Cambridge South East Transport Phase 2

Environmental Statement

Appendix 15.1 Climate Vulnerability Detailed Baseline

31st July 2023

Background

15.1.1 The Scheme is situated within the Anglian catchment. To inform adaptation decisions this section presents data from the Meteorological Office (Met Office) to summarise the Anglian catchment's current climate. The Met Office's standard average data tables are used, they show the latest set of 30-year averages covering the period 1981-2010. Context to this is provided by including comparison to the equivalent national dataset (UK minimum, average and maximum temperatures).

15.1.2 To support the above average regional data a local dataset has also been collected from the closest long running climate station to the Scheme. The closest climate station is located at Cambridge National Institute of Agricultural Botany (NIAB) (543500E, 260600N) – approximately 10 miles north of the scheme) and has been recording observations since 1959[1].

Current temperature

15.1.3 The climate in the Anglian catchment is one of relatively mild winters and warm summers. As shown in Figure A15.1.1 and Figure A15.1.2, monthly average and mean maximum temperatures are high for the UK. Across the timeseries, 1981-2010, peak summer (July) average maximum temperatures of 22 °C in the Anglian catchment are equal to the maximum across the UK. Note that average maximum temperatures are calculated as the monthly average of daily maximums – as such some individual days are likely to have recorded hotter temperatures than those stated.

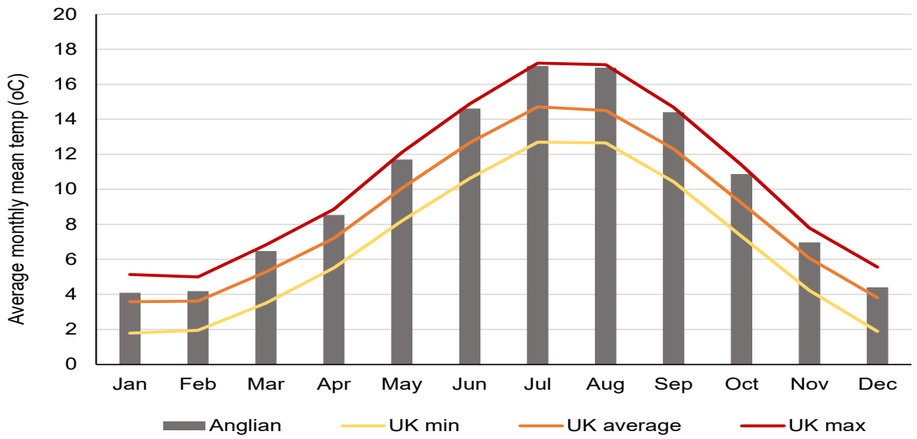


Figure A15.1.1 Long-term average monthly mean temperature (°C) (1981-2010)

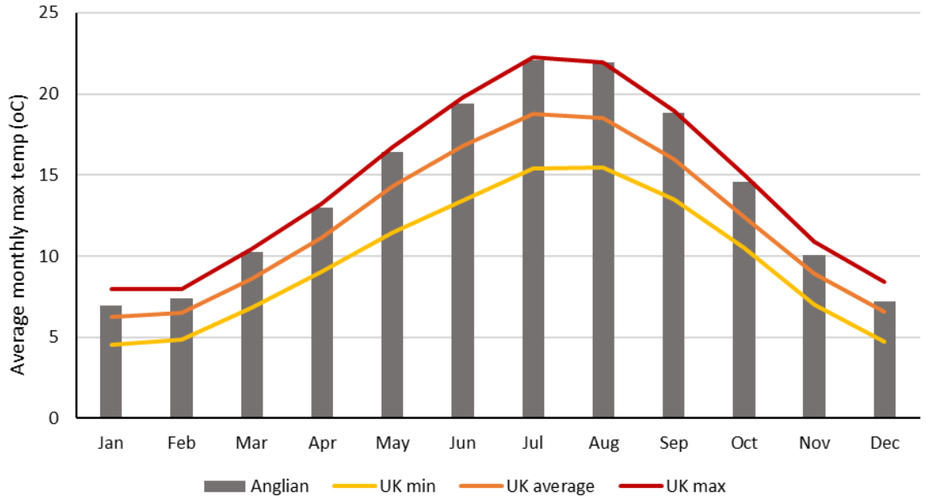


Figure A15.1.2 Long-term average monthly maximum temperature (°C)(1981-2010) Note: the maximum data presented is a monthly average of daily maximums.

