#### **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 2024 Issue 229

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### Soil Moisture Deficit

'Warmer and wetter' sums up May 2024. If the Met Office forecast for the next 50 days (page 5) proves to be correct, the chances of this being a surge year are quite low.



ID Data provided by the Met office. Tile 161, Medium Avai Water Capacity with grass and tree cover

#### **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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### **District and Sector Risk**

East Cambridgeshire is the subject of the 'Risk by District' series in this month's edition. It has superficial deposits of peat and till overlying clay and chalk – see Page 7.



The risk maps are built from a data sample covering four claim years, including one surge and three 'normal' years.

#### **CRG Newsletter Readership**

The CRG newsletter is downloaded by nearly 5,000 readers every month, a significant increase since its launch in December, 2005. The site receives in excess of 40,000 hits a month.

#### OS + BGS

The BGS have agreed a collaboration with Ordnance Survey to add nine geological data sets to the OS open data hub.

https://osdatahub.os.uk/downloads/open



#### **Climate Change**

European Union's Copernicus Climate Change Service report that the global average for the past 12 months is the highest on record, at 1.6°C above the 1850 to 1900 average. Global temperatures in April 2024 were 1.6°C higher than the average for April during the pre-industrial era. Global temperatures last month were the highest ever recorded for the month of April, making this the 11th month in a row to set a record. 2023 has witnessed an unparalleled surge in global temperatures, setting a new record with an average annual value of 14.98°C, surpassing the previous high in 2016 by 0.17°C.

This means average global temperatures were 1.6°C higher during April 2024 than the average for April between 1850 and 1900, regarded by climate scientists as the pre-industrial benchmark.



The global average temperature for May 2024 was 15.91°C, which is 0.19°C above the temperature of the previous warmest May, in 2020. This is also 0.65°C warmer than the 1991-2020 global average for May.

May 2024 also marks the 12th consecutive record-breaking month, with every month since June 2023 being the hottest ever recorded.

#### https://climate.copernicus.eu/news

A paper determining temperature by measuring tree rings was published in the journal Nature<sup>1</sup>. Findings suggest the temperature in 2023 was the hottest in 2,000 years. The research suggests that the Northern-Hemisphere summer of 2023 was at least 0.5 °C hotter than 246 AD, the hottest year prior to the industrial revolution.

<sup>1</sup> Esper, J., Torbenson, M. & Büntgen, U. 2023 summer warmth unparalleled over the past 2,000 years. *Nature* (May 14<sup>th,</sup> 2024). https://doi.org/10.1038/s41586-024-07512-y



### AI – what does the future hold?

We have long promoted the use of AI components and hopefully contributed as the images, right, outline. This is fine and helps claims handlers and engineers understand the potential risk on FNOL.

However, we don't want it taking over the claims process. Take the case of a homeowner reporting what they think might be subsidence related damage to their home only to be answered by a **Al**bot (whatever one of those might be) explaining that "your call is important to us", and "we take complaints very seriously". These responses aren't dissimilar to those that some future AI system might generate. No compassion or understanding, simply referring to a list of risk factors and arriving at a decision that the homeowner then has to challenge. Unimaginable stress. AI systems should generate data that can be used by human beings. Not take over the handling of the claim.



A small selection of the risk elements that contribute to our AI system.

#### Treewatch

The Treewatch web site provides an excellent plot of sap flow and associated trunk diameter variation taken at 15 minute intervals, measured over several years. Researchers have access to a variety of trees and take account of rainfall and evaporation etc. Soil moisture is measured to a depth of 5mtrs below ground, at 500mm intervals. They consider "the effects of drought on tree performance and tree-internal water budgets are of interest".

https://treewatch.net/thunen-institute-forest-ecoystems/

There is a linked facility in the UK at the Open University in Milton Keynes https://treewatch.net/en-open-university-milton-keynes/ where monitoring of a tree, a Fraxinus excelsior, commenced in May 2018. Meteorological data was also collected at the site and access to the ongoing research is available via the internet. The web page contains graphs showing water uptake, trunk diameter change along with weather data – temperature, humidity, solar radiation etc., from July 2019 to the current time. The Treezilla link is:

https://learn5.open.ac.uk/course/format/sciencelab/section.php?name=treezilla



#### **ChatGPT – Testing Clay Soil to Determine Desiccation**



#### **Our Question to ChatGPT**

In terms of domestic subsidence caused by root induced clay shrinkage, which tree is regarded as presenting the highest risk?

