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
Electrokinesis Osmosis
Intelligent Systems

Edition 131

April 2016

The Clay Research Group

CONTENTS

Edition 131, April, 2016

Aston University

Although claim numbers are low the current workload of the CRG means that the annual subsidence conference at Aston has had to be postponed.

Current projects include the work on AI, appraisal of our contribution to the UKCRIC program and of course the routine production of the newsletter.

Our thanks to people who offered to speak. Topics this year came mainly from those interested in the business process and 'looking to the future'. What is evident from the list is the fact that change is on the way and hopefully we will hear more on this topic at the 2017 conference.

THE CLAY RESEARCH GROUP
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UKCRIC Research Project Plan

The UK Collaboratorium for Research in Infrastructure and Cities (UKCRIC) is lodging an application for funding and a meeting was held at Birmingham University on the 15th March to discuss the proposal.

Thirteen centres from across the UK have applied for joint funding to model threats to buried infrastructure by building a test centre expanding on the work undertaken by Professor Ian Moore at Queens University, Canada. See page 5 for further information.

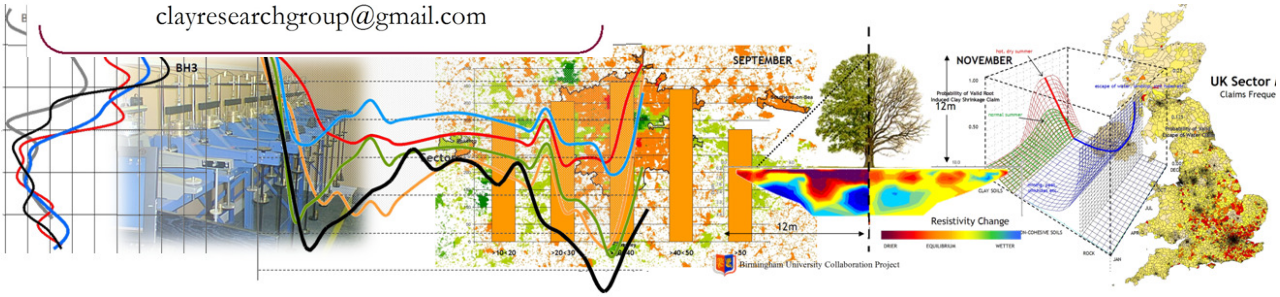
Subsidence Forum Cash Prize

The Subsidence Forum are offering a cash prize of £500 for the best undergraduate, final year dissertation for 2016.

The stipulation is "the subject matter must be related to subsidence but it does not necessarily have to be restricted to technical aspects; it may encompass wider issues, such as climate change, social and/or financial impact on communities be they rural or urban and the wider environmental implications."

The dissertation must be received by the UK Subsidence Forum, duly marked and externally examined, by Friday 2 September 2016.

The Award Ceremony will be held at The Subsidence Forum`s Annual Training Day held at the BRE at Garston, Watford on or before the 20th October 2016. The exact date is to be confirmed.



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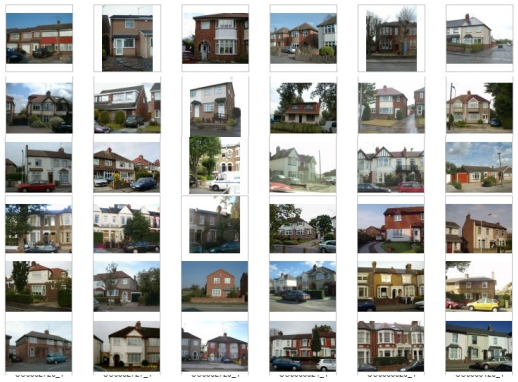
INTELLIGENT SYSTEMS - REMOTE CLAIMS HANDLING

Remote viewing of properties has been transformed over the last 10 years, thanks to Google. They have delivered a new way of working. In some instances, we can carry out surveys from our desk. Almost every house is a box - we simply need to understand its environment and response to stress. This is a key element to settling claims faster, at less cost, delivering improved service and reducing the impact of surge.

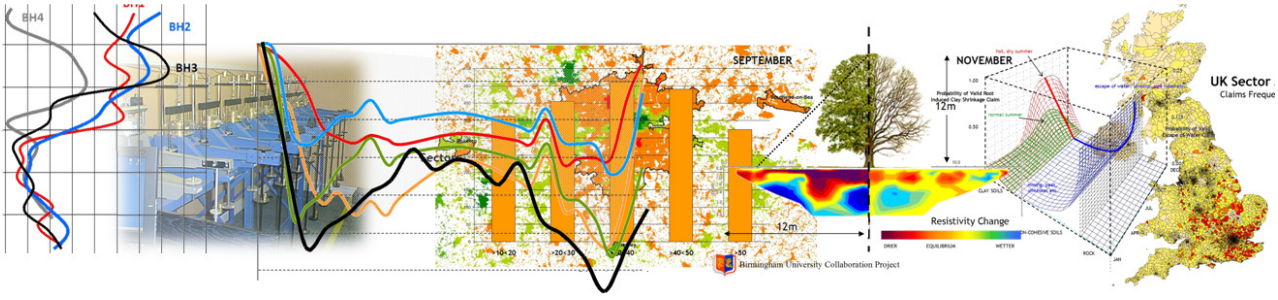


Google Earth is a valuable resource and helps identify the location and style of the property and location of any nearby vegetation and drainage.

It is far easier to engage with the policyholder when we have a picture of their home. Knowing where the damage is immediately adds context and means that enquiries can be better directed.

We estimate this approach, when combined with the ‘self-serve’ interface and ability to view pictures and video clips provided by the client, could resolve over 50% of routine claims.

Rather than reading “semi-detached house” on the claim form, Google’s Street View adds context. Being advised that there are cracks between the garage and house becomes meaningful in this example and looking at the photograph might prompt the question, "can you tell me when the garage was built?" etc. We see a nearby rainwater pipe and the absence of vegetation. What is the geology? Instead of sending out an engineer, monitoring company and site investigation crew, do we instruct a drainage company?



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Self-Insured Housing – Assessing the Risk

The analysis on this and the following page looks at the increased risk to insurers if account isn't taken of council and social housing bodies who self-insure.

For example, if insurers receive say 10 claims in a postcode sector that has a total of 1,000 houses, the risk expressed as frequency = 10/1000 = 0.01.