15.1.4 From 1959 to 2021, the highest monthly mean daily maximum temperature recorded at Cambridge NIAB is 28.3 °C in July 2006. Conversely the lowest mean daily minimum temperature it has recorded is -5.7 °C in January 1963. January 1963 also recorded the station's maximum monthly number of days with air frost, 29 days.

15.1.5 Observations for the UK show that the decade leading up to the publication of UKCP18 (2008-2017) was on average 0.3 °C warmer than the 1981-2010 average and 0.8 °C warmer than 1961-1990. All of the top ten warmest years have occurred since 2002[2].

15.1.6 As shown in Figure A15.1.3 the long-term average days with ground frost (1981-2010) in the Anglian catchment are close to average for the UK.

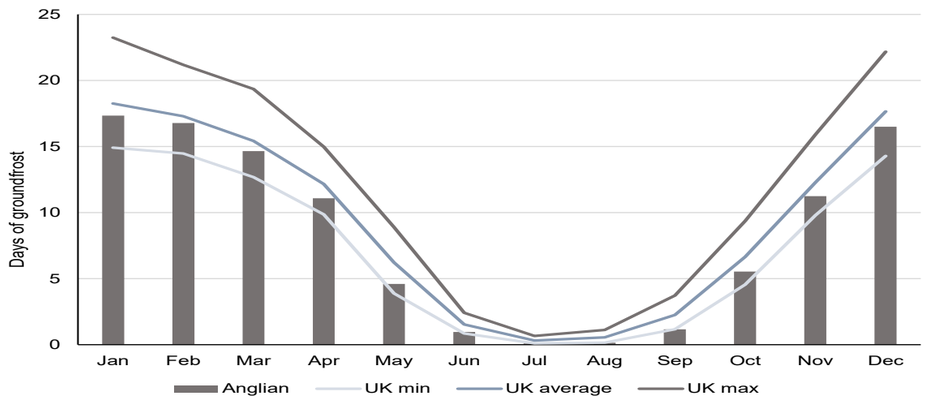


Figure A15.1.3 Long-term average days with ground frost (1981-2010)

1 https://www.metoffice.gov.uk/pub/data/weather/uk/climate/stationdata/cambridgedata.txt

2 https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2019/state-of-the-uk-climate-2018

Current precipitation

15.1.7 Observations across the UK show a high level of variability in precipitation from year to year, with a slight overall increase in UK winter precipitation in recent decades.

15.1.8 As shown in Figure A15.1.4, long-term average monthly rainfall (1981-2010) in the Anglian catchment is below average for the UK.

