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

June 2022
Issue 205

The Clay Research Group

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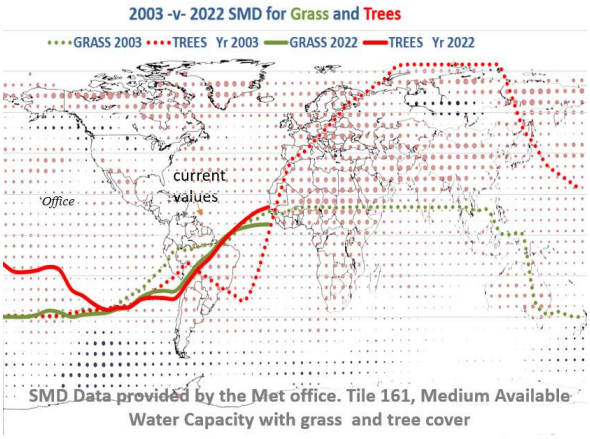
Issue 205, June 2022

Soil Moisture Deficit

Below, current SMD values provided by the Met Office for both grass and tree cover, comparing them with the 2003 event year (dotted lines).



Both tree and grass cover have values similar to 2003, with tree cover drier for the last 6 weeks or so.

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District and Sector Risk

Hackney is the topic of the District Risk series in this month's edition and increased resolution is provided with examples at postcode sector level.

The study includes a review of cause and liability by season, providing a useful reference for underwriters, engineers and claims handlers.

Weather

A review of weather records provided by the Met Office reveal why the summer of 2018 delivered a surge in claims and a suggestion that 2022 may deliver hotter than average conditions.

CRG Web Site – Update

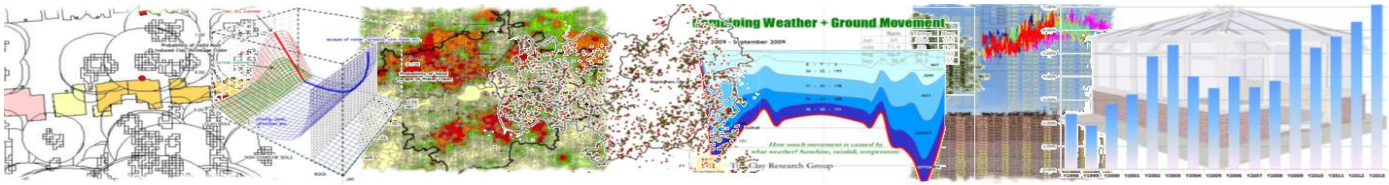
There are plans to update the CRG web site and any suggestions welcome. Currently, visits to the site average 3,000 per month and https security has been added. Go to:

https://www.clayresearchgroup.co.uk/

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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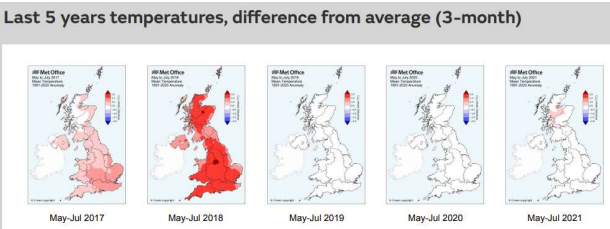
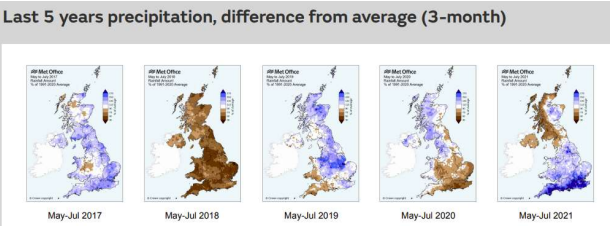
Weather - on Reflection

What caused the 2018 surge in third quarter subsidence claims? The Met Office anomaly maps below, provided by the, compare year values with the average for 1991 - 2020 and provide a clue.

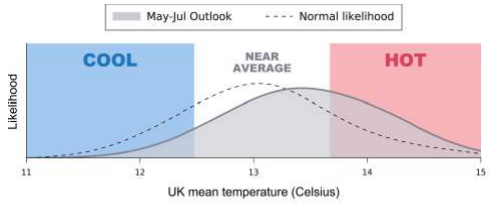


Above, the temperature was significantly higher in 2018 than other 'normal' claim years and below, much drier.



Weather Outlook

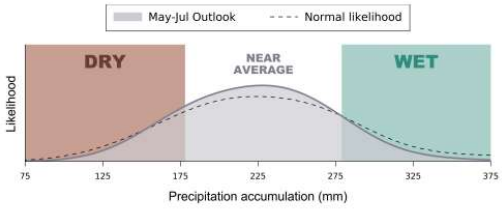
The Met Office web site has several pages predicting future trends and below we reproduce the graphs relating to temperature and precipitation.



Likelihood leans towards hot conditions

The graphs cover the quarter May to July, with the dotted line plotting the normal outlook and the solid line the prediction.

In general terms, a warmer quarter, perhaps just a little riskier in terms of subsidence although the peak values do not appear too onerous.



