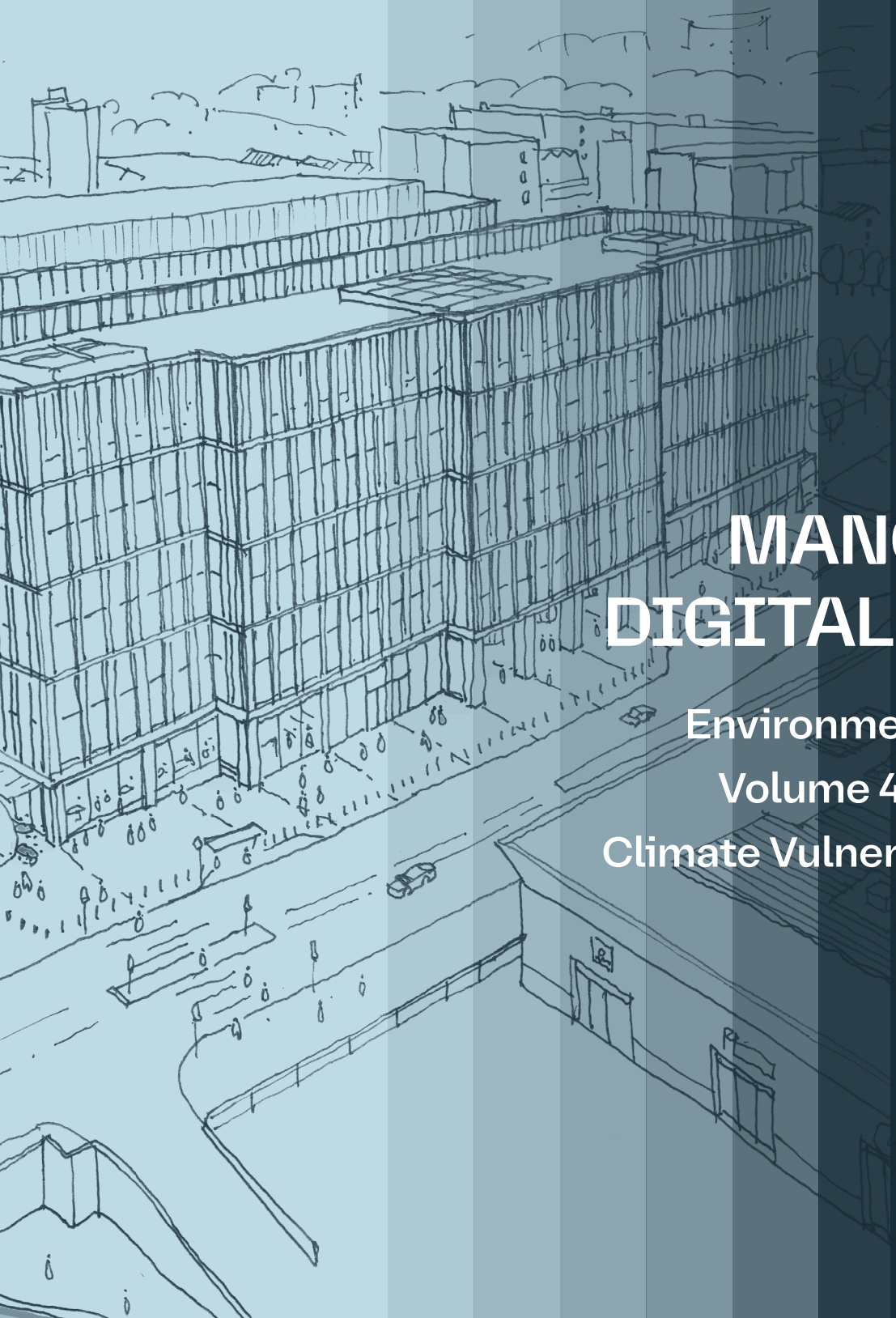
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AtkinsRéalis



MANCHESTER DIGITAL CAMPUS

Environmental Statement
Volume 4 - Appendix 9.1: Climate Vulnerability Baseline

NOVEMBER 2024

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Appendix 9.1. Climate vulnerability baseline

The baseline for climate change vulnerability is presented in two parts:

- Current climatic conditions - an examination of the current climate (Section 9.1.1); and
- Climate projections – a consideration of the forecast future climate (Section 9.1.2).

