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

November 2020
Edition 186

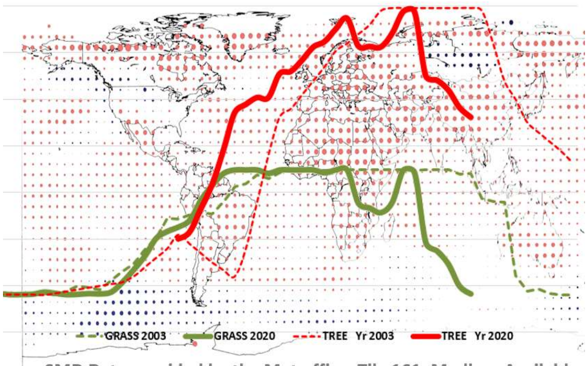
The Clay Research Group

CONTENTS

Issue 186, November 2020

SMD Update

SMD data for both grass (green) and trees (red). Dotted lines plot data for the 2003 surge year.



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

Data supplied by the Met Office for Tile 161 situated to the SE of England.

'Risk by District' series

The format of the 'Risk by District' series has evolved since it started some years ago (Islington was the first borough and appeared in the April 2009 edition). The updated series includes more detailed maps at sector level with data where available. In this edition we re-visit Barnet.

Tree Root Stability & Physiology

A paper entitled, "Evaluating the effects of trenching on growth, physiology and uprooting resistance of two urban tree species over 51-months" explores the effect of cutting through tree roots in terms of health and stability. Published in the journal **Urban Forestry & Urban Greening** at:

https://www.sciencedirect.com/science/article/abs/pii/S1618866719308556

Two Houses Collapse

Right, widely reported case of two houses in Durham Place, Chelsea collapsing following roof alterations and excavation for basement extension.

Contributions Welcome

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

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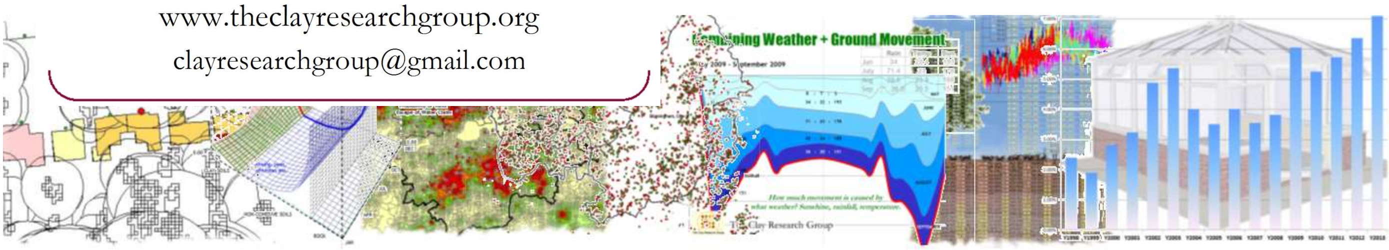

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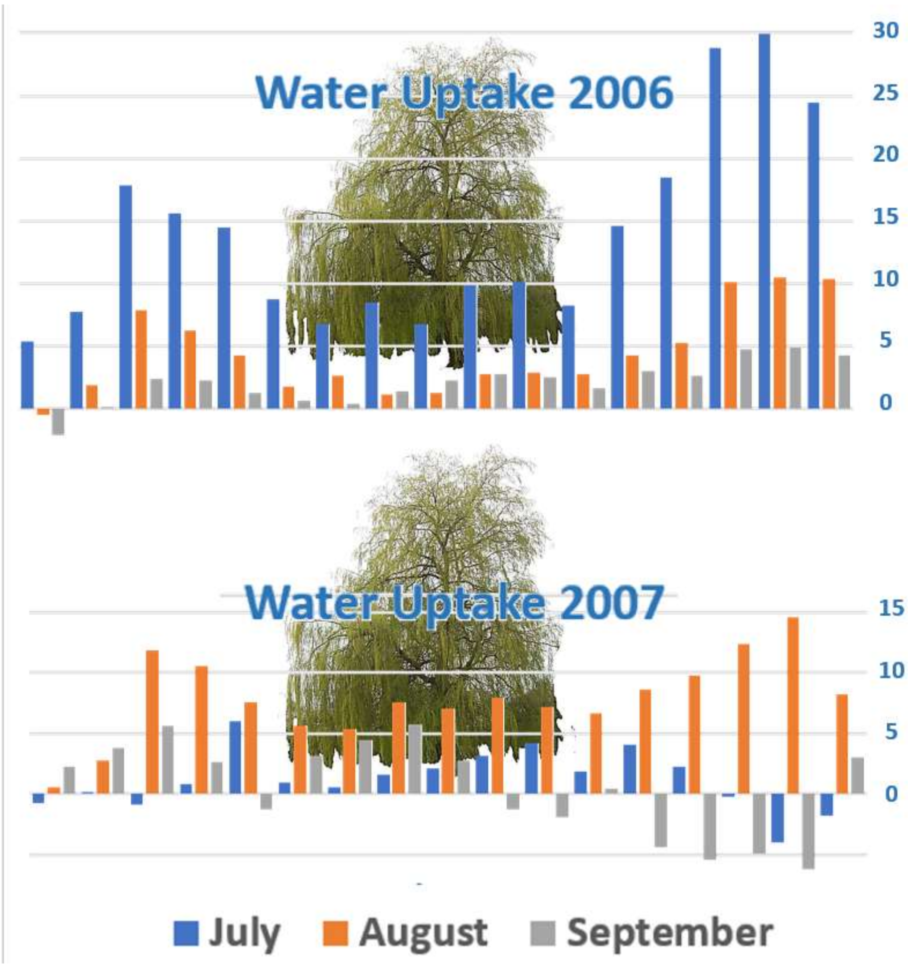
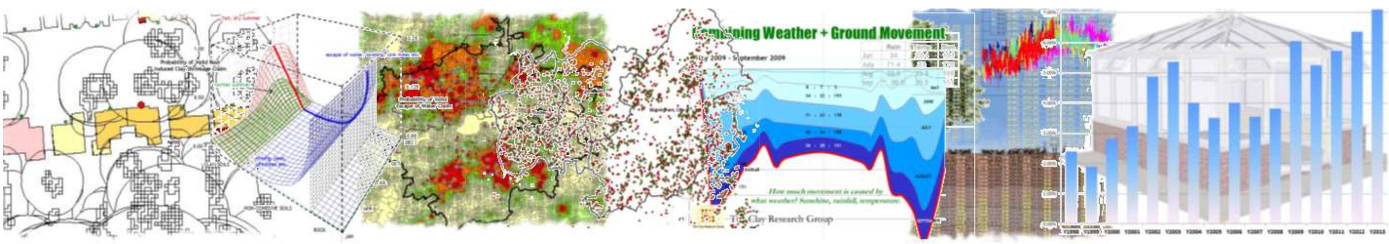
Water Uptake by Month
Aldenham Willow, 2006 - 2007

The graphs below illustrate the water uptake (estimated using ground movement as a proxy) across the two level station arrays. In a dry year (2006), water uptake peaked in July and increased towards the root periphery.