#### **ChatGPT Response**

In terms of domestic subsidence caused by root-induced clay shrinkage, the oak tree (Quercus spp.) is often regarded as the most dangerous. Oak trees have extensive root systems that can extend far from the tree and are highly effective at extracting moisture from the soil. This can lead to significant shrinkage of clay soils, which in turn causes ground subsidence and potential damage to nearby buildings and structures.

Clay soils are particularly susceptible to changes in moisture content. When they dry out, they shrink, and when they get wet, they expand. The roots of large trees like oaks can exacerbate this natural process by removing large amounts of water from the soil, particularly during dry periods. This can result in pronounced and uneven ground movement, leading to structural issues such as cracking in foundations and walls.

Other trees known for causing similar problems, though generally considered less aggressive than oaks, include willows (Salix spp.) and poplars (Populus spp.). However, due to their significant water uptake capacity and extensive root systems, oak trees are typically at the top of the list when it comes to concerns about subsidence in areas with clay soils.



#### Met Office Anomaly Maps for May 2024

Anomaly maps from the Met Office web site for the month of May 2024 reproduced below. The month can be summed up as being wetter and warmer than the average with less sunshine for May when compared with the 1991 – 2020 average.



htts://www.metoffice.gov.uk/research/climate/maps-and-data/uk-actual-and-anomaly-maps

In March we had 107.8mm of rain compared with the average of 84.9mm, and April was even wetter with 111.4mm of rain, compared to the average of 71.9mm. Apparently it was the sixth wettest April of the last 189 years.

The Met Office report that May was apparently the warmest on record since 1884, with a mean temperature of 13.1°C, 2.4°C above the average for the month. Rainfall was also a little higher – 116% of the average for May.

Britain is bracing itself for one of the wettest summers on record with forecasters predicting there could be at least 50 days of rain in just three months.

The Government has reportedly been advised by the Met Office to expect extremely wet conditions between the start of June and the end of August, with wet weather 50 per cent more likely than average.



#### Subsidence Risk Analysis – East Cambridgeshire

East Cambridgeshire is located in Cambridgeshire and occupies an area of 651.4km<sup>2</sup> with a population of around 90,000.



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

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

East Cambridgeshire is rated 79th out of 413 districts in the UK from the sample analysed and is around 1.479x the risk of the UK average, or 0.383 on a normalised 0 - 1 scale.

There is a varied risk across the district as can be seen from the sector map, right. The varied geology (see pages 7 and 8) no doubt accounts for this with shrinkable clay soils to the north. Sector and 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.



Sector risk compared to UK average from the sample analysed. Private ownership.



#### East Cambridgeshire. 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 taking out the policy.



Distribution by ownership is shown below. Detached private properties are the dominant class across the borough.



### Subsidence Risk Analysis – East Cambridgeshire

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

See page 11 for a seasonal analysis of the sample which reveals that, at district level, there is around a 70% probability of a claim being valid in the summer and, of the valid claims, there is around a 70% chance that the damage will have been caused by clay shrinkage. In the winter, the likelihood of a claim being valid falls to around 50% and of the valid claims there is a 75% chance of the cause being escape of water.

Maps at the foot of the following page plot the seasonal distribution and provide an indication of risk by geological series.



Above, extracts from the 1:625,000 series British Geological Survey maps. Working at postcode sector level and referring to the 1:50,000 series delivers far greater benefit when assessing risk.



#### 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.



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.



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

Combining the risk maps by season and reviewing the table on page 11 is perhaps the most useful way of assessing the potential liability, likely cause and geology using the values listed.

The 'claim by cause' distribution and the risk posed by the soil types is illustrated at the foot of the following page. 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.



### District Risk. EoW and Council Tree Risk.



Below, left, mapping the frequency of escape of water claims confirms the presence of noncohesive soils. The distribution on the map reflects the presence of drift deposits of till, sand and gravel. As we would expect, the 50,000 scale BGS map provides a more detailed picture. The CRG 1:250 grid reflects claims experience.

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.





#### **East Cambridgeshire - Frequencies & Probabilities**

Below, mapping the risk of subsidence by ownership. Claims frequency that includes council and housing association properties delivers a misleading value of risk as they tend to self-insure. The following show the normalised risk, taking account of the private housing population – that is, the rating compared with the average value for each category.



On a general note, a 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 usually 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 fairly steady throughout the year.

District	valid	valid	Repudiation	valid	valid	Repudiation
	summer	summer	Rate	winter	winter	Rate
	clay	EoW	(summer)	clay	EoW	(winter)
East Cambridgeshire	0.554	0.179	0.267	0.14	0.42	0.44

#### Liability by Season - East Cambridgeshire



### 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 of course.



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.





times of surge (from sample)

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