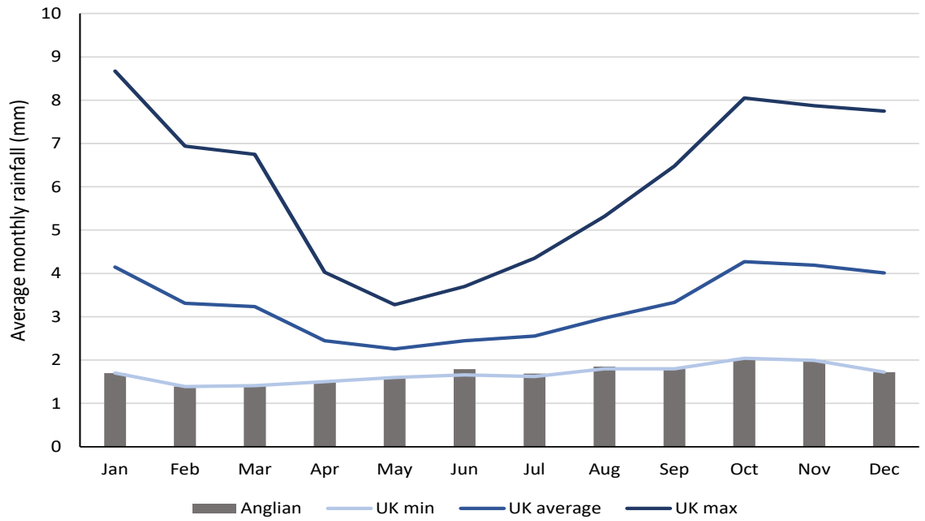


Figure A15.1.4 Long-term average monthly rainfall (1981-2010)

15.1.9 Figure A15.1.5 shows the long-term average number of days that had rainfall over 10mm. It shows that for most of the year the Anglian catchment experiences fewer heavy rainfall days than is usual (average) for the UK.

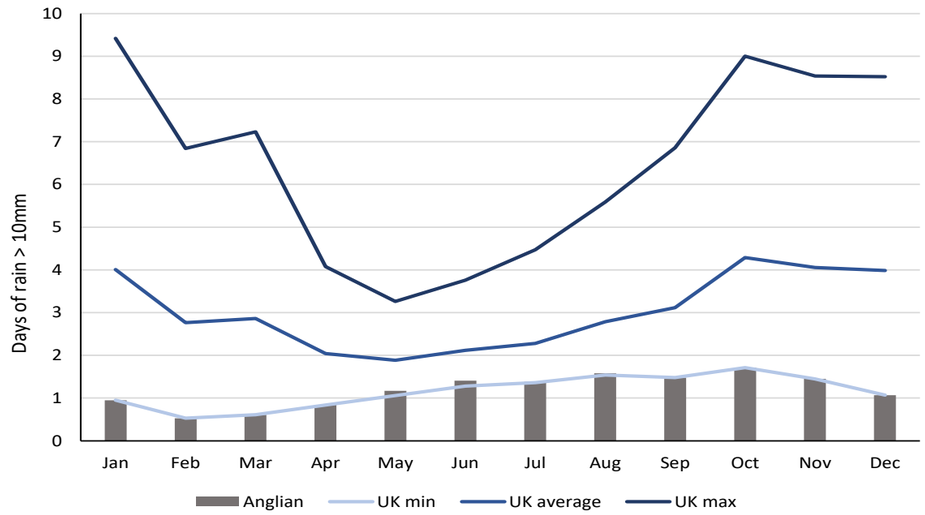


Figure A15.1.5 Long-term average days with rainfall above 10mm (1981-2010)

15.1.10 The closest long running climate station to the Scheme is located at Cambridge NIAB, approximately 10 miles north of the Proposed Development. Since 1961 the highest total monthly rainfall recorded at the station is 166.2 mm in September 2005.

15.1.11 Across the UK the amount of rain from extremely wet days has increased by 17% when comparing the period 2008-2017 to the 1961-1990 period (Met Office, 2018[3]). These changes are largest for Scotland and not significant for most of southern and eastern areas of England. Other extreme rainfall indices exhibit large inter-annual variability but are broadly consistent with increased rainfall over the UK. Other extreme rainfall indices exhibit large inter-annual variability but are broadly consistent with increased rainfall over the UK[4].

15.1.12 In the study area impacts from extreme weather have been recorded, for example:

- The highest daily maximum temperature recorded at Cambridge NIAB is 39.9 °C on 19th July 2022[5].
- In December 2022, flood alerts were issued for Lower River Cam due to rising river levels as a result of rainfall and snowmelt[6].
- In July 2021, nearby roads in Linton, South Cambridge were submerged in floodwater after nearly 45mm of rain fell within 30 minutes in the Cambridgeshire area[7].