Details about the method and data used can be found in Section 9.4 and Section 9.5 respectively of the main report.

9.1.1. Current climate

Background

The Proposed Development is situated within North West of England. To inform adaptation decisions this section presents data from the Meteorological Office (hereafter referred to as the Met Office) data has been examined in order to summarise the current climate in the North West England River Basin. The Met Office's standard average data tables are used to inform the current climate, these 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).

Current temperature

Observations for the UK show that for the most recent decade (2010-2019) temperatures were on average 0.3 °C warmer than the 1981-2010 average and 0.9 °C warmer than 1961-1990. All of the top ten warmest years have occurred since 2002. A.1.1.3. North West England's climate is one of mild winters and mild summers. As shown in Figure A.9.1 and Figure A.9.2, monthly average and mean maximum temperatures are average for the UK. Across the timeseries, 1981-2010, peak summer (July) average maximum temperatures of 19.34 °C in the North West are comparable to the maximum UK average of 22.26 °C. Note that mean 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.

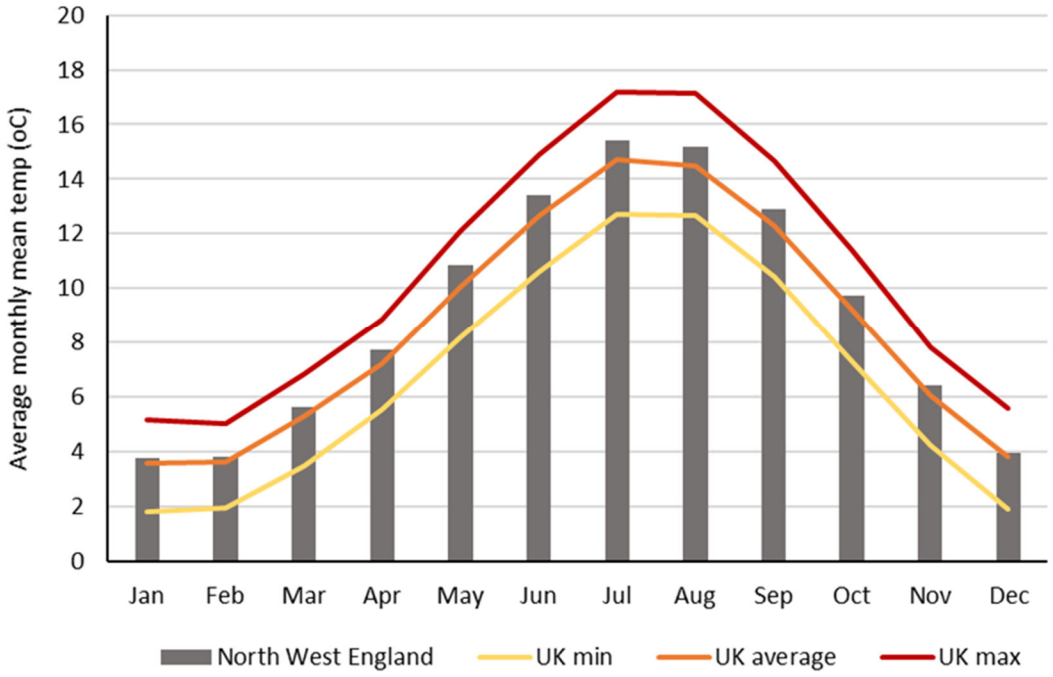


Figure A.9.1 Long-term average monthly mean temperature (°C) (1981-2010) (Source data: Met Office's standard average data tables)