In contrast, 2007 revealed peak moisture uptake in August, again with higher activity towards the root periphery.

In both examples, maximum movement takes place around 15mtrs away from a 14m high tree which may have relevance to the article on the following page relating to H/D ratios.



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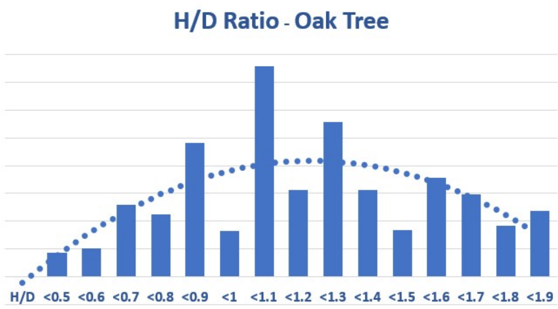
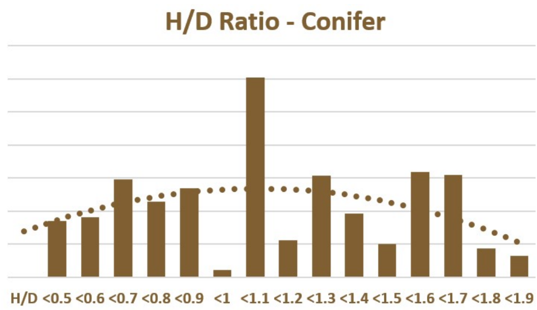
Deriving Probabilities from H/D Ratios

The majority of trees share a 'danger zone' with regard to the H/D ratio of around 1 – 1.1. That is to say, the risk increases significantly when the height of the tree is about the same as the distance to the building. The graphs below plot the H/D ratios for the oak and conifer which share this value, but with very different characteristics in respect of height and distance. Most frequent damage by the conifer in terms of height is in the range 3 – 7mtrs with a distance of between 2 – 3mtrs whereas the oak starts to become riskier at 10mtrs, increasing with both height and distance. The values are typically erratic but when smoothed using trendline analysis the general characteristics emerge.



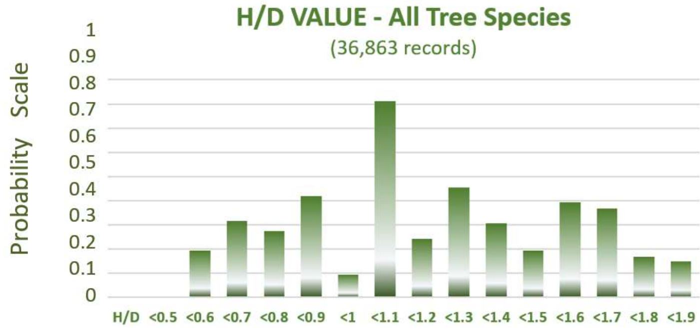


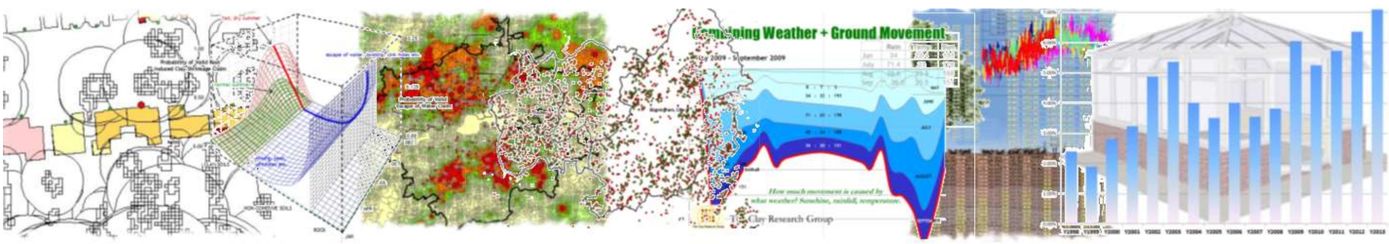
Incorporating H/D values to assess risk posed by trees into our Ai system requires a probability scale. Just how likely is it that the subject tree is implicated when subsidence cracks appear in a property? The approach would be far better if we had some idea of frequency – do we see more or less of a value simply based on population for example? Unfortunately, although we have this data on a national scale, we do not have it for trees growing on clay soils.

The graph below gives a probability allowing the system to assess the likelihood that a tree of known species, with an H/D value of 'x' is implicated. This can be used by the system to factor in geology, weather etc.

The CRG LiDAR survey undertaken in June 2006 modelled root overlap to be 1.2 x tree height to take account of the fact that roots extend beneath the property, not just to its perimeter walling.

See page 12 for more details.





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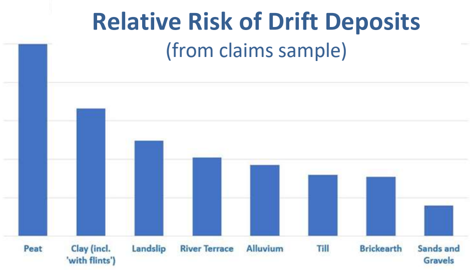
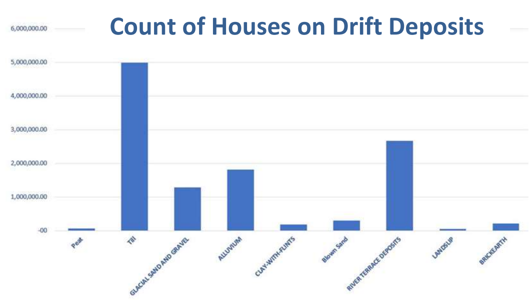
Risk by Geological Series

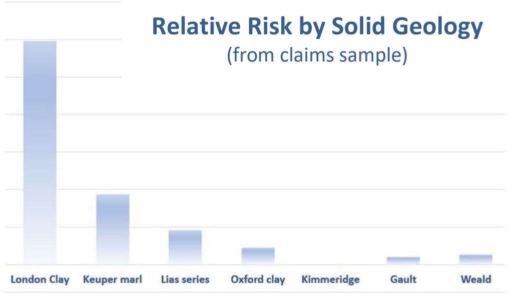
What is the risk by geological series in terms of exposure? An earlier study has revealed peat to be high risk, but how many houses are there built on peat? This overview is based on a sample of around nearly 116,000 claims – estimates are of course approximate.



