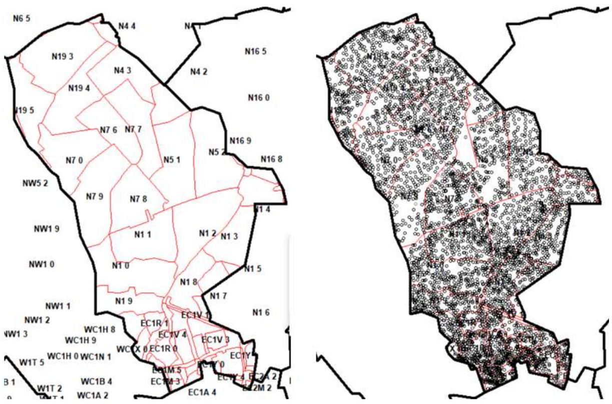


The Clay Research Group

Subsidence Risk Analysis – ISLINGTON

Islington occupies an area of 14.86km^2 with a population of around 317,250. The district was originally covered in edition 47, April 2009 of the CRG newsletter. It is re-visited here to bring it in line with the current series and allow comparisons in terms of risk.

ISLINGTON

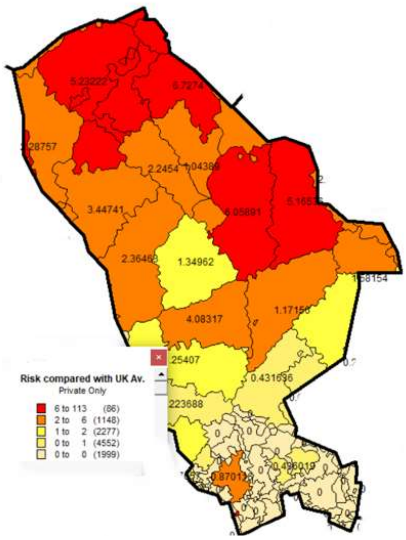


Postcode Sectors **Housing Distribution by Full Postcode**

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.

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?

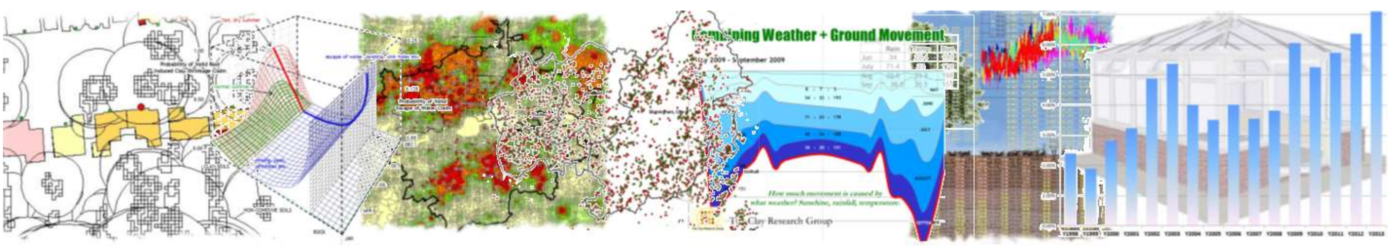
Using a frequency calculation (number of claims divided by private housing population) the relative risk across the borough at postcode sector level is revealed, rather than a 'claim count' value.



Risk compared with UK Average.
Islington is rated as high risk for domestic subsidence claims from the sample analysed based on the high frequency to the south of the borough. Above, values at postcode sector level compared with UK average.

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

Islington is rated as high risk and is 14th in the UK from the sample analysed, although the distribution across the borough varies considerably as can be seen from the sector map.

