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 2019
Edition 168

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Issue 168, May 2019

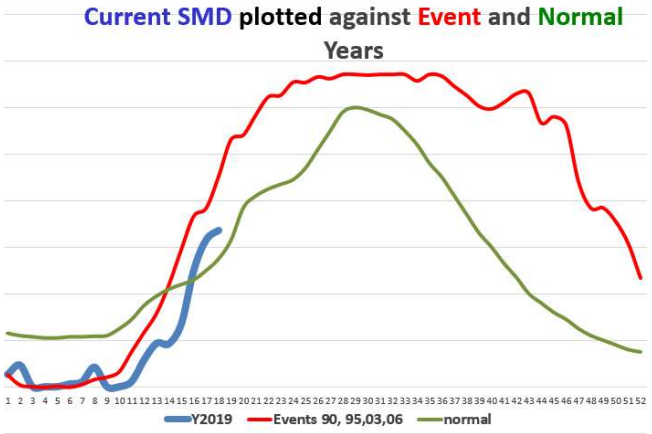
GISS Global Warming Update

The following is an extract from the GISS web site at:
https://www.giss.nasa.gov/research/news/20190206/

"Earth's global surface temperatures in 2018 were the fourth warmest since 1880, according to independent analyses by NASA and National Oceanic and Atmospheric Administration (NOAA). Global temperatures in 2018 were 1.5 degrees Fahrenheit (0.83 degrees Celsius) warmer than the 1951 to 1980 mean, according to scientists at NASA's Goddard Institute for Space Studies (GISS) in New York. Globally, 2018's temperatures rank behind those of 2016, 2017 and 2015. The past five years are, collectively, the warmest years in the modern record."

2019 Surge?

Far too early to say what the coming summer holds of course, but below is the current SMD for tile 161 in the south east of the UK.



Soil Moisture Deficit data from tile 161, supplied by the Met Office for grass cover, medium available water capacity soils.

Data and Truth

Next month we return to the topic of data and how Ai can deliver significant benefits, but not without risk. Who determines the rules and what is the danger of self-interest skewing the output amongst the various participants?

How do we derive a version of the truth, and what role does personal bias play? Do we understand the data we collect? How do we ensure the interests of the homeowner are protected?

Contributions Welcome

We welcome contributions relating to the subsidence peril from readers. Contact us at *clayresearchgroup@gmail.org*

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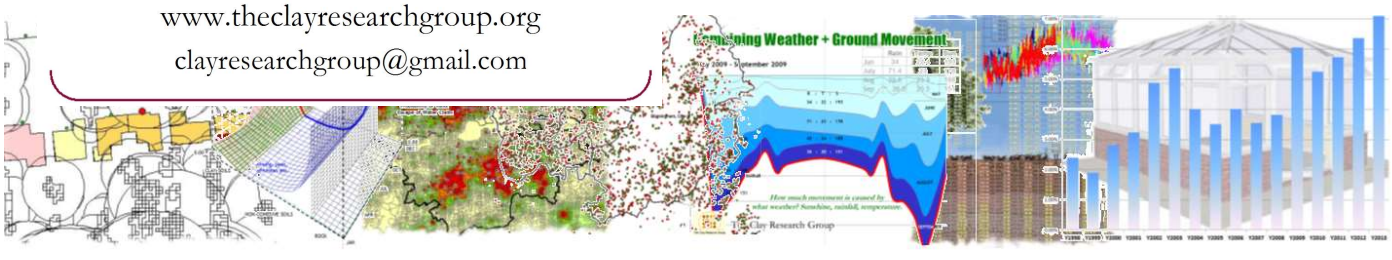

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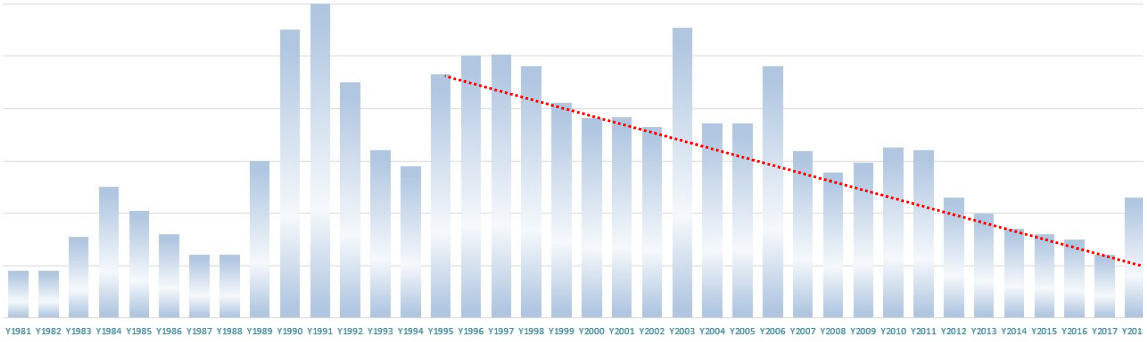
Defining Surge Years and Weather Elements

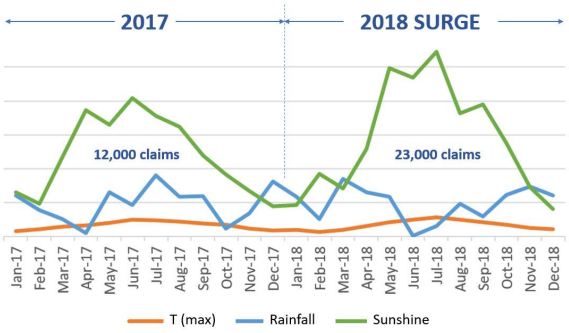
Below, a graph of subsidence claim notifications from 1980 to 2018 based on data provided by the ABI, showing the uneven distribution between years. The red line shows the steady decline over the last 20 years or so and the relative standing of 2018 compared with earlier years classified as 'surge'. See previous page for definition of the term.