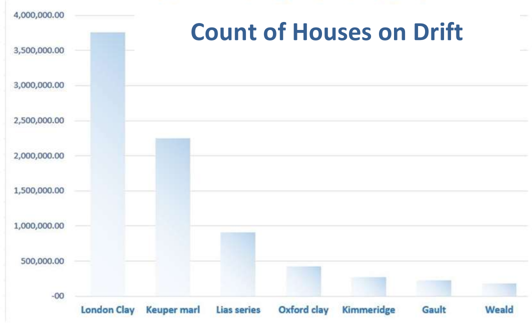
Of the drift deposits, peat poses the highest risk in terms of domestic subsidence claims frequency, followed by a range of clay deposits, landslip etc. See graph, left.



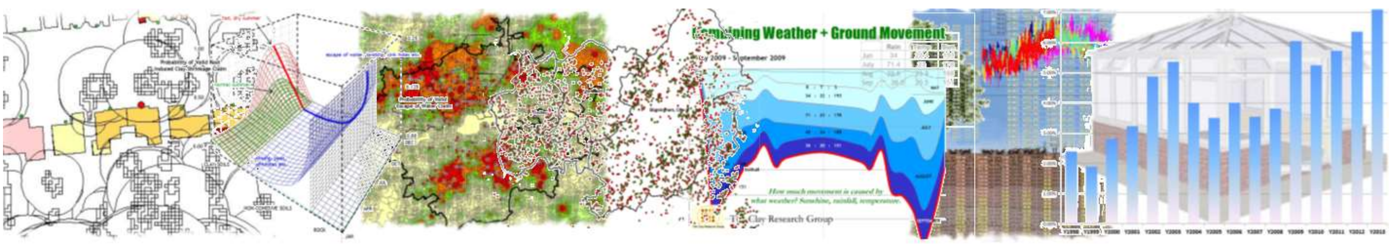
Although peat is rated as a high risk deposit in terms of domestic subsidence, it has far fewer houses built on it leaving claim numbers relatively low but delivering a high frequency.



Unsurprisingly, London clay is rated the highest risk in terms of domestic subsidence, followed by other clay series including Mercia mudstone, Lias, Oxford clays etc.



Unlike peat, London clay represents the highest risk both in terms of count and frequency. The calculation is based on private housing only.



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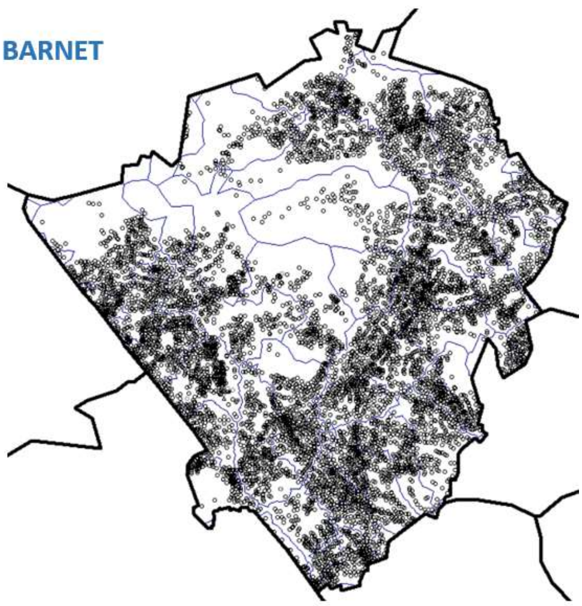
Subsidence Risk Analysis – BARNET

Barnet occupies an area of around 87km^2 with a population of around 350,000.

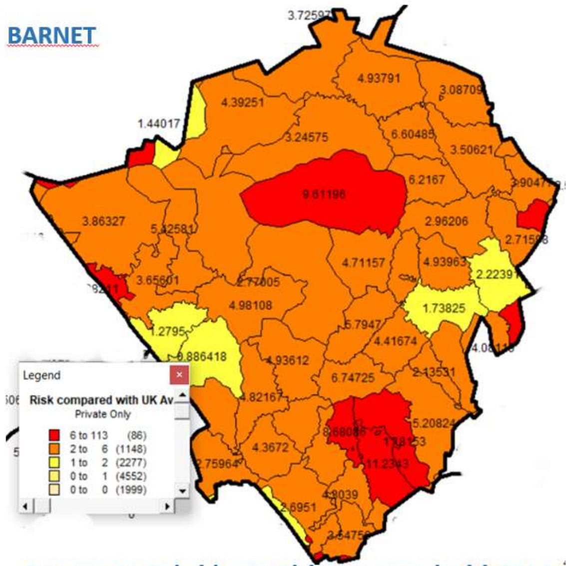


Housing Distribution by Postcode

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.

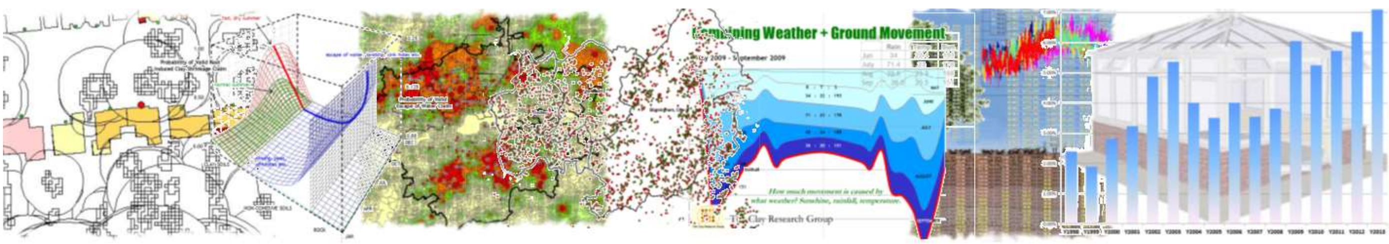


Frequency Subsidence Risk Compared with UK Average

Barnet is ranked as a high risk in the UK in terms of 'risk by district' for domestic subsidence claims from the sample analysed. Above, values at postcode sector level compared with UK average.