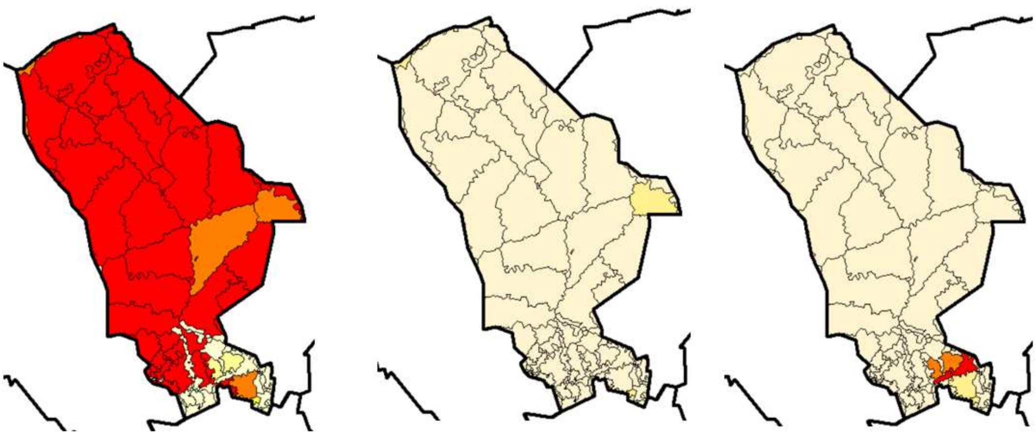


The Clay Research Group

ISLINGTON - 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 policies allow insurers to assign a rating to individual properties.

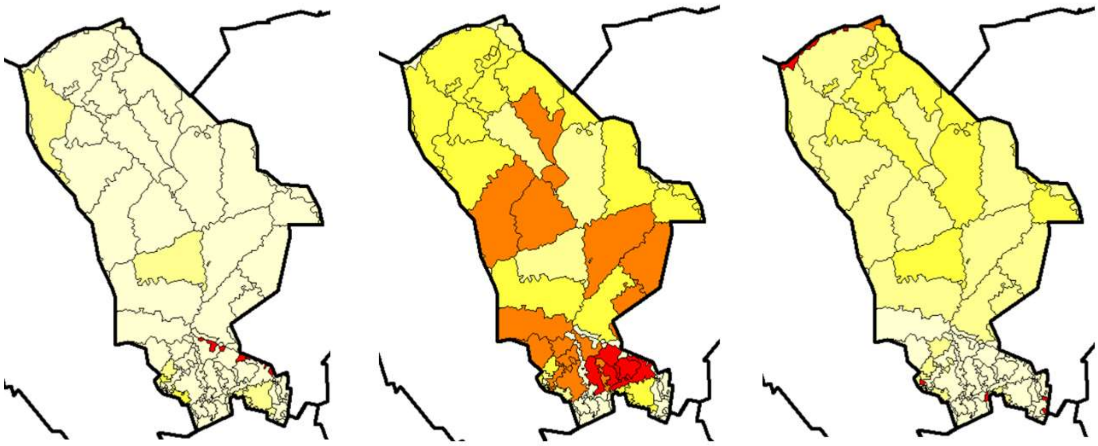
DISTRIBUTION BY HOUSE TYPE – ISLINGTON



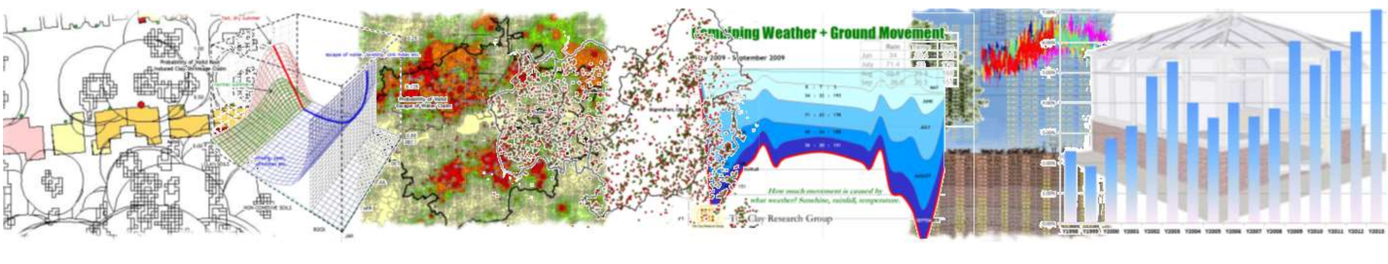
Terraced | Semi-Detached | Detached

Distribution by ownership is shown below. The maps reveal a high frequency of council properties to the north of the borough and higher concentration of privately owned properties to the south, which will influence the outcome of the risk analysis.