If 30% of the houses belong to a self-insuring organisation, then the risk increases to 10/700 = 0.014.

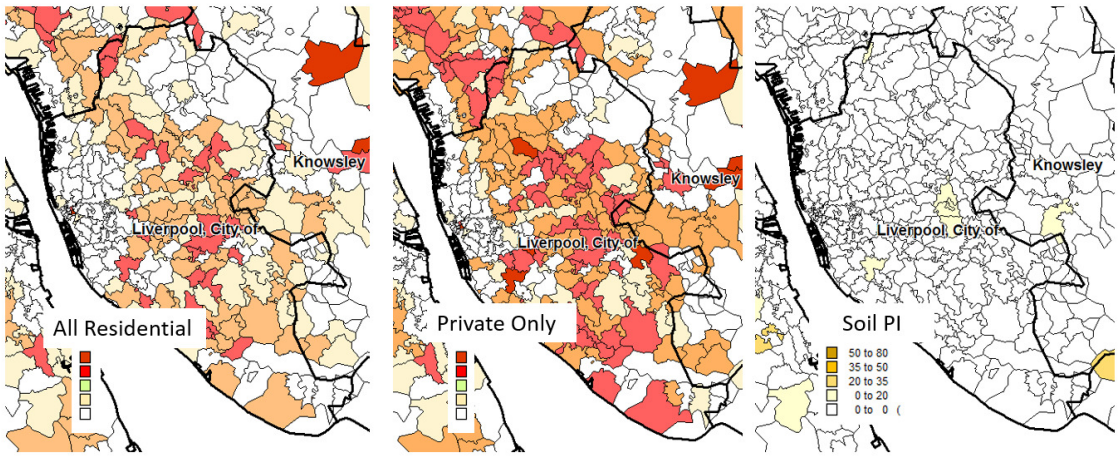
Across the UK the risk would be nearly 30 - 40% greater taking this into account. The assessment assumes that all Council and social housing organisations self-insure which of course may not be so.

The maps below show the amended risk. Left, assuming that all houses are privately owned. Centre, the increased risk if Council and social houses are omitted (assuming they are self-insured, which isn't known) and right, the presence (or absence) of shrinkable soils.

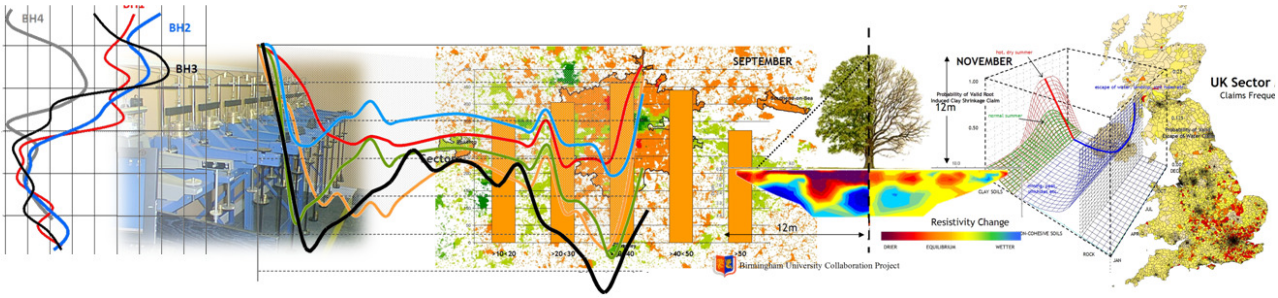
The value at postcode sector level shows the risk expressed as an increase or decrease from the average for the UK, standardised at a value of 1.

So, a 20% increase in risk would produce a value of 1.2. A decrease of 20% would deliver a value of 0.8.

The maps show the influence of (a) a biased population and more generally, (b) the importance of clay soils.