15.1.13 With regard to storminess, across the UK historical data provides no compelling trends as determined by maximum gust speeds from the UK wind network over the last four decades (UKCP18).

3 https://www.metoffice.gov.uk/research/climate/understanding-climate/uk-and-global-extreme-events-heavy-rainfall-and-floods
4 http://research.ncl.ac.uk/convex/ [accessed 21st February 2018]
5 https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-extremes
6 https://check-for-flooding.service.gov.uk/target-area/052WAFLOCAM
7 https://www.cambridge-news.co.uk/news/local-news/cambs-village-graveyard-underwater-roads-21106124

Projected future climate

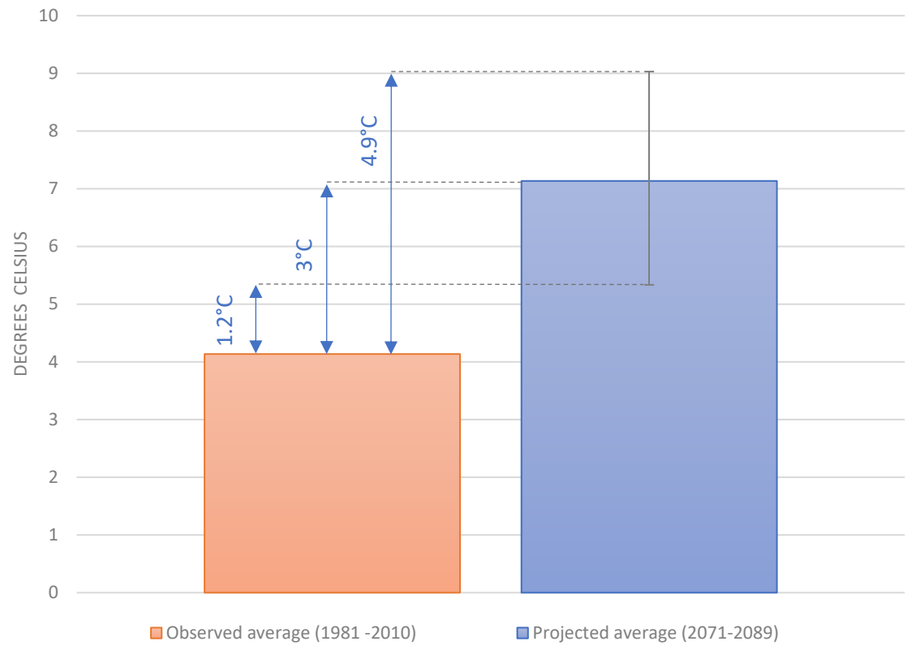
15.1.14 This section presents the outputs of climate change models that cover the study area. In summary it finds that, on average, the UK is likely to experience hotter and drier summers and warmer and wetter winters. This is a widely agreed finding[8]. Alongside these changes in the average conditions, it is possible that climate change will also increase the frequency and severity of extreme weather events, such as heavy rainfall, storms and heatwaves.

15.1.15 Unless otherwise stated the climate projections presented in this section are probabilistic and from UKCP18. These projections have been developed by the Met Office Hadley Centre Climate Programme which is supported by the Department for Business, Energy and Industrial Strategy (BEIS) and Defra. They provide the most up-to-date assessment of how the climate of the UK may change over the 21st century. The projections presented are for the Anglian catchment, within which the Scheme is located. The data is presented as averages for the period 2071 to 2089 to align with the expected life of the Schemes assets. For temperature and precipitation seasonal data is provided for summer and winter only (not autumn and spring) as these seasons are where changes will be most extreme.

15.1.16 In accordance with Design Manual for Roads and Bridges (DMRB) LA114 (Section 3.28) the UKCP18 high emissions projections presented are for Relative Concentration Pathway 8.5 (RCP8.5). This is the most extreme emissions scenario, it represents a future where greenhouse gas (GHG) emissions continue to rise, and the nations of the world choose not to switch to a low carbon future.