DISTRIBUTION BY OWNERSHIP - ISLINGTON



Housing Association | Council Ownership | Private Ownership



The Clay Research Group

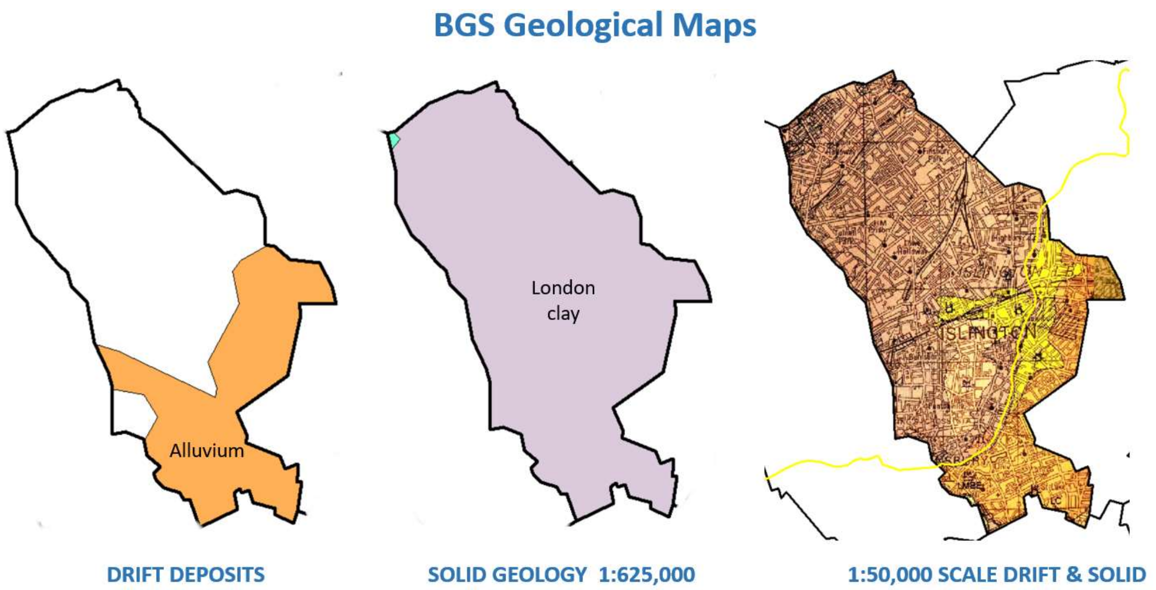
Subsidence Risk Analysis – ISLINGTON

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.

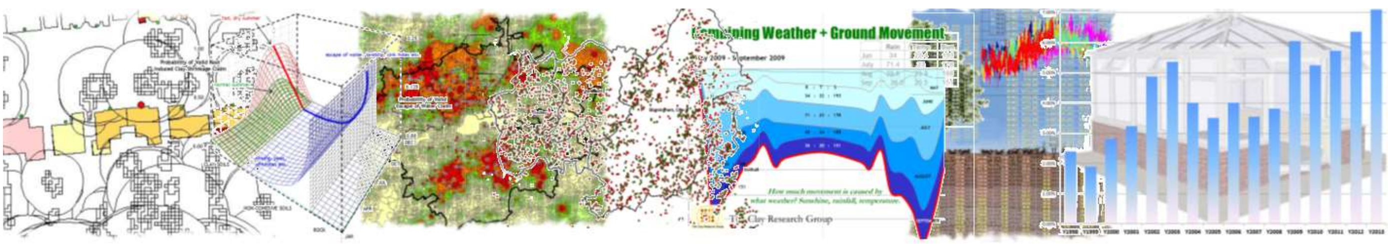
See page 10 for a seasonal analysis which reveals that in the summer there is around a 70% probability of a claim being valid, and of the valid claims, there is a high probability (greater than 90% in the sample) that the cause will be due to clay shrinkage.

In the winter the situation reverses. The likelihood of a claim being declined is around 70%.

The analysis reflects the influence of the outcropping clay series



Above, comparing the level of definition between the 1:625,000 and 1:50,000 series extract from the British Geological Survey maps. Working at postcode sector and referring to the 1:50,000 series maps deliver far greater benefit when assessing risk.

