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

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The Clay Research Group

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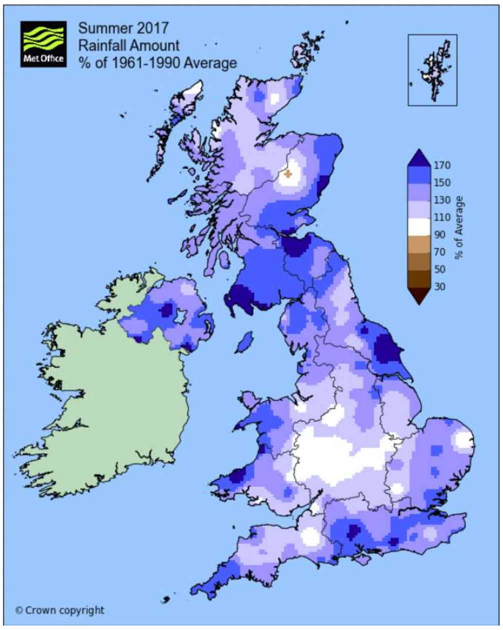
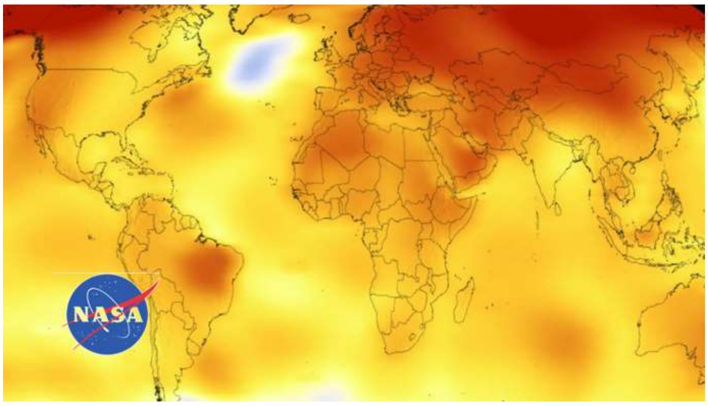
Weather -v- Climate



Above, the Met Office anomaly map comparing rainfall in the summer of 2017 as a percentage of the 1961 - 1990 average.

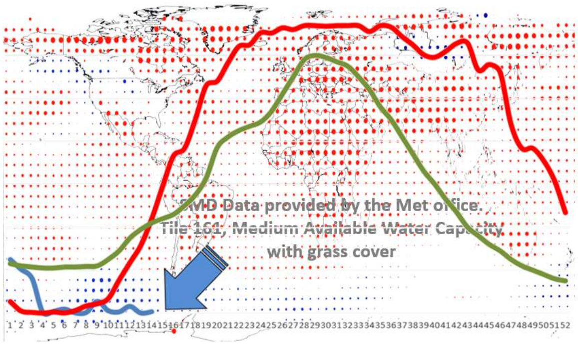
Claim numbers continue to fall as a result of increased rainfall and time will tell if this is a long-term trend relating to climate change or simply anomalies in weather patterns. Below, the NASA map showing patterns of global warming with 2017 reported to be the second warmest year since 1880.

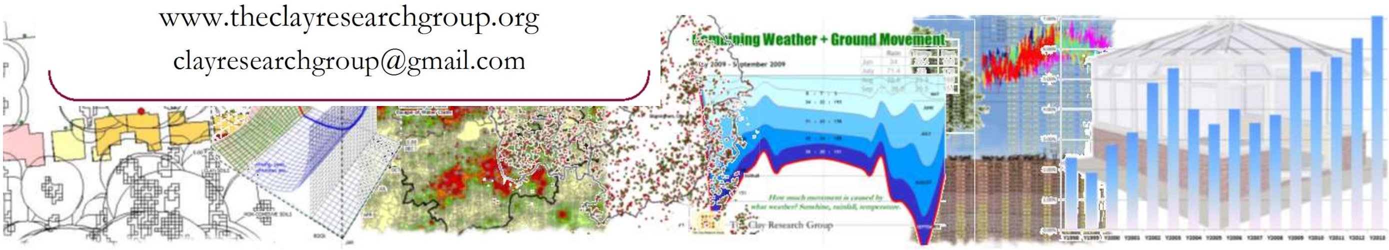


SMD Update

Far too early to be useful in terms of prediction of summer claim numbers, but a note that the soils in the south east (tile 161) are fully hydrated. The figure for the same week in 2003 was a deficit of 60mm.

Current SMD plotted against Event and Normal Years





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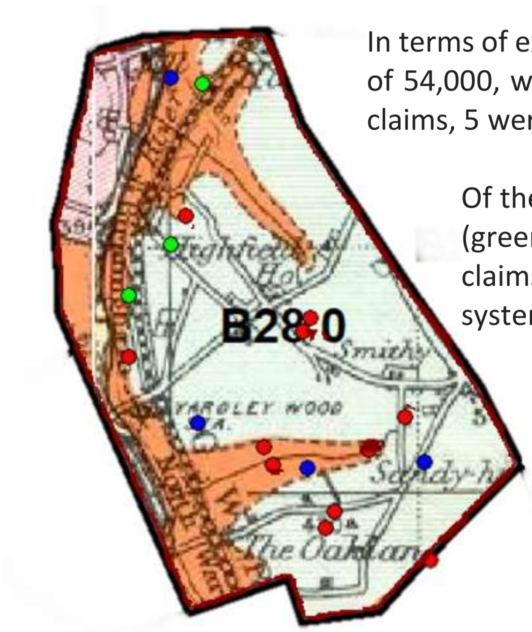
Risk Analysis – Postcode Sector B28 0

In recent issues postcode sectors NW11 6 and N20 8 have been analysed to understand their relative risk and whether the geology could be inferred from the seasonal notification of valid, compared with declined, claims.