Temperature projections - Warmer winters

15.1.17 Figure A15.1.6 shows that under RCP8.5 average winter temperatures in the Anglian catchment are expected to increase from 4.1ºC (observed average 1981-2010) to 7.1ºC (projected average 2071-2089), an increase of 3.0ºC (based on the central estimate, i.e. 50th percentile). The uncertainty around this estimate of change ranges from 1.2ºC to 4.9ºC (represented by the 10th and 90th percentiles respectively).



NB: The projected data is probabilistic. It shows the central estimate (50th percentile) with error bars that indicate the 10th & 90th percentiles.

Figure A15.1.6 Projected average mean winter temperatures (2071-2089)

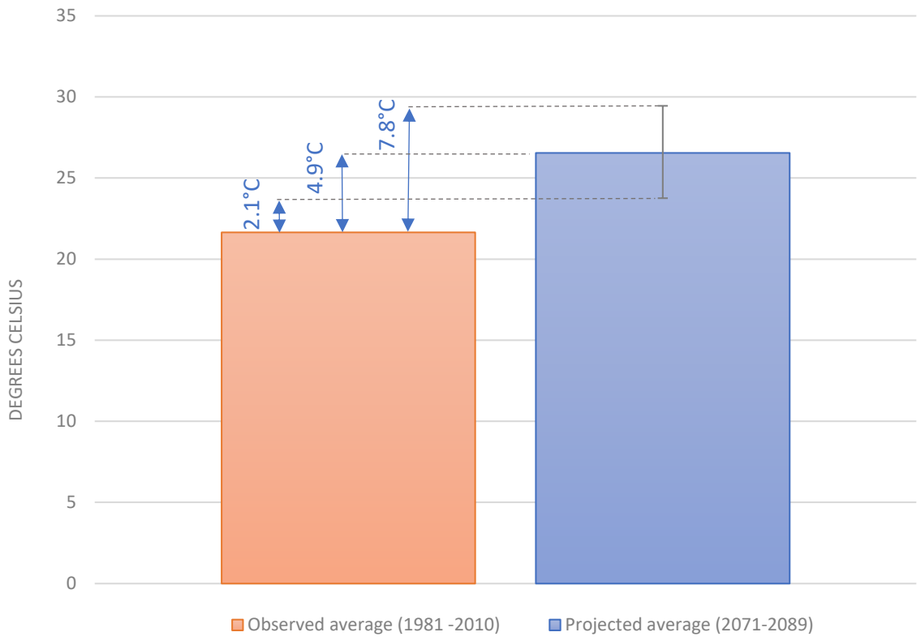
15.1.18 In the UK, the heaviest snowfalls tend to occur when the air temperature is between zero and 2 °C[9]. The projected increase in winter temperatures is therefore expected to reduce mean snowfall, number of snow days and heavy snow events[10]. While there is less certainty in the magnitude of these changes, there is confidence in the negative direction of the change[11]. This is supported by the fact that the decade leading up to the publication of UKCP18 (2008-2017) had 5% fewer days of air frost and 9% fewer days of ground frost compared to the 1981-2010 average, and 15% and 14% respectively compared to 1961-1990[12]. For the period 2061-2080, under a high emissions scenario (RCP8.5), the Regional (12km) and Local (2.2km) projections show a decrease in both falling and lying snow across the UK relative to the 1981-2000 baseline[13].