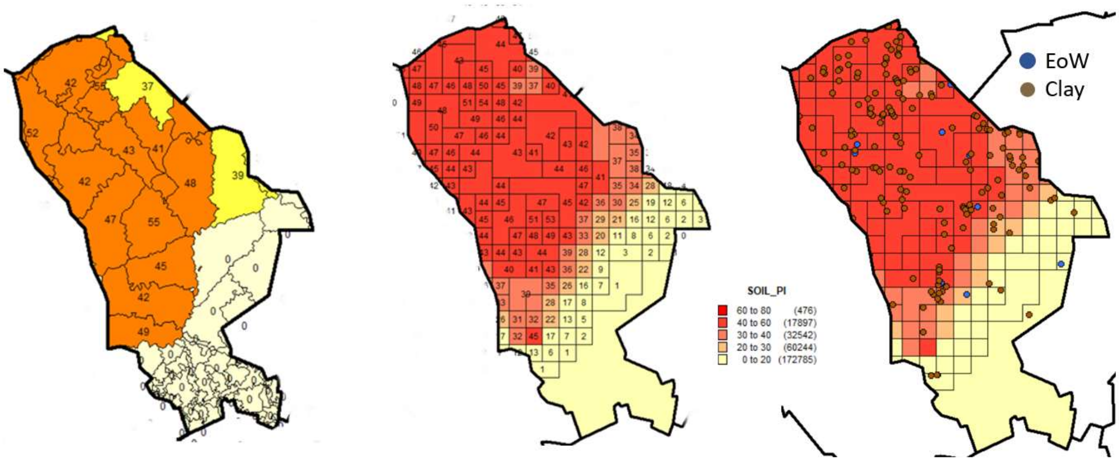


The Clay Research Group

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 presence of a shrinkable clay in the CRG model matches the BGS maps on the previous page with clay having an average PI of around 46% where it exists. The higher the PI values, the darker red the CRG grid.

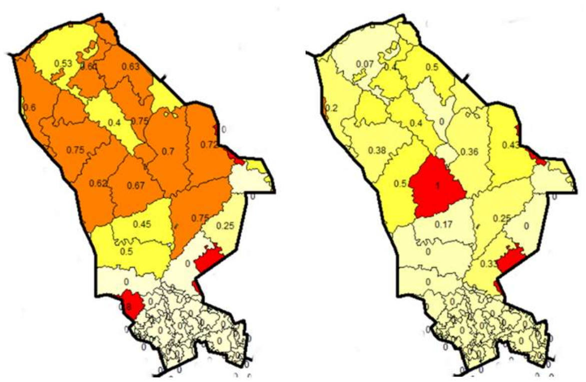
SOIL PLASTICITY INDEX – ISLINGTON



Soil PI Averaged by Sector | PI Interpolated on 250m CRG grid | Claims by Cause Relative to 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.

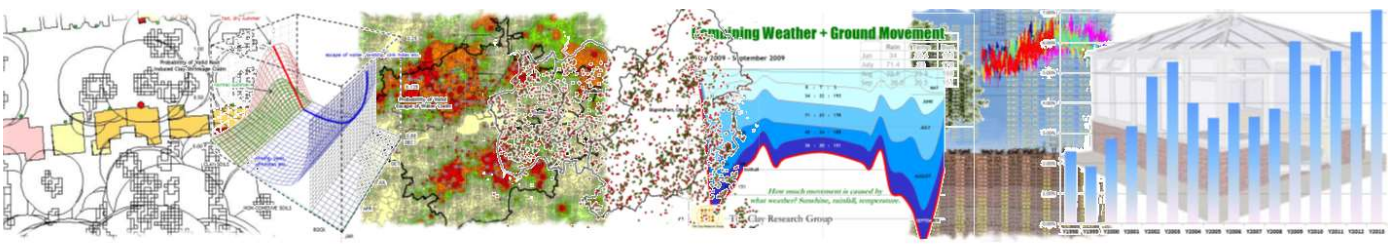
PROBABILITY VALID by SEASON - ISLINGTON



Probability Valid, Summer | Probability Valid, Winter

Mapping the risk by season (table on page 10) is perhaps the most indicative factor when assessing likely risk, causation and geology using following values.