Both sectors are underlain by the London clay series and a link between the date of notification of valid claims and cause was evident. The dominant cause of subsidence damage in both sectors was root induced clay shrinkage.

B28 0 has a different geology - see extract from BGS 1:50,000 series map below, showing mixed sand and gravel drift deposits (blue) covering the majority of the sector, overlying mudstone (brown).

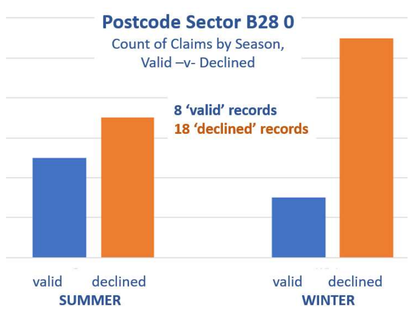


In terms of experience, the sector has 26 claims from our sample of 54,000, with 18 declined (red dots), and 8 valid. Of the valid claims, 5 were notified in the summer and 3 in the winter.

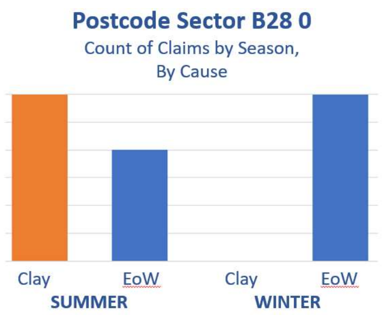
Of the valid summer claims, 3 were due to clay shrinkage (green) and 2 escape-of-water (blue). All 3 valid winter claims were due to an escape-of-water from the drainage system.

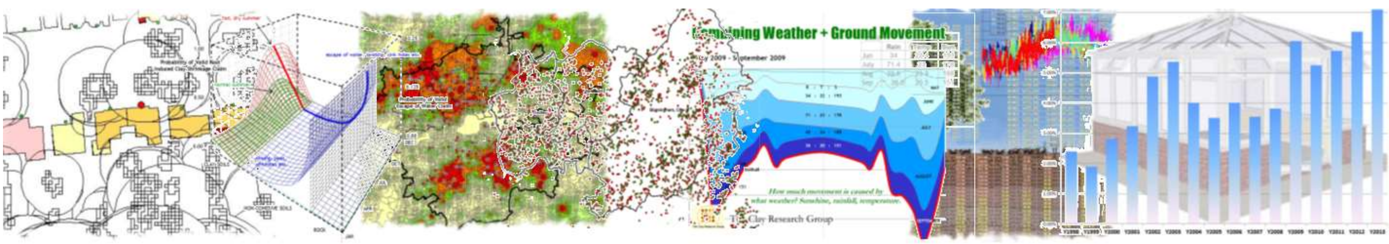
What risk does B28 0 present, expressed as frequency? Dividing the valid claims by the housing population for the sector (around 5,300) delivers a risk frequency of 0.0015. The NW11 6 rating was 0.008 - over 5 times riskier. The London sector N20 8 (see edition 152) is four times riskier.

Below, left, the relative number of valid and declined claims by season. Right, the seasonal claims distribution by cause.



In summary, claims are more likely to be declined than accepted in this postcode whatever the time of year. In the summer the most likely cause is clay shrinkage, and in the winter, EoW.





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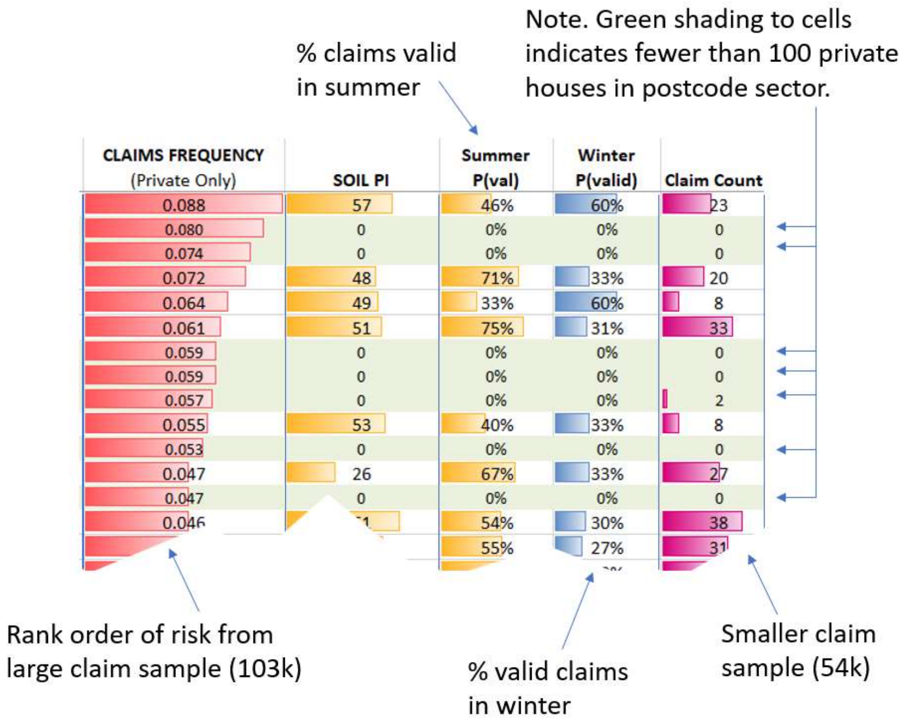
Intelligent Systems – the Database

Below, a small extract from a database underlying an 'intelligent system' to handle subsidence claims at postcode sector level with the aim of improving triage, diagnosis, handling and underwriting.

