

BGS INFORMATION PRODUCTS

User update: BGS GeoClimate Shrink-Swell

Release: BGS GeoClimate Shrink-Swell

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This version of GeoClimate utilises state-of-the-art climate projection data from the UKCEH CHES-SCAPE future climate dataset (Robinson et al., 2023), which is derived and extended from the climate model output provided by the UK Climate Projections 2018 (UKCP18).

Overview

GeoClimate shrink-swell provides information on the potential for clay shrink-swell subsidence under a range of climate scenarios. The data provide projections for the Representative Concentration Pathways (RCPs) 2.6, 4.5 and 8.5 emission scenarios. The data are modelled outputs based on a combination of geological, hydrological and climate projection data. GeoClimate shrink-swell is a national geological dataset produced by BGS and is provided at a quasi-1:50 000 scale. It is based on the best and most appropriate resolution datasets available at national scale and coverage; the 1:50 000 BGS geological data and 1km grid CHES-SCAPE climate projection data. GeoClimate shrink-swell has almost complete coverage of Great Britain (not including Shetland and parts of the Orkneys), as shown in Figure 1 below.

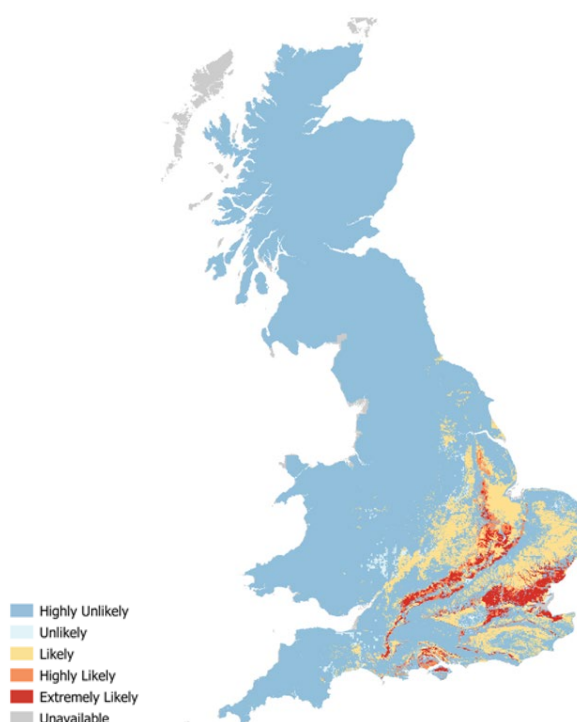


Figure 1 Coverage of GeoClimate shrink-swell. *Coastline: Contains OS data © Crown copyright and database right (2026)*

Benefits of GeoClimate shrink-swell compared to GeoClimate UKCP18

UKCP18 uses cutting-edge climate science to provide observations and climate change projections of rainfall, temperature and sea level rise during the 21st Century. The GeoClimate methodology requires the most detailed, highest resolution projections, which provide a model at a spatial resolution on a par with operational weather forecast models. UKCP18 produced these high-

resolution projections for only one emissions scenario, RCP8.5, the high greenhouse gas (GHG) emissions scenario. Consequentially, GeoClimate UKCP18 could only be provided for RCP8.5.

CHESS-SCAPE is a new climate projections dataset produced by UK Centre for Ecology & Hydrology (UK CEH), as part of the UK-SCAPE project (Robinson et al., 2023), which meets the need for enhanced, consistent, extended and accessible high resolution climate projections to drive impact models. It is derived from the regional climate projections in the UKCP18 regional climate model (RCM) 12 km ensemble, based on four ensemble members, which were selected from the original 12 in UKCP18 to represent the ensemble climate model uncertainty. The data was downscaled, bias corrected, time shifted, and pattern scaled. It contains the relevant meteorological variables, at high spatial and temporal resolution, allowing for integration into the GeoClimate methodology, and provides projections for the full range of RCPs. CHESS-SCAPE has therefore enabled the development of GeoClimate outputs for RCP2.6, RCP4.5 and RCP8.5. The continuous CHESS-SCAPE projections, from 1980 to 2080, allow the generation of a larger number of time periods than was possible for GeoClimateUKCP18: 11-year windows centred on 2030, 2050 and 2070.