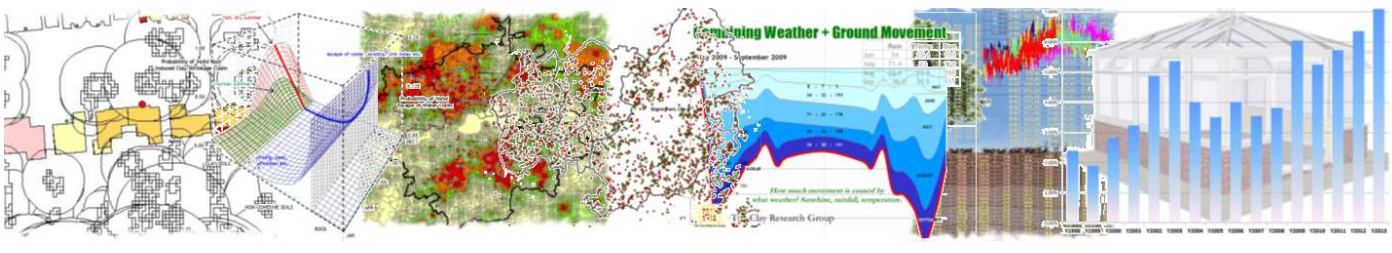
So, was 2018 a surge? The table below uses a definition of surge as being a year with a 30% or greater increase on the preceding years numbers. On this basis, 1976 saw the greatest surge, followed by 1989 and, perhaps surprisingly, 2018 coming third.

Claim numbers have been falling since 2006 as shown by the red trendline, but what are the drivers behind these surge years? Is there a weather anomaly – reduced rainfall, high temperatures, more sunshine - that triggers them?

A general indicator of which weather elements are implicated is shown below.



The graph, left, plots rainfall, hours of sunshine, maximum temperatures etc., from the Heathrow weather station. The area between hours of sunshine (green) and rainfall (blue) is shown as an example of the difference between 2017 (non-surge) and 2018 (surge). Unfortunately, there is little by way of a predictive algorithm that we might apply.



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2019 – to surge, or not to surge, that is the question.

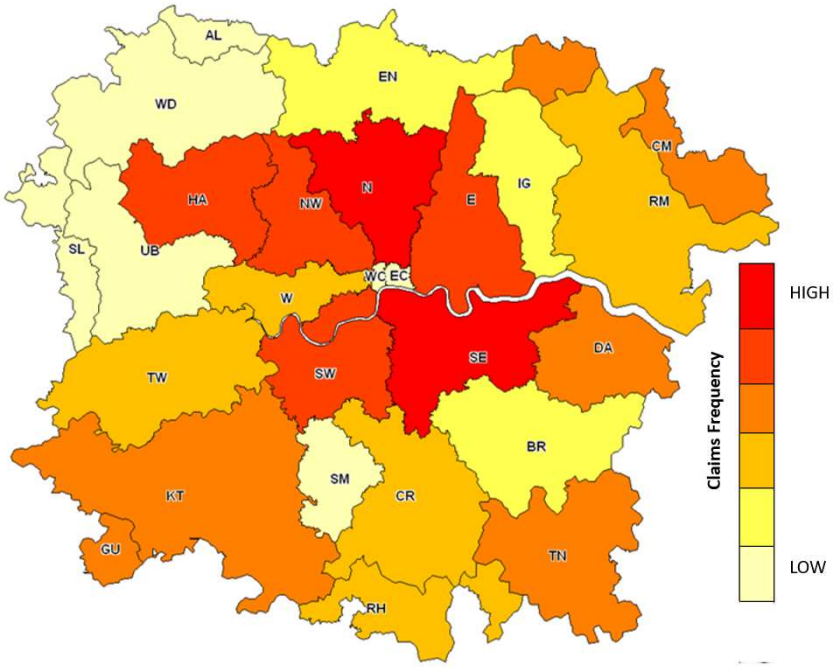
As can be seen from the graph on page 1, the current SMD is rising quite steeply, following the profile of a surge year. Will it reach a deficit of 100mm by the end of May? According to the Met Office 3 month forecast, it could happen.

