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 2017
Edition 150

The Clay Research Group

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Issue 150, November, 2017

Subsidence Forum Award

The Subsidence Forum Dissertation Initiative 2017 award of a £500 prize went to Harry Sturley, who delivered his paper, "An Updated Review of the Significance of Clay Subsidence as a Threat to Domestic Property in the United Kingdom". More inside.

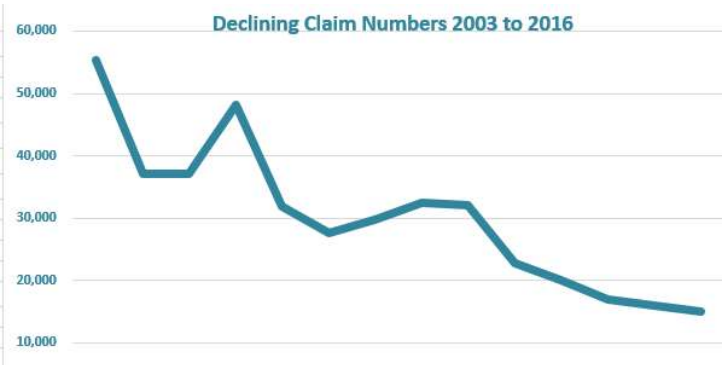
Harrow – Maps and Analysis

This edition includes a review of the London Borough of Harrow, mapping claims onto the geology and looking at risk frequency by postcode sector.

Climate and Claims Update

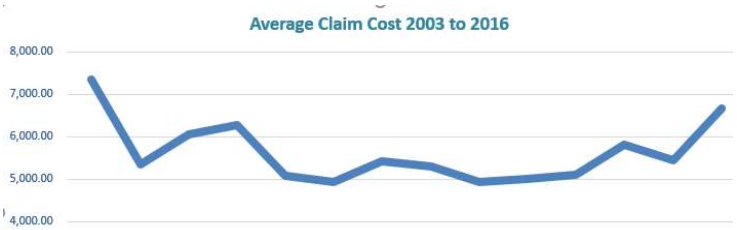
According to the NOAA web site, 2016 was the warmest year since records began in 1880. The latest estimate (6th November, 2017) from the Met Office is that, "2017 could be the warmest in records stretching back to 1850".

The fear that global warming would lead to an increase in root induced clay shrinkage claims doesn't seem to correspond with recorded claim numbers – ABI extract below.



Instead, there has been a steady decline over recent years, with notifications falling well below the previous average for 'normal' claim years. The decline commenced in 2012 and has fallen steadily since.

Interestingly, estimated claim costs have remained fairly constant, rising in 2016, perhaps reflecting the warming phase and the cost of dealing with the more technically challenging clay shrinkage claims.



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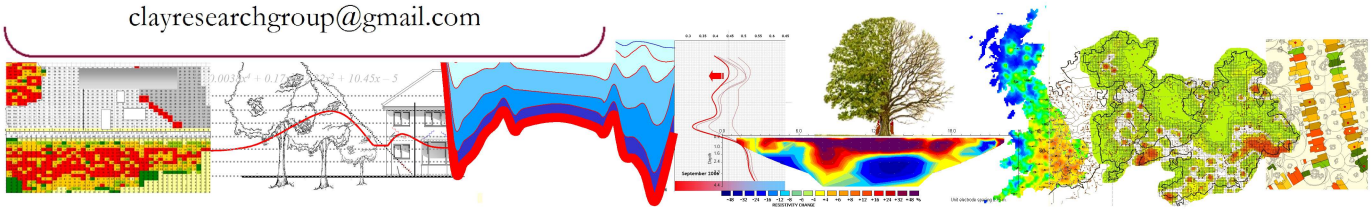

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Research Updates

The UK Collaboratorium for Research on Infrastructure and Cities (UKCRIC), described in CRG Newsletter 121, June 2015, has been awarded grant funding of £125m from the Engineering and Physical Sciences Research Council (EPSRC).

The EPSRC web site explains …" *Inadequate infrastructure costs the nation £2M a day, and extreme events can cost hundreds of millions more. To plan for the future, we need a coherent national research programme to de-risk, help prioritise and provide evidence for investment. Existing research is fragmented and under-resourced."*

The UKCRIC research team consists of 14 university-based, infrastructure, civil and construction engineering research groups in the UK.

Professor Ian Jefferson from Birmingham University, a speaker at the 2015 Aston Subsidence Conference, is part of the UKCRIC team.

Birmingham will be researching buried pipes, culverts, shallow tunnels, barrier walls and other structures at, or near, full scale, all fully instrumented.

Go to http://www.ukcric.com/about/ for further details.

On a separate, but related topic, congratulations to Harry Sturley from the School of Water, Energy and Environment Geographic Information Management at Cranfield University.

Harry has been awarded The Subsidence Forum Dissertation Initiative 2017 prize of £500 for his paper entitled "An Updated Review of the Significance of Clay Subsidence as a Threat to Domestic Property in the United Kingdom."

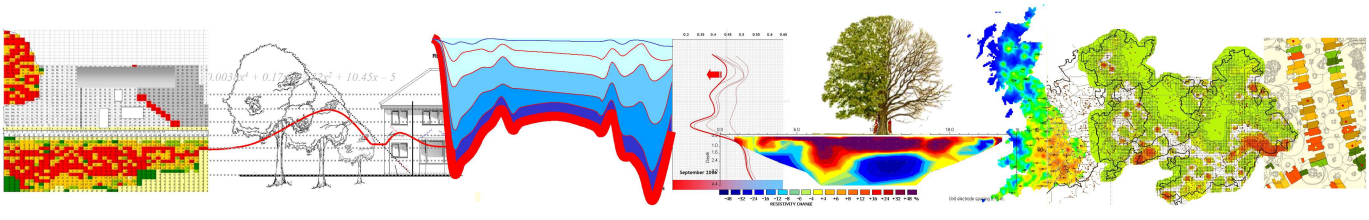
Harry's paper is part of the work he is undertaking towards his MSc. It includes a study of ABI subsidence claims data with additional information supplied by Zurich Insurance.

The award was announced at the Subsidence Forum Training Day held at the Building Research Establishment on the 19th October 2017.

Harry's supervisor at Cranfield, Tim Farewell, is the joint author of a paper entitled "Probabilistic soil moisture projections to assess Great Britain's future clay-related subsidence hazard", published in Climatic Change in 2015.

The 'related topic' referred to above is that Cranfield University are part of the UKCRIC team looking to advance our understanding of long term performance and serviceability of water infrastructure.

The CRG are supporters of the project and hope to provide updates going forward.



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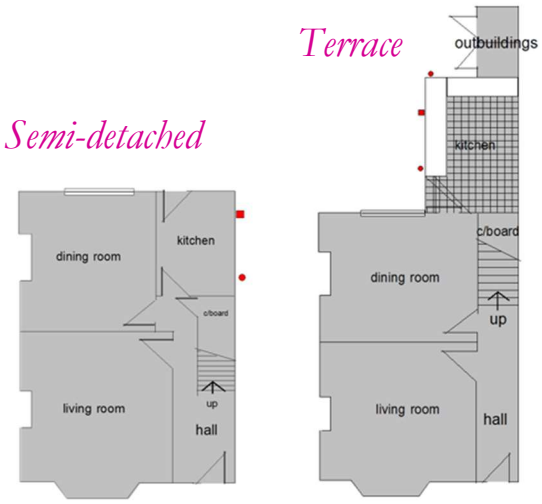
Data Entry Using a Web Interface

Continued from previous edition …

In last month's edition, methods of selecting the house type (semi-detached, mid/end terrace etc) were explored using a web interface.