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

Barnet is rated as high risk. The UK average has been estimated using private housing only and the figure for Barnet is high due to the relatively low risk across most postcode sectors in the UK.



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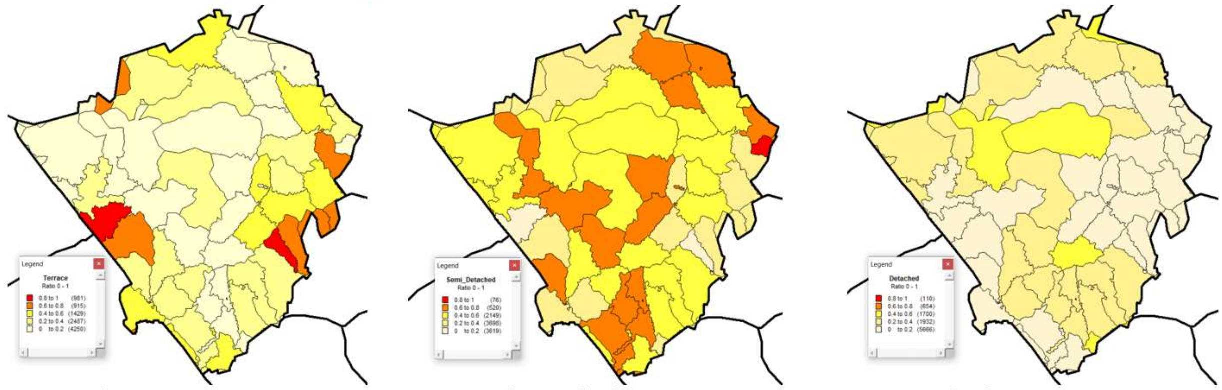
BARNET - Properties by Style and Ownership

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.

BARNET - Distribution by House Type



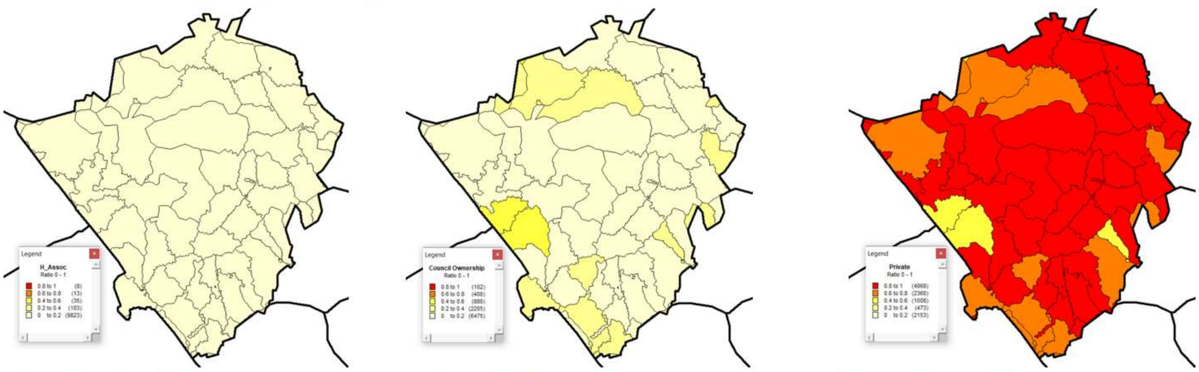
Terraced

Semi-Detached

Detached

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

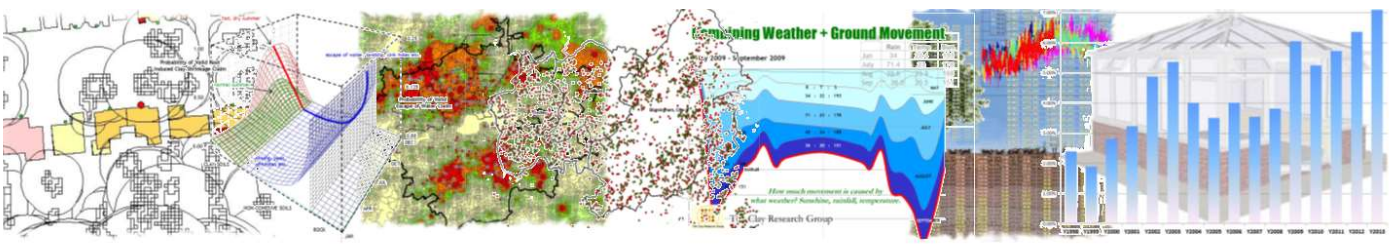
BARNET - Distribution by Ownership



Housing Association

Council Ownership

Private Ownership



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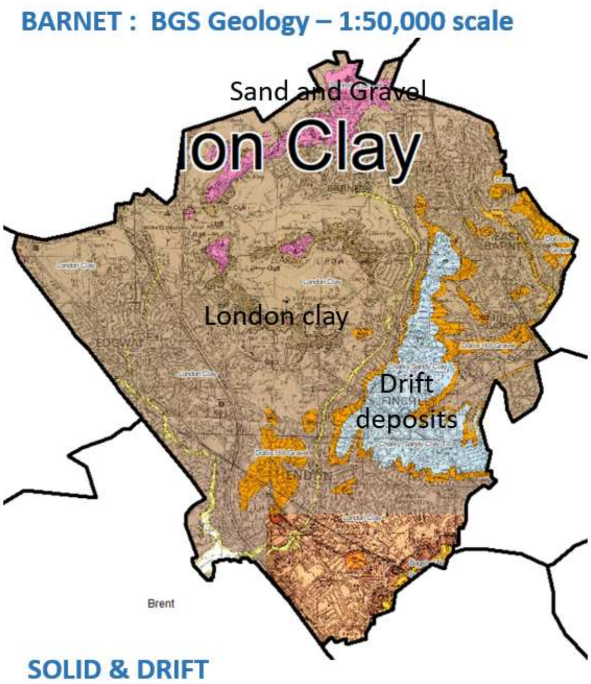
Subsidence Risk Analysis – BARNET

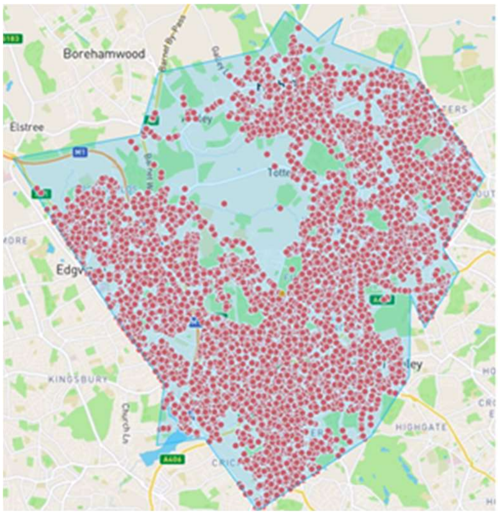
Below, extracts from the British Geological Survey 1:50,000 scale geological maps showing the solid and drift series. View at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html for more detail.