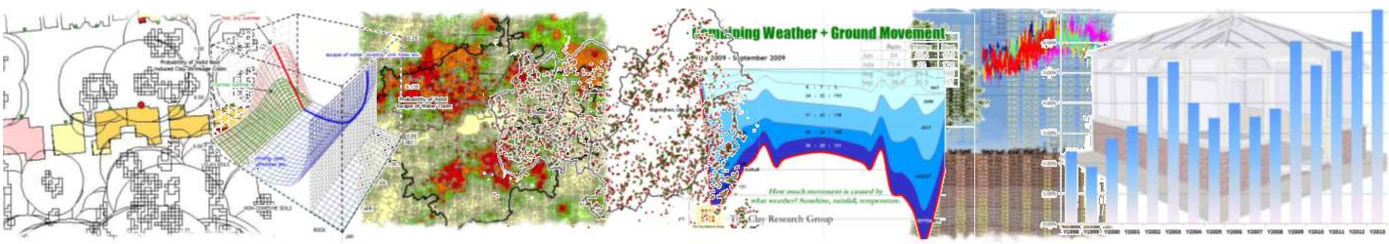


CLAIMS FREQUENCY (Private Only)	SOIL PI	Summer P(val)	Winter P(valid)	Claim Count
0.088	57	46%	60%	23
0.080	0	0%	0%	0
0.074	0	0%	0%	0
0.072	48	71%	33%	20
0.064	49	33%	60%	8
0.061	51	75%	31%	33
0.059	0	0%	0%	0
0.059	0	0%	0%	0
0.057	0	0%	0%	2
0.055	53	40%	33%	8
0.053	0	0%	0%	0
0.047	26	67%	33%	27
0.047	0	0%	0%	0
0.046	[illegible]	54%	30%	38
[illegible]	[illegible]	55%	27%	31

The structure shown places each sector in rank order of risk, expressed as frequency – claims/housing population. Some of the perceived riskiest postcodes have very low housing populations, skewing results. One claim involving a leaking drain can place a small village of say 12 houses at the top of the national risk league. The database recognises this and such instances are shaded green in the example. Obviously, this would be dealt with digitally in practice.

It is useful to record the soil plasticity index as this is a factor behind seasonal notification of claims, identifying cause and likelihood of validity. The season of notification links into this analysis.

Finally (in this small example) the system needs to record claim numbers to assess the confidence factor. Just how reliable is the outcome likely to be? Is it based on 1, 3 or 10 claims?



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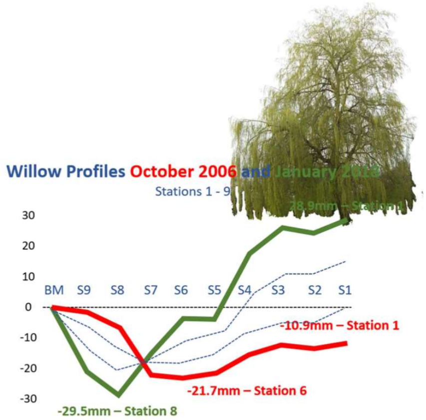
Ground Recovery at the Site of the Aldenham Willow

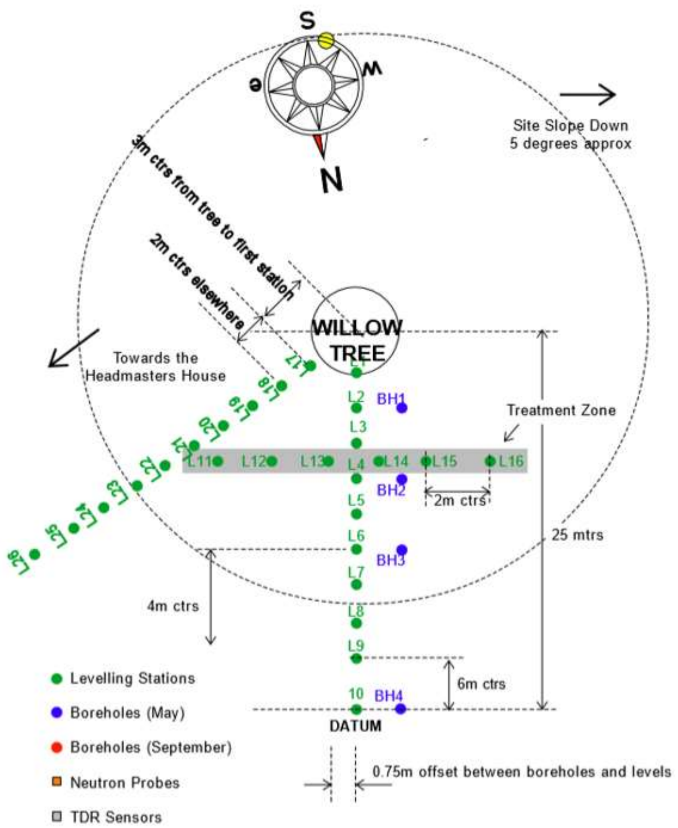


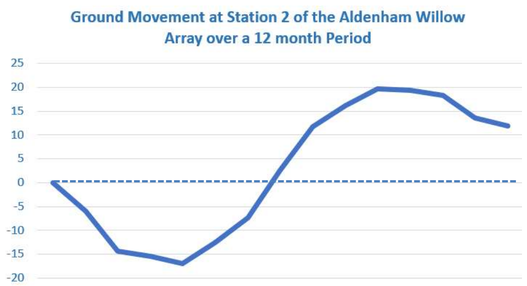
The image, left, is taken from the previous edition of the newsletter and shows the difference in ground levels in the vicinity of the Aldenham willow between October 2006 and January 2018. The ground nearest the tree had recovered by 28.9mm from the original datum, and 41mm from its lowest recorded point. Although the site investigations undertaken by MatLab Limited in May 2006 did not coincide exactly with the dates of level readings (June), the presence of a persistent deficit (i.e. the soils did not rehydrate through the previous winter) is clear.

