

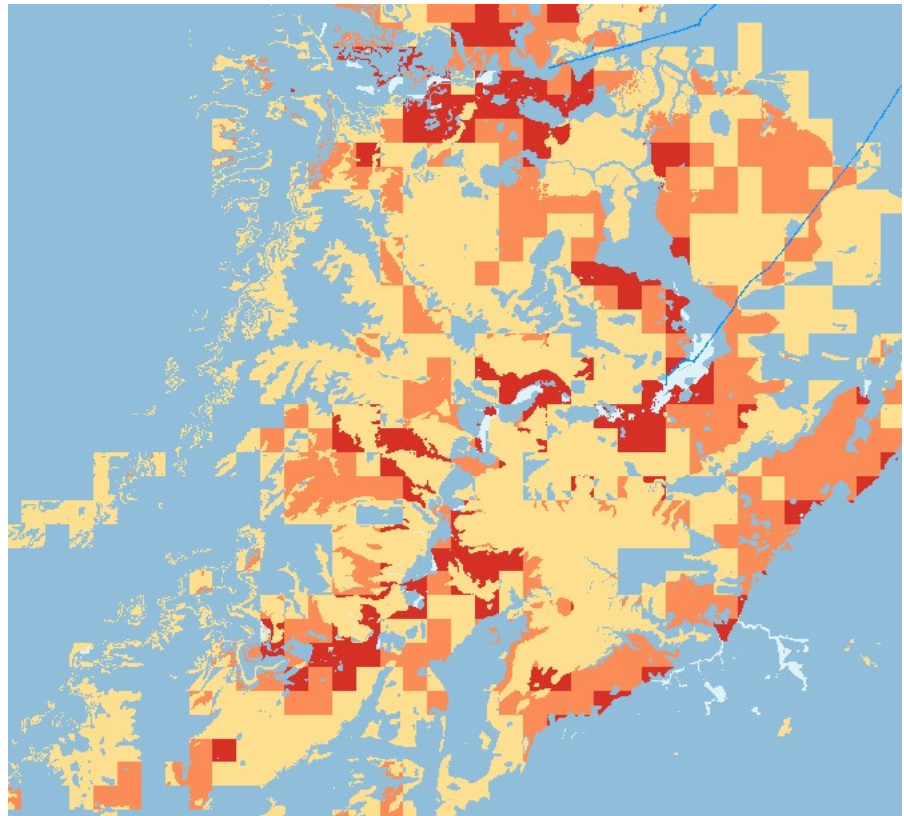


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# User Guide for the British Geological Survey GeoClimateUKCP09: Clay Shrink- Swell dataset

GeoAnalytics & Modelling Programme

Open Report OR/19/064





BRITISH GEOLOGICAL SURVEY

GEOANALYTICS & MODELLING PROGRAMME

OPEN REPORT OR/19/064

# User Guide for the British Geological Survey GeoClimateUKCP09: Clay Shrink-Swell dataset

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## Summary

This report is the guide for users of the British Geological Survey (BGS) GeoClimateUKCP09 clay shrink-swell dataset. This is a national scale assessment of variations in clay shrink swell susceptibility due to climate change. GeoClimateUKCP09 clay shrink-swell provides information on the potential for clay shrink swell to occur at a given location, during a given future time period, based on a combination of geological, hydrological and climate projection data.

## Acknowledgements

A number of individuals in the GeoAnalytics & Modelling and Engineering Geology & Infrastructure Programmes have contributed to the development of this dataset. This assistance has been received at all stages of the study. In addition to the collection and processing of data, many individuals have freely given their advice, and provided the local knowledge. The authors would also like to acknowledge the input received throughout the development from our Focus Group members who provided invaluable input and advice regarding user needs, data requirements and data visualisation/outputs.

# 1 Introduction

The British Geological Survey (BGS) is a world-leading geological survey, focusing on public-good science for government, and research to understand earth and environmental processes. BGS are the UK's premier provider of objective and authoritative geoscientific data, information and knowledge to help society to:

- use its natural resources responsibly
- manage environmental change
- be resilient to environmental hazards

BGS provide expert services and impartial advice in all areas of geoscience. As a public sector organisation, BGS are responsible for advising the UK Government on all aspects of geoscience as well as providing impartial geological advice to industry, academia and the public. Our client base is drawn from the public and private sectors both in the UK and internationally.

The BGS is a component body of the Natural Environment Research Council (NERC), part of UK Research and Innovation (UKRI).

## 1.1 BGS DATA PRODUCTS

Our innovative digital data products aim to help describe the ground surface and sub-surface for the whole of Great Britain. These digital products are based on the outputs of the BGS survey and research programmes and our substantial national data holdings. This data coupled with our in-house geoscientific knowledge are combined to provide products relevant to a wide range of users in central and local government, insurance and housing industry, engineering and environmental business, and the British public.