Risk Compared with UK Average for All Residential
LIVERPOOL



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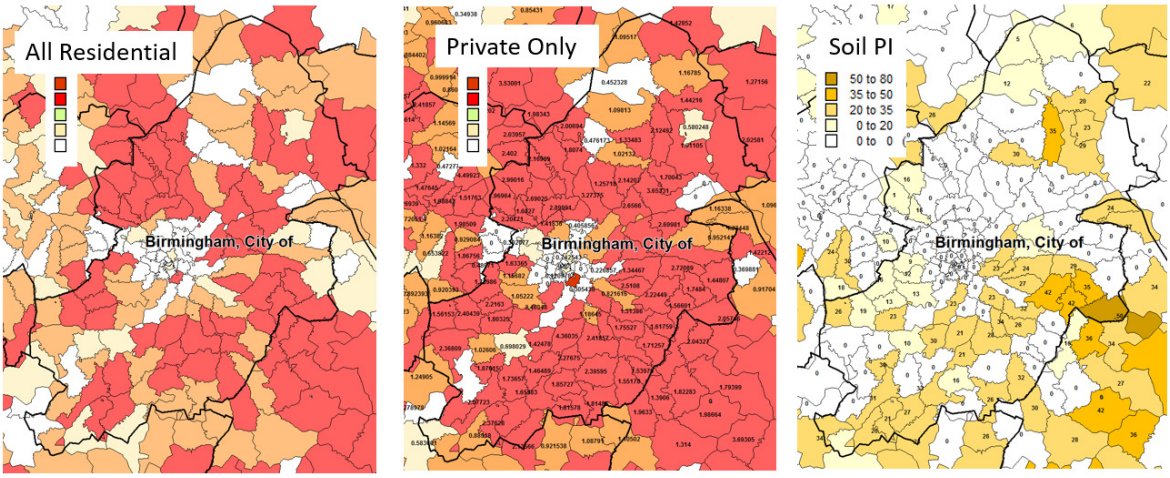
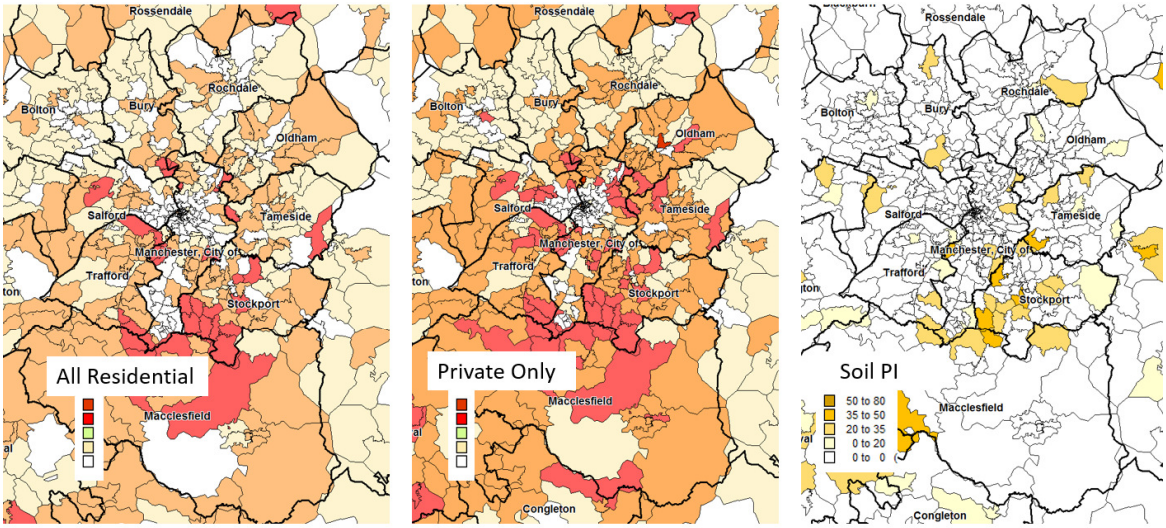
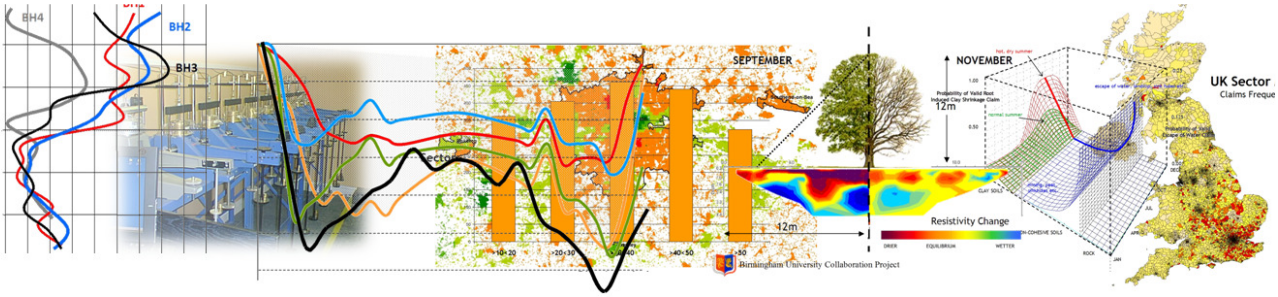


Risk Compared with UK Average for All Residential
BIRMINGHAM



Risk Compared with UK Average for All Residential
MANCHESTER



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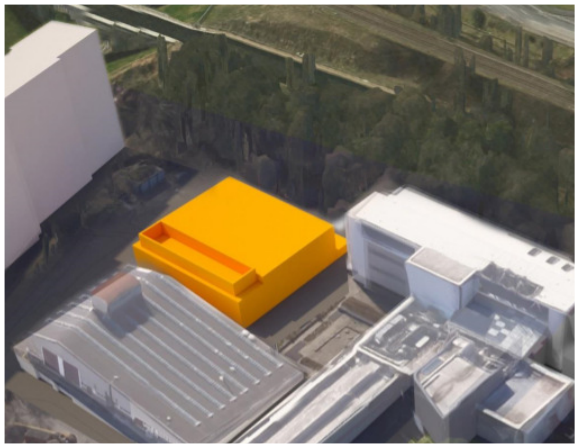
The UKCRIC Vision – a large scale test facility

Extract from presentation delivered by Professor Ian Jefferson

A meeting was held at Birmingham University on the 15th March to review and discuss the proposed development of a National Buried Infrastructure Facility (NBIF) - see architect's visual below.

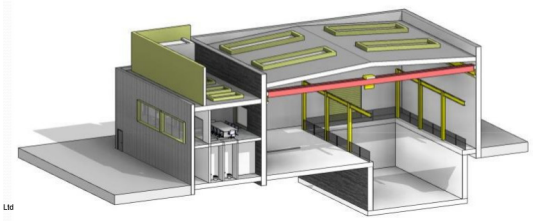


The building would be 35 x 32m on plan and house a variety of test facilities allowing academics and researchers to model the influence of soils on buried facilities – drains, services and tunnels etc.

This is an ambitious project bringing together 13 centres from across the UK all working in partnership. Hopefully we will form part of the team looking at topics that concern insurers. For example, underpinning, landslip, swallow holes etc.

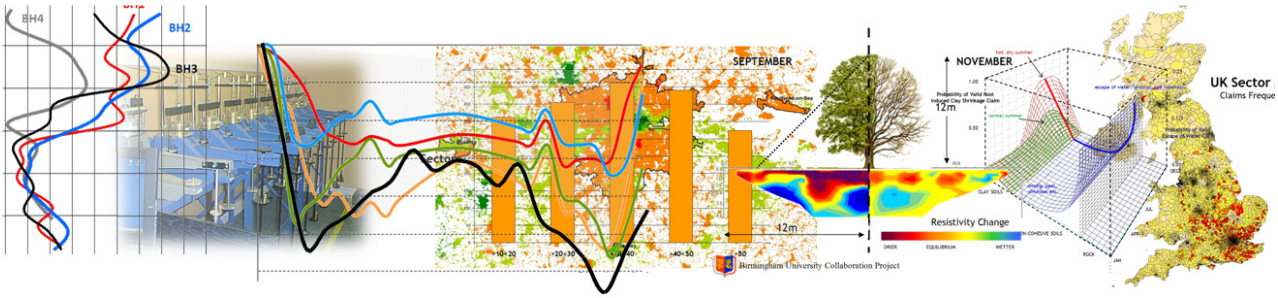
The facility will have test pits, strengthened floors and a laboratory facility as well as a meeting room to demonstrate the findings and outcomes.

More generally the project will be looking at the possible influence of basement construction, retaining walls, foundations, ground improvement etc., all in relation to buried infrastructure.



The research will develop the themes tackled by Professor Ian Moore at Queens University, Canada. Professor Moore carries out similar work researching problems encountered with Leda clays which are highly sensitive and prone to collapse. He works from a similar facility at Queens – see example below.