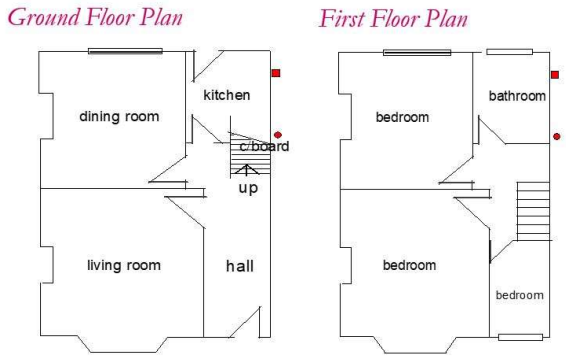
This article looks at a method of describing internal damage using the house type selected. Below, examples from terraced and semi-detached styles of property.



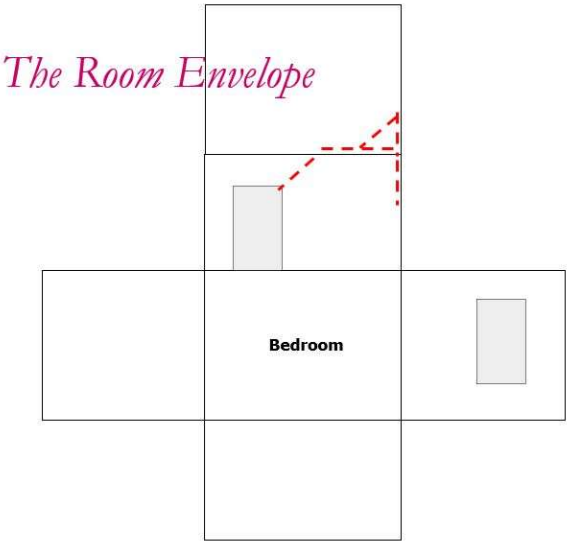
A range of typical floor plans exist in the library, selected by elevation – see last month's edition.

Using a semi-detached plan in this example, the user would drag and drop 'intelligent' icons from the legend to describe the damage.

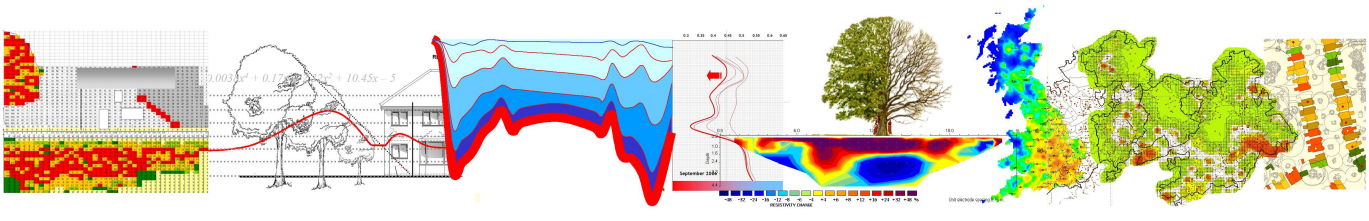
The figure at the head of the next column shows typical floor plans for a left-handed semi.



The user selects the damaged rooms in turn by clicking on the name. Clicking on 'bedroom' identifies the room for damage location, analysis of whether the damage is likely to be subsidence and prompts the system to produce a schedule of repairs.



In the example, the user has dragged and dropped icons (in this case, broken lines to indicate crack damage) from the legend and placed them to identify damage location.



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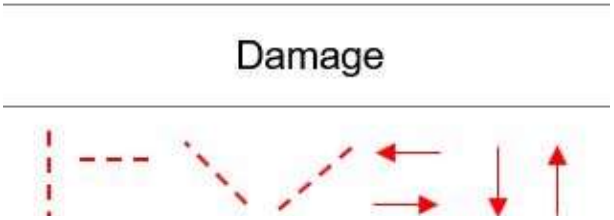
Data Entry Using a Web Interface

Below, an extract from the 'intelligent' legend. Slopes and cracks are indicated as below.



The user (homeowner, claims handler, engineer or site investigation company) drags the appropriate symbol to the desired location, adjusting the length as required.

The intelligence lies in the fact that the floor plans are drawn to scale. If the bedroom in the above example is say 4m deep, stretching the crack symbol over half the length of the ceiling informs the system that it is 2m long.

We needn't be too concerned at any notion of great accuracy. Crack lengths are rarely accurately measured on site now, and in any event repairs often change once the paper is stripped off.

Each of the zones in the room is identified. The system recognises a 'wall/ceiling interface' or if the crack is above or below the window.

This takes us to the next stage. Automating schedule production.

As soon as the sketch has been completed, the schedule is ready – assuming of course there is a supporting schedule of rates in the system.

1. Rake out and repair crack to ceiling in front bedroom … £78.48
2. Re-decorate bedroom. … etc

TOTAL COST OF REPAIRS … £3,750.33

Finally, causation analysis. How can this approach assist in the diagnosis of claim validity?

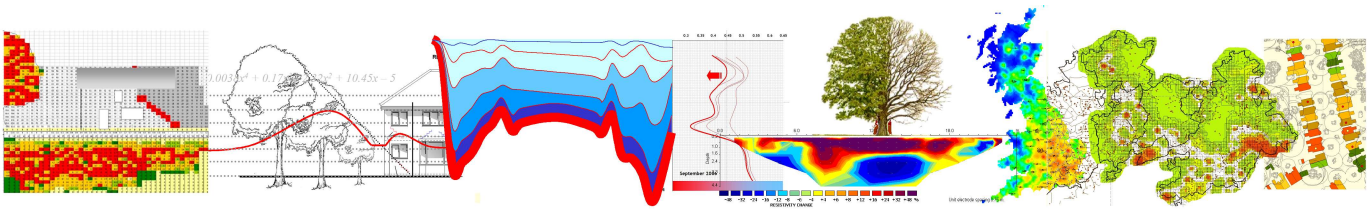
The selection of symbols drives the decision-making process. If the user has only selected vertical and/or horizontal cracks, the system will be biased towards shrinkage.

Diagonal cracks would be indicators of a potentially valid claim, subject to other considerations. For example, does the orientation of one or more of the diagonal cracks link in with any external factors - the location of a drain perhaps, or tree?

The system checks the geology. If the tree is a possible influencing factor, is the soil a shrinkable clay? If so, what was the weather at the time the damage appeared? Was it summer or winter?

Each step influences the final probability of cause and claim validity and suggests the next action. Is an inspection needed? Or do we appoint site investigations – drainage tests and soil testing perhaps, or monitoring?

This desk-topping approach would probably resolve around 20% of claims received – more in an event year. The remainder may be better directed with fewer delays.



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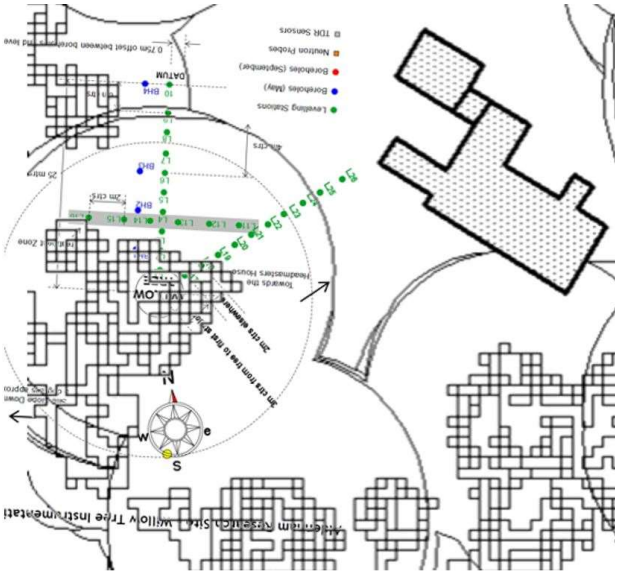
Long Term Monitoring of Ground Movement at the Site of the Aldenham Willow. May 2006 to September 2017.

Funded by Crawford & Co., GeoServ Limited have been monitoring ground movement at the above site since 2006. The data has provided a valuable insight into the seasonal influence of a mature, high risk species of tree on clay soil – possibly one of the longest studies undertaken.