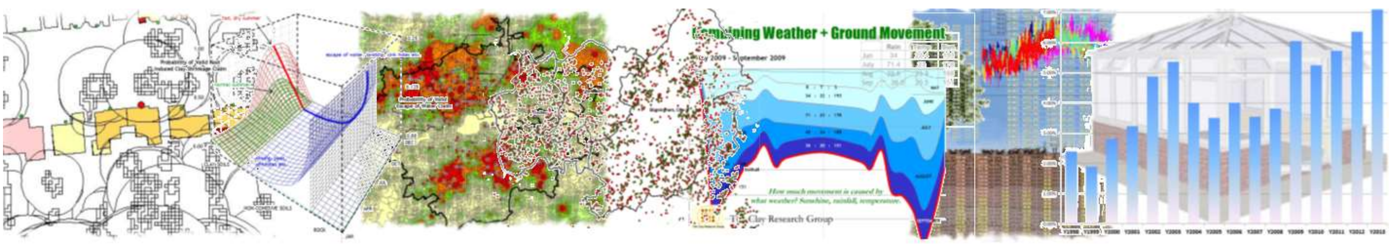
The location of the boreholes relative to the level stations is shown on the plan, right, and the results of soil testing appear on the following page.

This exercise considers the results from BH1 and movement at the nearest level station, L2.

Below, Ground movement recorded at Station 2 showing initial downward movement through the summer of 2006 (i.e. further soil drying) followed by recovery (20mm above the starting point) in the ensuing winter.







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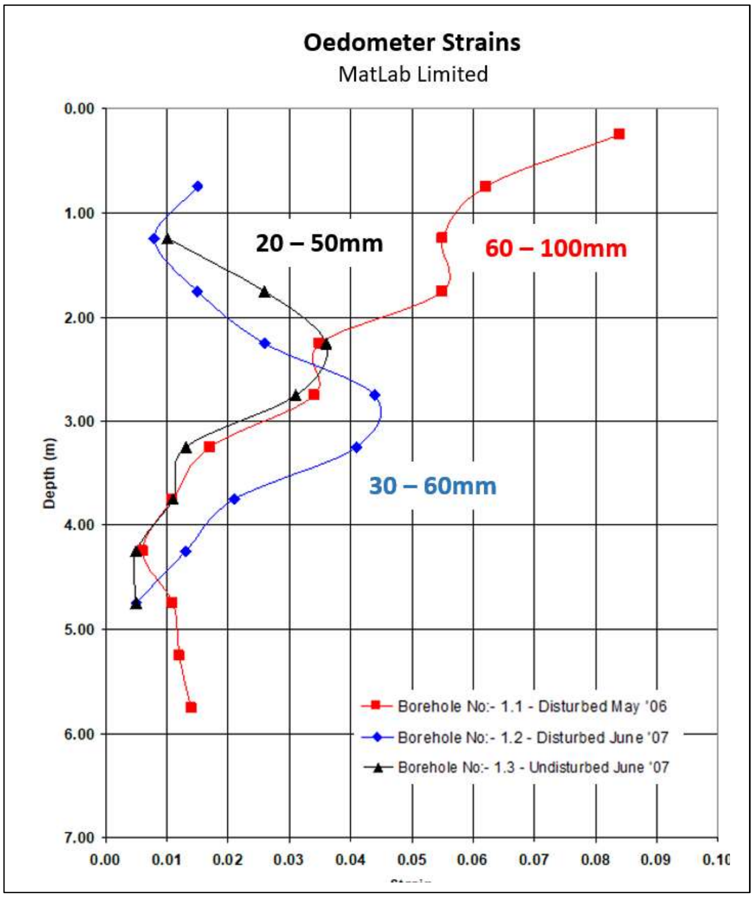
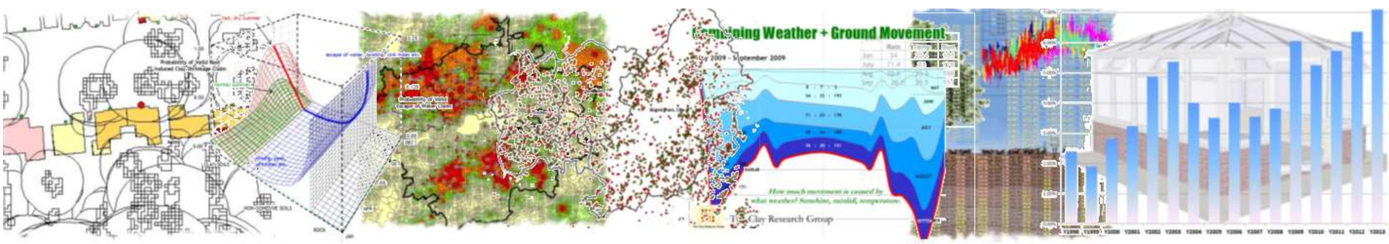
Ground Recovery at the Site of the Aldenham Willow

The results of soil tests undertaken following investigations in May 2006 and June 2007 are reproduced below. MatLab Limited undertook a range of tests over several years, including filter paper suctions, oedometer strains and moisture contents using disturbed, undisturbed and remoulded samples.