## 1.2 THE BGS GEOCLIMATE DATA PRODUCT

The purpose of GeoClimateUKCP09 clay shrink-swell is to provide information on the projected future change in susceptibility of clay shrink–swell hazard across Great Britain due to climate change. It considers the changing climate and the associated changes in near-surface ground water content, as well as the static variables of geology and geotechnical properties. Within this user guide, GeoClimateUKCP09 clay shrink-swell is hereafter referred to as GeoClimate.

Two versions of the GeoClimate are available: GeoClimate Open, which is a freely available overview dataset; and GeoClimate Premium, which is a licenced higher resolution and more detailed dataset. GeoClimate Open is designed as an overview for national use, whereas GeoClimate Premium data is designed to provide input data into regional – local risk and mitigation assessments.

The GeoClimate datasets, and accompanying documentation, provide information for users on the *natural* characteristics and properties of shrink-swell prone geological deposits for the assessment of climate change impacts in Great Britain. GeoClimate looks specifically at the geological factors that influence shrink-swell subsidence and the climatic effects/interactions. It does not consider any human or artificial factors.



Further information on all the digital data provided by the BGS can be found on our website at [Data Products](#) or by contacting

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## 2 About the GeoClimate Datasets

### 2.1 GEOLOGY AND CLIMATE CHANGE

Across the UK, clay-rich geological deposits, such as the London Clay Formation, are susceptible to volume change due to changes in water content. The susceptibility to this shrinking and swelling varies, dependant on the clay mineralogy and lithology. Changes in annual rainfall and temperature patterns are increasing the likelihood of this volume change occurring (Harrison et al., 2012). These changes can lead to ground movement that damages houses, near surface infrastructure, and other light structures. This damage can result in insurance claims due to subsidence (Crilly, 2001).

Water content within a clay-rich lithology is the overarching controlling factor (primarily from rainfall), however, water loss, due to evapotranspiration, also has an influence. Specific sites can be affected by local factors such as trees and other vegetation, which remove water from the ground, as well as human induced factors such as ‘surface sealing’, where rainwater enters drains rather than naturally infiltrating into the ground (Jones, 2002, 2004).

### 2.2 LICENSED & OPEN DATA PACKAGES

The GeoClimate data product is provided as two options, either Open data (under an [Open Government Licence](#)) or more detailed licenced Premium version. The data content of each package is as follows:

#### 2.2.1 GeoClimate Open:

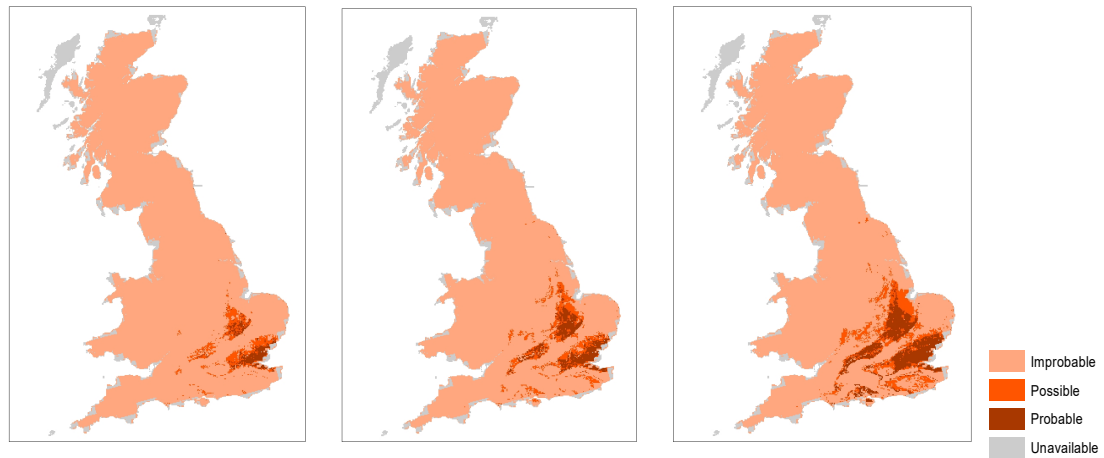
This is a 1:200 000 scale product, consisting of 2 km grid squares, and is made freely available on the BGS GeoIndex. The outputs are shown for time period envelopes, centred on 2030, 2050 and 2080, and based on the medium emissions scenarios, with no percentile statistics provided.

One dataset is provided for each time period, based on the average outcome for the medium emissions scenario and the most susceptible GeoSure value (worst case) within the grid cell.