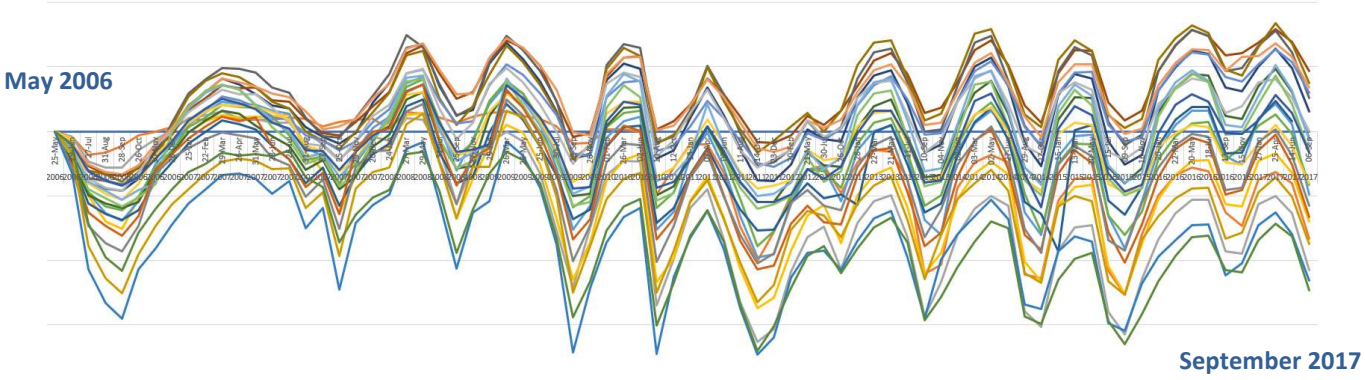


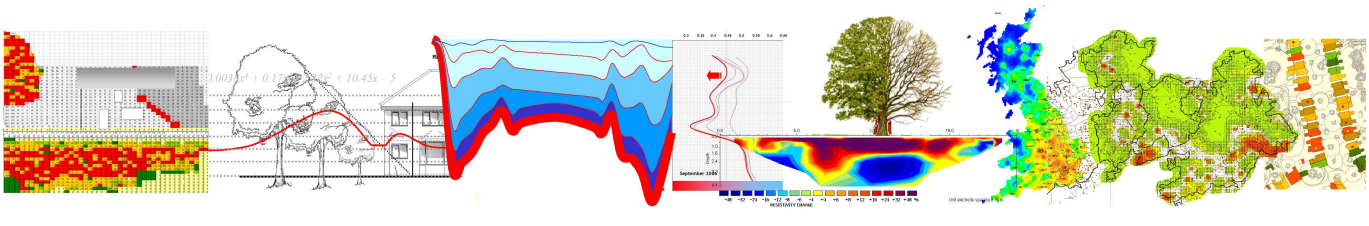
Earlier in the year, some of the stations had to be replaced and the concern was that the new stations may show an irregular profile as a result. The latest readings suggest little change has occurred. The profile appears to follow the earlier readings seamlessly so once again, our thanks to Chris of Optera Limited for this item of maintenance.

Left, the willow in relation to the headmaster's house, with level stations (green) and past boreholes (blue) superimposed.

Below, the ground movement levels. The latest readings (extreme right) were taken following replacement of the damaged level stations earlier in the year, and the profile appears to be unaffected.

Aldenham Willow - Ground Movement Profile - May 2006 to September 2017





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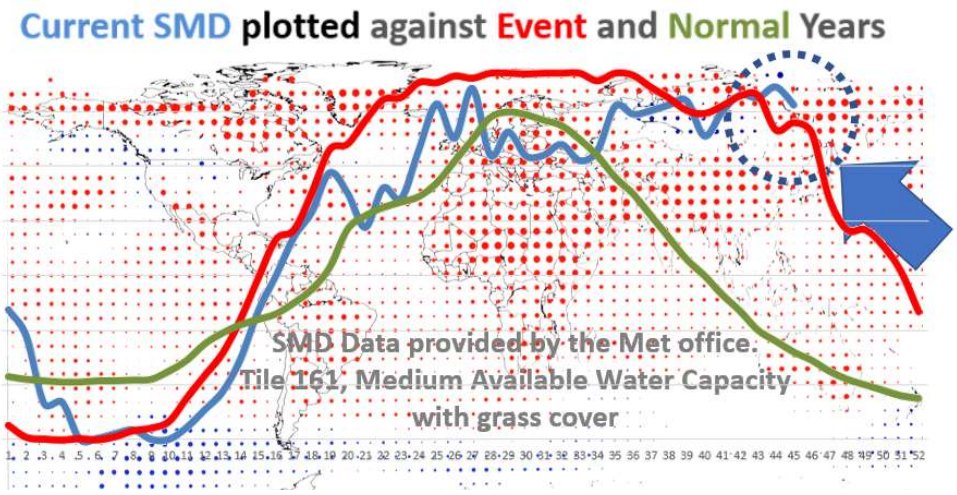
SMD Update and Indian Summers

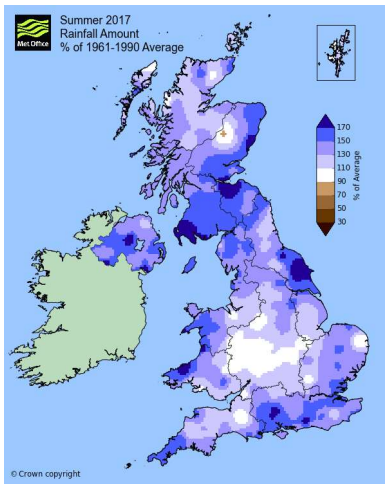
The latest values for Soil Moisture Deficit (SMD) in the south east of England (tile 121 of the Met Office grid) shows a late increase (drying) which is a little unusual, but not unique.

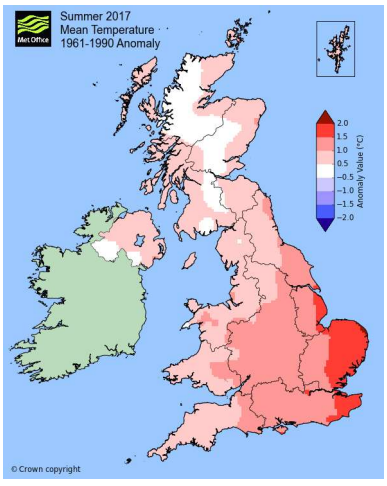


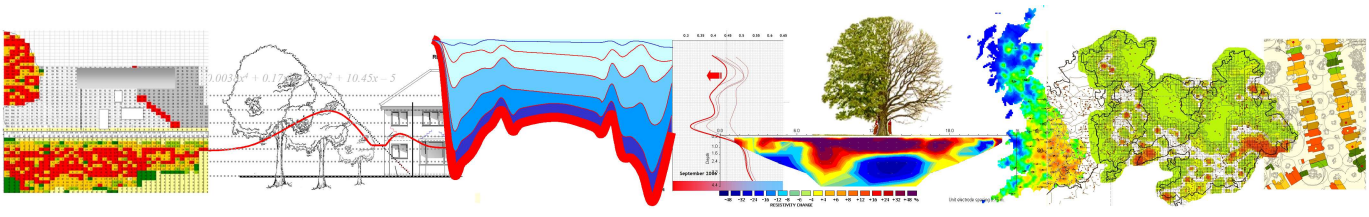
Not meteorologically an Indian Summer perhaps, but the soil in the south east (tile 161 at least) remains quite dry. The latest reading of 129mm might trigger alarms that we are going to see a surge year, although the reduced influence of vegetation associated with leaf fall, suggest it's unlikely that we shall see more than a late seasonal blip.

Below, anomaly maps of the UK from the Met Office web site reveal a summer that was both wetter and warmer than the 1961–1990 average.