Likelihood leans slightly away from wet conditions

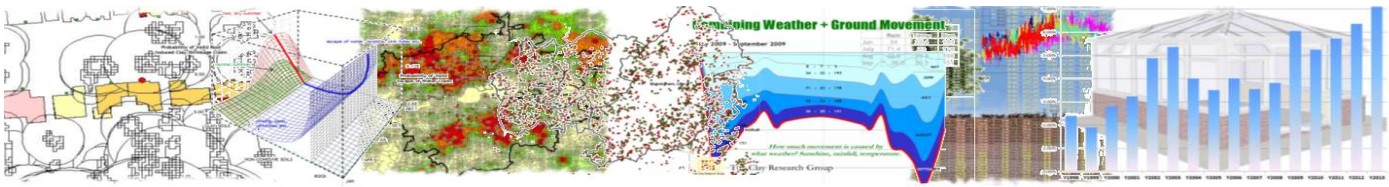
In terms of precipitation (above) the outlook suggests near average rainfall. Go to:

https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/business/public-sector/civil-contingency/3moutlook-mjj-v2.pdf

Saline Drip

A paper published in Plant Physiology journal dated the 17/05/2022 entitled "Coupled effects of soil drying and salinity on soil–plant hydraulics", Mohanned Abdalla *et al* summarises their findings as follows: "*The physical model of water flow and solute transport supports the hypothesis that a buildup of osmotic potential at the root-soil interface causes a large drop in $\psi_{leaf\text{-}x}$ and limits transpiration rate under drought and salinity.*"

Although research papers dealing with this approach (there are several) deal with crops and vegetation triggering a reduction in the transpiration rate and leaf xylem water potential (ψleaf-x) it would be worth exploring a treatment on trees as an economic way of resolving root induced clay shrinkage claims.



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Taking Account of Change.

As we have seen from the steady decline in claim numbers since 2006, risk changes. A system designed to support underwriters and claims teams has to take account of this and below we see how this process can be resolved using artificial intelligence.

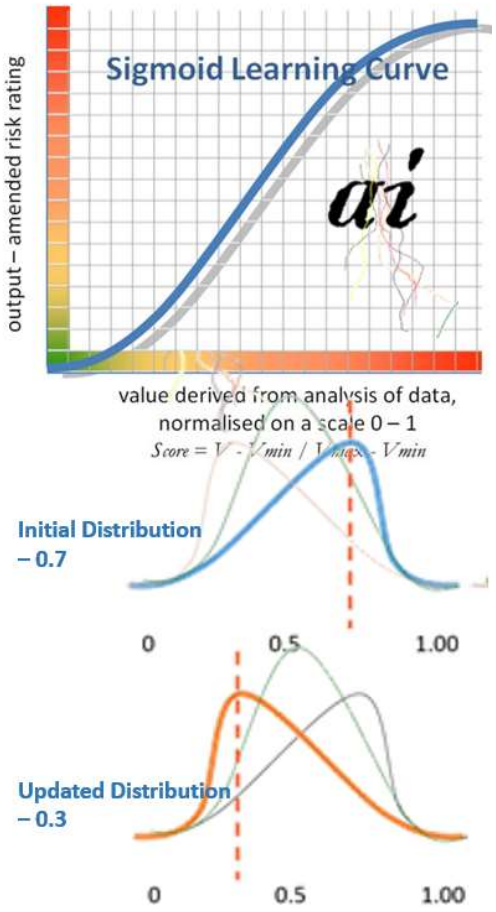
First, (bottom right) plot peak probabilities using distribution curves.

Taking sector level claims data as a starting point, what happens when the frequency risk of the peril starts to decline and its rating in the UK league table reduces?

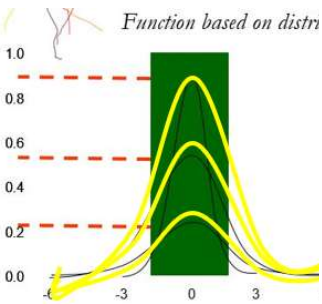
Distribution curves plot the peak and as can be seen, the lower of the two graphs reveals a reducing risk – falling from an initial score of 0.7 on the normalised UK rating down to 0.3.

The output is taken from a value on the 'y' scale which has values agreed with the user – premium change or risk rating.

The benefit of the sigmoid curve is the ability to make changes quickly (in the example, towards the centre of the graph) or slowly (top and bottom values). Other plots can be used where required.

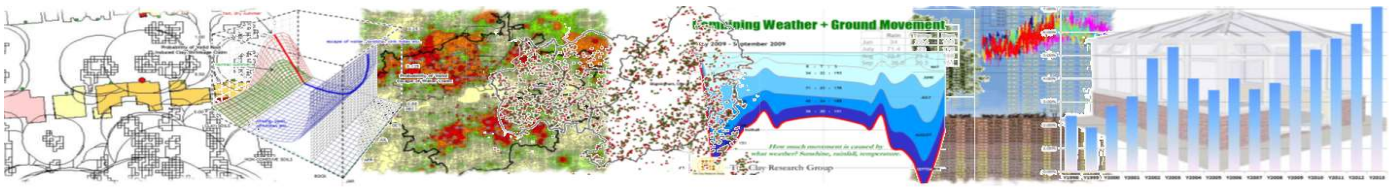


For claims handlers, the system will include a table of risk values for certain items. For example, PI of clay soils, tree species and H/D values age of property etc., all on a normalised scale with weighting introduced to take account of the contribution of the element.



How much weight can we place on the findings? Do values change often, reducing the value of the output? The distribution curves can be assigned ratings as shown, left.

When considering clay shrinkage claims the rating will vary based on the PI. A non-cohesive soil will have a low (or zero) value.