They report *"For April-May-June as a whole, above-average temperatures are more likely than below-average temperatures. The probability that it will fall into the warmest of our five categories is 45%."*

For the same period, they say *"For April-May-June as a whole, below-average precipitation is slightly more likely than above-average precipitation. The probability that UK-average precipitation for April-May-June will fall into the driest of our five categories is between 20% and 25%."*

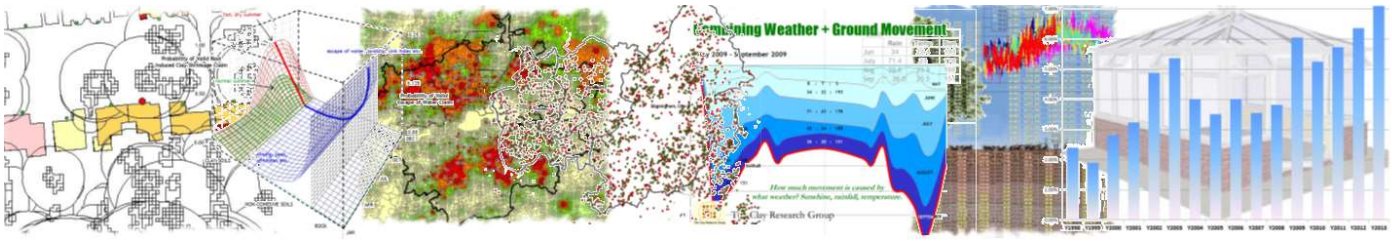
Warmer and drier provide early indications of potentially higher claim numbers, but taking into account the general trend towards declining claim numbers over the last 10 years or so, it is probably unlikely that we shall see figures exceeding 25,000.

Subsidence Risk by Postcode Area - London



A generalised view of the risk of subsidence in the map, left, plotting frequency data based on valid subsidence claims over a five-year period divided by private housing stock for London by postcode area.

The five-year claim sample used to build the map includes one surge year



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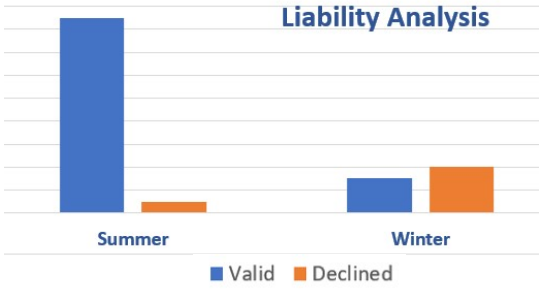
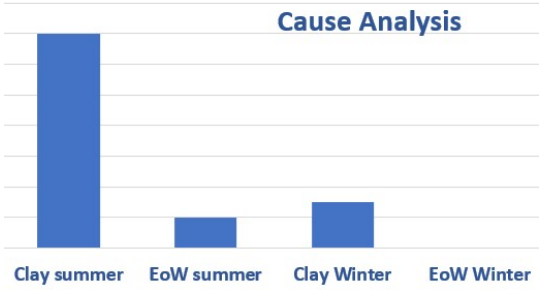
Using Claims Data to Determine Probability of Liability, Cause and to infer Geology





NW11 6 - Claims plotted by postcode and by month provide a strong indication of the underlying geology.

Valid claims (blue) increase significantly in the summer, peaking around October. In contrast, declinatures (orange) show an increase in the winter months with reduced numbers in the summer.

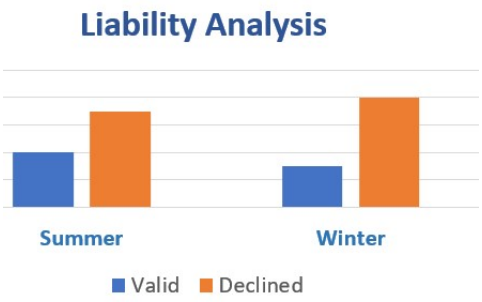
The data here suggests the area is underlain by a predominantly shrinkable clay soil. Checking the BGS web site confirms the presence of London clay.

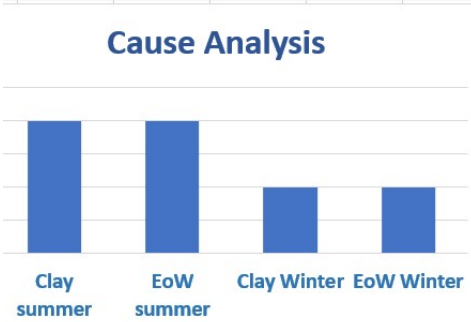
Total spend on valid claims from sample = £397,433

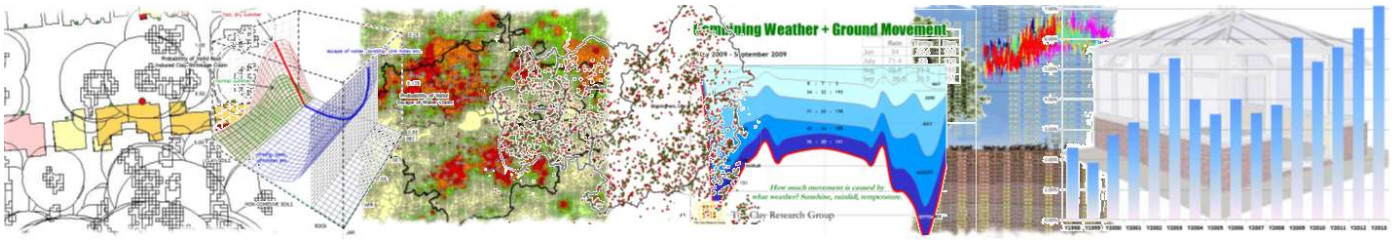
M21 9 – this has a different seasonal profile with smaller peaks of valid claims in the summer, a third the volume of claims in NW11 6, and a steady rate of declinatures throughout the year, following the profile of a non-cohesive, predominantly sandy soil.