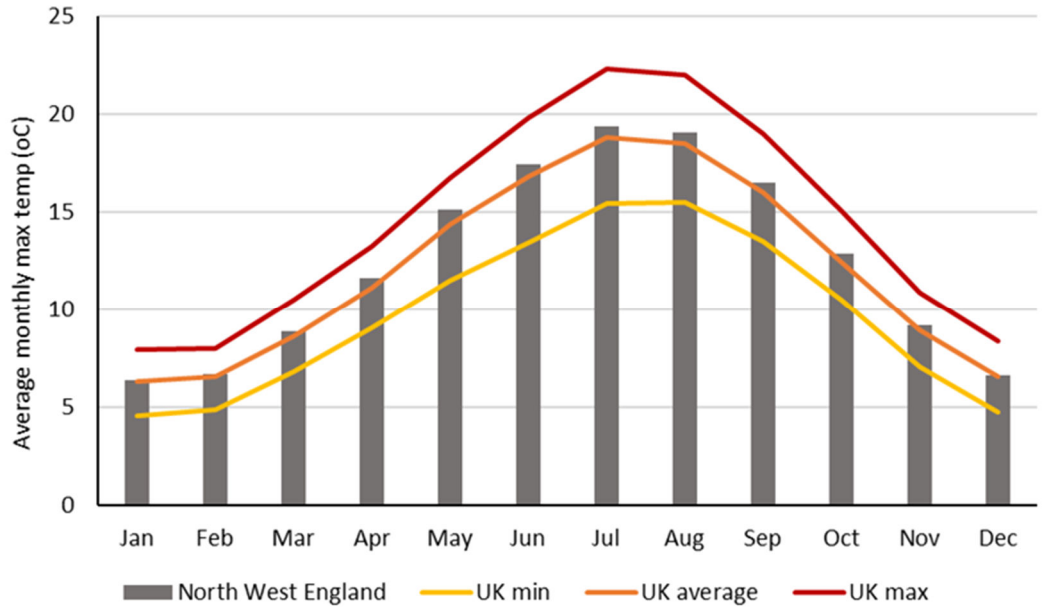


Figure A.9.2 Long-term average monthly maximum temperature (°C) (1981-2010) (Source data: Met Office's standard average data tables)

Long running climate data has been collected from the Ringway Met Station, the closest long running climate station (approximately 8.5 miles south of the Site). Data was collected here from 1946 to 2004. The highest monthly mean daily maximum temperature (t-max) it recorded was 24.6 °C in August 1995. Conversely the lowest mean daily minimum temperature (t-min) it recorded was 0.9°C in January 1963. January and February 1963 recorded the stations joint maximum monthly number of days with air frost, 27 days.

As shown in Figure A.9.3, the long-term average days with ground frost (1981-2010) in North West England are close to the UK average.

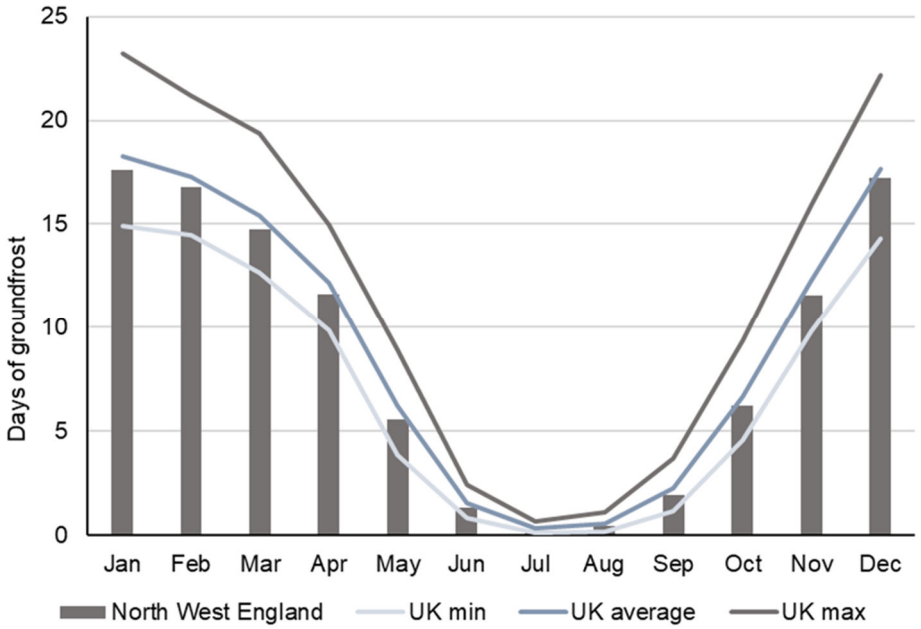


Figure A.9.3 Long-term average days with ground frost (1981-2010) (Source data: Met Office's standard average data tables)