Insurers offer an opportunity and provide access to situations that may be difficult to model in the facility.



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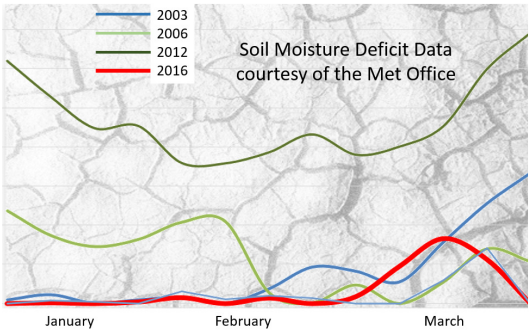
Soil Moisture Deficit (SMD)

So far this year little to report. Below, the red line traces the SMD for 2016 up to the first week in April.



The 2012 profile gave early suggestions of posing a threat of high claim numbers. Clay soils in parts of the south east didn't fully rehydrate through the winter months and the year had a high starting point in terms of moisture deficit.

In fact, little happened in terms of claims due to exceptionally heavy rainfall around weeks 16 – 17.

In contrast, 2003 shows the ground to have been fully rehydrated over the 2002/2003 winter and drying commenced in March. 2006 gave no indication of being unusual when in fact it also delivered quite high claim numbers. A late start and one that peaked fairly quickly.

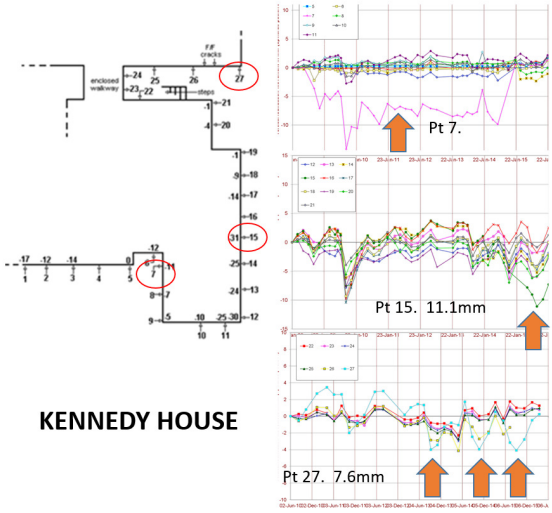
So far 2016 is following a fairly typical 'average year profile' and experience over the last 10 years suggests numbers may continue to be low.

Aldenham Levels

Precise level readings continue to be taken at the Aldenham Research Site by GeoServ Limited, the latest on 22nd March, 2016.

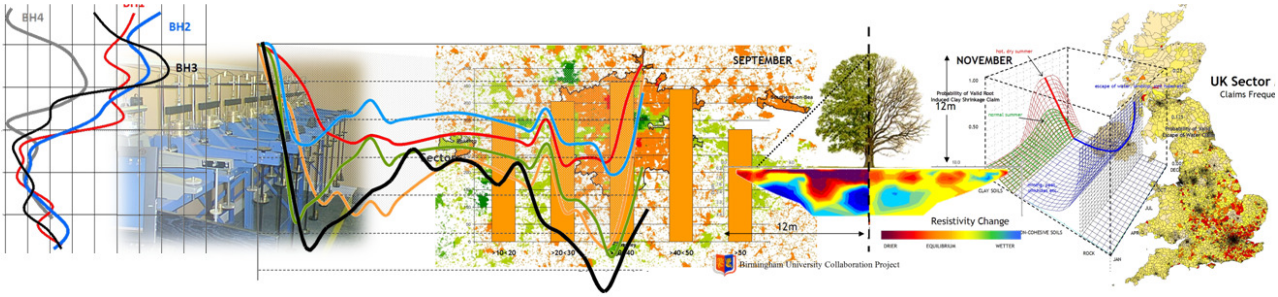
Little change in general. Ground movement within influencing distance of the willow continues to deliver a regular periodic signature.

There are small changes to stations fixed to Kennedy House (below) which may be linked to re-growth of vegetation that was trimmed a few years ago following notification of minor damage.



KENNEDY HOUSE

Graphs above show 11.1mm of subsidence at Station 15 (rear wall) and 7.6mm of movement at Station 27 (adjacent corner – rear wall). The latter has a seasonal signature and is almost certainly related to the activity of vegetation.



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Electrolevels – Use and Benefits

Precise levels record differential building movement. Interpretation of the data helps engineers to determine if there is a seasonal element (clay shrinkage), continued upwards movement (heave) or subsidence (leaking drains, landslip, mining etc.).

An alternative method and one used to monitor the Leaning Tower of Pisa and other large scale building projects is the use of electrolevels, or tilt sensors. The technique fits in very well with a digital and AI strategy and this article looks at the benefits and drawbacks.

The approach of fitting boxes to walls to measure rotation accurately and transmit data to the office via the web fits with the theme of 'Internet of all Things' and the 'connected home' approach. Gathering data hourly or daily has to be better than one reading every two or three months using the traditional approach.

Using electrolevels requires one visit to fit the monitoring boxes and another to remove them, each of perhaps half-hour duration and carried out by one person.

	Existing System	Proposed System
Fix and Forget?	No	Yes
Never forgets to take a reading?	No	Yes
Fully automated interpretation?	No	Yes
Homeowner has to take time off work?	Yes	No
System integrated?	No	Yes
Part of Remote Sensing strategy?	No	Yes
Strategy for future developments. ERT etc	No	Yes
Removes redundant process?	No	Yes
Reduces cost for improved quality?	No	Yes
Future value from data?	No	Yes

Table showing the benefits of an automated monitoring approach.

The drawbacks are (a) capital cost of purchasing the equipment, (b) initial development of software to receive and interpret the data and (c) the cost of transmitting data from site to the server.