Reference to the BGS 1:50,000 scale map reveals widespread drift deposits of alluvium, clay, sand and gravel.

By mapping and analysing each sector, profiles can be constructed to help identify the risk of subsidence. Total spend on valid claims from sample = £39,892.







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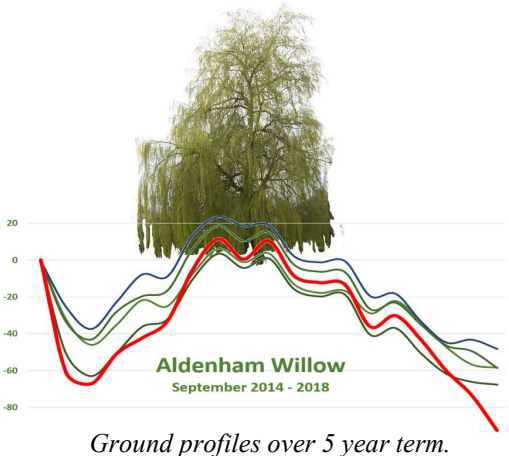
Aldenham willow – ground movement profiles over time.

Below, left, an illustration of how summer ground movement profiles have developed over a five-year term, using September as the comparative month. The profile of the drier summer of 2018 that produced a sudden increase in claim numbers is shown in red.

Each of the months reveals a similar profile, undulating across the root footprint fairly consistently, dipping away to the extreme right of the image suggesting the increased moisture uptake at the root periphery in times of stress in this location. All levels are taken from the initial readings in June 2006.

The sometimes-held view that roots create haphazard and unpredictable ground movement isn't supported at the site of the Aldenham willow. Ground movement varies as a direct result of the interaction between the geology and zones of root activity, as can be seen below.



Ground profiles over 5 year term.

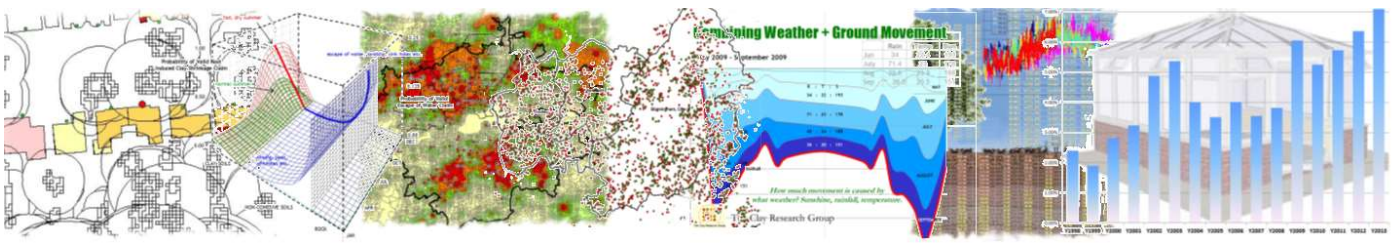
Ground profiles over 12 month term.

The image to the right plots ground movement over a 12 month period, extending from January 2018 through to January 2019.

Rehydration took place between January and May, before subsiding in July through to September. There was little movement between September and October, and recovery in January 2019 restored the ground profile to that of July 2018.

Again, the ground movement profiles are similar month by month.

Precise levelling has been undertaken by GeoServ Limited and funded by Crawford & Co.



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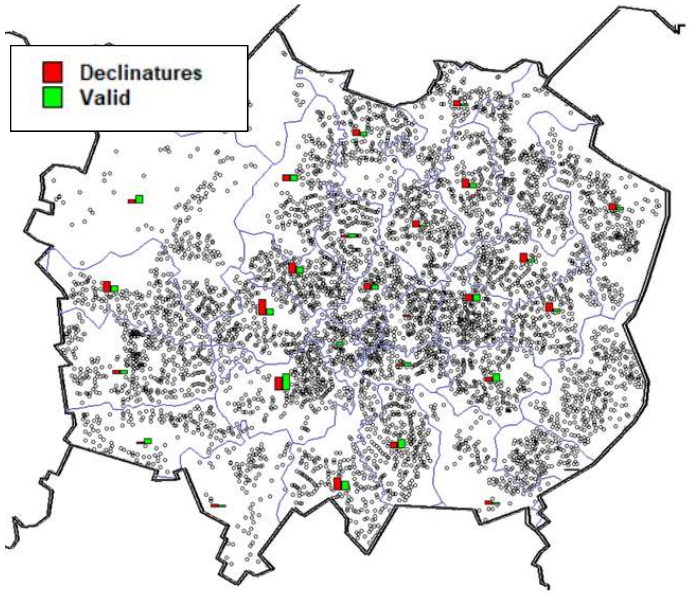
Subsidence Risk Analysis - Coventry

The following pages examine the risk of subsidence in Coventry. Coventry has around 105,000 houses, a population of around 326,000 and an area of 98.65km^2.