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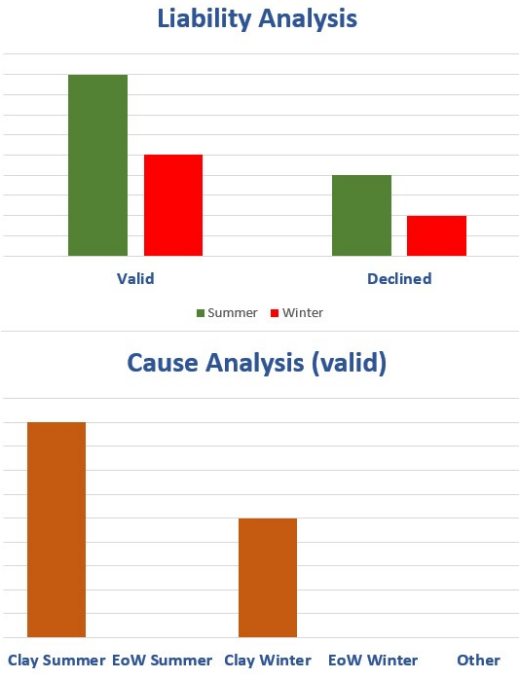
Using Past Claims Data to Infer Geology and Derive Probability of Cause and Liability – Sector Level Analysis



N16 5 – This is a one of the higher risk postcode sectors in Hackney with nearly 70% of claims accepted in both the summer and winter months.

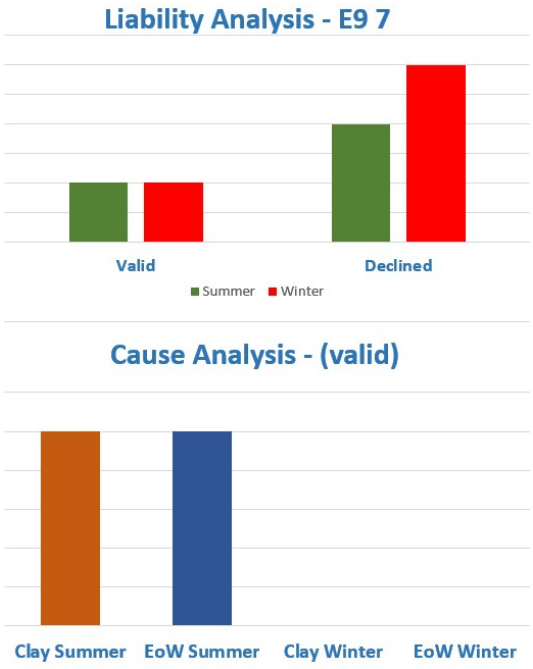
The primary cause of subsidence in the sector is clay shrinkage both in the summer and winter months. No claims resulting from an escape of water were recorded in the sample.

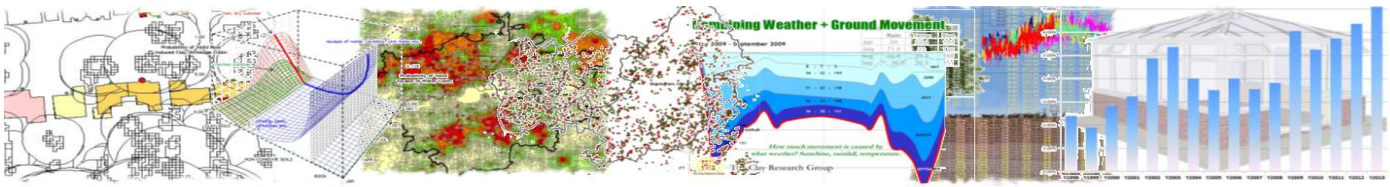
The 1:625,000 scale BGS map suggests outcropping bedrock, with no superficial deposits. The 1:50,000 scale map confirms the bedrock to be London clay, which explains the risk profile.

E9 7 – Situated to the south east of the district, this is a low-risk sector with an equal number of claims associated with clay shrinkage and escape of water in the summer and no recorded valid claims in the winter.

The geology comprises superficial deposits of sand and gravel overlying bedrock (London clay) which no doubt explains the lower risk profile.

The 1:50,000 scale map shows River Terrace Deposits overlying bedrock comprising sand and gravel overlying the Thames Group – clay, silt, sand and gravel.





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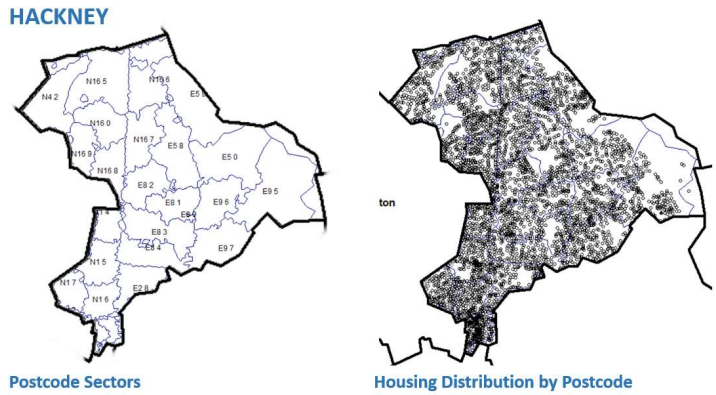
Subsidence Risk Analysis – HACKNEY

The Hackney district is situated in inner London and occupies an area of 19km^2 with a population exceeding 280,000.



Distribution of housing stock using full postcode as a proxy. Each sector covers around 2,000 houses and full postcodes include around 15 – 20 houses on average, although there are large variations.

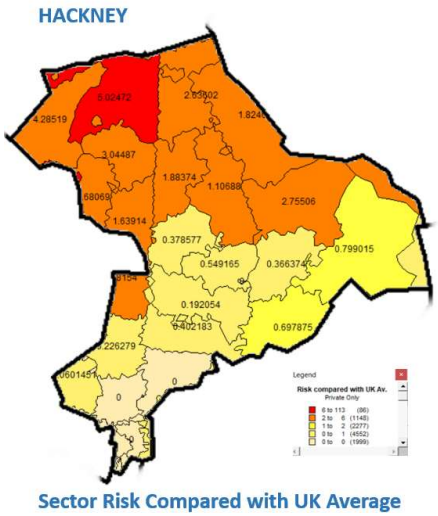
From the sample we have, sectors are rated for the risk of domestic subsidence compared with the UK average – see map, right.