GeoClimate Open is provided for 3 11-year windows:

- Centred on 2030 (11 year window 2025 to 2035)
- Centred on 2050 (11 year window 2045 to 2055)

- Centred on 2080 (11 year window 2075 to 2085)



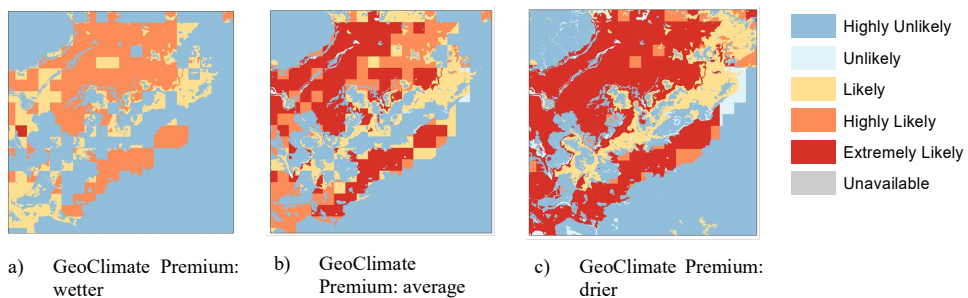
**Figure 1 GB overview of GeoClimate Open datasets for 2030, 2050 and 2080**

### 2.2.2 GeoClimate Premium:

This is a 1:50 000 scale product, provided as area polygons, for 5 time period envelopes, centred on 2020, 2030, 2040, 2050 and 2080, and based on the medium emissions scenarios, with the 10th and 90th percentile (wetter and drier) statistics provided.

GeoClimate Premium is provided for 5 11-year windows:

- Centred on 2020 (11 year window 2015 to 2025)
- Centred on 2030 (11 year window 2025 to 2035)
- Centred on 2040 (11 year window 2035 to 2045)
- Centred on 2050 (11 year window 2045 to 2055)
- Centred on 2080 (11 year window 2075 to 2085)



**Figure 2 GeoClimate premium data showing the likelihood that foundations will be affected by wetter (a), average (b) and drier (c) conditions.**

**Table 1 GeoClimate Open and Premium comparison**

	<b>GeoClimate Open</b>	<b>GeoClimate Premium</b>
<b>Susceptibility categorisation</b>	3 categories	5 categories
<b>Scale</b>	1:200 000	1:50 000
<b>Coverage</b>	Great Britain	Great Britain
<b>UKCP09 Emissions scenario</b>	Medium emissions	Medium emissions
<b>Temporal projections (11 year windows)</b>	2030s, 2050s, 2080s	2020s, 2030s, 2040s, 2050s, 2080s.
<b>Projections provided</b>	Median average	Median average, wetter, drier
<b>Number of individual layers supplied</b>	3	15
<b>Format</b>	Vector grid, supplied as ESRI shp.	Vector polygons, supplied as ESRI shp.

### 2.3 BACKGROUND

Shrink-swell is recognised as the most costly geohazard across Great Britain. For example due to the hot dry summer of 2018, more than 10,000 households made insurance claims worth a total of £64 million to deal with the impact of subsidence between July and September, according to the Association of British Insurers (ABI) (Insurance Times, 2018). This was the highest level of subsidence insurance claims since the heatwaves of 2006 and 2003 (Which.co.uk, 2018). Over an average year, insurers would usually expect to pay out approximately £75 million to rectify the impact of subsidence on homes (Guardian, 2018).

The BGS GeoSure shrink-swell dataset considers the physical properties of the geology to provide a susceptibility rating for potential ground movement. It does not, however, account for changes in climate, and parameters that will affect soil water content.

GeoClimate clay shrink-swell has been developed to enable the climate variables to be considered, alongside the geotechnical properties of the ground immediately below and around the foundations, and provide a longer term, modelled analysis for resilience assessments. It is essentially a national hazard susceptibility map, showing change in susceptibility with time, due to changes in climate. This methodology has been developed by engineering geologists, hydrogeologists, geophysicists and information developers at the British Geological Survey, following stakeholder engagement, and is presented as a series of GIS data layers.

The UK Climate Projections (UKCP)<sup>1</sup> provide an assessment of how the UK climate may change, providing projections of rainfall, temperature and sea level rise during

<sup>1</sup> <http://ukclimateprojections.metoffice.gov.uk/>

the 21st Century. In 2009 the UK Met Office Hadley Centre, in collaboration with a consortium of organisations and funded by the Department of Environment, Food and Rural Affairs (DEFRA), released UKCP09, based on the most sophisticated scientific research, providing projections for three scenarios: low, medium and high greenhouse emissions.

Alongside these global climate models (GCMs), the Centre for Ecology & Hydrology (CEH) also produced 11 regional climate models (11RCMs) realisations, based on UKCP09 medium emission scenario. CEH utilised these 11RCM to generate the ‘Future Flows’ datasets, providing available precipitation and GB potential evapotranspiration for hydrological and groundwater modelling (Prudhomme et al., 2012, Boorman et al., 1995, Murphy et al., 2009). This enabled BGS to access the UKCP09 medium emission projection and combine it with BGS geological datasets and groundwater models, to produce GeoClimate.