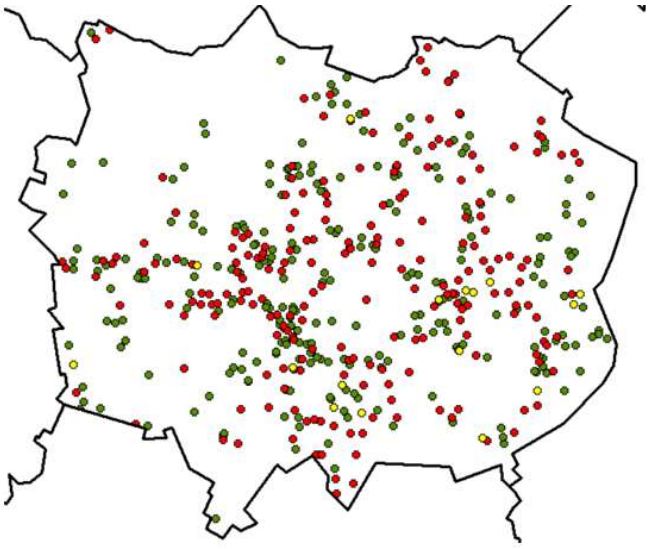
Borough	Edition	Date
Islington	Issue 47	Apr-09
Camden	Issue 69	Feb-11
Brent	Issue 71	Apr-11
Haringey	Issue 72	May-11
Barnet	Issue 77	Oct-11
Waltham Forest	Issue 79	Dec-11
Welwyn and Hatfield	Issue 80	Jan-12
Ealing	Issue 84	May-12
Sutton	Issue 91	Dec-12
Hillingdon	Issue 106	Mar-14
Havering	Issue 149	Oct-17
Harrow	Issue 150	Nov-17
Enfield	Issue 155	Apr-18
Southwark	Issue 156	May-18
Lewisham	Issue 157	Jun-18
Bromley	Issue 158	Jul-18
Croydon	Issue 159	Aug-18
Basingstoke & Deane	Issue 160	Sep-18
Merton	Issue 161	Oct-18
Wandsworth	Issue 162	Nov-18
Basildon	Issue 163	Dec-18
Redbridge	Issue 166	Mar-19
Leicester	Issue 167	Apr-19

Table of earlier studies.

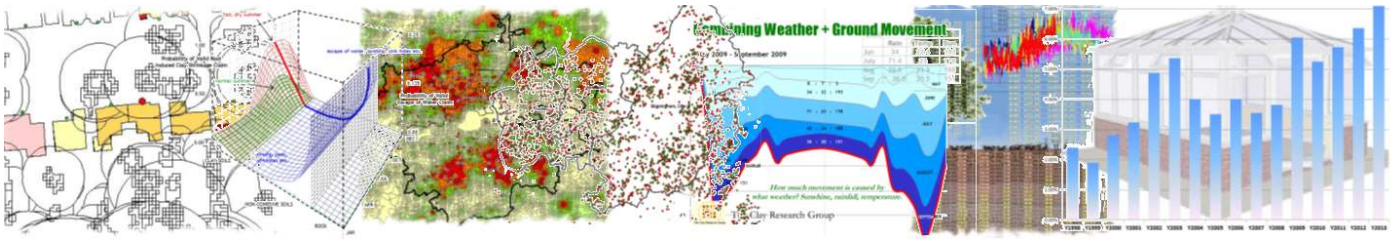
Above, the distribution of housing across the district shown by full postcode with the valid/declined rating from a sample of over 88,000 claims superimposed as a bar graph.

Right, the distribution of claims, both valid (green) and declined (red).

Coventry is rated 126th in our 'rank order of risk by district' table, with a rating of 1.286 in relation to the UK 'average by district' table. That is to say, Coventry is 1.286 times greater risk than the UK average.



Valid and Declined Claims Distribution



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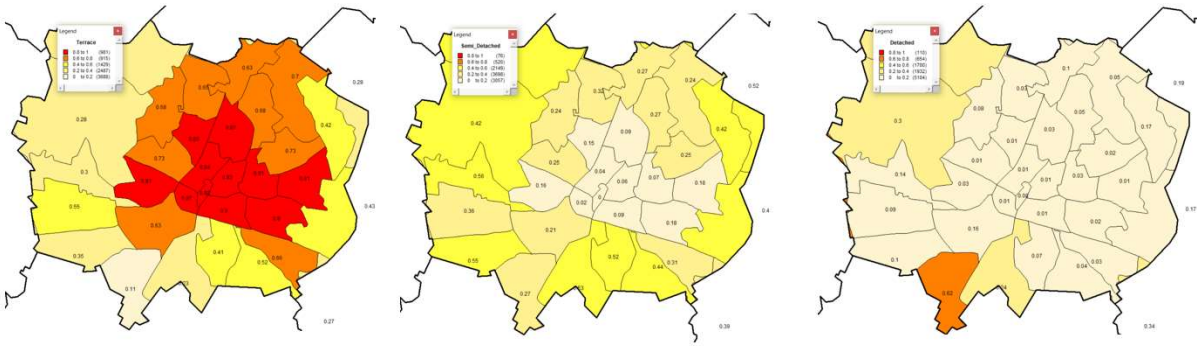
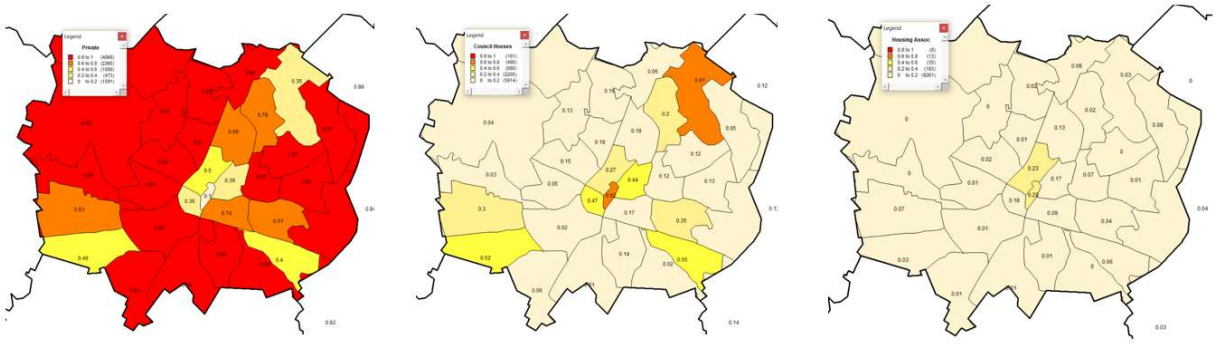
Coventry - Properties by Style and Ownership