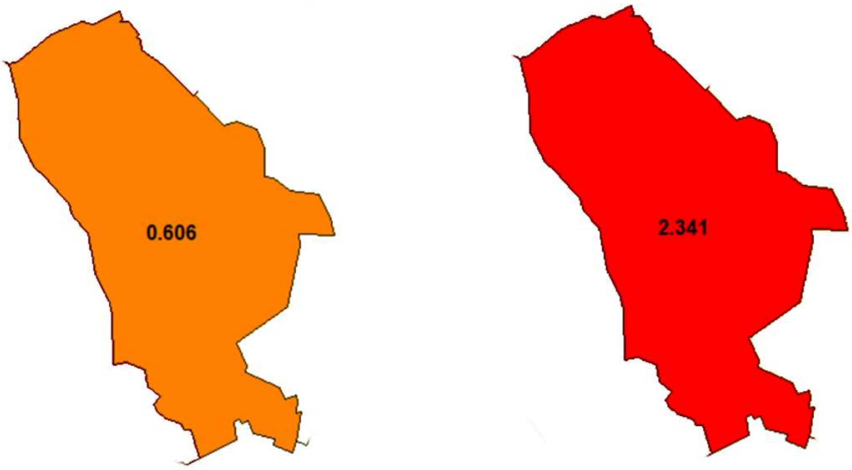
Declinatures of 20% or less in the summer, and of the valid claims, around 70% or more in the summer is usually an indicator of clay shrinkage.



The Clay Research Group

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

SUBSIDENCE RISK RELATIVE TO UK - ISLINGTON



Normalised (0 – 1) Scale   Compared with UK Average

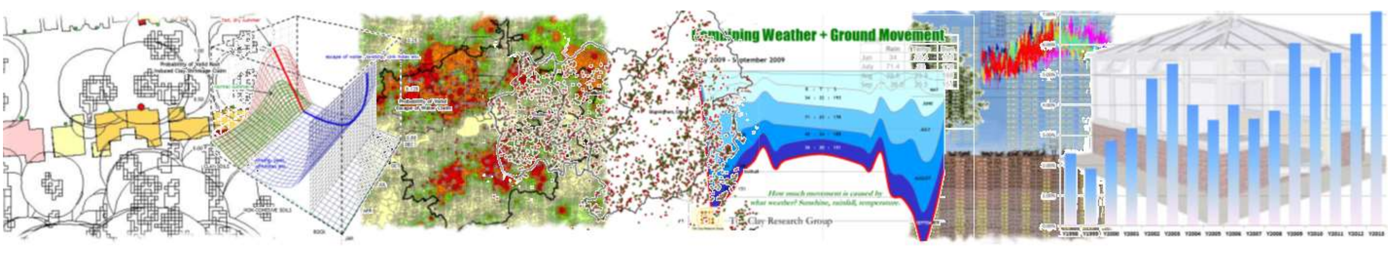
Below, left, mapping the frequency of escape of water claims from the sample reflects the presence of drift deposits (sands and gravels etc) to the south of the borough, bordering the Thames. The absence of shading does not indicate an absence of claims, but a low frequency. Below, centre, tree related claims map plotting claims from a sample of around 10,231 UK claims where damage has been attributable to vegetation in the ownership of the local authority. Right, a map showing the modelled root encroachment (grey shading - public and private trees) beneath domestic properties in Islington using a root radius = 1.2 x the tree height.

Escape of Water –v- Tree Claims ISLINGTON

Higher Risk Escape of Water (17,852 claim sample)

Claims Involving Trees (10,231 claim sample)

Modelled Root Overlap Zones on outcropping London clay

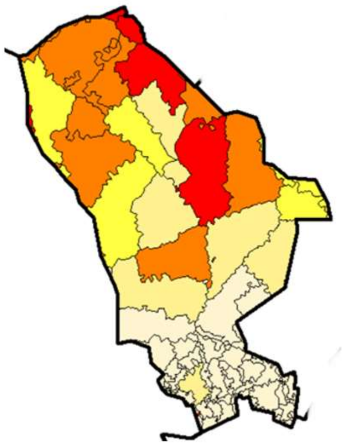


The Clay Research Group

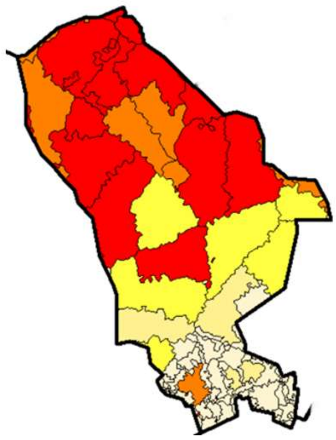
ISLINGTON - Frequencies & Probabilities

Mapping claims frequency against the total housing stock by ownership, (left council, housing association and private) and private housing only, right, reveals the importance of understanding risk by portfolio.