## 2.4 WHO MIGHT REQUIRE THIS DATA?

Natural ground stability hazards, such as clay shrink-swell may lead to financial loss for anyone involved in the ownership or management of property. These hazards could increase in likelihood and propensity when considering the impacts of a changing climate. These impacts could relate to increased insurance premiums, depressed house prices and, in some cases, engineering works to stabilise land or property.

The identification of areas of potential increased risk of clay shrink–swell susceptibility from climate change will be of use to all those required to plan for longer-term resilience into the 21<sup>st</sup> Century. This includes planners, developers, construction companies, and utility companies, consulting engineers, builders, loss adjusters, the insurance industry, architects and surveyors. These hazards may also impact on anyone involved in infrastructure networks (road or rail) or utility companies.

The key benefit of GeoClimate is that it provides a ‘hot spot’ map of potential risk areas, which can inform mitigation strategies (and therefore save time associated with fewer manual site visits), prioritise works and aid risk reduction. The product might be used to inform changes in the design of foundations so buildings are not affected by the increased hazard. The cost of such prevention may be very low, and is often many times lower than the repair bill following ground movement. When integrated within the workflows of our intended user base it can support prioritisation of remedial action, or help define buildings at most risk, thereby reducing subsidence events and potentially saving the costs of rebuild and disruption.

## 3 The GeoClimate development

GeoClimate combines current GB clay shrink-swell hazard susceptibility, GB groundwater modelling, and climate change projections to project future clay shrink-swell hazard susceptibility. The wetter, drier and average projections have been calculated to convey the variation within the scenario modelling and to allow the user to consider both end members for shrink-swell potential according to their needs.

### 3.1 INPUT DATASETS

The datasets utilised and combined to create GeoClimate are:

1. **CEH Hydrology of Soil Types (HOST)** (Boorman et al., 1995).  
<https://www.ceh.ac.uk/services/hydrology-soil-types-1km-grid>
2. **UKCP09 rainfall and temperature, processed by CEH in 11RCM (Future Flows FF-HadRM3-PPE)** to provide future potential evapotranspiration (PET) projections (Prudhomme et al., 2012, Boorman et al., 1995, Murphy et al., 2009).  
<https://www.ceh.ac.uk/services/future-flows-maps-and-datasets>
3. **BGS Hydrogeology 625k** GIS polygon data.  
<https://www.bgs.ac.uk/products/hydrogeology/maps.html>
4. **NEXTMap** Britain elevation data from Intermap Technologies
5. **BGS GeoSure shrink-swell** dataset  
[https://www.bgs.ac.uk/products/geosure/shrink\\_swell.html](https://www.bgs.ac.uk/products/geosure/shrink_swell.html)
6. **OS Open Map** – Local (coastline) <https://www.ordnancesurvey.co.uk/business-government/products/open-map-local>

### 3.2 MODELS UTILISED

The BGS Groundwater Zooming Object Oriented Distributed Recharge (ZOODRM) distributed recharge model (Mansour & Hughes., 2004) was used to generate gridded daily soil moisture deficit (SMD) values for UK, based on inputted climate variables and ground data listed in Section 3.1.

## 4 GeoClimate Open: Technical Information

**Note:** These data are intended to be used as a national overview and are not suitable for local assessments. The data is derived from the GeoClimate Premium dataset by taking the ‘worst-case’ susceptibility classification for each grid cell. Users should therefore be aware that this score does not necessarily apply to the whole of the 2km cell but that the cell does include some proportion of the worst-case rating.

### 4.1 OUTPUTS

The GeoClimate Open data layers have been provided as 3 datasets, 1 for each given time period and identify a GB-wide distribution for increased susceptibility to clay shrinkage, related to subsidence, for the 21<sup>st</sup> century. The data are provided on a 2km<sup>2</sup> grid. GeoClimate Open provides 1 layer for each time period:

- Average (50<sup>th</sup> percentile of days above threshold)

### 4.2 TEMPORAL SCALE

For the GeoClimate Open suite of layers, a susceptibility score is provided for the following 11-year time periods:

- 2030s (2025 to 2035)
- 2050s (2045 to 2055)
- 2080s (2075 to 2085)

### 4.3 ATTRIBUTES

The GeoClimate Open datasets contain the fields summarised in Table 2 below.

**Table 2 GeoClimate Open fields and descriptions**

Field Name	Field Description
CLASS	Classification of hazard using values:- Improbable, Possible, Probable, Unavailable
LEGEND	Description of the potential for the hazard to change (see Table 3)
VERSION	Dataset name and version number

The GeoClimate Open susceptibility legend descriptions include the class values described in table 2, plus an ‘unavailable’ category (Table 3).