Hackney is rated 105th out of 413 districts in the UK from the sample analysed and is around 1.2x the risk of the UK average, or 0.3 on a normalised scale.

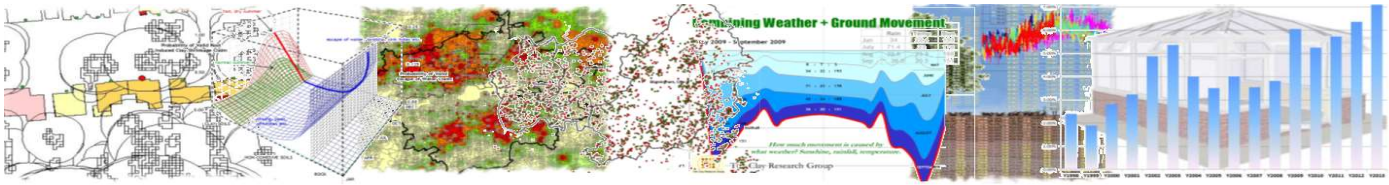
The increases to the north of the borough as can be seen from the sector map, right. This corresponds with the presence of outcropping clay soils as shown on page 7.

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.



Hackney district is rated around 1.2 times the UK average risk for domestic subsidence claims from the sample analysed. Above, risk by sector.



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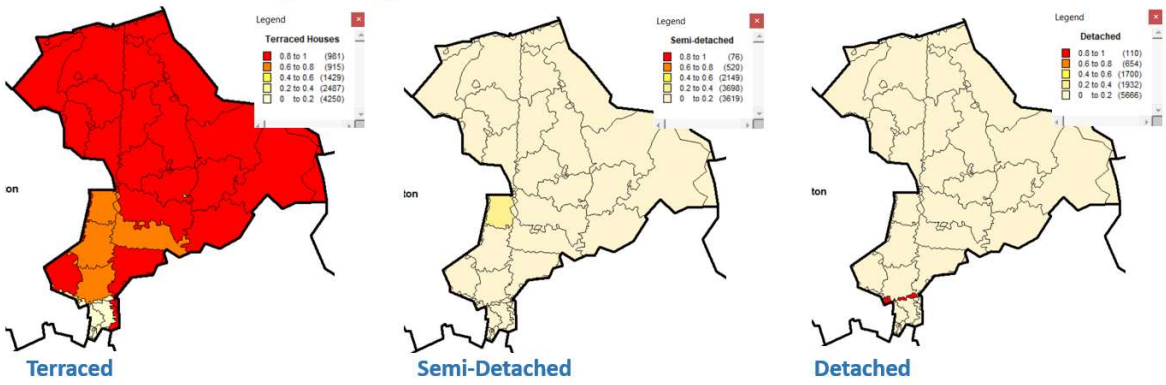
HACKNEY - Properties by Style and Ownership

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.

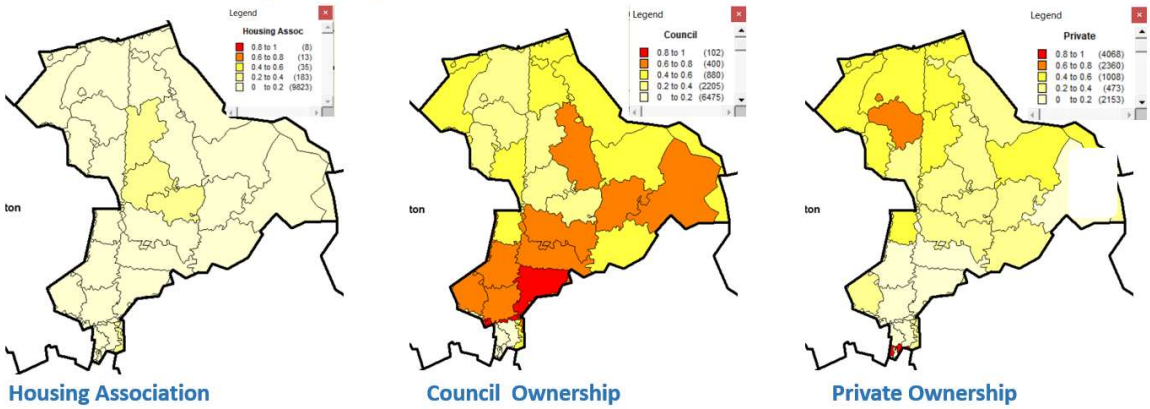
HACKNEY - Distribution by House Type



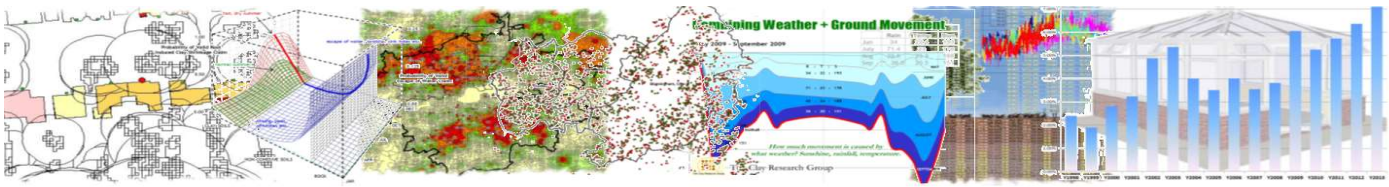
Terraced Semi-Detached Detached

Distribution by ownership is shown below. Council properties are the dominant class and are spread across the borough. See page 10 for distribution of risk by ownership.