Recovery over the twelve-month term is evident from the oedometer test results above. The red line indicates the profile in May 2006. Rehydration over the ensuing twelve months significantly reduced the zone of desiccation, resulting in ground swell.

The current enhanced seasonal movement towards the root periphery is presumably a function of earlier soil drying close to the tree, and the response of the tree to extend the zone of root activity, taking moisture from further away, allowing ground closer to the tree to recover.



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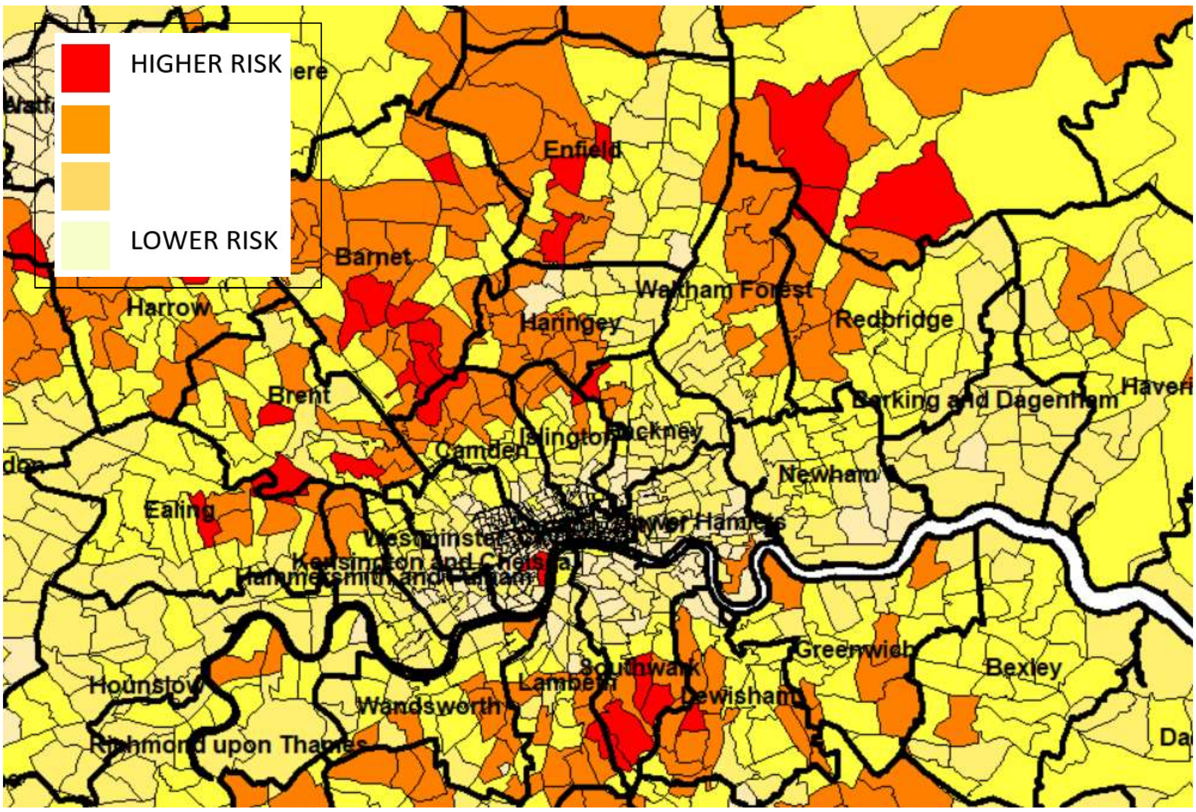
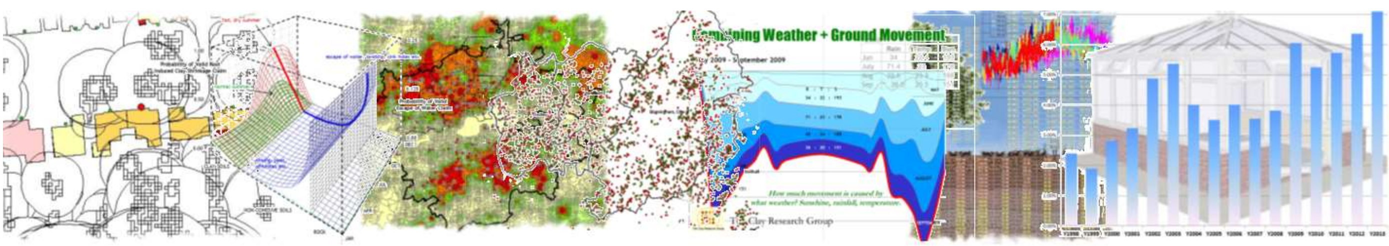
Enfield Borough – Study Area

The most northern of the London Boroughs, Enfield covers an area of 82.20 km^2 and has a population of around 331,400 with 119,916 households.