See page 10 for a seasonal analysis which reveals that in the summer the probability of a claim being valid is slightly less than 80%, and of the valid claims, there is a high probability (around 95% from our claim sample) 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 of valid claims is an escape of water – a leaking drain most likely or water service.

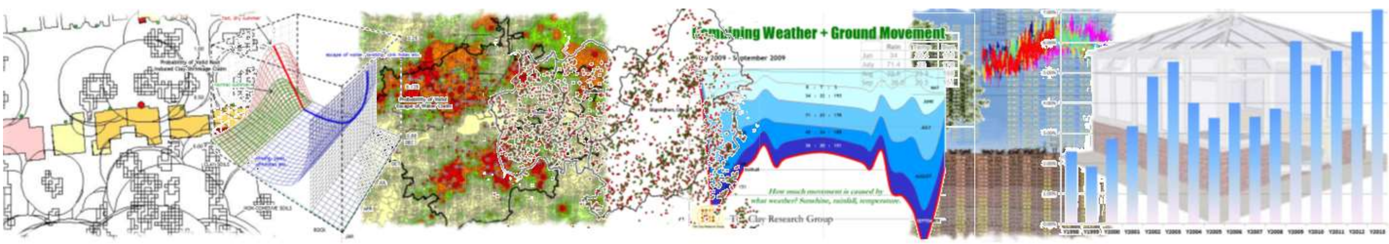
The analysis reflects the influence of the underlying clay series and the apparent shallow thickness of the superficial deposits.



Tree Location and Species

Right, an image from the Treezilla web site showing trees plotted by contributors to the site. Click on a tree to find species etc., and the date the information was last updated.

Access the web site at *https://treezilla.org/*



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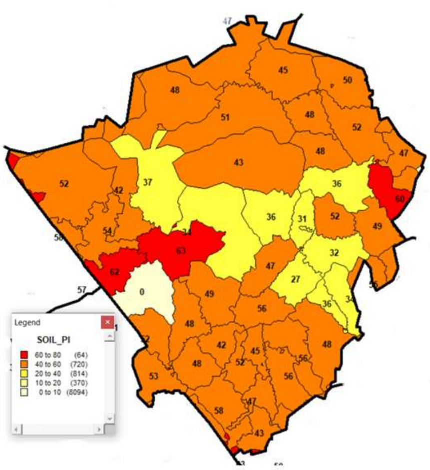
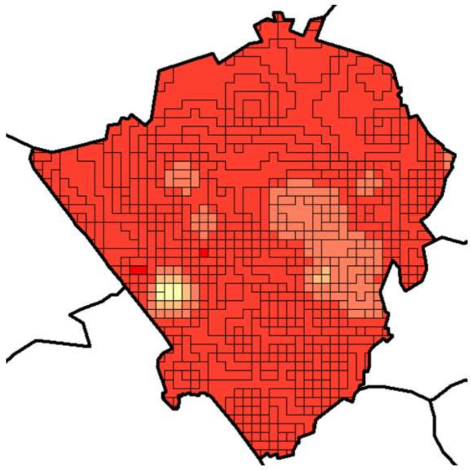
Liability by Season and Geology

Below, the average PI by postcode sector (left) derived from site investigations and interpolated to develop the CRG 250m 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 50% where it exists. The higher the PI values, the darker red the CRG grid.

BARNET – Soil Plasticity Index



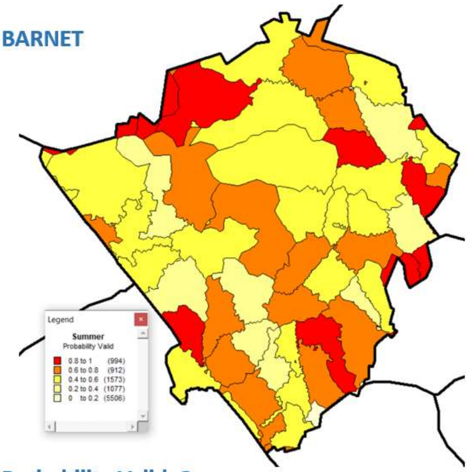
Soil PI Averaged by Sector



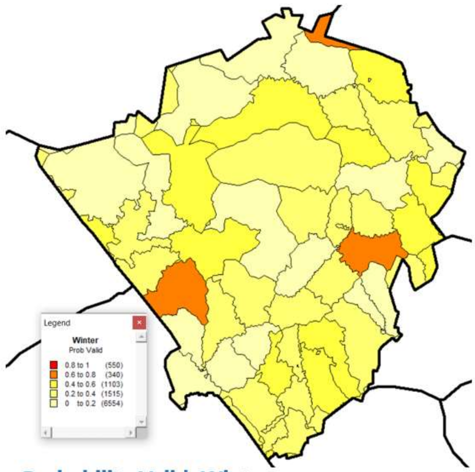
PI Interpolated on 250m CRG grid

Zero values for PI in one sector 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.