Current precipitation

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

The exposure of North West England to westerly maritime air masses and the presence of extensive areas of high ground mean that the region has some of the wettest places in the UK. The higher parts of the Lake District are particularly wet, with an average of over 3200 mm of rain each year. In contrast, the reputedly wet city of Manchester averages only 830 mm and the more sheltered areas of Cheshire and the Eden valley in Cumbria are even drier with less than 800 mm per year. These areas benefit from the 'rain shadow' effect of the high ground of North Wales and the Lake District respectively.

As shown in Figure A.9.4, the overall long-term average monthly rainfall (1981-2010) in North West England is close to the UK average.

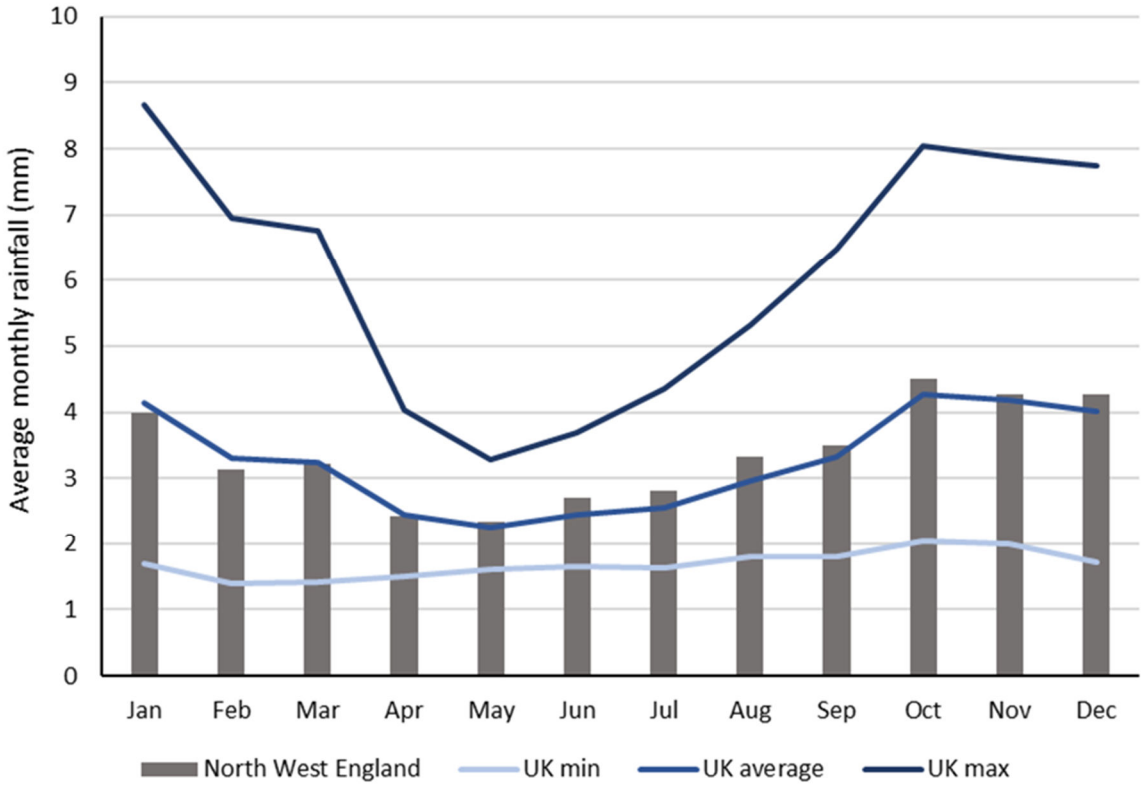


Figure A.9.4 Long-term average days with ground frost (1981-2010) (Source data: Met Office's standard average data tables)

Between 1946 and 2004 the highest total monthly rainfall recorded at Ringway Met Station was 285.6 mm, in October 2000.

Figure A.9.5 shows the long-term average number of days that had rainfall over 10 mm. North West England experiences an average number of heavy rainfall days when compared to the rest of the UK.