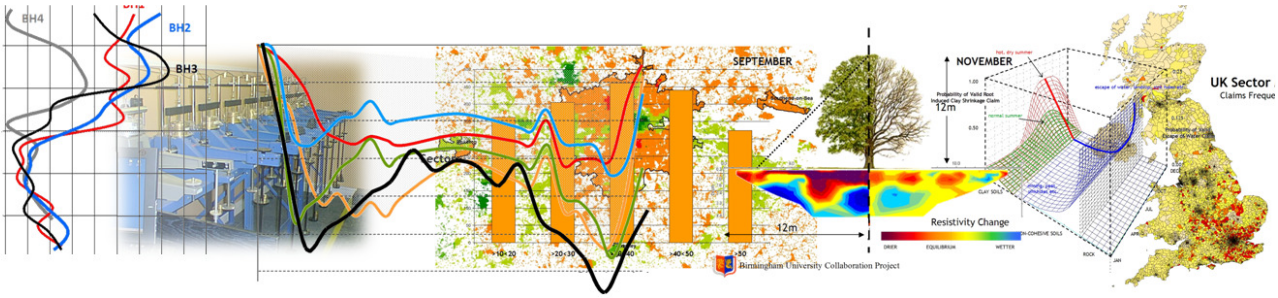
In terms of AI, the computer receives the data any time of the day or night. Modules interpret its significance and generate draft outputs – letters, reports etc., - and in some instances, determine the next action.

This removes a process and ensures that engineers only get involved where their expertise is required, instead of reviewing every case. The claim handler no longer has to receive the monitoring file, pass it to the engineer who makes an assessment and passes it back with recommendations for the claims handler to implement.

The AI element compares the data with a series of or signatures that are likely to be encountered. There are profiles for subsidence, heave, poor ground, escape of water etc., each taking into account the time of year the devices were installed, where they are fitted and their rotation – clockwise or anti-clockwise.

By matching the incoming data with these templates, the system assigns a probability value each. "Clay Shrinkage = 0.82", "EoW = 0.18" sort of thing.

A similar approach is used to interpret soils data.



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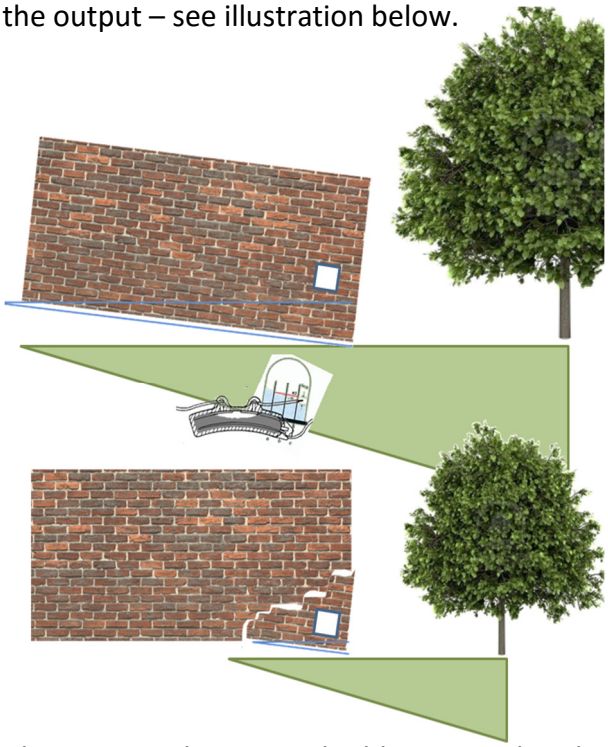
Measuring Vertical Movement Using Electrolevels

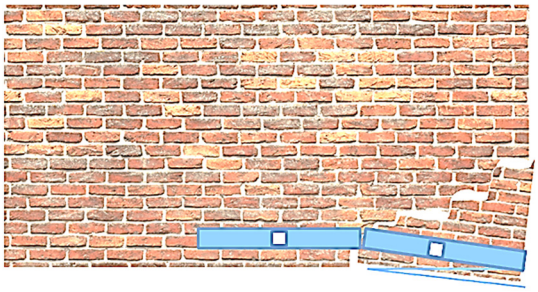
Electrolevels are useful for determining (a) if there is movement and (b) the presence or absence of a periodic signature. However, there can be issues in the interpretation of the output – see illustration below.



Above, top, the entire building is under the influence of root induced clay shrinkage. Over a length of say 8mtrs a tilt of 1 degree means the front corner has dropped by around 140mm.

Over a 1m length of wall (lower illustration) the same amount of rotation would detect 18mm of subsidence. Unfortunately, electrolevels don't provide the answer we need without an idea of the length of wall involved.

The question is, how much rotation is significant?

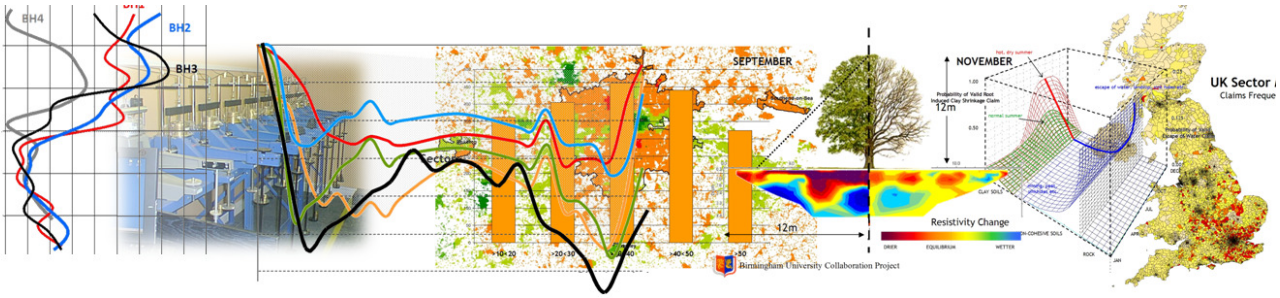


Modern sensors are housed in short lengths of aluminium channels, joined using a central bolt (above). This allows free rotation to be measured over defined distances and the sum records the amount of movement that has taken place.

The DataReader software analyses the output immediately it is received. The example below records the date, max and min temperatures and offers a probability of cause. Here the most likely peril is clay shrinkage with a probability of 0.84.