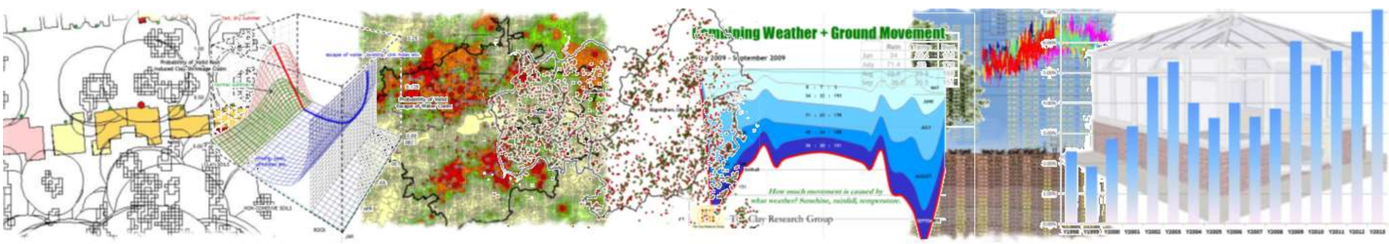
BARNET



Probability Valid, Summer



Probability Valid, Winter



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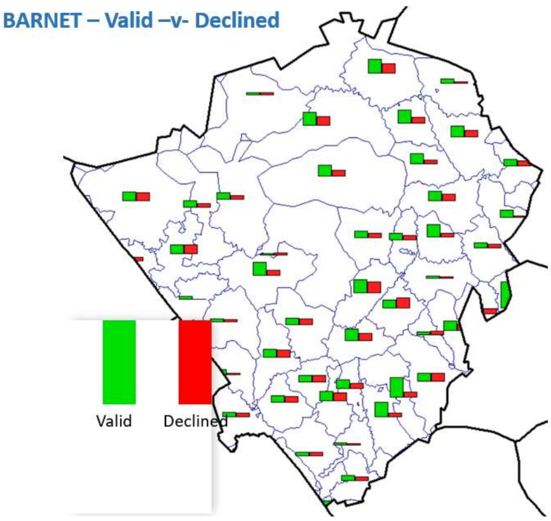
District Layout. EoW and Council Tree Risk.

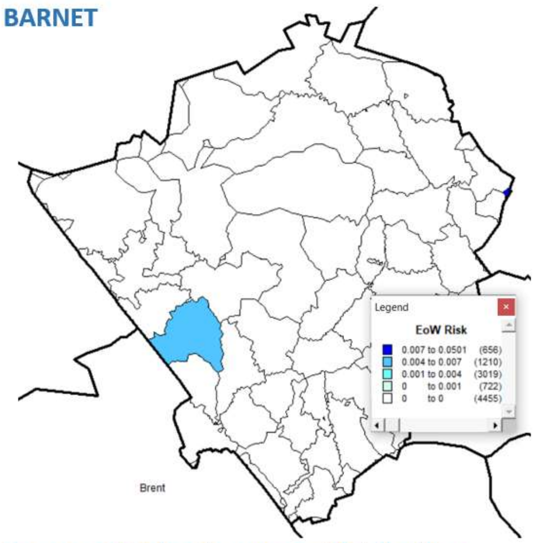


Left, annual valid-v-declined data which changes significantly when considering seasonal data – see page 10.

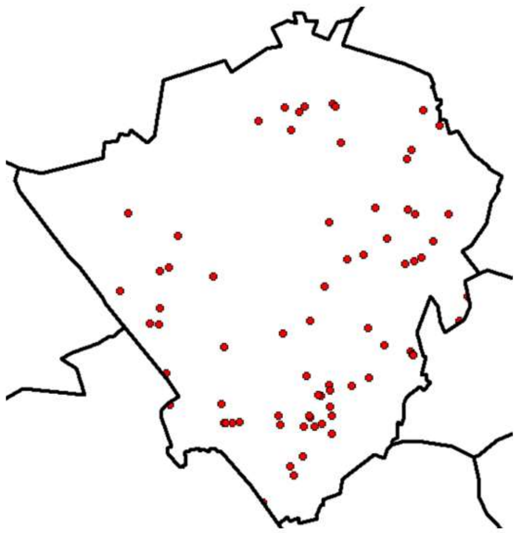
A review using Google Street View is useful in providing context and exploring the differences in property ages and styles of construction across the district.

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

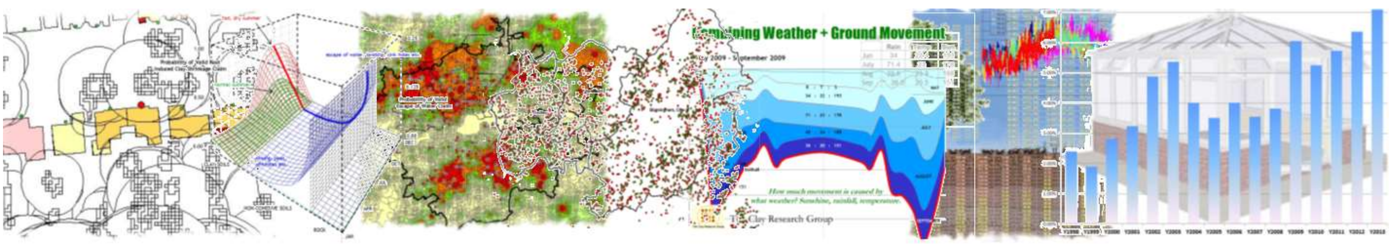
Below, left, mapping the frequency of escape of water claims from the sample reflects the presence of the non-cohesive drift deposits or shallow foundations on backfill given the age of some of the housing stock. Below, right, 'Council Tree Claims' map plotting claims from a small sample of around 2,700 UK claims where damage has been attributable to vegetation in the ownership of the local authority.



Escape of Water Frequency Distribution



Local Authority Street Tree Claims



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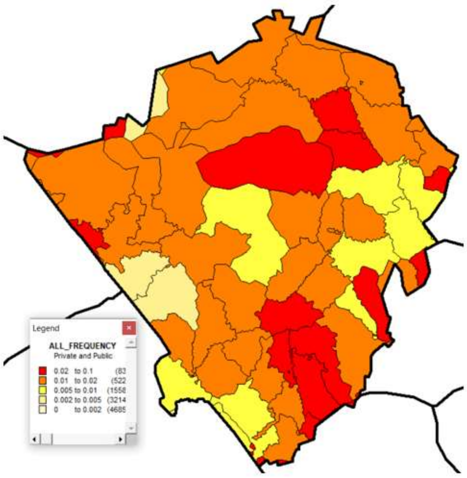
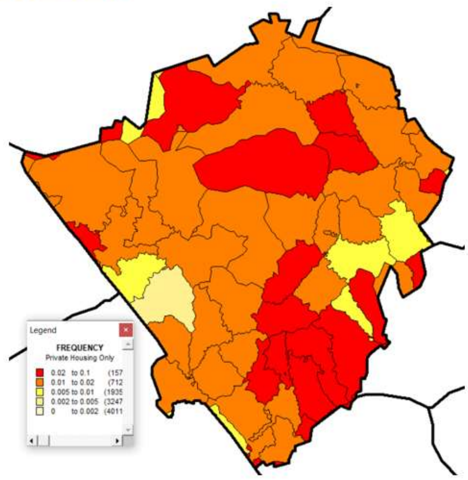
BARNET - Frequencies & Probabilities