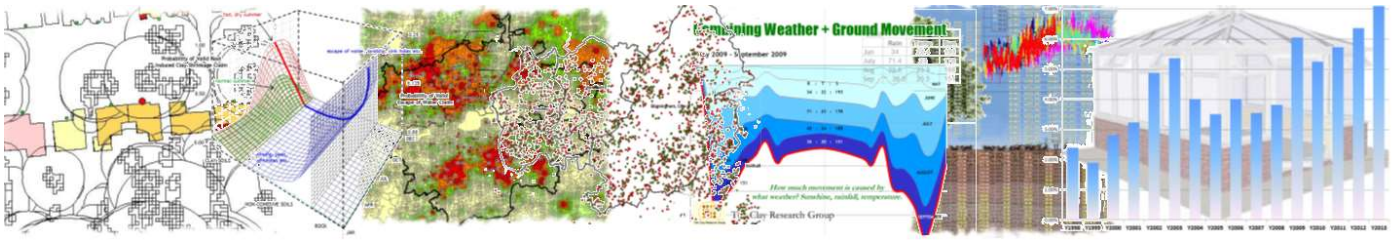
TERRACED SEMI-DETACHED DETACHED

Above, the frequency distribution of differing house styles at postcode sector level showing the concentration of each style in relation to the total housing stock. The 2001 census lists 12,000 detached, 34,000 semi-detached and 60,000 terraced properties (all figures rounded).

Distribution by ownership is shown below. In addition to the above, there were around 20,000 flats at the time the census was taken.



PRIVATE COUNCIL HOUSING ASSOCIATION



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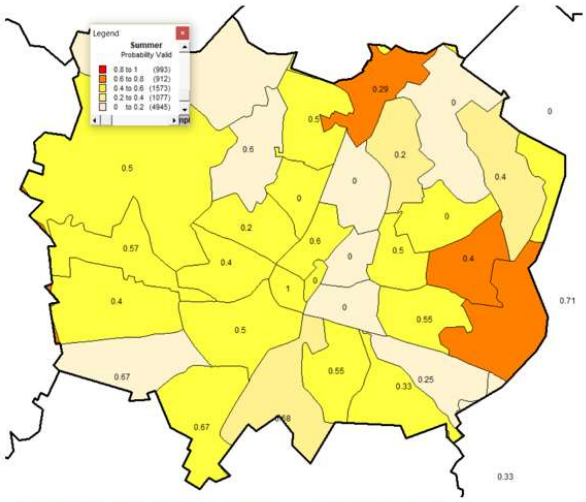
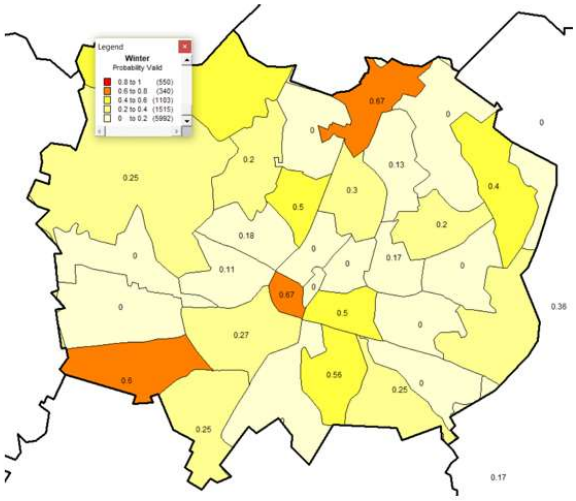
Coventry - Liability by Season and Geology