Temperature Details
Datalogger:22954
Min Temp:-3.5 Max Temp:27.75
Temperature Variance:31.25

tilt EL Details
Datalogger: 22954 **Clockwise**
Min Reading:0.000 Max Reading:0.100
Readings Variance:0.100
RH Elevation of rear S/S extension, Rear corner :
Unit installed 22.05.08
Clay Clockwise Probability: 0.84
Clay Anti-Clockwise Probability: -0.84



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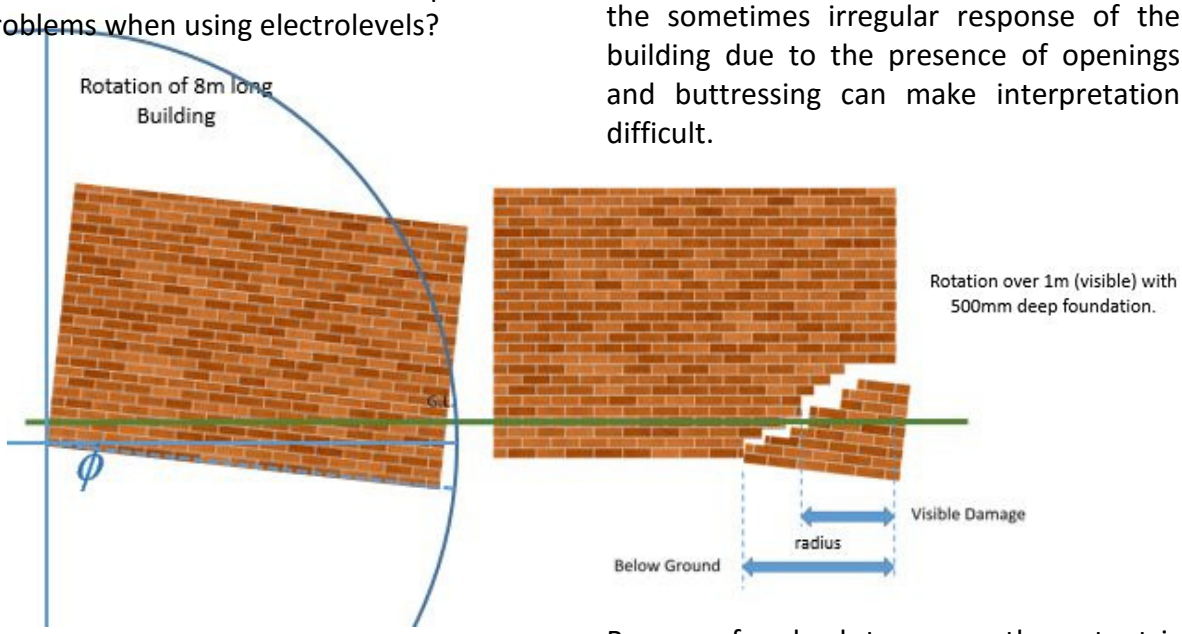
But how does this technique compare with precise levels - what are the potential problems when using electrolevels?



First, the calculation using a tilt sensor involves establishing the fulcrum – the point of contraflexure - at the underside of the foundation. Not just where the crack is visible above ground level.

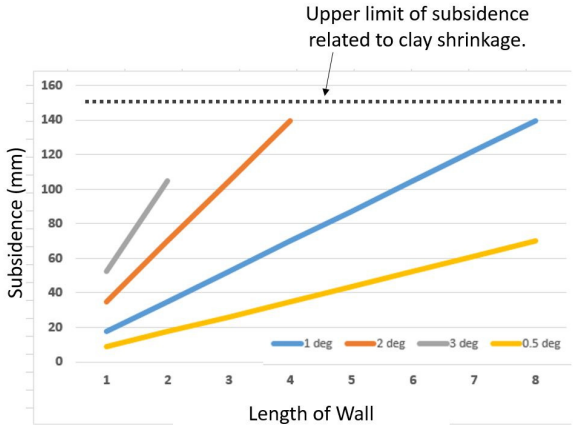
If we see the crack terminating at ground level, 1m in from the corner of the wall, the estimate would be 17.45mm. Following the crack down to the underside of a 1m deep foundation would deliver a value of 35mm.

Also, the user needs to understand the limits of the device or may mistake a value for enhanced seasonal subsidence when in fact it represents the upper bound of the equipment. Much like the penetrometer the shear vane readings when testing soils.

Is the recorded rotation sufficient to cause damage or just modest seasonal movement?

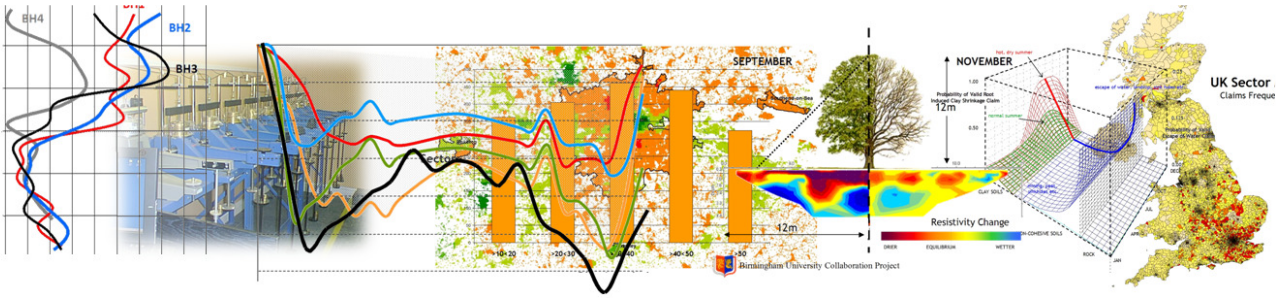
Whilst the equipment is more than capable of delivering fine resolution measurements, the sometimes irregular response of the building due to the presence of openings and buttressing can make interpretation difficult.

By way of a check to ensure the output is sensible, below is a table limiting values of tilt over known length of wall to fall within the maximum swell properties of clay soil.



A tilt of 1 degree (blue) over wall length reveals the subsidence that has taken place, limited to 150mm (black dotted line).

In summary, evidence of rotation alone isn't sufficient to prove causation or the amount of movement that has taken place.



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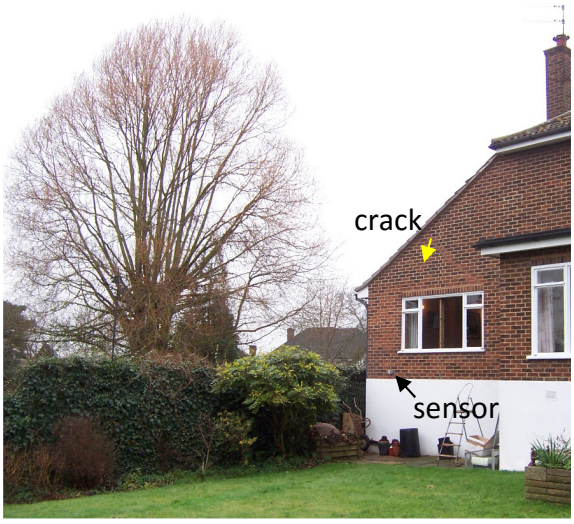
Below, an example of an installation showing a repaired crack above the rear kitchen window of a domestic property with a tall tree in a neighbour's garden. The nature of construction – the kitchen is an extension and extending the crack line down to the underside of the foundation would be difficult – illustrates the practical problem.