**Table 3 GeoClimate Open colours, classes and susceptibility text**

Class	Associated susceptibility text (legend text)
Improbable	It is ‘improbable’ that climate change will effect clay shrink-swell susceptibility and change the likelihood of ground movement, which causes subsidence.
Possible	It is ‘possible’ that climate change will effect clay shrink-swell susceptibility and change the likelihood of ground movement, which causes subsidence.
Probable	It is ‘probable’ that climate change will effect clay shrink-swell susceptibility and change the likelihood of ground movement, which causes subsidence.
Unavailable	Input datasets are unavailable.

**Note** ‘Unavailable’ classification: It is not possible to generate output grids for islands **remote** to mainland UK, due to groundwater modelling limitations. Therefore GeoClimate values for the Scottish Islands (including Orkney and Shetland Isles) are categorised as ‘Input datasets are unavailable’.

Similarly, some areas of the coastal zone are not classified due to the incomplete extent of the input datasets.

**Example Score Interpretation:** The GeoClimate Open rating for the area of interest is Probable (Brown) in the 2050 projection. This shows that it is probable that the likelihood of clay shrink-swell occurring in this area, causing subsidence in low-rise buildings, will increase due to changes in climate, by 2050.

For all GeoClimate Open results, the rating provided is the highest GeoClimate value within the selected 2km pixel. For a more precise rating, please consult the GeoClimate Premium product (Section 5).

## 5 GeoClimate Premium: Technical Information

### 5.1 OUTPUTS

The GeoClimate Premium data layers have been provided as a series of temporal datasets for a given time period and identify a GB-wide distribution for increased susceptibility to clay shrinkage, related to subsidence, for the 21<sup>st</sup> century.

GeoClimate Premium provides 3 scenarios for each time period:

- Average (50<sup>th</sup> percentile of days above threshold)
- Wetter (10<sup>th</sup> percentile of days above threshold)
- Drier (90<sup>th</sup> percentile of days above threshold)

### 5.2 TEMPORAL SCALE

These 3 data layers are provided for the following 11-year time periods:

- 2020 (2015 to 2025)
- 2030 (2025 to 2035)
- 2040 (2035 to 2045)
- 2050 (2045 to 2055)
- 2080 (2075 to 2085).

### 5.3 ATTRIBUTES

The GeoClimate Premium datasets contain the fields summarised in Table 4 below.

**Table 4 GeoClimate Premium fields and descriptions**

Field Name	Field Description
CLASS	Classification of hazard using values:- Highly Unlikely, Unlikely, Likely, Highly Likely, Extremely Likely
LEGEND	Description of hazard (Table 5)
VERSION	Dataset name and version number

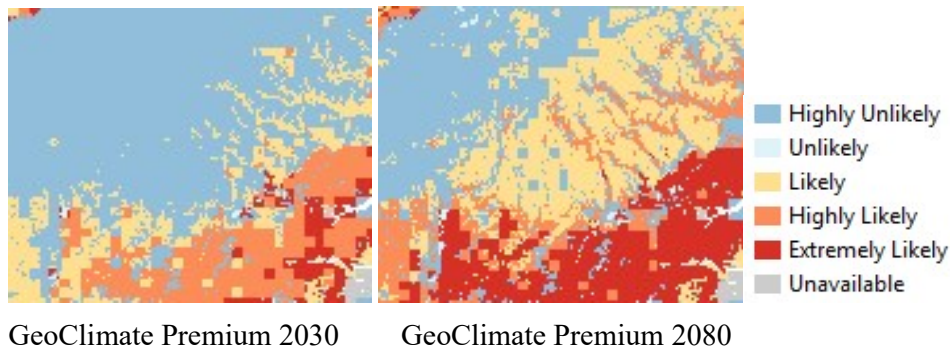
The GeoClimate Premium susceptibility class descriptions include the following 5 categories, plus an 'unavailable' category (Table 5).

**Table 5 GeoClimate Premium colours, classes and susceptibility text**

Class	Associated susceptibility text (legend text)
Highly unlikely	It is 'highly unlikely' that foundations will be affected by increased clay shrink-swell due to climate change.
Unlikely	It is 'unlikely' that foundations will be affected by increased clay shrink-swell due to climate change.
Likely	It is 'likely' that foundations will be affected by increased clay shrink-swell due to climate change.
Highly likely	It is 'highly likely' that foundations will be affected by increased clay shrink-swell due to climate change.
Extremely likely	It is 'extremely likely' that foundations will be affected by increased clay shrink-swell due to climate change.
Unavailable	Input datasets are unavailable.

**Note** 'Unavailable' classification: It is not possible to generate output grids for islands remote to mainland UK, due to groundwater modelling limitations. Therefore GeoClimate values for the Scottish Islands (including Orkney and Shetland Isles) are categorised as 'Input datasets are unavailable'.

Similarly, some areas of the coastal zone are not classified due to the incomplete extent of the input datasets.