HACKNEY - Distribution by Ownership



Housing Association Council Ownership Private Ownership



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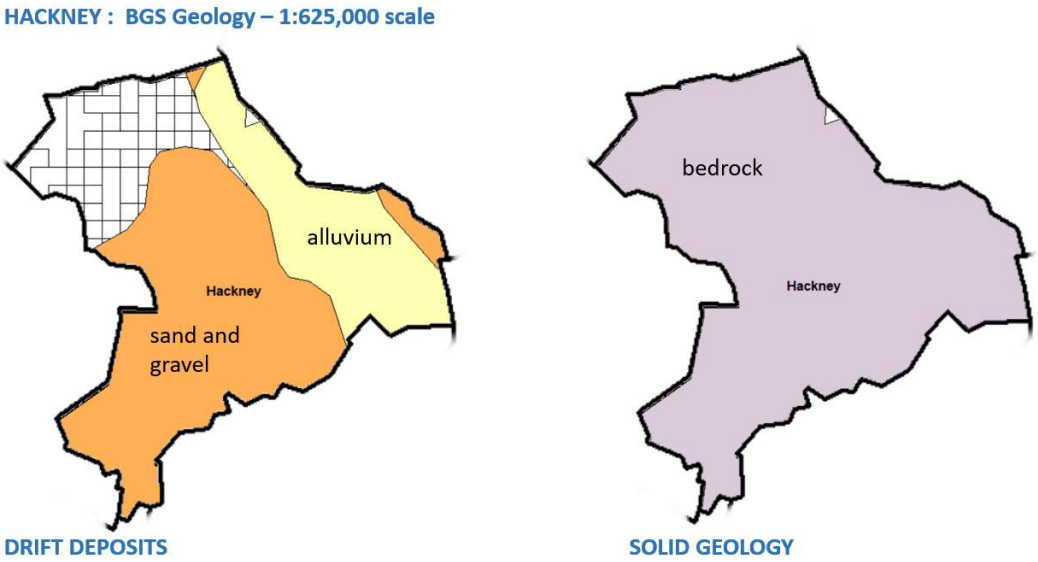
Subsidence Risk Analysis – HACKNEY

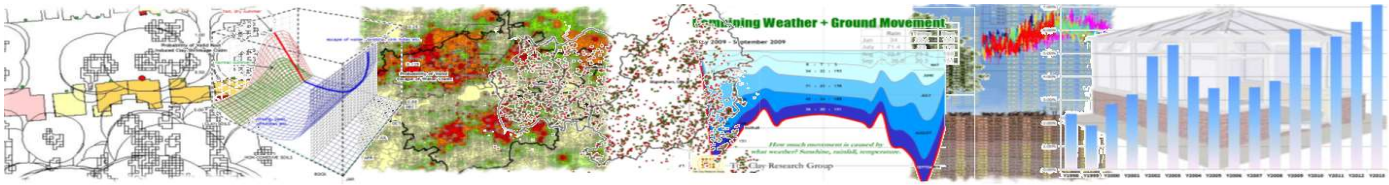
Below, extracts from the British Geological Survey low resolution 1:625,000 scale geological maps showing the solid and drift series. View at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html for more detail.

See page 10 for a seasonal analysis of the sample we hold which reveals that in the summer there is a greater than 70% probability of a claim being valid, and of the valid claims, there is a high probability (around 75% in the sample) that the cause will be clay shrinkage.

In the winter the likelihood of a claim being valid is around 45% - and if valid, there is nearly 80% probability the cause will be due to an escape of water. Maps at the foot of the following page plot the seasonal distribution.



1:625,000 series British Geological Survey maps. Working at postcode sector level and referring to the 1:50,000 series maps deliver far greater benefit when assessing risk. Clay shrinkage is the dominant cause in the summer, and escape of water in the winter months.



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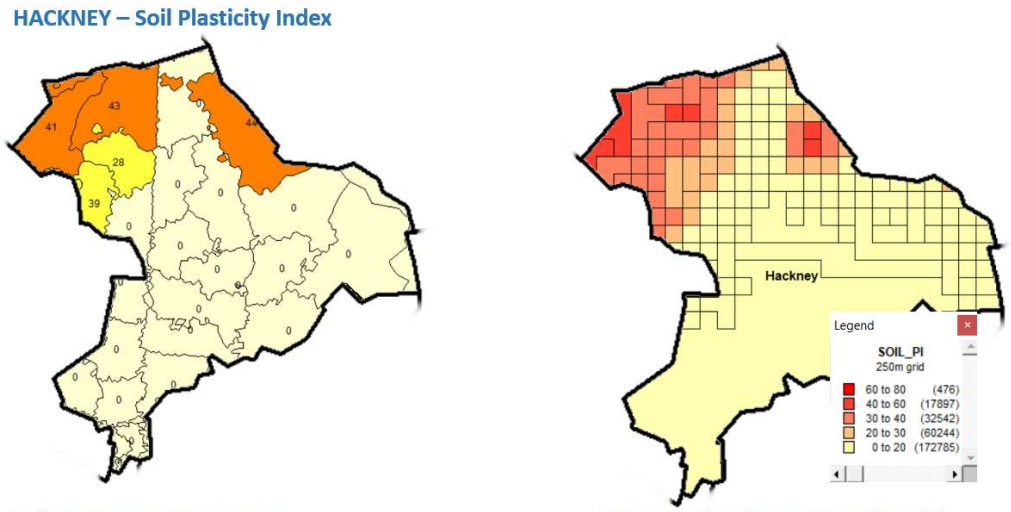
Liability by Geology and Season

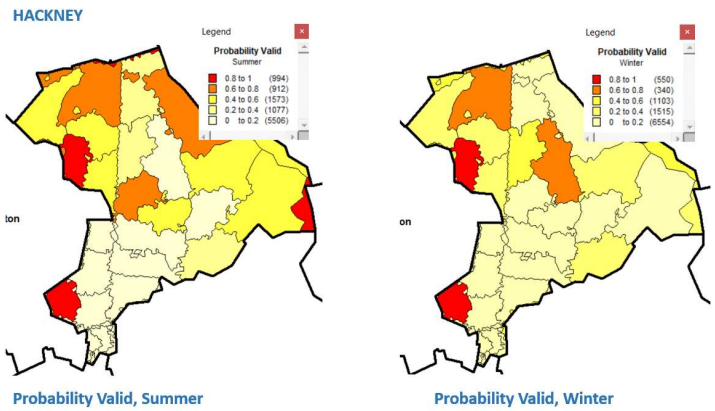
Below, the average PI by postcode sector (left) derived from site investigations and interpolated to develop the CRG 250m grid (right). The higher the PI values, the darker red the CRG grid. The general pattern agrees with the BGS maps on the previous page.