Right, anomaly maps reproduced from the MetOffice web site at https://www.metoffice.gov.uk/public/weather/climate-anomalies/#?tab=climate Anomalies







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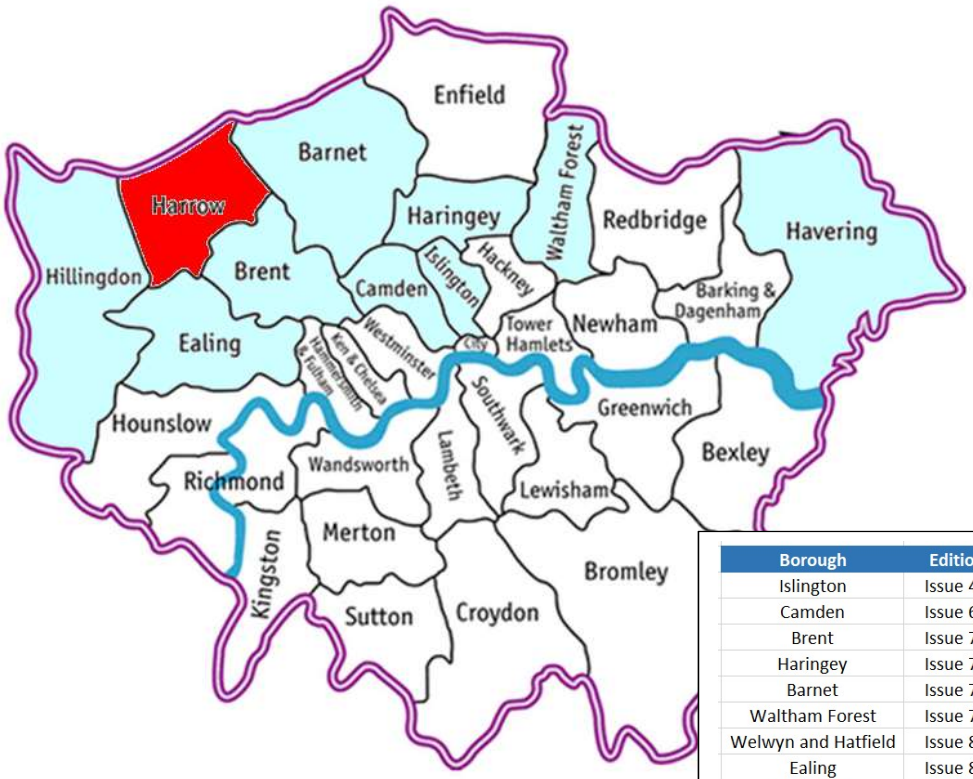
Subsidence Risk – London Boroughs

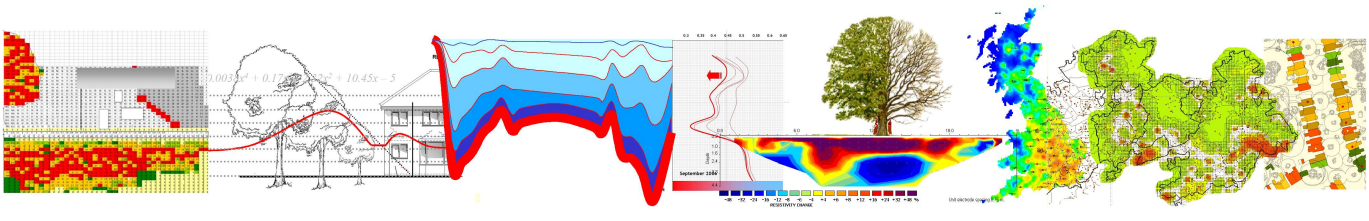
Continuing the analysis of the risk by London borough, on the following pages we look at Harrow in north west London. Harrow has a reported population of 215,000 and a housing stock of around 83,000. Area = 50.47km^2.



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
Hillingdon	Issue 106	Mar-14
Havering	Issue 149	Oct-17
Harrow	Issue 150	Nov-17

Harrow may be considered a high-risk borough for subsidence in terms of claim count, cost and frequency. Much of its area is underlain by highly shrinkable London clay soil with a small percentage of drift – see page 10.

Care is needed when referring to the various maps on the following pages. The colour themes reflect a scale of risk rather than an ultimate value. It is useful as an alert to surveyors undertaking pre-purchase surveys for example, and of course underwriters and claims handlers dealing with relatively low frequency events.



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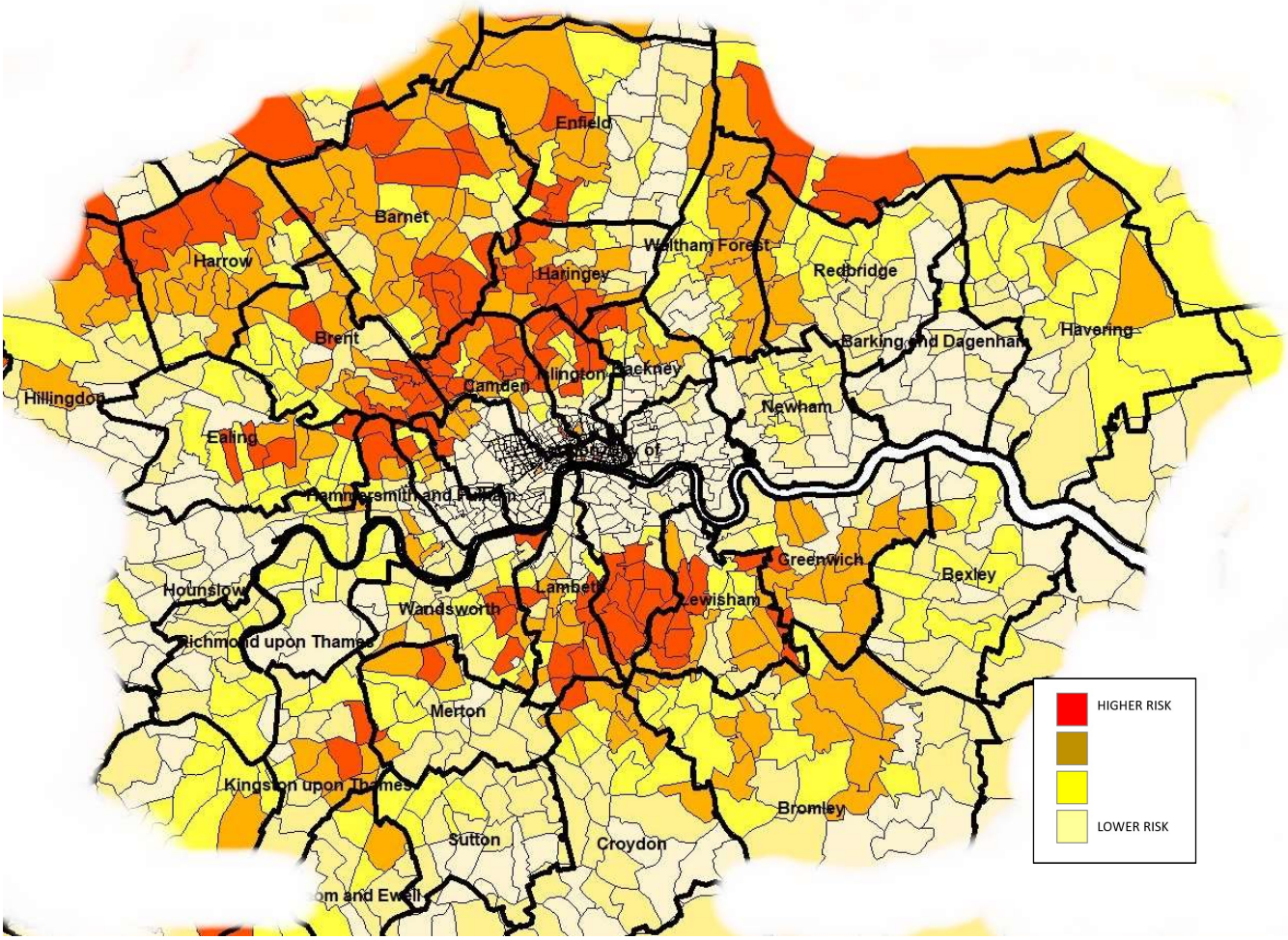
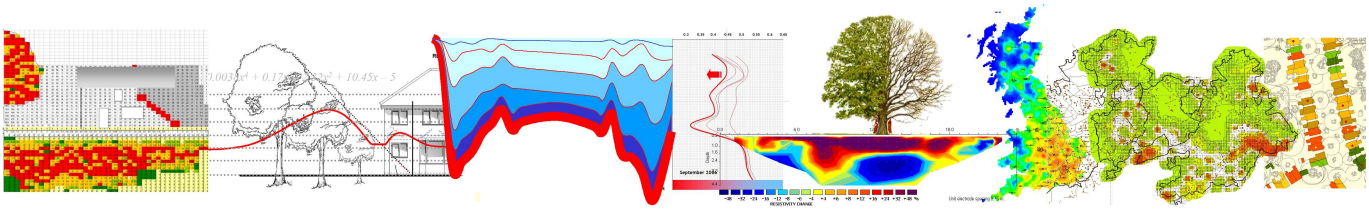
Harrow Study Area – Relative Risk by Sector and District