These updated GeoClimate shrink-swell datasets have been developed using the same methodology as previous versions of GeoClimate, and the new GeoClimate shrink-swell RCP8.5 projections are very comparable to GeoClimate UKCP18 RCP8.5 projections, demonstrating the reliability of the dataset.

Consequences of updated climate projections

The CHESS-SCAPE projections, although similar and projecting comparable levels of rainfall and temperature changes to UKCP18, lead to variations in the outputs. The CHESS-SCAPE RCP8.5 average climate projection is slightly drier than UKCP18, providing projections with slightly higher increases in subsidence susceptibility. However, overall, the difference in outputs is modest, showing the robustness of the CHESS-SCAPE subset of 4 ensemble members in representing the original 12 UKCP18 ensemble members.

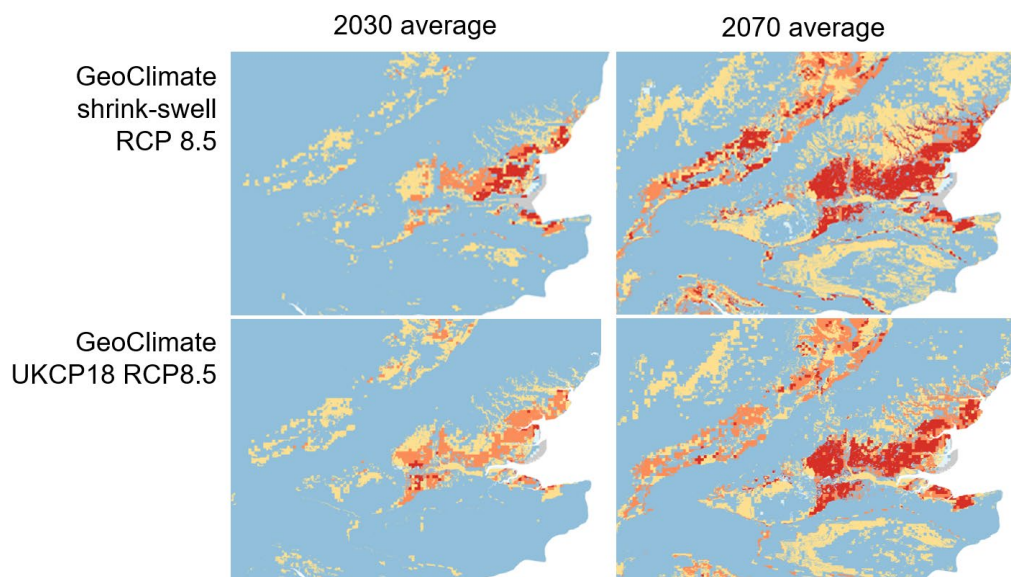


Figure 2: Comparison of GeoClimate shrink-swell RCP8.5 (utilising CHESS-SCAPE) and UKCP18 RCP8.5 projections for 2030 and 2070

Tables 1 to 4 below provide overviews of the difference in coverage of the susceptibility classifications between GeoClimate UKCP18 (RCP8.5) and the new GeoClimate shrink-swell (RCP8.5).

Table 1: Difference in classification areas between GeoClimate UKCP18 (RCP8.5) 2030 and new GeoClimate shrink-swell 2030 (RCP8.5)

Class	GeoClimate UKCP18 RCP8.5 2030		GeoClimate shrink-swell RCP8.5 2030	
	km ²	Percentage	km ²	Percentage
Highly unlikely	219569.16	94.79	220211.45	94.93
Unlikely	73.87	0.03	69.46	0.03
Likely	4544.50	1.96	3376.91	1.46
Highly likely	1750.43	0.76	1022.78	0.44
Extremely likely	153.77	0.07	592.61	0.26
Unavailable	5546.68	2.39	6696.05	2.89

Table 2: Magnitude of change in classification areas between GeoClimate UKCP18 (RCP8.5) 2030 and new GeoClimate shrink-swell 2030 (RCP8.5). When a classification is only 'unavailable' in either UKCP18 or CHES-SCAPE, the difference in classification value is change from zero.