Borough	Edition	Date
Islington	Issue 47	Apr-09
Camden	Issue 69	Feb-11
Brent	Issue 71	Apr-11
Haringey	Issue 72	May-11
Barnet	Issue 77	Oct-11
Waltham Forest	Issue 79	Dec-11
Welwyn and Hatfield	Issue 80	Jan-12
Ealing	Issue 84	May-12
Sutton	Issue 91	Dec-12
Hillingdon	Issue 106	Mar-14
Havering	Issue 149	Oct-17
Harrow	Issue 150	Nov-17
Enfield	Issue 155	Apr-18





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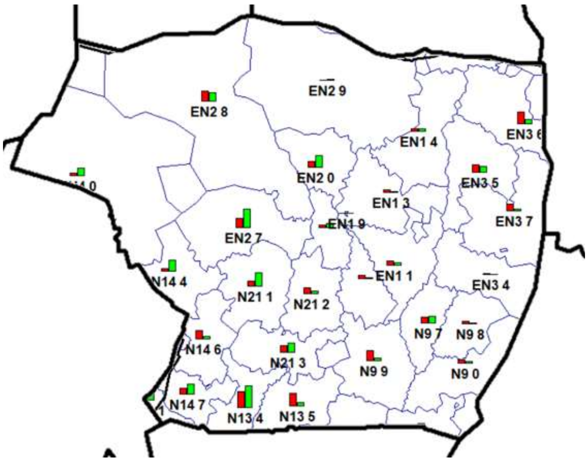
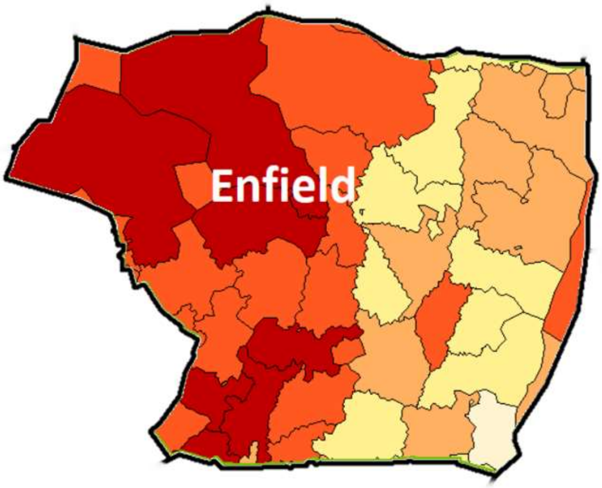
Enfield Borough – Study Area

VALID/DECLINED

In terms of subsidence, Enfield is around 4.28 times the UK average risk in terms of frequency (claims sample/private housing population).

The map, right, plots the valid/declined ratios at postcode sector level. Green represents the proportion of valid claims, and red, declined claims.





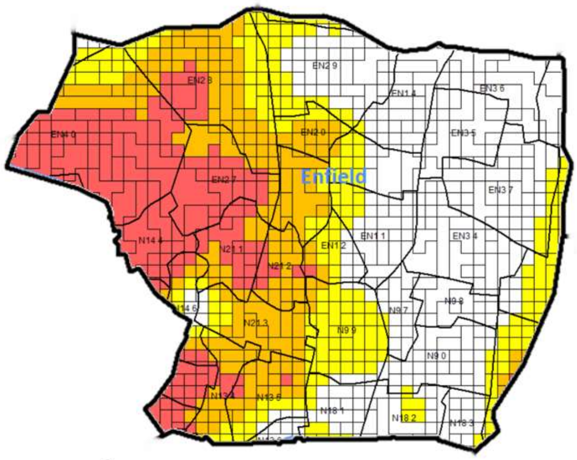
CLAIMS FREQUENCY

Left, the relative risk of subsidence by postcode sector, with red representing the highest rating.

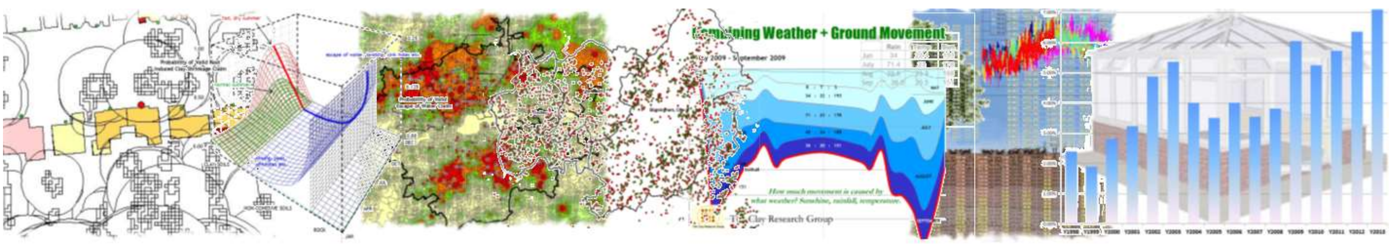
Frequency maps can be misleading when there are relatively small numbers of houses and account has to be taken population when estimating risk. See page 4.

SOIL PLASTICITY INDEX

Right, soil plasticity index plotted on a 250m grid using interpolated values from soil samples retrieved at depths of between 1.5 – 2m bGL (where available) from site investigation undertaken when investigating domestic subsidence claims.



More information on pages 10 and 11.