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.



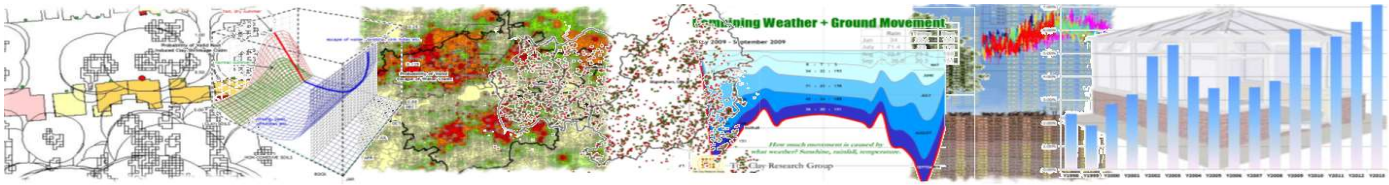
Probability Valid, Summer

Probability Valid, Winter

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

Combining the risk maps by season combined with the table on page 10 is perhaps the most useful way of assessing the likely cause, potential liability and geology using the values listed.

The claim distribution and the risk posed by the soil types is illustrated at the foot of the following page. Escape of water related claims are associated with the superficial deposits or simply shallow foundations on poor ground and the dominant clay shrinkage claim, the outcropping clay. 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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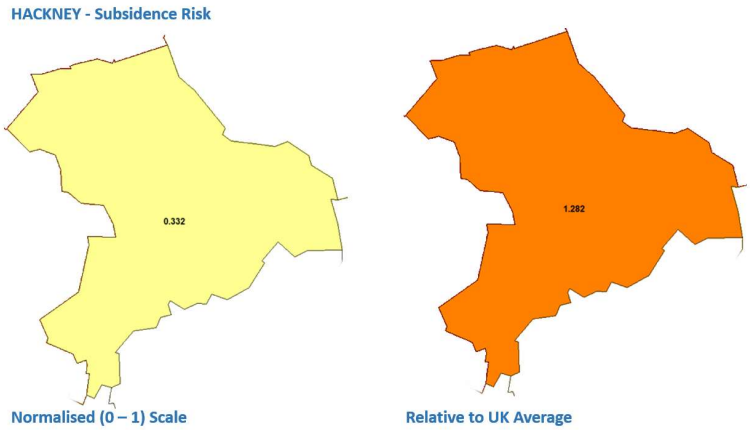
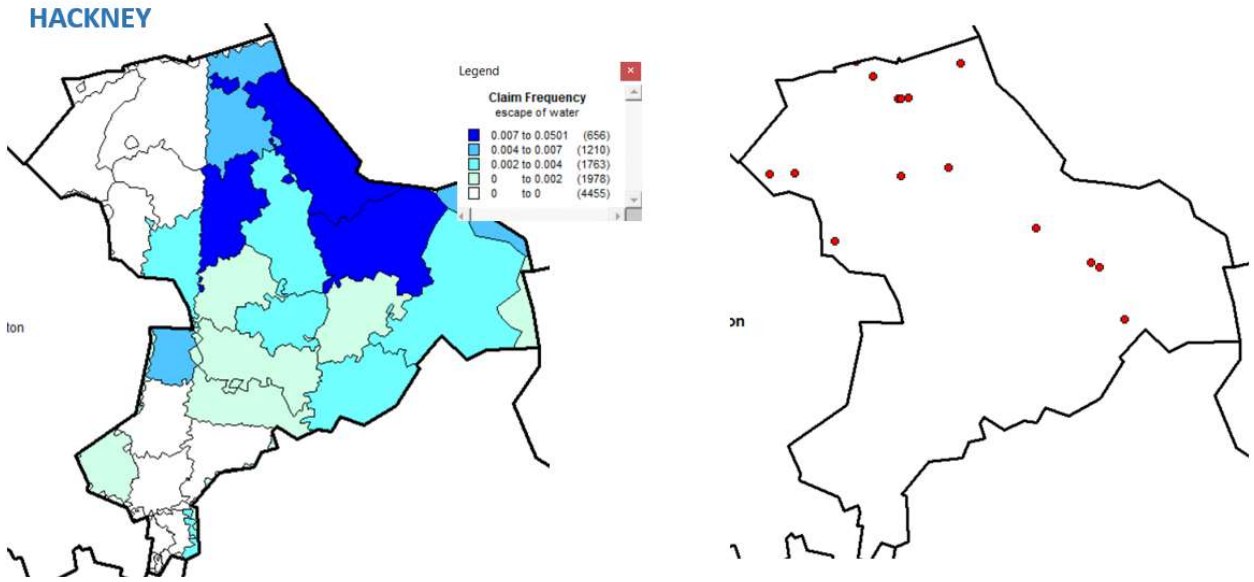
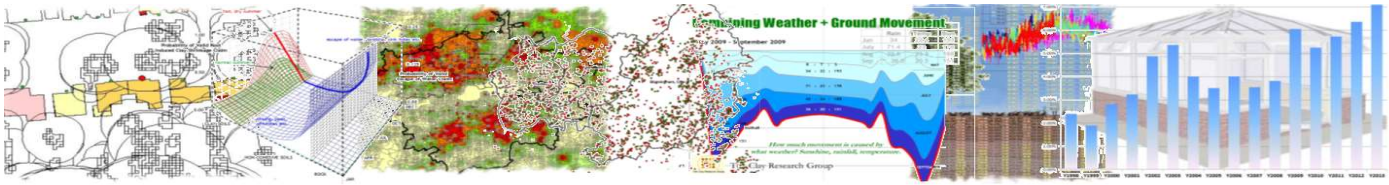
District Risk -v- UK Average. EoW and Council Tree Risk.