**Figure 3 GeoClimate 2030 and 2080 median average datasets example**

## 6 GeoClimate Premium: Difference maps

An additional set of GeoClimate Premium datasets are provided, which show the differences between a modelled baseline and the modelled forecasts.

Modelled outputs for the time period 2005-2015 were generated using the same methodology as for all GeoClimate datasets. The differences in classification from the 2005-2015 GeoClimate score (baseline) were calculated for each time period, to provide a value for difference-in-classification.



## 6.1 ATTRIBUTES

The GeoClimate Premium: Difference datasets contain the fields summarised in Table 6 below.

**Table 6 GeoClimate Premium: Difference fields and descriptions**

Field Name	Field Description
DIFFERENCE	Number of classification changes (-4 to +4)
LEGEND	Description of the changes (see Table 7)
BASE_CLASS	Classification of the baseline value:- Highly Unlikely, Unlikely, Likely, Highly Likely, Extremely Likely in the baseline dataset (2005-2015)
LEGEND	Description of hazard (Table 5)
VERSION	Dataset name and version number

Table 7 describes this classification of the GeoClimate Premium Difference maps.

**Table 7 GeoClimate Premium difference map colours, values and text**

	Difference from 2005-2015 susceptibility
<b>-4</b>	Decrease of 4 classifications
<b>-3</b>	Decrease of 3 classifications
<b>-2</b>	Decrease of 2 classifications
<b>-1</b>	Decrease of 1 classification
<b>0</b>	No change in classification
<b>1</b>	Increase of 1 classification
<b>2</b>	Increase of 2 classifications
<b>3</b>	Increase of 3 classifications
<b>4</b>	Increase of 4 classifications
<b>-999</b>	Unavailable

## 7 Frequently Asked Questions

### What is the relationship between GeoSure and GeoClimate?

The projected changes in climate vary across Great Britain, so whereas GeoSure shrink-swell considers only the physical properties of the geology, GeoClimate considers how these physical properties may be affected in the future as a consequence of projected changes in climate according to UKCP09.

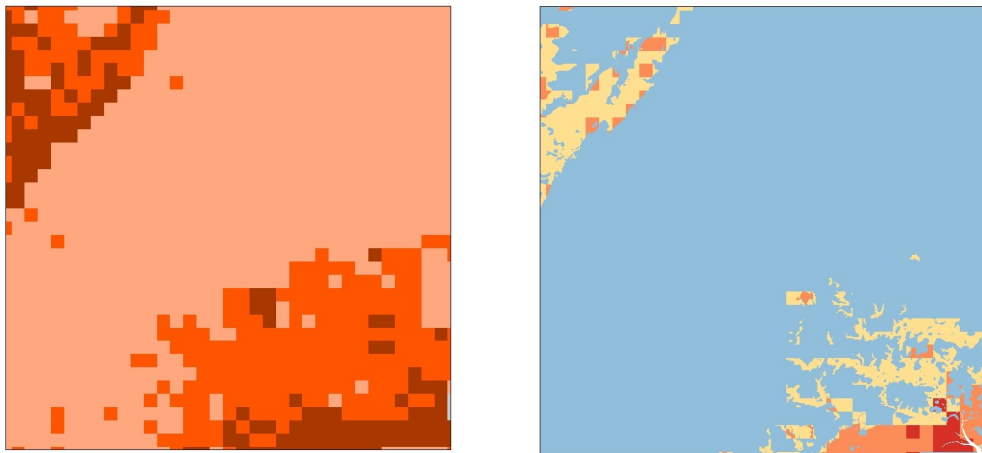
The ‘difference’ maps (based on the time period 2005-2015) can be used to identify potential change from current ‘modelled’ conditions.

### **How do GeoClimate Open and Premium compare?**

GeoClimate Open data has been generated at 1:200 000 and is intended to be used as a national overview. It has been derived from the GeoClimate Premium dataset by taking the ‘worst-case’ susceptibility classification for each grid cell. GeoClimate Open is therefore not suitable for local assessments.

GeoClimate Premium has been developed at 1:50 000 to provide a more detailed assessment of variations in clay shrink-swell susceptibility due to climate change.

For a visual comparison of the 2 datasets, Figure 4 demonstrates the difference of GeoClimate Premium and Open, for an area in the south east of Great Britain.



**Figure 4 GeoClimate Premium and Open comparison for an example area in south east GB**

### **Which Climate projections are used in GeoClimate?**

GeoClimate is a new BGS product, the first of its kind to look at the effects of climate change on geohazard susceptibility. It uses the UK Climate Projections UKCP09, developed under the Met Office Hadley Centre Programme, as they provide the most suitable assessment of how the UK climate may change over the 21st century.

GeoClimateUKCP09 utilises the UKCP09 medium emissions projections.