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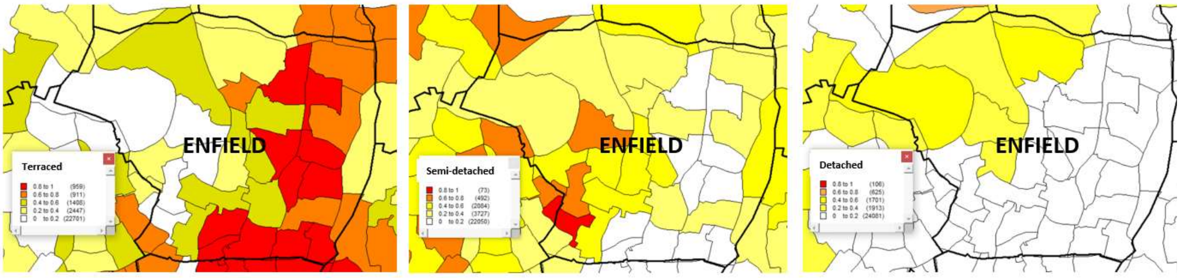
Enfield Borough – Study Area

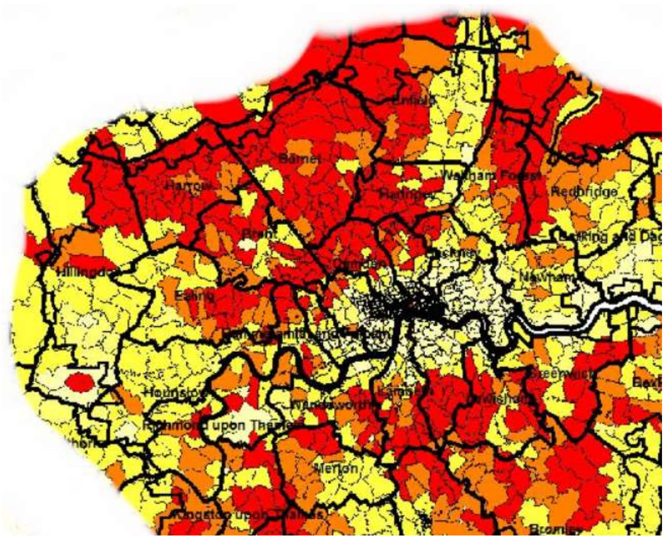
Below, distribution of houses by style, illustrating frequency/total housing population at postcode sector level in five equal ranges. The distribution plot reveals a higher concentration of terraced houses to the east, detached to the west, with a spread of semi-detached across the borough.

Is there a link between house type and risk in terms of building vulnerability?



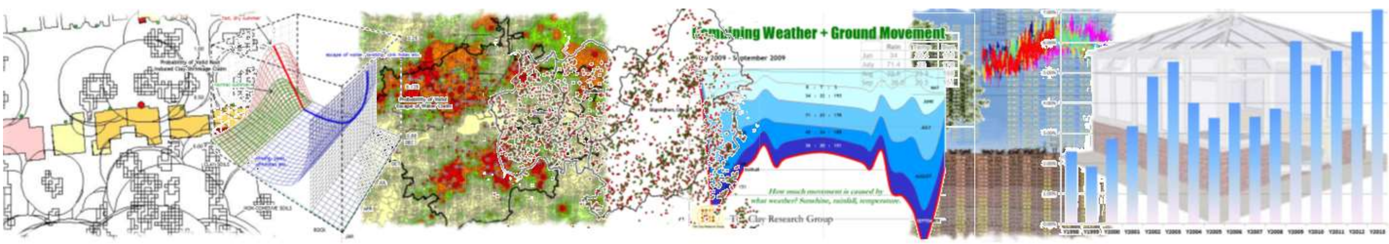
Distribution of house types across the borough, distinguishing by terraced, semi-detached and detached. Flats etc., omitted to simplify analysis.

Housing styles alone don't provide the answer as they don't take account of frequency for each category. Below, distribution of risk taking account of private, insured properties only, plotting claims/private housing and omitting self-insured housing association and council properties.



Many sectors register an increase in risk when taking into account private housing only. The picture left shows a range of typical increases in the region of 110 – 130%, 130 – 140% and 140-150%..

The image above reveals an increased risk to postcode sectors in the borough when taking account of the social housing population.



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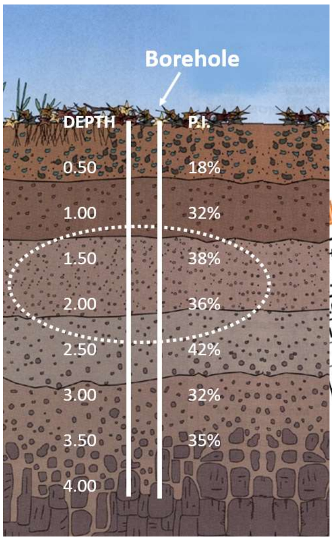
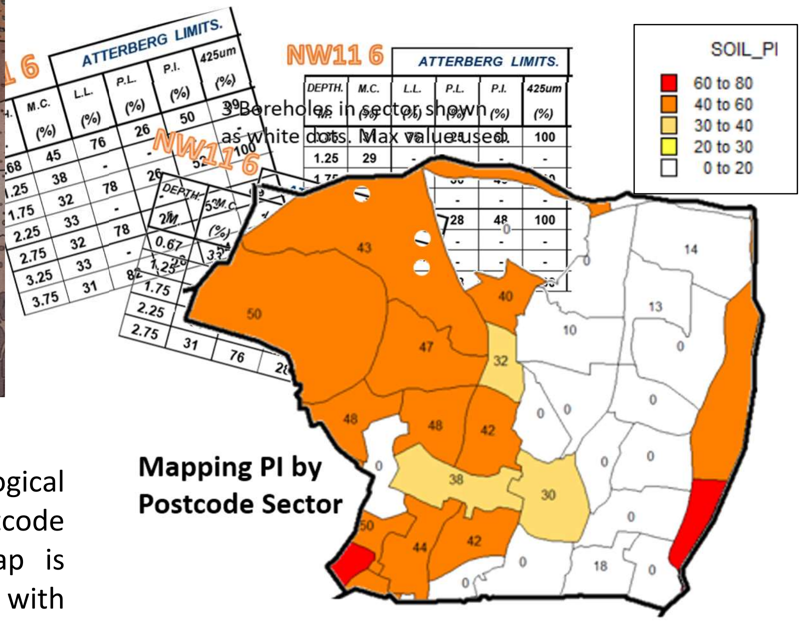
Mapping the Plasticity Index

The CRG geological map uses data obtained from site investigations undertaken relating to domestic subsidence claims and records the maximum plasticity index from the clay samples retrieved and tested.