Below, left, mapping the frequency of escape of water claims reflects the presence of, non-cohesive soils – alluvium, sands and gravels etc., to the east and south of the district. The absence of shading can indicate a low frequency rather than the absence of claims.

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. The location coincides the presence of shrinkable clay soils – see both BGS (page 7) and CRG (page 8).





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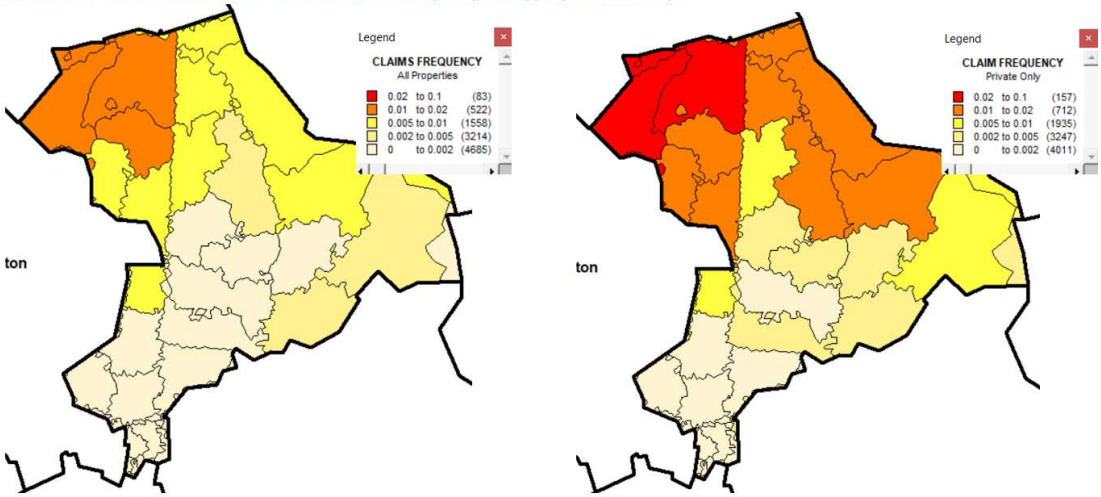
HACKNEY - Frequencies & Probabilities

Mapping claims frequency against the total housing stock by ownership (left, private council and housing association combined and right, private ownership only revealing an increased risk), the importance of understanding properties at risk by portfolio.

HACKNEY - Postcode Sector Subsidence Risk (frequency) by Ownership

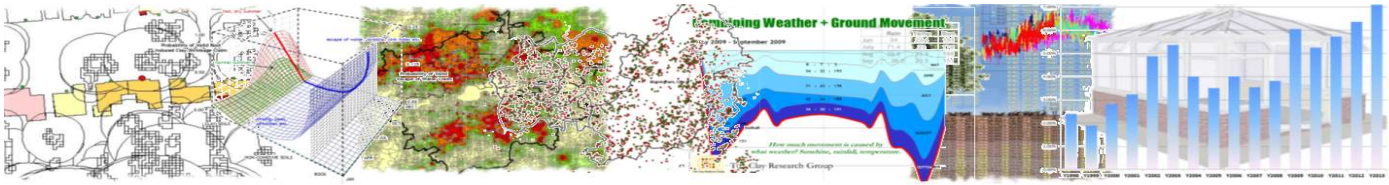


Combined Public and Private Frequency **Private Only**

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 declined in the summer is 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 lower throughout the year.

Liability by Season - HACKNEY

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Hackney	0.575	0.158	0.267	0.10	0.35	0.55



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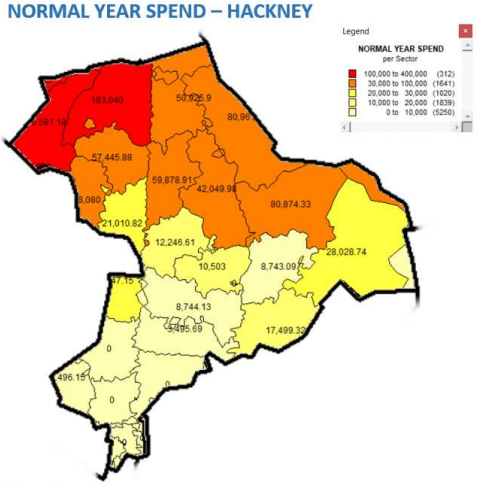
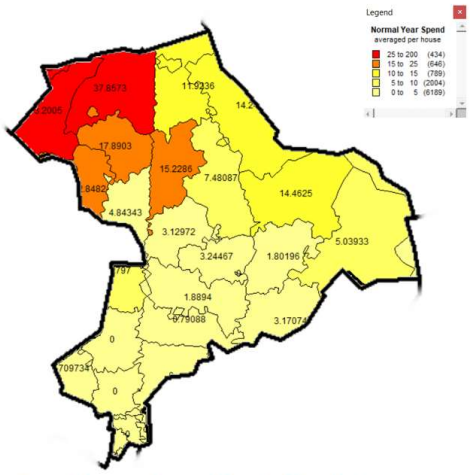
Aggregate Subsidence Claim Spend by Postcode Sector and Household in Surge & Normal Years

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.