### **Will the dataset be updated based on UKCP18 projections?**

In November 2018, initial UKCP18 datasets were released, drawing upon the most recent scientific evidence. Additional UKCP18 products providing a finer spatial scale, comparable with that used in GeoClimateUKCP09, have been released during 2019. GeoClimateUKCP18 will utilise these finer spatial scale UKCP18 projections to ensure the existing resolution is maintained.

The UKCP18 clearly outlined that general climate change trends over land for the 21st Century are broadly consistent with UKCP09 projections; both showing increased chance of milder, wetter winters and hotter, drier summers. Based on this, it

is unlikely that the overview of projected GB clay shrink-swell susceptibility will change significantly, but differences may be seen locally and in rates of change.

### **Why does the susceptibility change over time?**

Changes in susceptibility are driven by both the mineralogical and lithological characteristics of the geology, and climate. Some areas of the country will never experience clay shrink-swell due to the underlying geology, and these areas remain ‘improbable’ in every time period. However, in other areas, the underlying geology contains clay minerals that can shrink and swell due to the presence of water. Some of these areas are not yet experiencing moisture fluctuations large enough to trigger visible volume change and ground movement. But as climate changes over time, and fluctuations in water content increase, it is likely that these areas will experience some ground movement.

### **Is GeoClimate Open enough for my needs?**

GeoClimate Open projections show that many areas will start to experience increased susceptibility to clay shrink-swell after the 2030s. As the climate continues to change, more geological formations containing shrink-swell susceptible clay minerals will experience larger fluctuations in water content. This will lead to the area projected to experience rising susceptibility increasing in size.

If it is consistently improbable that your area of interest will experience changes in clay shrink-swell susceptibility, then GeoClimate Open provides all the information you require to consider the impact of climate change on clay shrink-swell. You should however consult BGS GeoSure shrink-swell to identify the existing susceptibility.

If it is probable that the area of interest will experience changes in clay shrink-swell susceptibility, GeoClimate Premium will provide further, more detailed and higher resolution information, such as larger scale polygons rather than the small scale grid, more future time periods, maximum and minimum projections and increased categories of susceptibility.

See Figure 1 which demonstrates the change in GeoClimate Open projected susceptibility between 2030, 2050 and 2080.

### **How are the GeoClimate Premium average, wetter and drier scenarios calculated?**

The methodology provides 11 values for each grid square, originating from the use of the CEH 11 regional climate models. The 10th percentile has been utilised to represent the wetter conditions, the 50th percentile represents median average conditions and the 90th percentile represents drier conditions.

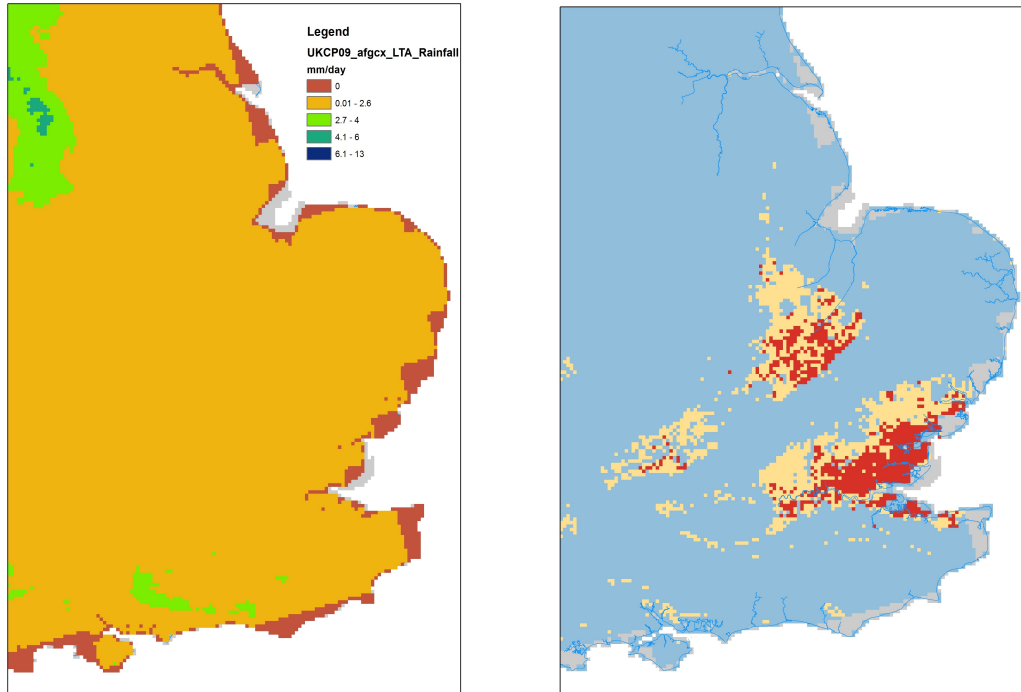
See Figure 2 which demonstrates the variation in the average, wetter and drier output datasets for an example time period.