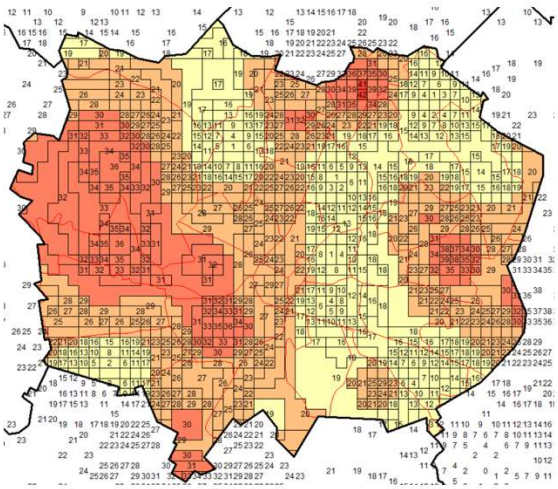


PROBABILITY VALID - SUMMER

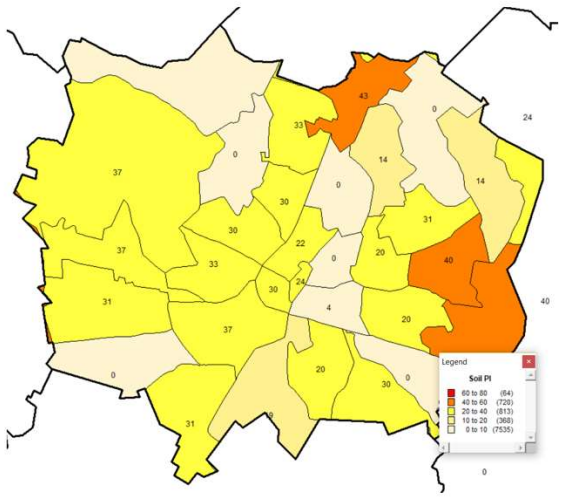


PROBABILITY VALID - WINTER

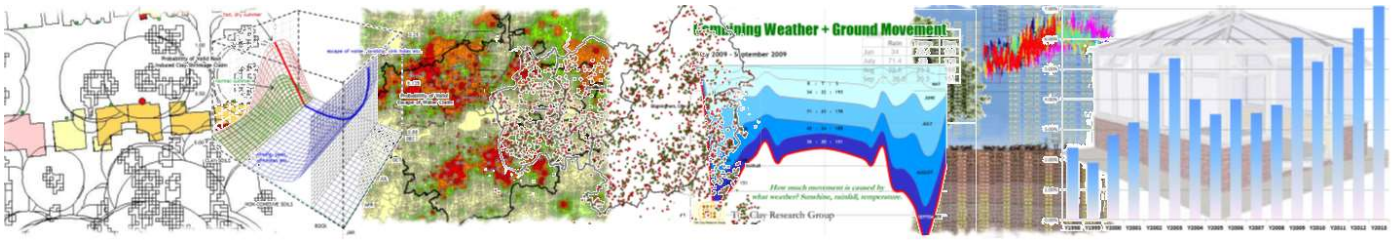
The probability of whether a claim is going to be valid or declined varies by season (above) and geology (below). Claim frequency data by season can be used to infer the nature of the underlying soil (i.e. either cohesive or non-cohesive) and its relationship with the weather. Clay soils respond to warm, dry summers, but deliver far fewer claims in the winter months. Houses on non-cohesive soils tend to deliver fewer claims overall, but with less change by season. The shrinkable clay series, where present, typically has a PI of between 20 – 35% as shown on the CRG map below. The divide between soil types roughly corresponds to the British Geological series maps, revealing the variable thickness of the drift as further exposed by the 'Total Private Claims' map on the following page.



CRG 250m GRID DATA



CRG SECTOR DATA



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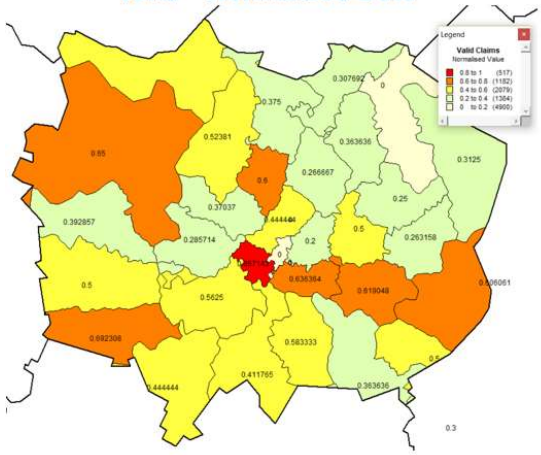
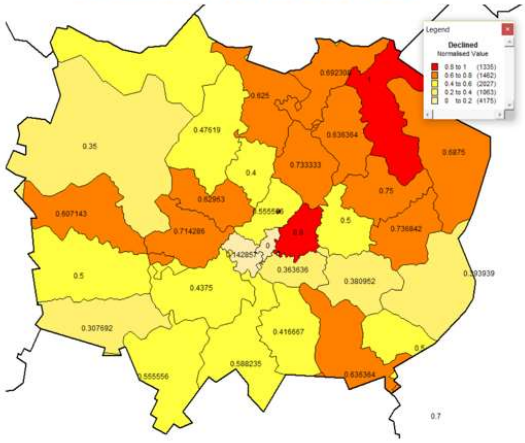
Coventry – Liability by Sector. Escape of Water and Council Tree Claims Distribution