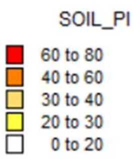


There are likely to be at least four or five boreholes sunk in a high risk sector. Below, the postcode map of Enfield, with results for each sector indicated.



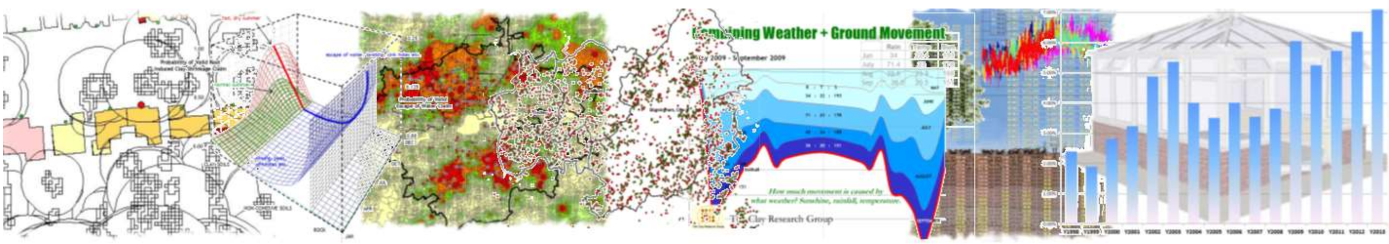
Map of PI for the London borough of Enfield, showing the results from actual site investigations at postcode sector level and using values from a depth of between 1.5 – 2mtrs.

Unfortunately, geological series do not follow postcode boundaries but the map is useful when dealing with initial notification of loss, and particularly when used in conjunction with the BGS 1:50,000 series.



The approach is particularly useful when modelling other data stored at postcode sector level.

The above example is thematically plotted at 20% intervals with 0 – 20% PI shown in white and the highest category – 60 80% shaded red. See legend, left.



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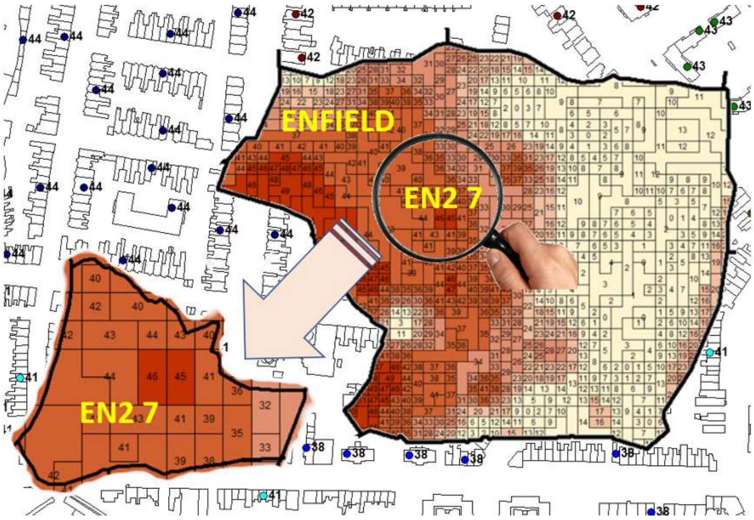
The High Resolution Geological Map

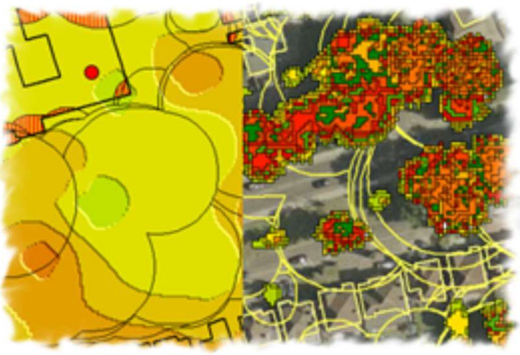
A higher resolution can be achieved using the interpolation function included in most GIS software. Below, the soil PI is superimposed onto a 250m grid. The enlarged image to the bottom left shows the definition in a particular location (in this case postcode sector EN2 7).

Of course, there is no suggestion of accuracy. The PI of clay soils can vary considerably over short distances and depths but the advantage, and particularly for modelling purposes, is the fact that a higher count of samples is retrieved from high risk sectors. It might be that clay soils exist elsewhere and there are no records due to the absence of claims and in this sense, the model has a dual function. It provides some indication of the risk of subsidence in terms of claim frequency as well as the soil shrink/swell potential.

The plasticity index is recorded a 250m grid, using interpolated data from actual site investigations.

The data can be further transposed to full postcode level (see the underlying image). As there are in excess of 1.7m full postcodes, and given the lack of accuracy, postcode sector level data will suffice. There are over 10,000 sectors, but only around 20% or so have clay soils.





The CRG geology model forms a component of the Disorder Model reviewed in Edition 151 (December 2017) and earlier newsletters. Left, a composite image showing tree canopies, modelled root zones and buildings superimposed onto the modelled geology.