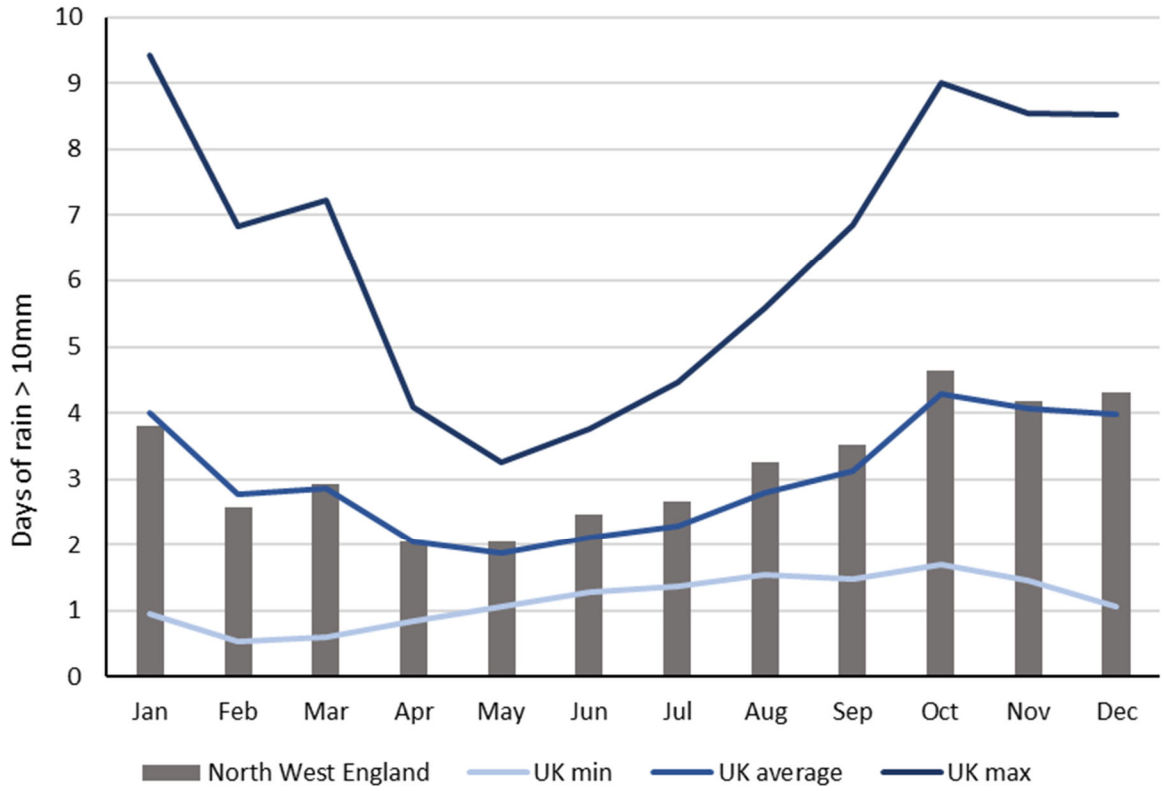


Figure A.9.5 Long-term average days with rainfall above 10mm (1981-2010) (Source data: Met Office's standard average data tables)

Current extreme weather

With regards to storminess, across the UK there are no compelling trends over the last five decades, as determined by maximum gust speeds from the UK wind network[1].

9.1.2. Future climate projections

Temperature projections

Warmer winters

Figure A.9.6 shows that under Representative Concentration Pathway 8.5 (RCP8.5)[2] average winter temperatures in North West England are expected to increase from 3.8ºC (observed average 1981-2010) to 6.6 ºC (projected average 2071-2089), an increase of 2.8ºC (based on the central estimate, i.e., 50th percentile). The uncertainty around this estimate of change ranges from ~1.1ºC to ~4.7ºC (represented by the 10th and 90th percentiles respectively).

[1] Royal Meteorological Society, State of the UK Climate 2019. Available at: https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/joc.6726 Last accessed: December 2020.

[2] RCP8.5 is one of a suite of scenarios that describe several potential future pathways which define different concentrations of carbon in the atmosphere. RCP8.5 represents the pathway with the highest greenhouse gas emissions.