Below, a postcode sector map of London showing the risk of subsidence by postcode sector, expressed as frequency of claims/housing population. Reiterating the comments on the previous page, the postcode sector map reflects the risk using a five-year sample, including one event year, and delivers an idea of the comparable risk of subsidence across London.



The primary risk is root induced clay shrinkage, although there are a high percentage of claims relating to escape of water from leaking drains, possibly reflecting the older housing stock with shallow foundations bearings onto mixed soil deposits. There are also a limited number of claims relating to historic mining collapses associated primarily with the underlying chalk measures. See http://www.londongeopartnership.org.uk/gla36.html



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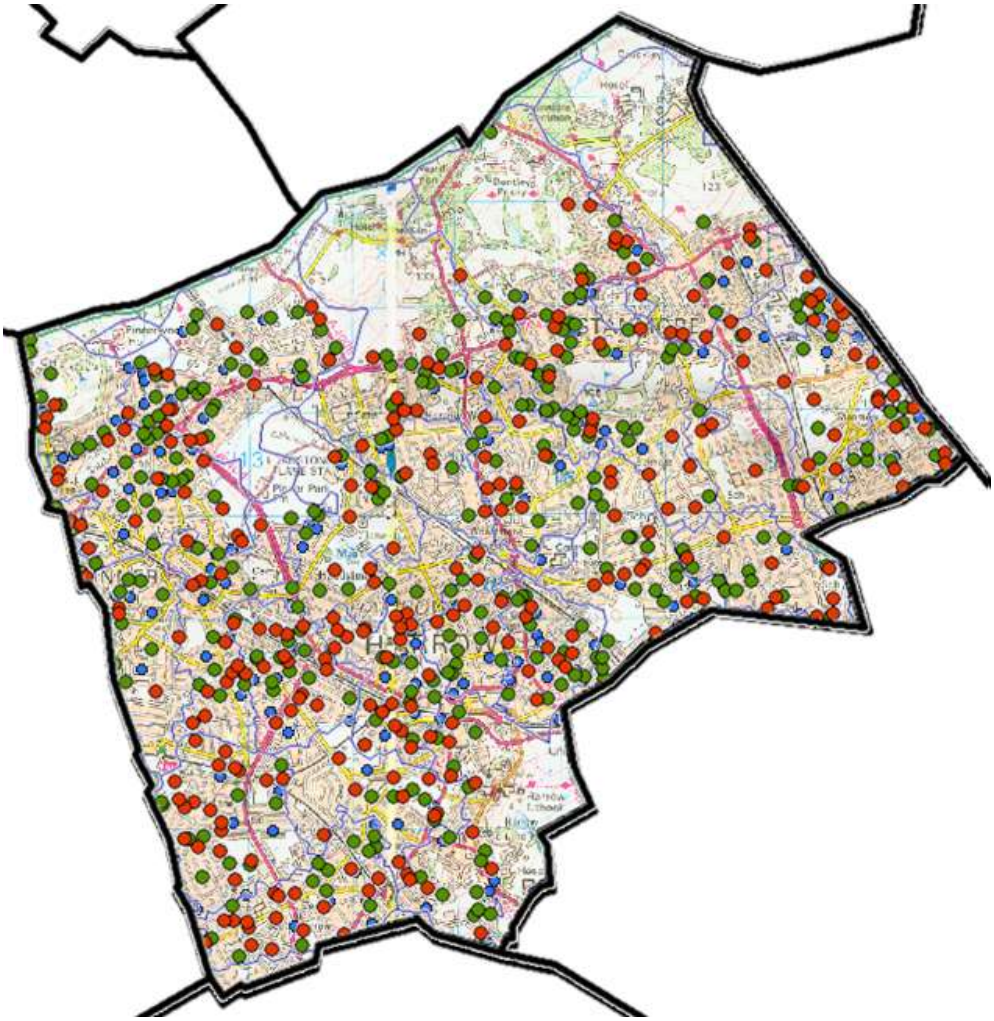
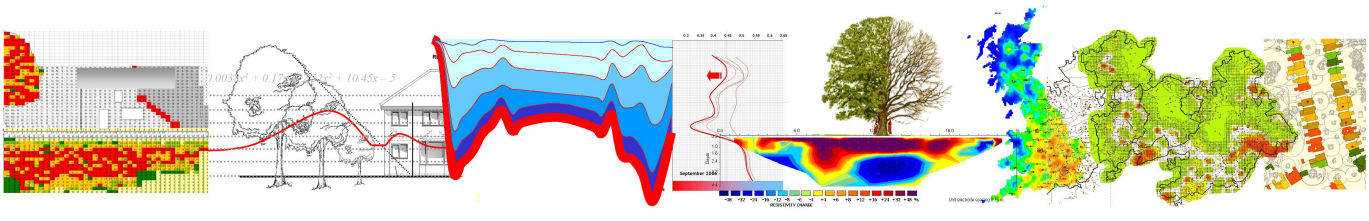
Harrow Study Area - Location

Valid (green) and red (declined) claims at full postcode (i.e. HA5 5SN) level superimposed onto a map showing housing layouts, road distribution and open spaces. The district outline includes Harrow, Stanmore and Pinner. As a full postcode might typically include a 15 – 20 houses, each dot may record one or more claims.





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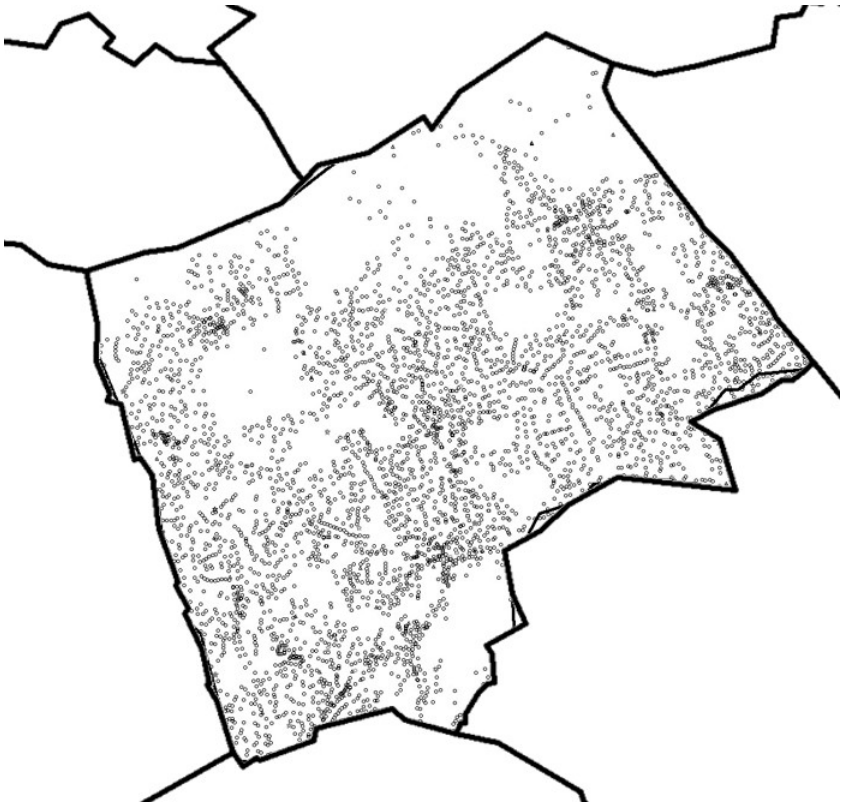
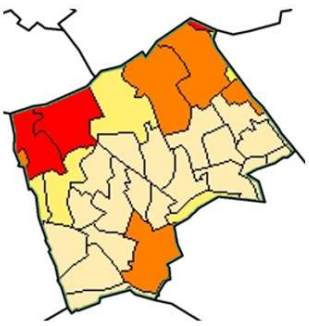
Harrow Study Area – Housing Population Density

The distribution of properties within the district boundary.