NORMAL YEAR SPEND – HACKNEY



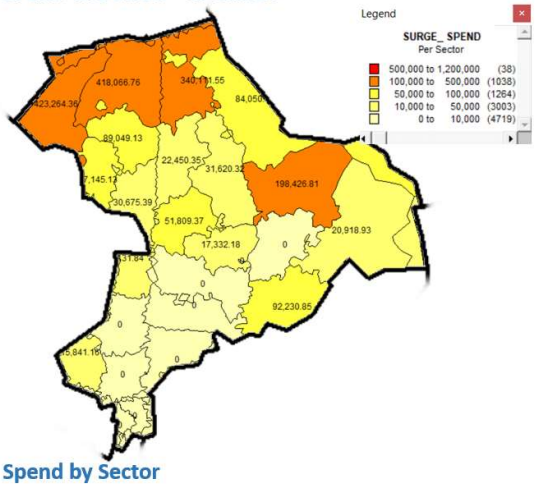
Spend by Sector



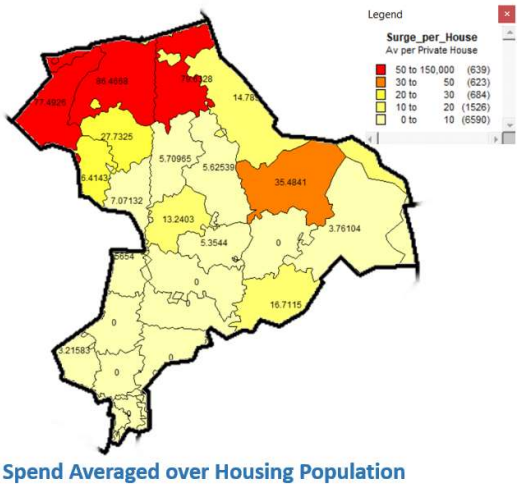
Spend Averaged over Housing Population

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.

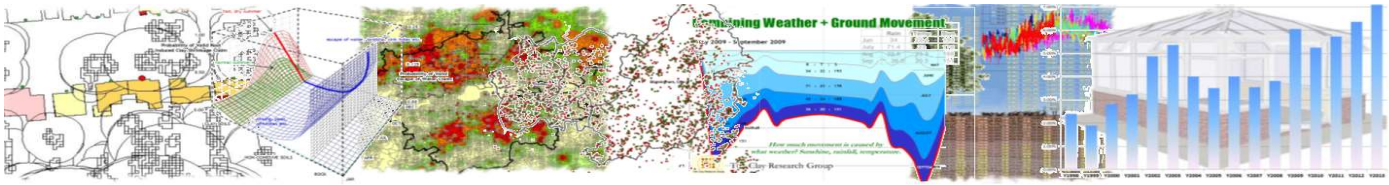
SPEND in SURGE – HACKNEY



Spend by Sector



Spend Averaged over Housing Population



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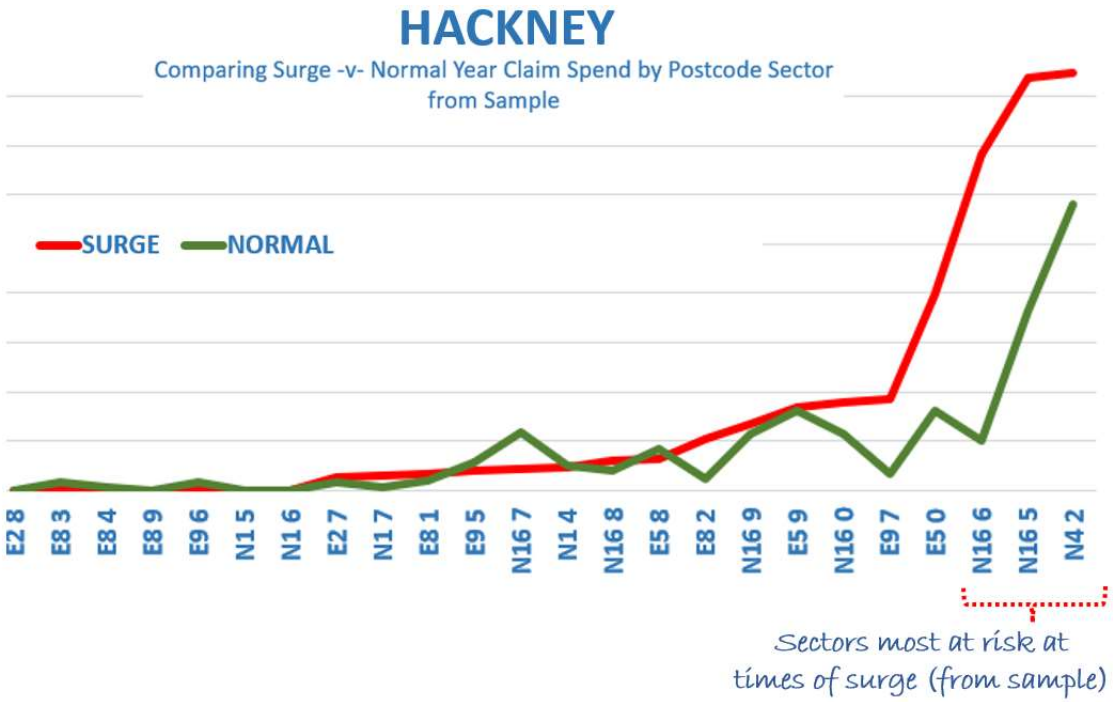

The above graph identifies the variable risk across the district at postcode sector level from the sample, distinguishing between normal and surge years. Divergence between the plots indicates those sectors most at risk at times of surge (red line).

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