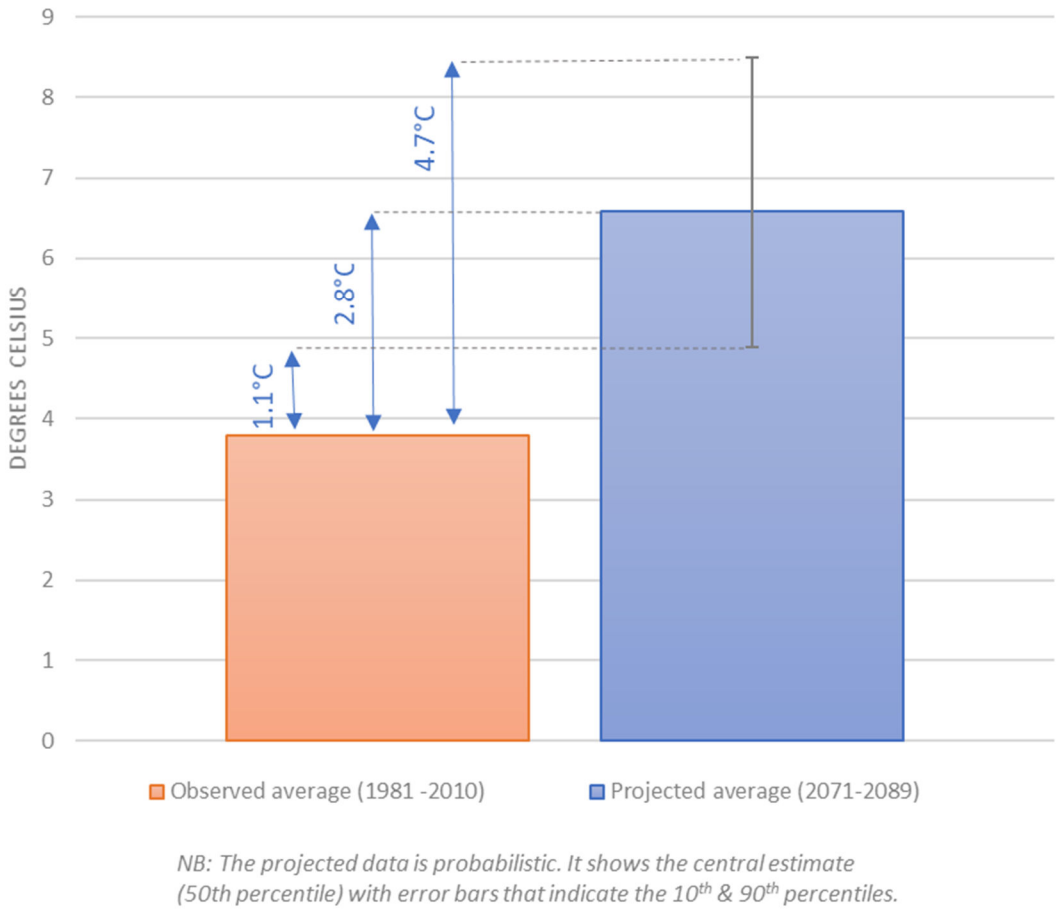


Figure A.9.6 Projected average mean winter temperatures (2071-2089)

In the UK, the heaviest snowfalls tend to occur when the air temperature is between zero and 2°C3. The projected increase in winter temperatures are therefore expected to reduce mean snowfall, number of snow days and heavy snow events4. While there is less certainty in the magnitude of these changes, there is confidence in the negative direction of the change. This is supported by the fact that the most recent decade (2010-2019), had 16% fewer days of air and ground frost per year than the 1961-1990 average, and 6% / 10% fewer, respectively, compared to 1981-2010[1].

Hotter summers

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 mid-century could become even more common (with probabilities of the order of 50% depending on the emissions scenario followed)[5].

In North West England projected mean daily maximum summer temperatures have been obtained from the UK Climate Projections 18 (UKCP18) probabilistic projections for 2071-89. Since these are an average of daily maximum values it should be noted that some days in this period are likely to be hotter than the values indicated below. Figure A.9.7 shows that under RCP 8.5 average maximum summer temperatures in North West England are

[3] Met Office. Weather & Climate. Available at: https://www.metoffice.gov.uk/weather/learn-about/weather/types-of-weather/snow/how-does-snow-form Last accessed: December 2020.