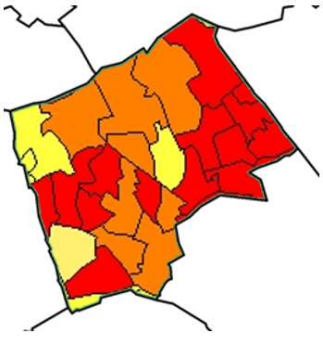


House Types by Sector

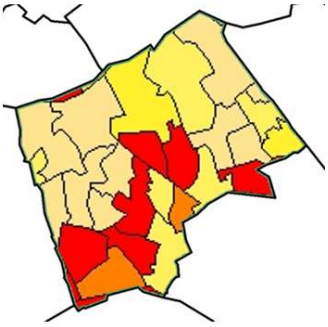
Detached

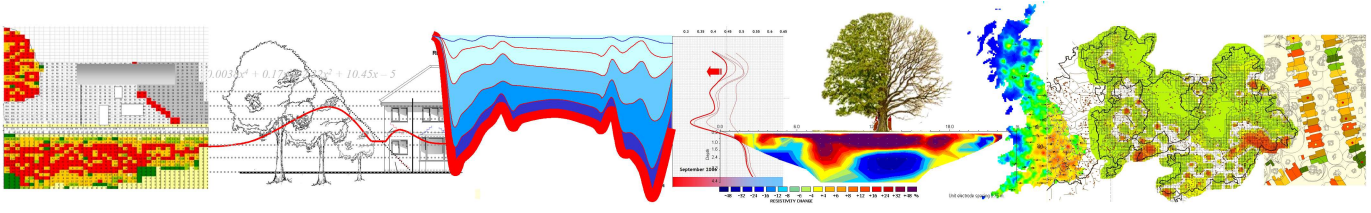


Semi-detached



Terrace





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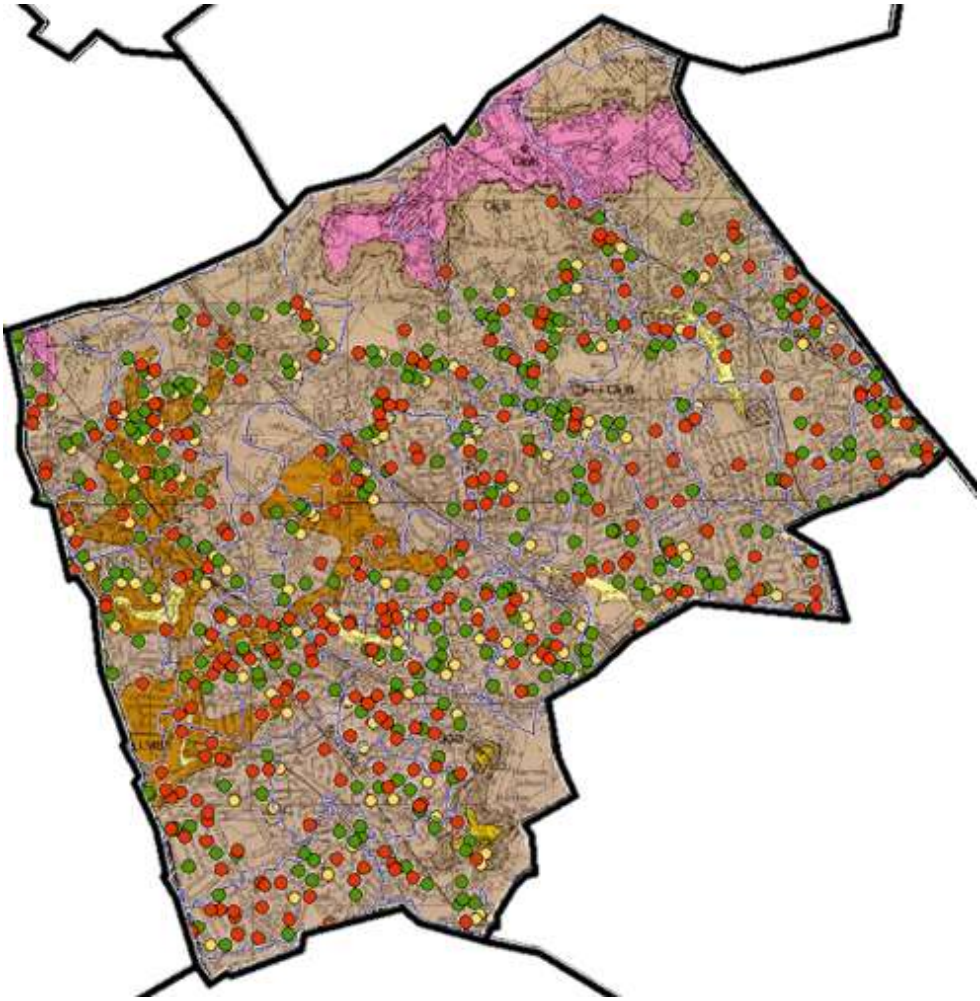
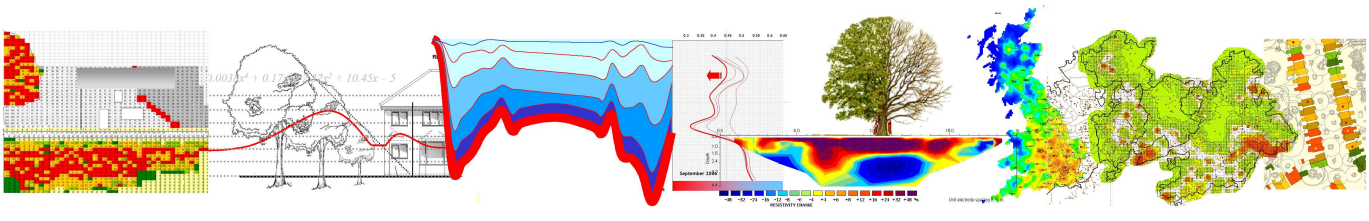
Harrow Study Area – Claims and Geology

Root induced clay shrinkage claims at full postcode level superimposed onto the British Geological Survey 1:50,000 scale solid and drift geological map of the area. The pink area outlines the extent of the Stanmore Gravel formation, comprising sand and gravel deposits at Bushey Heath. The darker brown area to the west plots the extent of the Lambeth Group.



For more detailed maps revealing the geology and providing access to borehole logs etc., visit the British Geological Survey web site at http://mapapps.bgs.ac.uk/geologyofbritain/home.html.