BARNET - Postcode Sector Subsidence Risk (frequency) by Ownership



Combined Public and Private Frequency



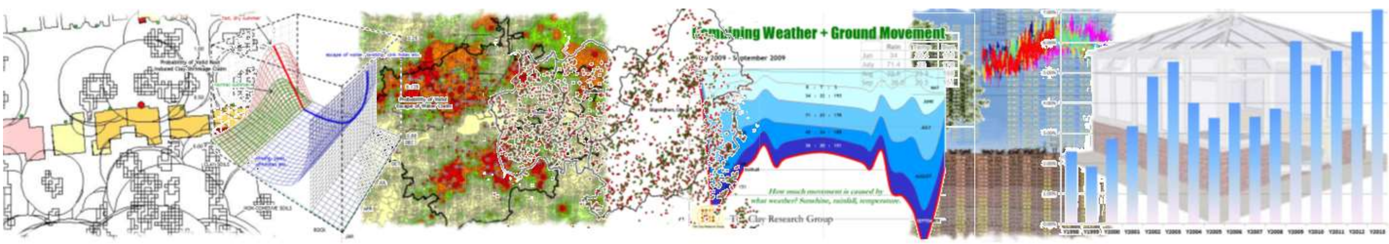
Private Only

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 80%) 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 - BARNET

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Barnet	0.746	0.039	0.215	0.01	0.16	0.83



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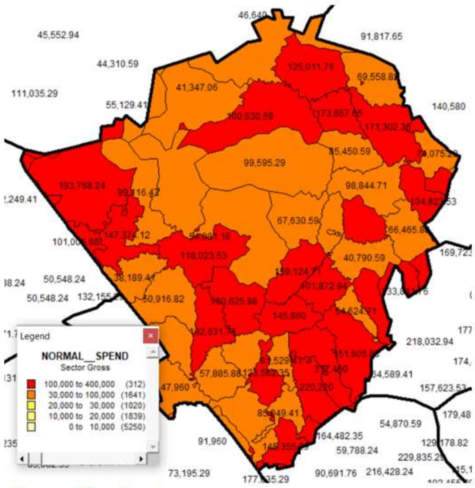
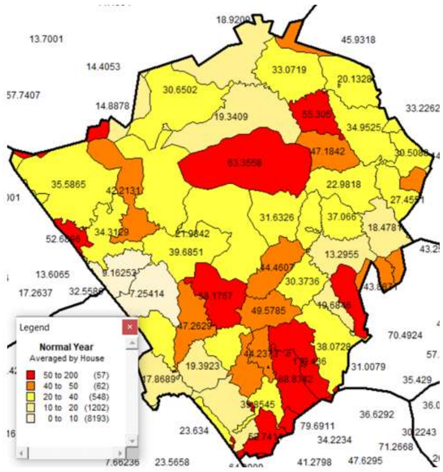
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

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 – BARNET



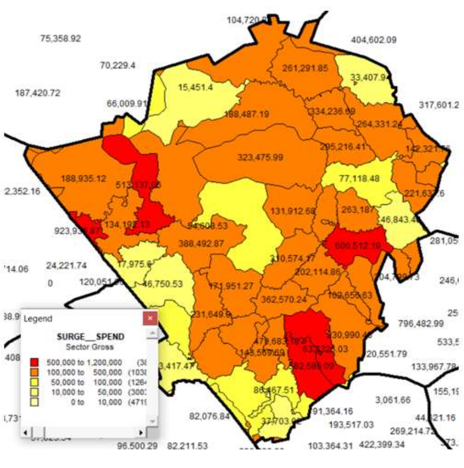
Spend by Sector



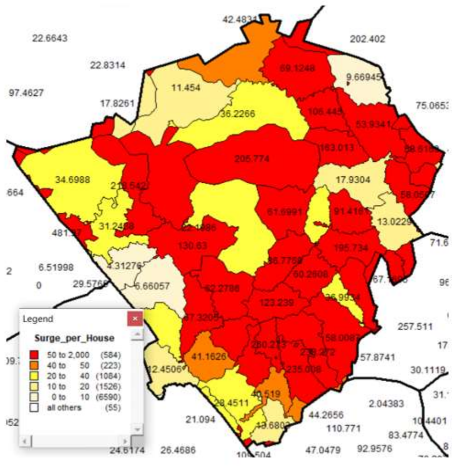
Spend Averaged over Housing Population

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.