Difference in class from UKCP18 to CHES-SCAPE	Area change (km ²)	Percentage change
-4	47.35	0.02
-3	368.39	0.16
-2	2284.03	0.99
-1	680.35	0.29
0	219256.09	94.72
1	2324.15	1.00
2	1073.30	0.46
3	142.05	0.06
4	30.27	0.01
5	6.23	0.00
Unavailable in both	5254.79	2.27

Table 3: Difference in classification areas between GeoClimate UKCP18 (RCP8.5) 2070 and new GeoClimate shrink-swell 2070 (RCP8.5)

Class	GeoClimate UKCP18 RCP8.5 2070		GeoClimate shrink-swell RCP8.5 2070	
	km ²	Percentage	km ²	Percentage
Highly unlikely	210850.86	91.03	203121.95	87.56
Unlikely	279.03	0.12	663.41	0.29
Likely	8551.40	3.69	14133.36	6.09
Highly likely	4131.94	1.78	3592.91	1.55
Extremely likely	2278.52	0.98	3761.57	1.62
Unavailable	5546.68	2.39	6696.05	2.89

Table 4: Magnitude of change in classification areas between GeoClimate UKCP18 (RCP8.5) 2070 and new GeoClimate shrink-swell 2070 (RCP8.5)

Difference in class from UKCP18 to CHES-SCAPE	Area change (km ²)	Percentage change
-4	60.30	0.03
-3	181.21	0.08
-2	1637.20	0.71
-1	1000.87	0.43
0	210587.89	90.98
1	4143.67	1.79
2	8064.64	3.48
3	338.98	0.15
4	189.40	0.08
5	8.08	0.00
Unavailable in both	5254.79	2.27

For the GeoClimate 2030 projections, the new GeoClimate shrink-swell outputs are mostly the same as for UKCP18, with 95% projecting the same classification. 1.5% project an increase in classification,

with the majority of this (1%) showing an increase in 1 classification. 1.5% also project a decrease in classification, with two thirds of this (1%) showing a decrease in 2 classifications. These differences in projected susceptibility can be seen in London and Cambridgeshire areas, in Figure 3.

The new GeoClimate shrink-swell 2070 projections show slightly more divergence from the UKCP18 outputs, with 91% still projecting the same classification. 5.6% project an increase in classification, with the majority of this (3.5%) showing an increase in 2 classifications. This can be seen across much of Suffolk, Norfolk and Essex (Figure 3). 1.3% project a decrease in classification, with more than half of this (0.7%) showing a decrease in 2 classifications.

The new GeoClimate shrink-swell has a slight increase of 0.5% in unavailable data. This initiates from the hydrogeological model outputs during the data processing, with various points along the coastline producing unrepresentative values of soil moisture deficit, due to the coastline transecting the cell.