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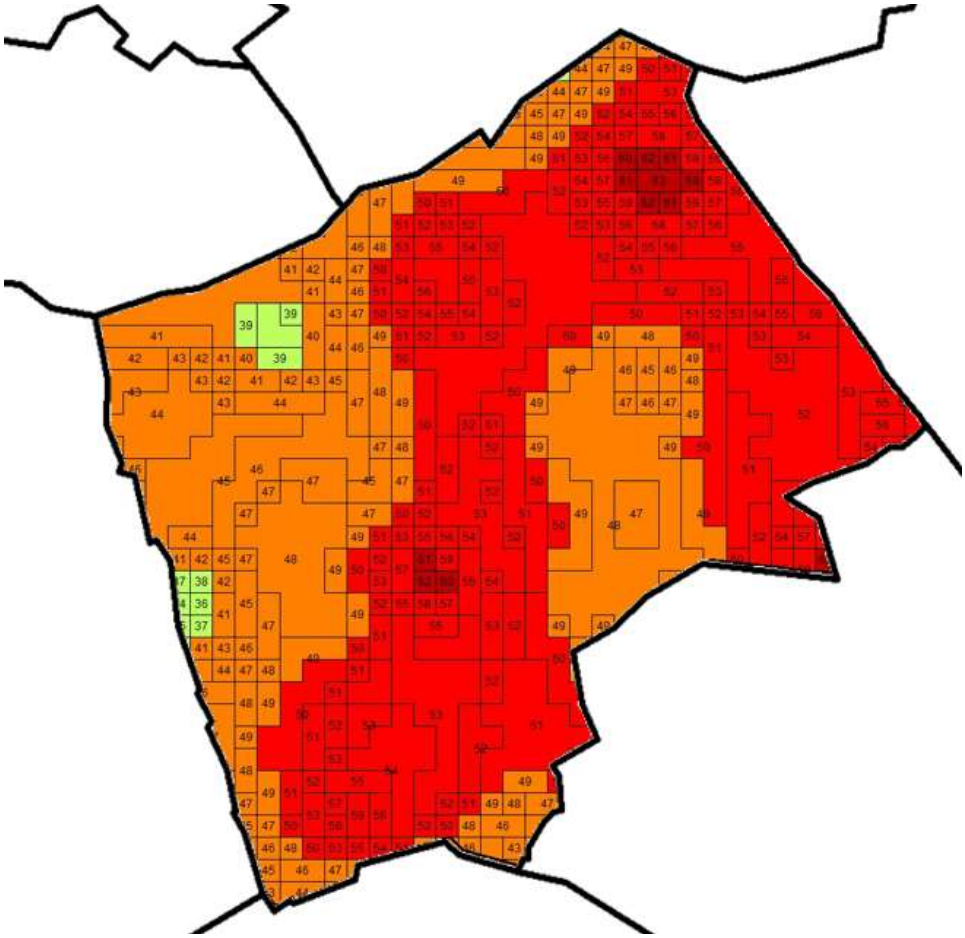
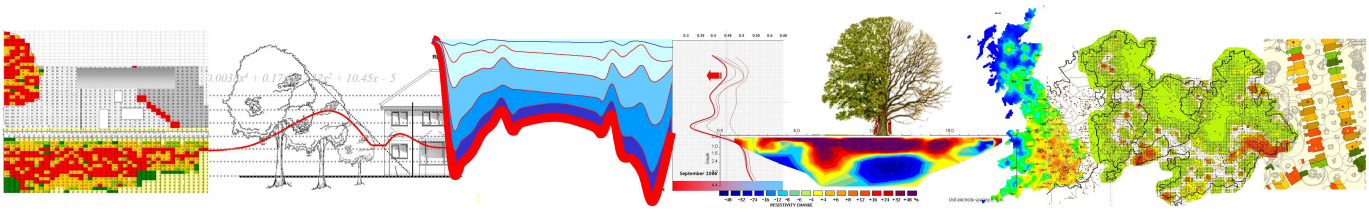
Harrow Study Area – Mapping Clay by PI

Plasticity Index (PI) values obtained from actual site investigations undertaken associated with domestic subsidence claims. The PI has been measured at depths of around 2 – 2.5mtrs below ground level where possible, and the results interpolated onto a 250m tiled grid.



There will often be significant variations in PI and composition over the depth of the bore. The depth from which values have been taken reflects the zone of peak moisture extraction for a large sample of deciduous trees.



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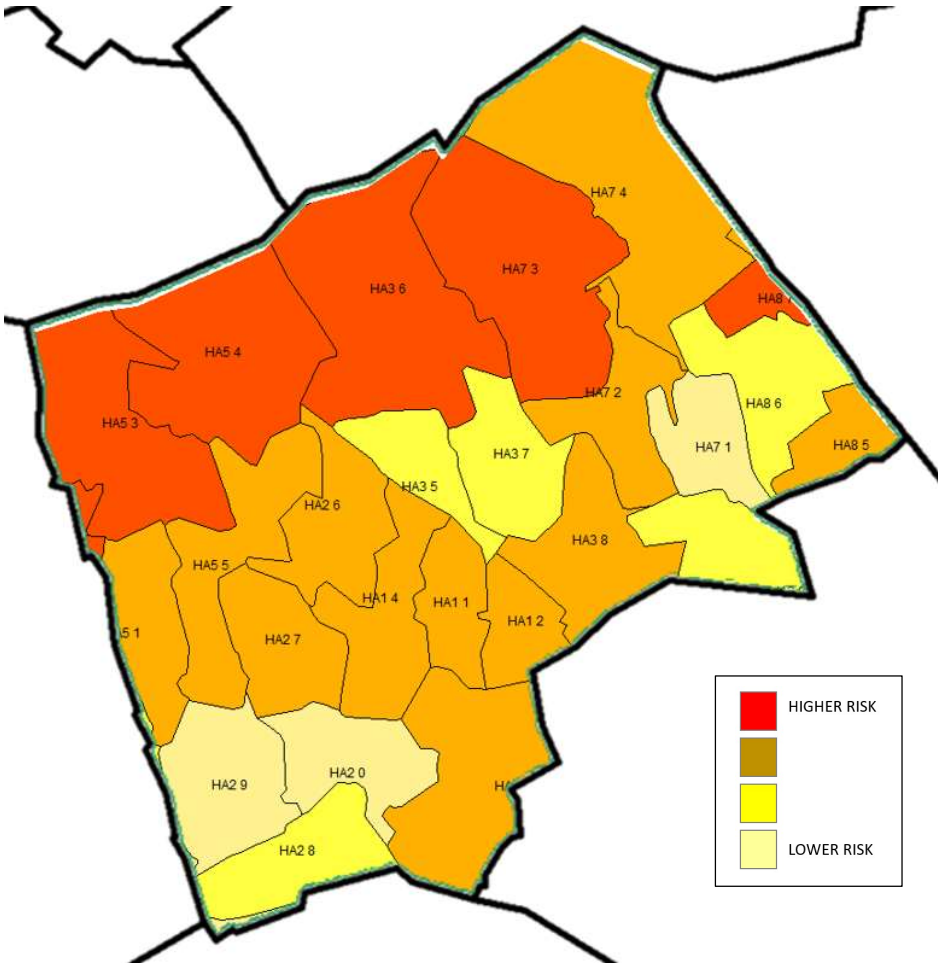
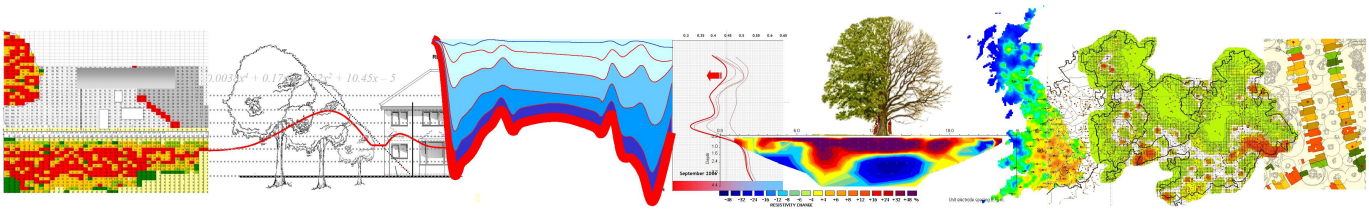
Harrow Study Area – Risk by Postcode Sector



There can be apparent discrepancies between various maps and this one suggests that the top four postcode sectors (HA5 3, HA5 4, HA3 6 and HA7 3) represent a higher risk than their neighbours and yet there are far fewer claims, as the map on page 9 reveals. This is the result of using frequency data, rather than count of claims. The sectors listed have fewer claims, but there are fewer houses and the risk on this sector map plots the frequency of claims/houses.