8 https://www.daera-ni.gov.uk/articles/uk-climate-change-projections#:~:text=The%20projections-,The%20projections,to%204.9%C2%B0C%20hotter
9 https://www.metoffice.gov.uk/weather/learn-about/weather/types-of-weather/snow/how-does-snow-form
10 Brown, S., Boorman, P. and Murphy, J. (2010). Interpretation and use of future snow projections from the 11member Met Office Regional Climate Model ensemble. UKCP09 Technical note, Met Office Hadley Centre, Exeter, UK
11 McColl, L., Palin, E. J., Thornton, H. E., Sexton,·D. M. H., Betts, R. and Mylne, K. (2012). Assessing the potential impact of climate change on the UK's electricity network. Climatic Change, 115: 821-835. OR McColl, L., Angelini, T. and Betts, R. (2012) UK Climate Change Risk Assessment for the Energy Sector. Department for Environment Food and Rural Affairs, London, UK
12 Met Office, (2019) UKCP18 Science Overview Report, online: https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf
13 https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-factsheet-snow.pdf

Temperature projections - Hotter summers

15.1.19 In the recent past (1981-2000) the probability of seeing a summer as hot as 2018 in the UK was low (<10%). This probability has already increased due to climate change and is now estimated to be between 10-25%. With future warming, hot summers by the mid-century could become even more common (with probabilities of the order of 50% depending on the emissions scenario followed). The summer of 2022 was the joint, with 2018, hottest summer on record for England[14].

15.1.20 In the Anglian catchment, within which the Scheme is located, projected mean daily maximum summer temperatures have been obtained from the UKCP18 probabilistic projections for 2071-89. Since these are an average of summer daily maximum temperatures it should be noted that some days in this period are likely to be hotter than the values indicated below. Figure A15.1.7 shows that an increase in summer temperatures is expected by the 2080s under RCP8.5. The central estimate (i.e., 50th percentile) projects an increase of 4.9ºC in summer mean daily maximum temperatures by 2071-89.

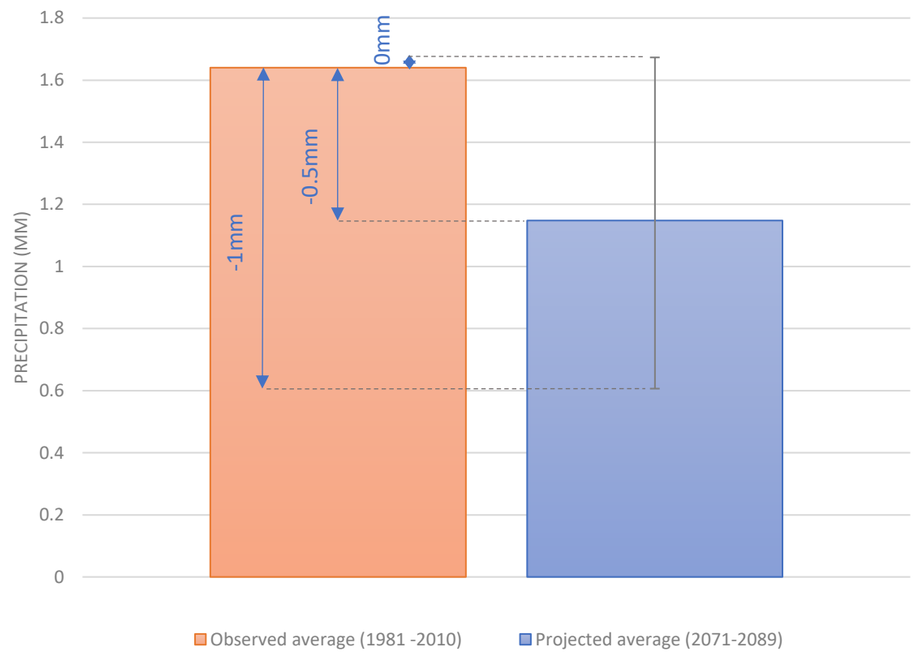


NB: The projected data is probabilistic. It shows the central estimate (50th percentile) with error bars that indicate the 10th & 90th percentiles

Figure A15.1.7 Projected average maximum summer temperature (2071-2089)