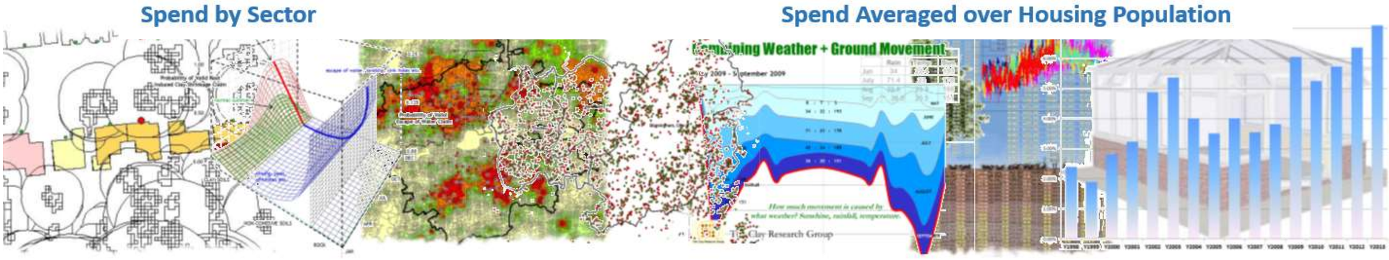
SPEND in SURGE – BARNET



Spend by Sector



Spend Averaged over Housing Population



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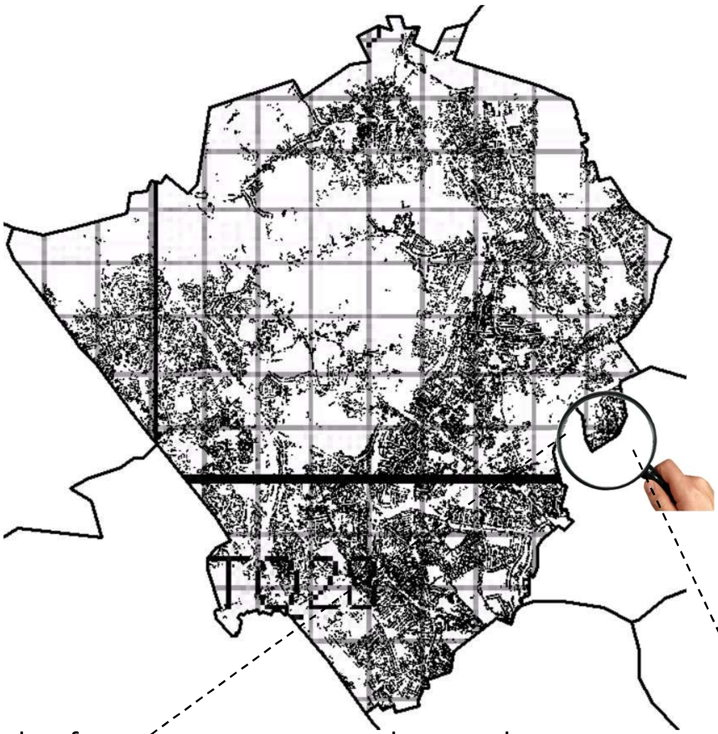
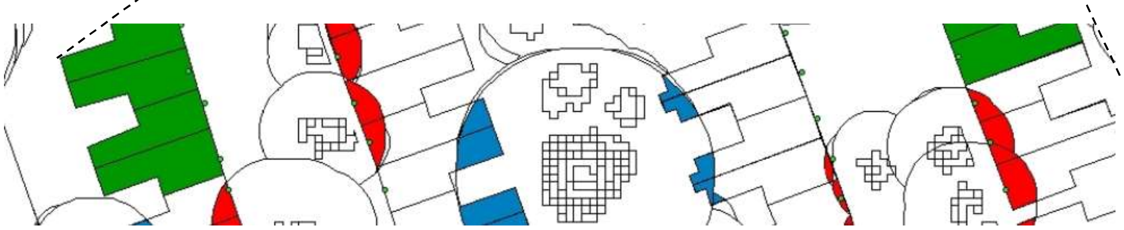
BARNET – Root Overlap Model

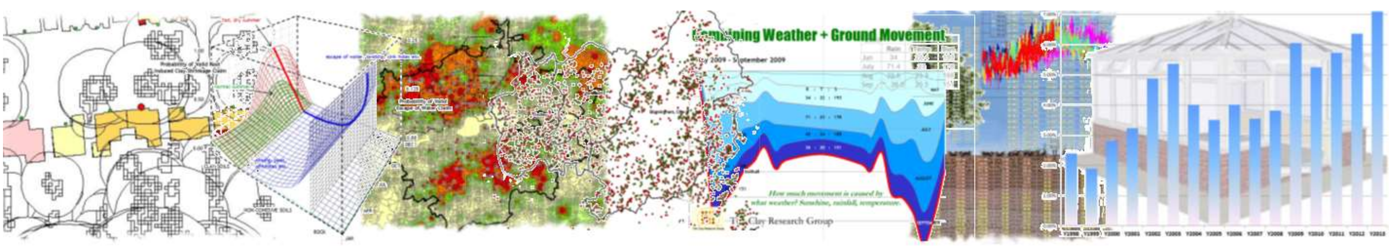
Below, a map of Barnet showing modelled root overlap zones – estimates of how far roots from trees might extend beneath nearby properties. The model uses a factor of 1.2 x the tree height to define the extent of root activity.



Our model recognises that for trees roots to cause damage the root zone must extend further than the building perimeter (i.e. 'D') and a value of 1.2 isn't considered unduly onerous. For example, the Aldenham willow (page 2) has a height of 14mtrs with maximum ground movement recorded 15m distant although this is of course a selective example.



Above, an enlarged image from the map, top, showing defined root overlap root zones from our model using the above criteria. Blue = encroachment by private trees, red = public trees. Houses with no root encroachment are shaded green.



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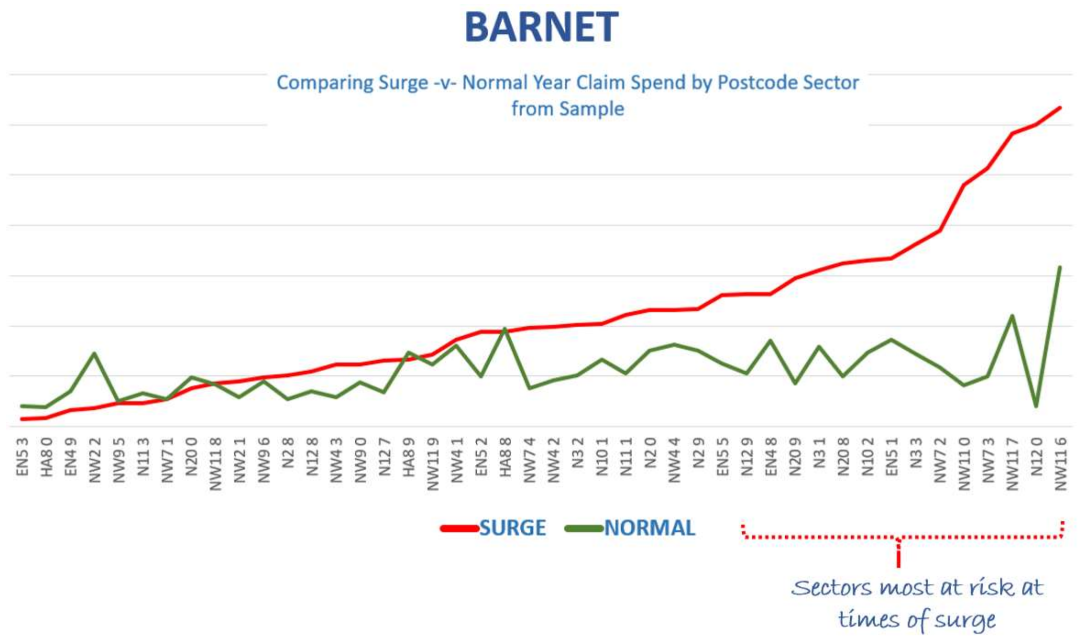

The above graph identifies the variable risk across the district based on house by house spend, distinguishing between normal and surge years by postcode sector. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

It is of course the case that a single expensive claim (a sinkhole for example) can distort the outcome using the above approach. 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 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.

From an underwriter’s point of view, the values would vary by sum insured and both overheads and profit need to be added.