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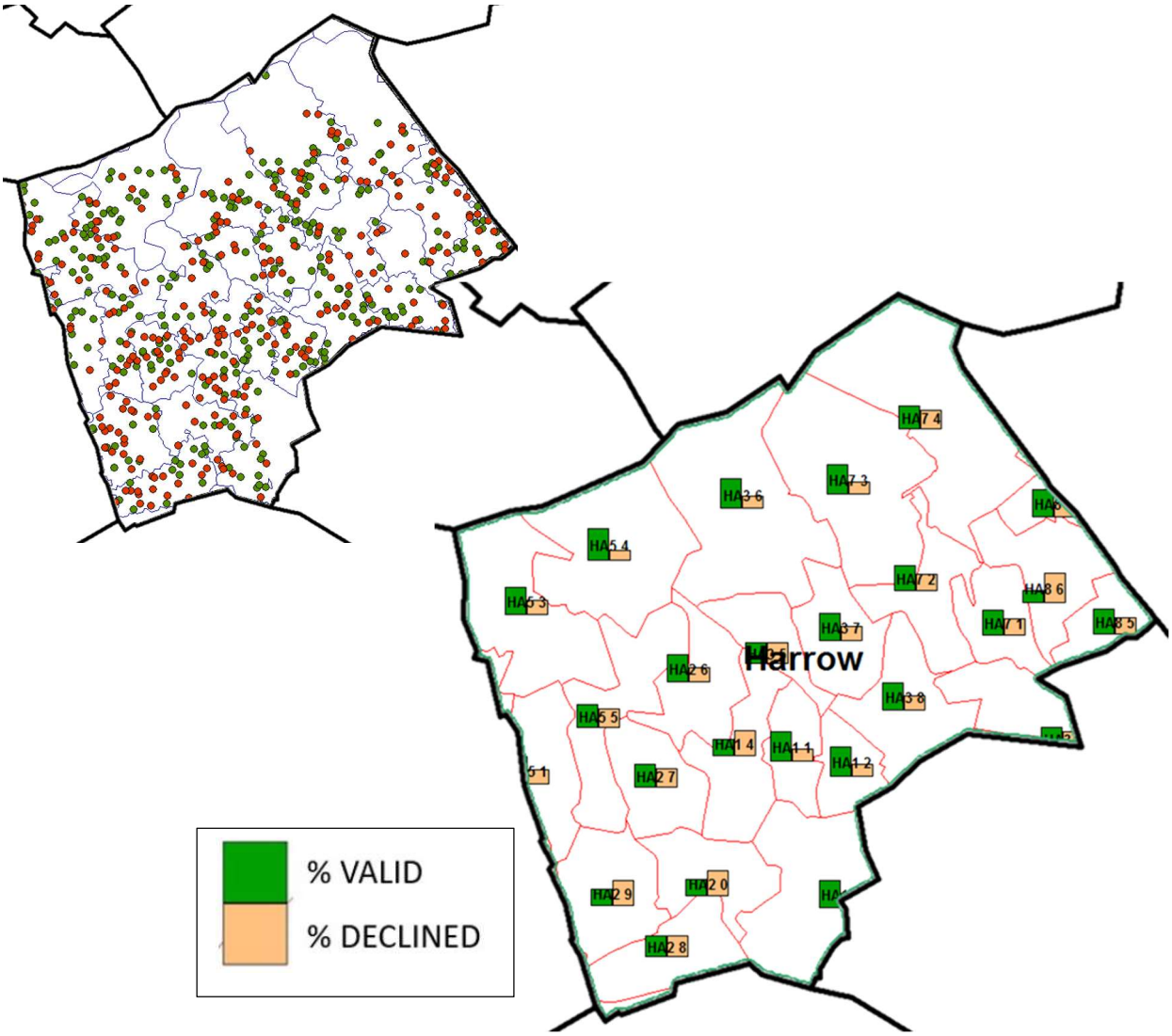
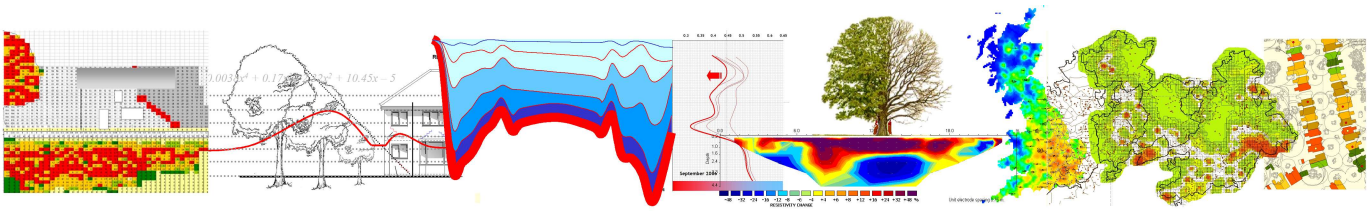
Harrow Study Area – Valid and Declined

Top, left, claims at full postcode level showing distribution of valid (green) and declined (red) claims. Below, right, a bar code graph revealing the variation by postcode sector with green representing the percentage of valids compared with declinatures.



It can be seen that in some sectors (HA7 3, HA3 6, HA5 3, HA5 4 etc.), the chances of a claim being valid are twice that of being declined. The opposite is the case in sectors HA8 6, HA2 0 and HA2 9, where the share of declined claims is greater.



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Harrow Study Area – Summary

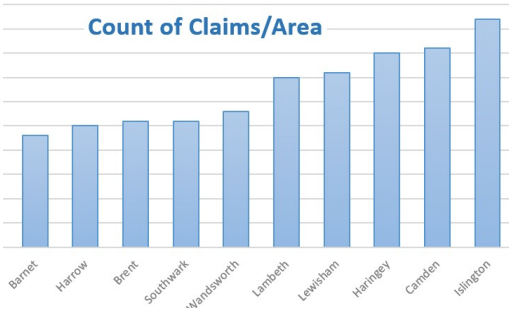
Harrow is a high-risk borough in terms of subsidence, with a significantly greater percentage of valid claims than declinatures.

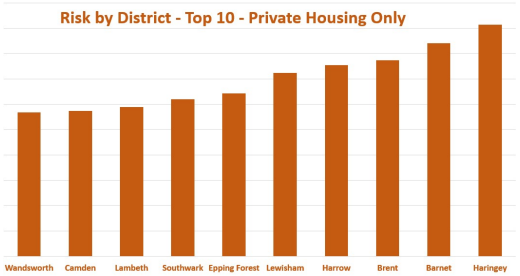
Unsurprisingly given the presence of outcropping London clay, the primary risk is root induced clay shrinkage. This is followed by escape of water from leaking drains and water services, which may be a little surprising considering the extent of outcropping London clay.

However, experience suggests that not all houses have foundations that will bear directly onto a clay formation. Many of the older properties may have shallow foundations bearing onto a mixture of topsoil and clay, and the age of the houses in Harrow corresponds with a higher than average risk of leaking drains due to the nature of their construction (i.e. drains with rigid joints).

The frequency calculation is based on a five-year sample and reveals that Harrow is around 3 times greater risk than the national average. This isn't unusual for London boroughs as the graphs below reveal.

Below, left, a graph showing the 'count of claims/area' revealing Harrow to be in 9th position. Right, the risk taking into account private properties only. By this assessment, Harrow is in 4th place. The ranking varies depending on the criteria used.





The study delivers no surprises. Root induced clay shrinkage remains the dominant peril and analysis suggests that over 70% of claims are likely to be valid.

To summarise, Harrow is a high-risk borough in terms of subsidence, but comparable with other neighbouring boroughs with outcropping London clay.