[4] Defra, BEIS, Met Office and Environment Agency. UKCP18 Factsheet: Snow. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-factsheet-snow.pdf Last accessed: December 2020.

[5] https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf Last accessed: December 2020.

expected to increase from 19.1 ºC (observed average 1981-2010) to 23.4 ºC (projected average 2071-2089), an increase of 4.3 ºC (based on the central estimate, i.e., 50th percentile). The uncertainty around this estimate of change ranges from ~1.9ºC to ~6.9ºC (represented by the 10th and 90th percentiles respectively).

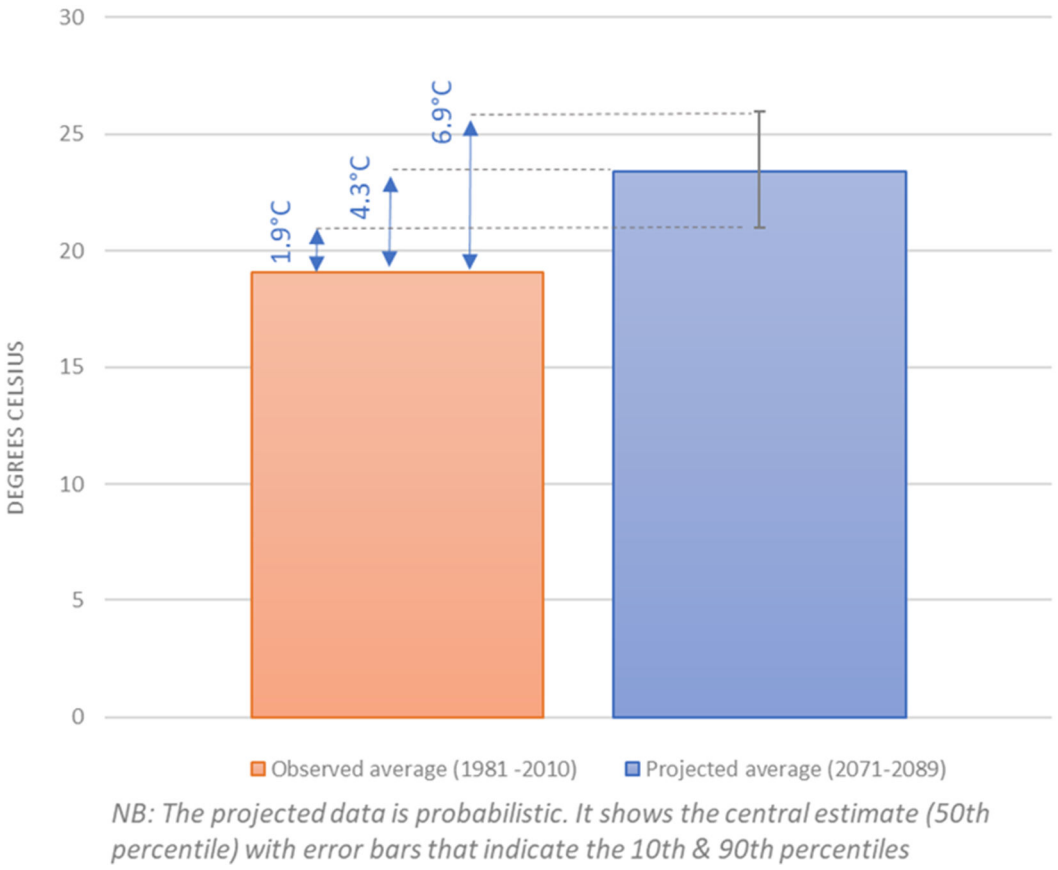


Figure A.9.7 Projected average maximum summer temperature (2071-2089)

Precipitation projections

Drier summers

In UKCP18, the probabilistic projections provide local low, central, and high changes across the UK, corresponding to 10%, 50% and 90% probability levels. Projected precipitation levels for RCP8.5 have been averaged across North West England, to give a range of projected average rainfall change between the 10% and 90% probability levels. As shown in Figure A.9.8 by 2071-2089 this range amounts to -52% to -5% for summer rainfall, where negative values indicate reduced precipitation. The central estimate of change (i.e., 50th percentile) in mean summer precipitation for the same period is -18.5%. These projections suggest that future average rainfall trends are uncertain, but it is highly likely that summer rainfall will decrease.