Whilst the monitoring graph (right) shows a clear periodic signature, how significant is the movement when shown as radians? When viewing precise level readings, we see values in mm, but care needs to be taken not to mis-read the graph as evidence of anything more than seasonal movement without taking into account the amplitude.

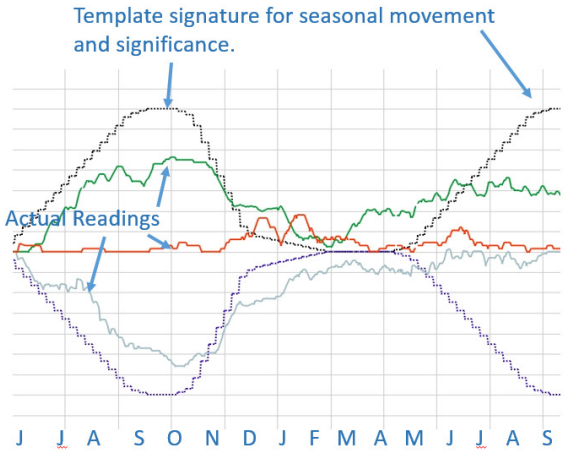
To assist, the software used in our DataReader application contains a series of templates against which actual readings are correlated.

The system can detect stability, seasonal movement, continued downwards (drains, landslip, ground instability) or upwards (heave) movement.

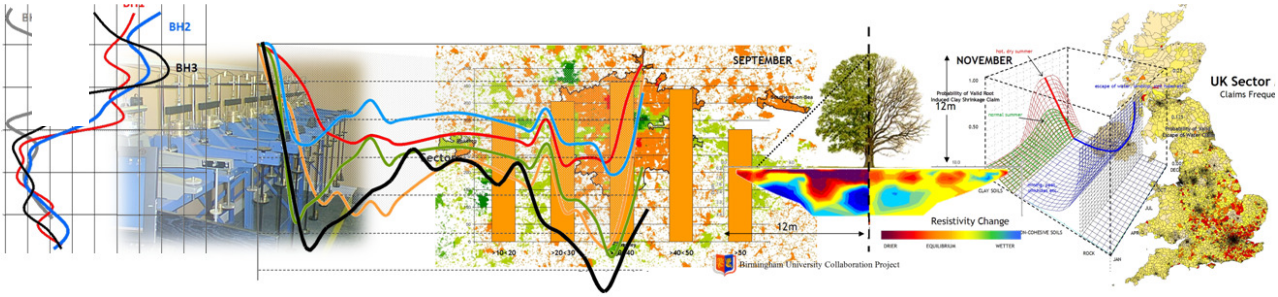
The software also checks whether recorded movement is structurally significant and can compare with weather records to determine links with rainfall, temperature and hours of sunshine etc.

To summarise, electrolevels fit in nicely with the vision of the future – the Internet of all Things and connected homes etc.

The idea that we receive a claim, consider pictures provided by the homeowner and instead of sending out a structural engineer, instruct a local tradesperson to fix sensors and connect them to the home WiFi may be appealing. The claims handler, engineer and homeowner view readings live via Facebook or Twitter, sharing their thoughts with whoever might be interested.



The technology offers considerable potential benefits. Fewer visits, accuracy when the foregoing is taken into account and more readings to detect patterns quicker all fit with an enhanced service delivery model.



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Risky Trees – and grass.

John Wenger of University College Cork has published the results of his study on the potentially negative influence of some species of trees and grass.

He explains that some trees can actually pollute the atmosphere and recommends that city planners take care when making decisions on urban greening.

Apparently, 90% of Volatile Organic Compounds (VOC) come from vegetation. He explains "examples of volatile organic compounds include the distinctive aroma of pinene in pine, limonene in citrus trees and linalool in lavender".

An article in The Irish Times explains "They interact with nitrogen-oxide pollutants from traffic and, in the presence of sunlight, produce ozone. This is a harmful pollutant at street level. It damages cells, injures lung function among vulnerable groups and has been linked to heart disease. Ozone is also toxic to plants."

Nick Hewitt from Lancaster University puts the crack willow, English oak, goat willow, poplar and sessile oak at top of the polluting league table, with ash, silver birch, field maple and scots pine improving air quality.

Intermediate are the hawthorn, hazel, holly, mountain ash and sycamore.

Dr. Galina Churkina from the Institute of Advanced Sustainability Studies in Postdam, Germany offers the following advice about grass. "If you walk along a busy street in summer and someone is mowing a lawn, don't breathe in very deeply".

Climate is Difficult to Model

Shao *et al.*, **Contrasting scaling properties of interglacial and glacial climates**. *Nature Communications*, 2016

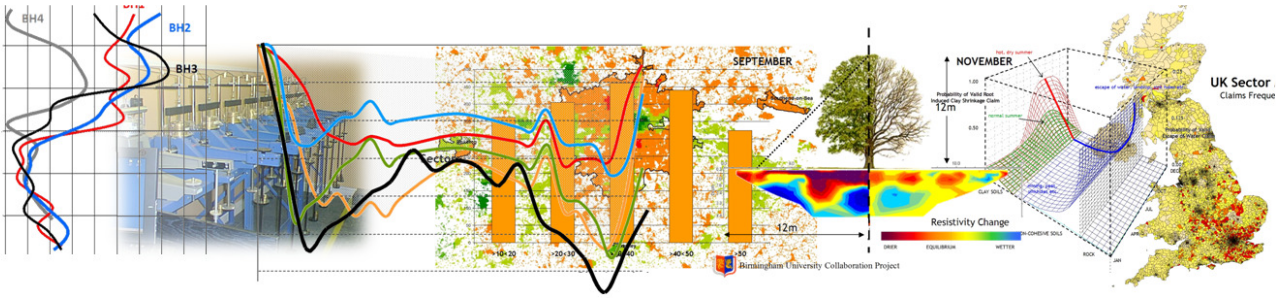
Researchers from the Niels Bohr Institute, Copenhagen, have analysed the natural climate variations over the last 12,000 years, and they have looked back 5 million years to see the major features of the earth's climate. The research concludes that both weather and climate are chaotic.