Valid – Normalised Data

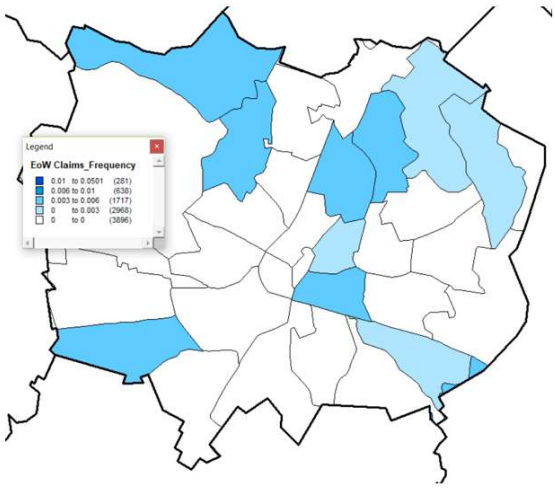


Declined – Normalised Data

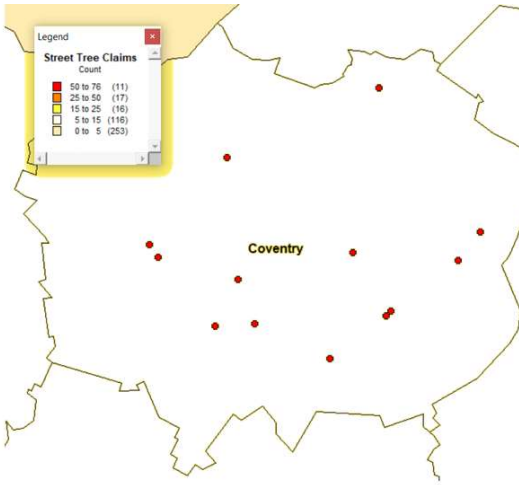


Above, mapping historic claim liability on a normalised scale revealing postcode sectors where the claim has either high or low probabilities of being accepted as valid or declined throughout the year, not taking into account any seasonal influence.

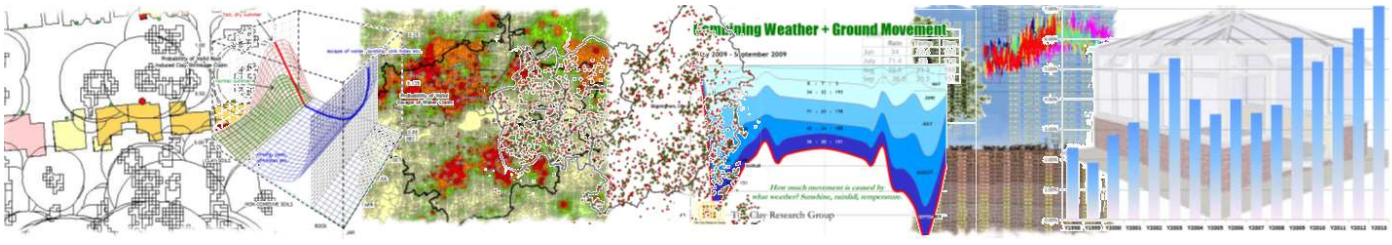
Below, left, mapping the frequency of Escape of Water claims from the sample. Below, right, dots on the 'Council Tree Claims' map, represent properties where damage has been attributable to vegetation in the ownership of the local authority. Is there an identifiable 'Hot Spot'?



EoW – Frequency from Sample



Claims Involving Street Trees



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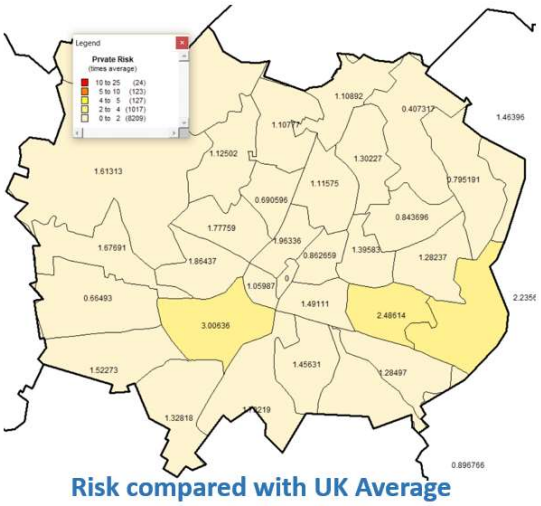
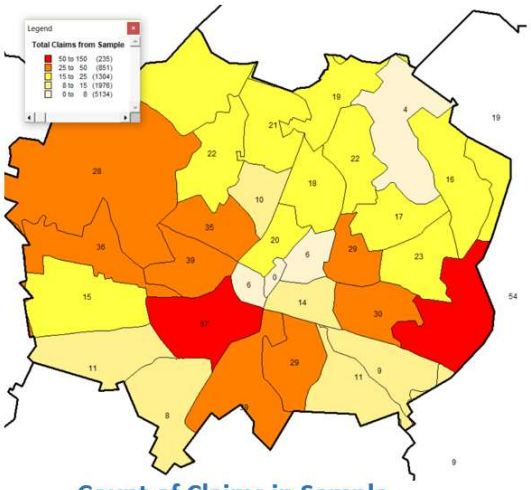
Coventry – Averages, Count & Probabilities



Risk compared with UK Average (Private Housing)



Count of Claims in Sample

Below, the table listing the outcome of our analysis at district level, showing that the chances of a claim being declined in the summer are around 30%, and if it is valid, the chances of it being due to clay shrinkage will be around 70%. In the winter, the repudiation rate is higher at 40%, and if it is valid, the chances of it being due to an escape of water is around 70%.

PROBABILITIES by SEASON – CAUSE AND LIABILITY

District	valid summer clay	valid summer EoW	Repudiation Rate (summer)	valid winter clay	valid winter EoW	Repudiation Rate (winter)
Coventry	0.366	0.252	0.382	0.25	0.37	0.382