Precipitation projections - Drier summers

15.1.21 Projected precipitation levels for RCP 8.5 have been averaged across the Anglian catchment, within which the Scheme is located, to give a range of projected average rainfall change between the 10% and 90% probability levels. As shown in Figure A15.1.8 by 2071-89 this range varies from an increase in rainfall of 0.0mm (2%) to a decrease in rainfall of 1.0mm (63%). The central estimate of change (i.e., 50th percentile) in mean summer precipitation for the same period is a 0.5 mm reduction. These projections suggest that future average rainfall trends are uncertain, but it is more likely than not that summer rainfall will decrease



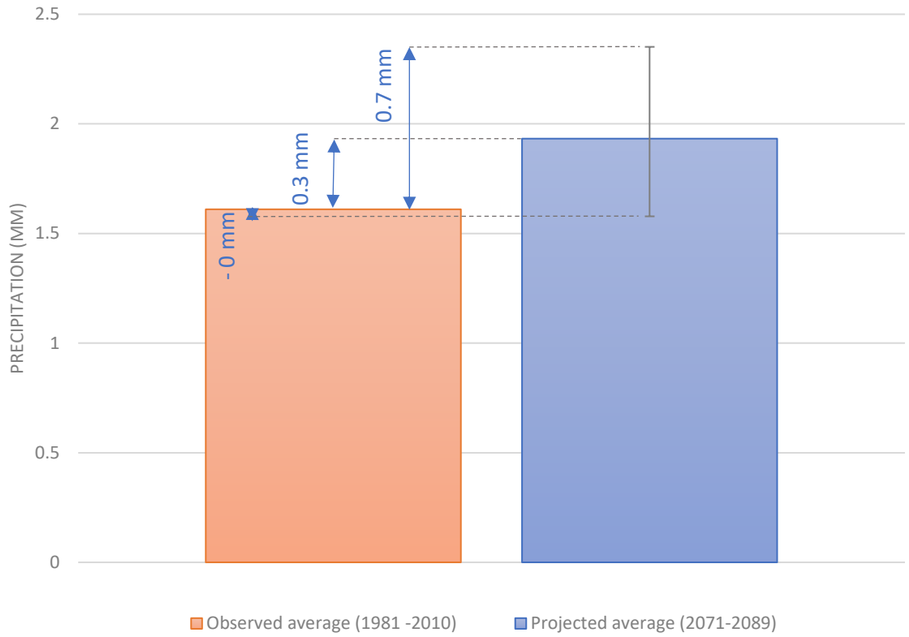
NB: The projected data is probabilistic. It shows the central estimate (50th percentile) with error bars that indicate the 10th & 90th percentiles

Figure A15.1.8 Projected average summer precipitation (2071-2089)

Precipitation projections - Heavier rainfall and wetter winters

15.1.22 Figure A15.1.9 shows that UKCP18 climate projections forecast that by 2071-89, under RCP 8.5 central estimate (i.e. 50th percentile), winter mean precipitation will increase by 0.3 mm. However, it should be noted that year to year levels are expected to continue to vary widely.

14 https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2022/joint-hottest-summer-on-record-for-england



NB: The projected data is probabilistic. It shows the central estimate (50th percentile) with error bars that indicate the 10th & 90th percentiles

Figure A15.1.9 Projected average winter precipitation (2071-2089)

15.1.23 Across the UK the amount of rain from extremely wet days has increased by 17% when comparing 2008-2017 with the 1961-1990 period[15]. Changes have been the largest for Scotland and are not significant for most of southern and eastern areas of England. Other extreme rainfall indices exhibit large inter-annual variability but are broadly consistent with increased rainfall over the UK.