POSTCODE SECTOR SUBSIDENCE RISK (FREQUENCY)
BY OWNERSHIP - ISLINGTON



Combined Public and Private Frequency

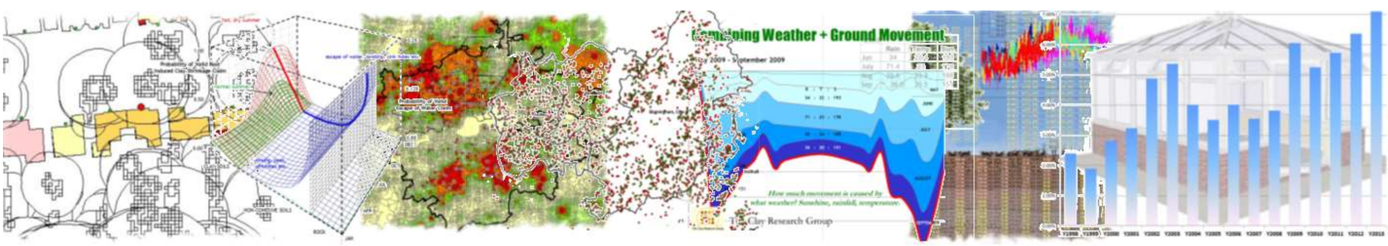


Private Only

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 valid in the summer is just under 80%, and in the winter, it falls to less than 20%. Valid claims in the summer are likely to be due to clay shrinkage, and in the winter, escape of water.

Liability by Season - ISLINGTON

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Islington	0.721	0.064	0.215	0.01	0.16	0.83

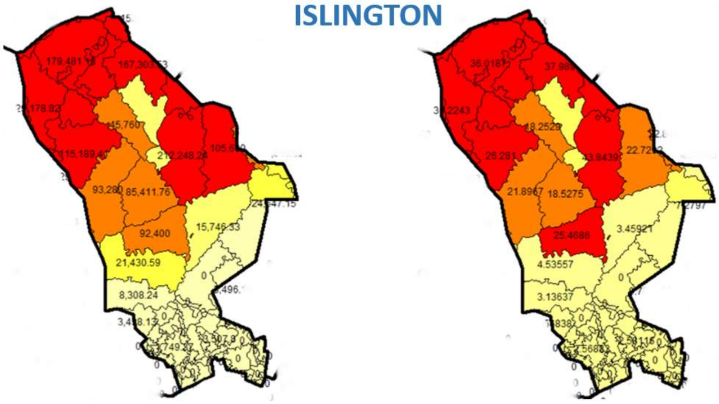


The Clay Research Group

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.

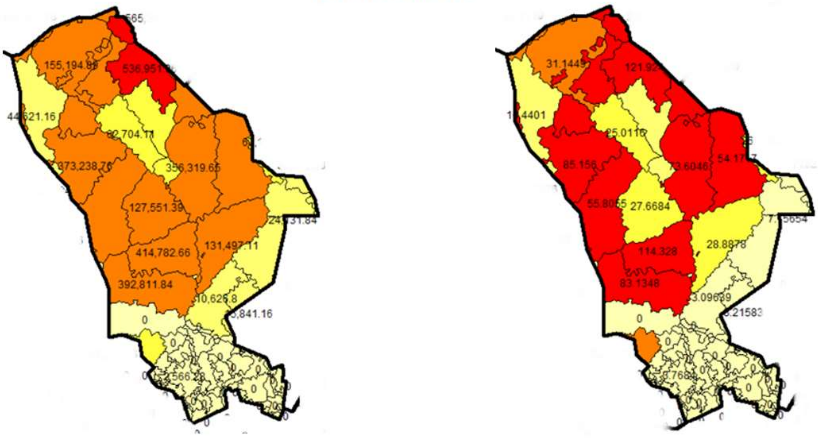
NORMAL YEAR SPEND – SAMPLE £200m
ISLINGTON