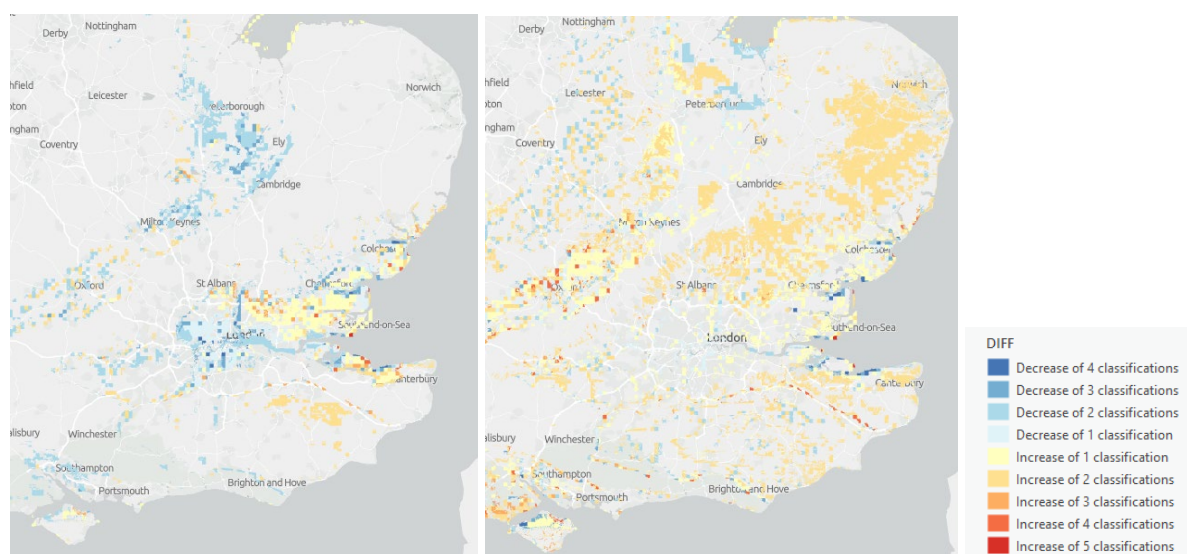


Figure 3: The locations of changed GeoClimate classifications, 2030 (left) 2070 (right). Areas are coloured by the change in classification from GeoClimate UKCP18 to new GeoClimate shrink-swell. Topography Contains OS data © Crown copyright and database right 2026.

Historic baseline dataset

In addition to the future projection datasets, we provide a modelled historic baseline dataset, centred on 1996 (11-year window 1991 to 2001). This allows provision of a difference map to show the differences between a modelled baseline and the modelled forecasts. Differences in classification from the baseline are calculated for each time-period to provide a value for a difference-in-classification map.

In GeoClimate UKCP18 the historic baseline dataset was 1990 (1985-1995). For the new GeoClimate shrink-swell this is slightly more recent, due to the historic climate projections available. CHES-SCAPE provides historic climate projections from 1980, and the groundwater model utilised in the methodology requires 10 years of input values, to provide robust soil moisture deficit values. Therefore, the earliest soil moisture deficit values generated are for 1991. The methodology utilises 11-year windows for which it provides a GeoClimate projection, thus the historic baseline for CHES-SCAPE is 1996 (representing 1991 to 2001).

Selecting the 'baseline period'

1996 was selected to provide the modelled baseline as it is the earliest available 11-year window projection and therefore represents the least amount of projected modelled change. When projections

are before present day, they are still 'modelled' historic data rather than absolute recorded values (modelled rather than observed). The model uses greenhouse gas emissions projections as described by the RCP. Therefore, if a later time-period (such as 2015-2025) had been selected, each RCP projection would be increasingly dependent on the projected greenhouse gas emissions, and potentially less accurately representing actual historical greenhouse gas levels, undermining its role as a baseline.

Variation in susceptibility temporally and across RCPs

There is an overall relationship that RCP8.5 is drier than RCP4.5, which is drier than RCP2.6, and the further into the future, the larger the increase in clay shrink-swell susceptibility. However, this is greatly simplified and there are deviations from this, due to the complexities such as;

- reductions in aerosols accompanying the reduction in GHG emissions. Aerosols have a cooling effect, and a much shorter lifetime in the atmosphere, leading to non-linear responses and potentially an increase in temperature following rapid mitigation strategies, followed by cooling in the longer term.
- lag times of decades in the GHG emissions reductions and impact on global temperatures, due to the long lifetime of carbon dioxide in the atmosphere.
- variation in rainfall infiltration rates due to increasing summer temperatures causing drying of the ground surface and leading to increased runoff.

Further information: please refer to the User Guide for the detailed information about the product content, attribution, displaying map colours, use, and licensing.

British Geological Survey 2025. User Guide: BGS GeoClimate Shrink-Swell, *British Geological Survey Open Report*, OR/25/076. 31pp

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References

ROBINSON, E.L., HUNTINGFORD, C., SHAMSUDHEEN SEMEENA, V., AND BULLOCK, J.M. 2023, CHESS-SCAPE: high-resolution future projections of multiple climate scenarios for the United Kingdom derived from downscaled United Kingdom Climate Projections 2018 regional climate model output. *Earth Syst. Sci. Data*, 15, 5371-5401