Urban Heat Islands

Monteiro et al., **The impact of greenspace size on the extent of local nocturnal air temperature cooling in London**

Brief summary of findings …

- Cooling distance increased linearly with area of greenspace, tree canopy and grass.
- Cooling intensity increased non-linearly with the different green areas.
- Widespread cooling of a city may come from greenspaces of 3–5 ha, set 150 m apart.



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Derby Council and the Cedar Tree

A homeowner in Derby was awarded £38k following damage to their home caused by a 17m tall cedar tree. £3,000 for stress and inconvenience with the balance paid to the insurer to cover the cost of repairs and underpinning.

Anna Madichie, the solicitor for Plexus Law, explained: 'The cost of underpinning the house was in the area of £35,000, which the council will pay to the insurers.

'Obviously, with all local authorities, we understand that everyone is given a budget and a target - but this is a claim that realistically could have been dealt with sooner.

'Only the city council can say why it took so long for it to settle the claim.'

Ms Madichie said the council's planners indicated they had suspicions that the tree was causing damage to the property years ago - even while it was blocking the owners from felling the problematic tree.

She said: 'The planning inspectorate which dealt with it said, as far as it was concerned, it did not believe it was 100 per cent conclusive that the tree was causing subsidence - but seemed to confirm it was possible.

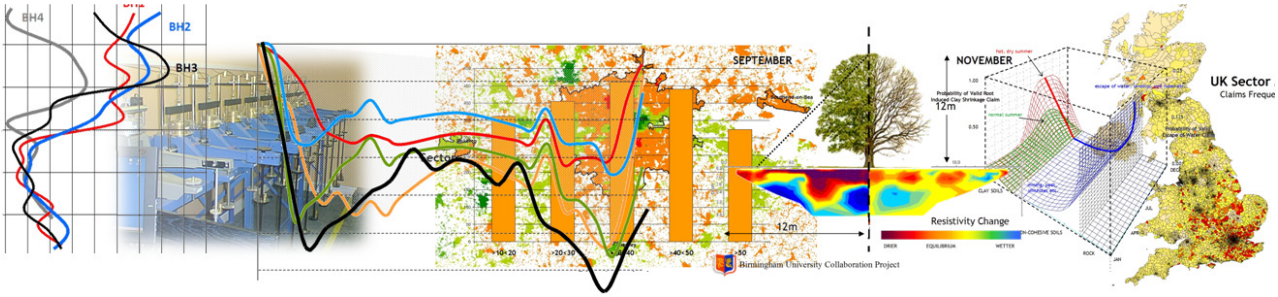
'Mr Nicholson's insurers were forced to do extensive work on the property, on the basis that the tree would stay in situ.

'The insurers had no choice but to underpin the property and, in addition, seek compensation for the damage and inconvenience caused to the couple.'

Camden Council

A report in the press of a similar situation but involving damage to the home of celebrities Diana Quick and her estranged husband, Bill Nighy. They claim that a horse chestnut tree in a neighbour's garden has been causing damage to their home, situated in Kentish Town, North London.

Camden Council disagree, claiming the damage is in any event modest and the tree adds character to the area and provides privacy and screening.



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The neighbour, Mr Stanley, says the tree is home to bats, birds and other wildlife, and that felling it would cause a loss of privacy. He also blames poor construction work relating to an extension. In 2013 Miss Quick applied for three trees in Mr Stanley's back garden – an ash, a willow and the horse chestnut – to be removed. Mr Stanley agreed to fell the ash and willow, which were closest to Miss Quick's home.

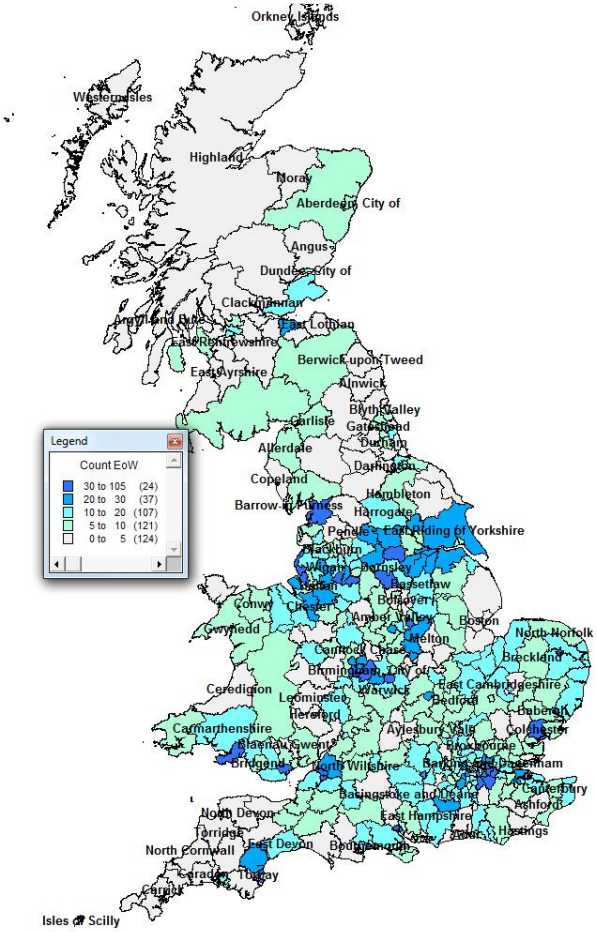
View from the rear garden of Miss Quick's home.

Both cases illustrate the vexatious issue of trees on the rare occasions they cause damage to people's homes and the difficulty in reaching an agreement with several parties, each with a different interest, about what needs to be done.

In the first case costs were awarded against the Council which far exceeded the cost of tree felling. Tree retention wherever possible is an objective we share. Whether individual trees that cause damage to people's homes are worth the expense of litigation when they form such a small percentage of trees felled may be debateable.

Escape of Water Claims. Distribution by Count

Below is a postcode sector map of the UK showing the distribution of subsidence claims where the damage was caused by water escaping from a domestic drainage system.



The legend records 24 sectors where between 30 and 105 claims were received, and 124 where up to 5 claims were accepted following investigations.

The map was compiled from a sample of just under 10,000 claims.