Extreme weather projections

15.1.24 Future projections of storms and high winds are uncertain. They depict a wide spread of future changes in mean surface wind speed, see Figure A15.1.10 which shows UKCP18 data specific to the 12 km grid square within which the Scheme is located. This uncertainty is partly due to large uncertainty in projected changes in circulation over the UK, and also because of wide ranging natural climate variability[16]. It is therefore difficult to represent extreme winds and gusts within regional climate models. Global projections show an increase in near surface wind speeds over the UK for the second half of the 21st century for the winter season[17]. These studies suggest that climate-driven storm changes are less distinct in the Northern than Southern hemisphere[18]. There is some agreement of a projected poleward shift in storm tracks across the Atlantic Ocean. However, for mid-Atlantic storms, such as those that affected the UK in early 2014, projections are less certain[19]. Potentially, those mid-Atlantic storms may become more intense, particularly with the long-term warming of the sub-tropical Atlantic that could increase the amount of moisture that those storms carry[20]. However, such is the wide range of inter-model variation, robust projections of changes in storm tracks over the UK are not yet possible, and there is low confidence in the direction of future changes in the frequency, duration or intensity of storms affecting the UK.

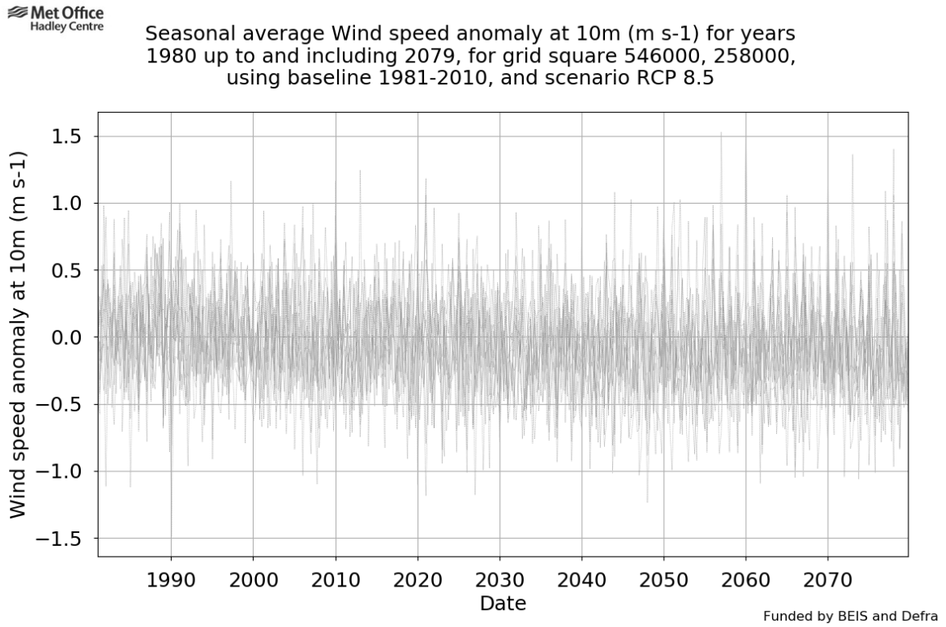


Figure A15.1.10 Projected seasonal average wind speed anomaly (1980-2010)

15 Met Office, UK extreme events, 2018, https://www.metoffice.gov.uk/research/climate/understanding-climate/uk-extreme-events-_heavy-rainfall-and-floods
16 Brown, S., Boorman, P., McDonald, R., and Murphy. J. (2012) Interpretation for use of surface wind speed projections from the 11-member Met Office Regional Climate Model ensemble. Post-launch technical documentation for UKCP09. Met Office Hadley Centre, Exeter, UK. Crown copyright
17 https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-wind_march21.pdf
18 Bengtsson, L., Hodges, K. I. (2005). Storm Tracks and Climate Change. Journal of Climate, 19: 3518-3543. http://dx.doi.org/10.1175/JCLI3815.1
19 Slingo, J., Belcher, S., Scaife, A., McCarthy, M., Saulter, A., McBeath, K., Jenkins, A., Huntingford, C., Marsh, T., Hannaford, J. and Parry, S. (2014). The recent storms and floods in the UK, Met Office, Exeter, 29pp
20 Ibid