### **What does the data unavailable category represent?**

The reason for the ‘unavailable’ category arises from 2 different sources. Firstly, all the input datasets required are not available for the Scottish Islands (including Orkney and Shetland Isles). Therefore, results for these areas are categorised as ‘Input datasets are unavailable’.

Secondly, during the data processing, extremely high outlying values above soil moisture deficit thresholds were observed. Those events were associated with the

coastline and originate with the UKCP09 11RCM climate scenarios data. Close to the coast, the runs provide a zero rainfall value, as highlighted in brown in Figure 5 below. To account for this, any grid point with over 350 days above threshold was removed and replaced with a null value. It is therefore not possible to provide a GeoClimate score and the cell is also recorded as ‘unavailable’.



**Figure 5 Rainfall input values from the UKCP09 11RCM dataset (left), associated with the grey GeoClimate OPEN unavailable values (right).**

### **Why does GeoClimate Premium appear to be pixelated, when it is derived from the 1:50 000 geology polygons?**

The gridded nature of areas of GeoClimate Premium is due to the resolution of the soil moisture deficit data generated using the BGS ZOODRM groundwater model. This provides an output grid with a resolution of 2km<sup>2</sup>. Therefore, when combined with the geological 1:50 000 polygon dataset, in areas where the soil moisture deficit values lead to a varying GeoClimate Premium classification, across areas of consistent volume change potential, the grid is clearly visible.

## **8 Considerations**

- The GeoClimate Premium dataset has been developed at 1:50 000 scale and must not be used at larger scales.
- The GeoClimate Open dataset has been developed at 1:200 000 scale and must not be used at larger scales.

- GeoClimate looks specifically at the geological factors that influence shrink-swell subsidence and the climatic effects/interactions. It does not consider any human or artificial factors (e.g. construction of buildings).
- GeoClimate is based on, and limited to, an interpretation of the records in the possession of the British Geological Survey at the time the dataset was created.
- An indication of natural ground movement due to shrink-swell does not necessarily mean that a location will be affected by ground movement or subsidence. Such an assessment can only be made by inspection of the area by a qualified professional.
- GeoClimate does not consider risk. GeoClimate examines the conditions that leave an area exposed to a hazard and the change in potential for this hazard to worsen due to climatic change.
- A high hazard does not necessarily translate to a high risk. For example, if a particular location has a relatively high ground stability hazard, but the properties are designed to withstand the hazard, with foundations that take the effects of climate change into consideration, they will not be at risk due to this geohazard.
- The text provided in the GeoClimate clay shrink-swell dataset are designed to provide a general indication of the meaning of the various GeoClimate clay shrink-swell dataset levels. If the data are to be used for advising specific sectors of end users in detail, e.g. home-buying, property insurance, site development and construction, then the BGS can provide additional end user guidance and attribution details for the data. To find more about this, please contact our Data Services team using the contact details at the start of this document.

## 9 Licencing Information

### 9.1 GEOCLIMATE OPEN

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The BGS is committed to ensuring that all the digital data it holds which is released to external parties under licence has been through a robust internal approval process, to ensure that geoscientific standards and corporate quality assurance standards are maintained. This approval process is intended to ensure that all data released: (i) is quality assured; (ii) meets agreed BGS data management standards; (iii) is not in breach of any 3rd party intellectual property rights, or other contractual issues (such as confidentiality issues), that would mean that release of the data is not appropriate.

When the BGS digital datasets are revised any upgrades will be automatically supplied to the licensee, at no additional cost. Geological map datasets are revised on a periodic rather than on an annual basis, licensees will therefore not automatically receive a new dataset each year unless changes have been made to the data.

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### **9.3 CONTACT INFORMATION**

For all data and licensing enquiries please contact:

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## Glossary

Clay shrink-swell	Shrink–swell occurs as a result of changes in the moisture content of clay-rich soils. This is reflected in a change in volume of the ground through shrinking or swelling. Swelling pressures can cause heaving, or lifting, of structures whilst shrinkage can cause differential settlement.
Hazard	A potentially damaging event or phenomenon.
Risk	The impact of the hazard on people, property or capital. The GeoClimate dataset does not identify the cost of a hazard being realised, and therefore does not consider risk. It only examines the conditions that leave an area exposed to the hazard. It is therefore a hazard dataset.
Subsidence	Subsidence is a lowering or collapse of the ground. It can be triggered by a change in drainage patterns, heavy rain, by water abstraction or man-made disturbance. Subsidence has the potential to cause engineering problems such as damage to foundations, buildings and infrastructure.
UKCP09	United Kingdom Climate Projections 2009. UKCP09 was produced in 2009, funded by a number of agencies led by Defra. It is based on sophisticated scientific methods provided by the Met Office, with input from over 30 contributing organisations.
ZOODRM	Zooming Object Oriented Distributed Recharge model
11RCM	11 Regional Climate Models

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