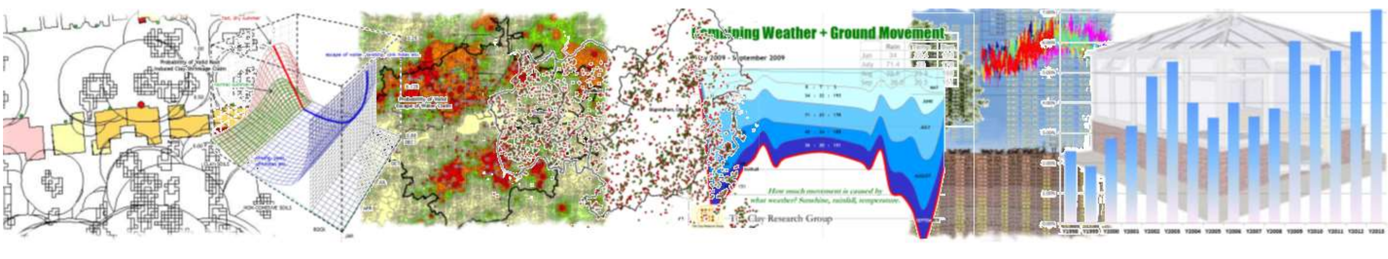
Spend by Sector — Spend Averaged over Housing Population

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.

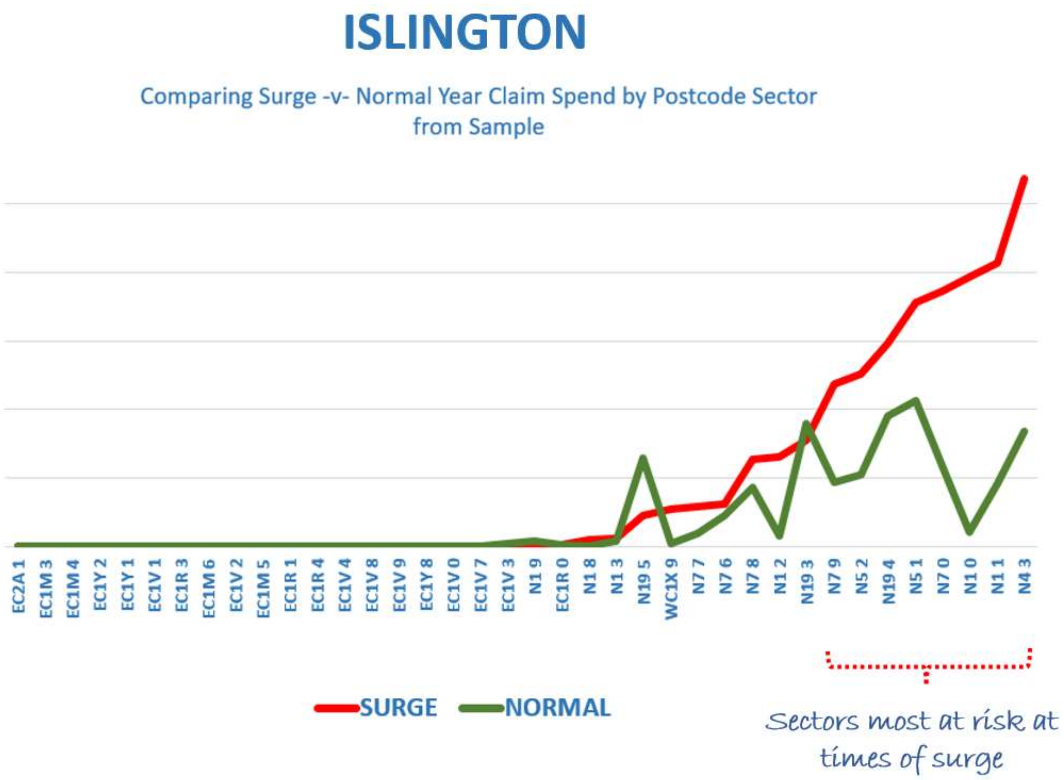
SPEND in SURGE – SAMPLE £419m
ISLINGTON



Spend by Sector — Spend Averaged over Housing Population



The Clay Research Group



The above graph identifies the variable risk across the district at postcode sector level, 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.