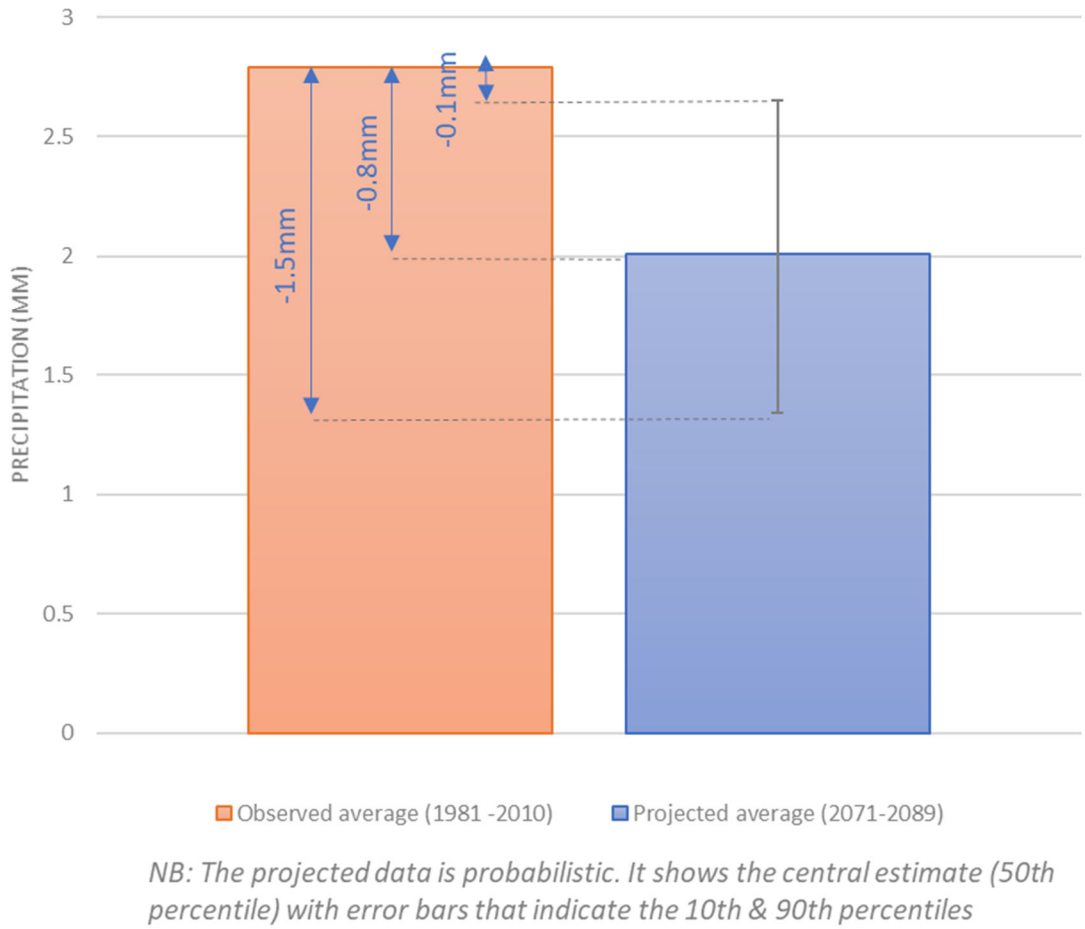


Figure A.9.8 Projected average maximum summer temperature (2071-2089)

Heavier rainfall and wetter winters

Figure A.9.9 shows that UKCP18 climate projections forecast that by 2071- 2089, under RCP8.5 central estimate (i.e., 50th percentile), winter mean precipitation will increase by 0.5mm. The variability in projections indicate that winter rainfall trends are uncertain, but it is more likely than not that winter rainfall will increase.

There is further support for increased winter precipitation when the latest 2.2km resolution "convection-permitting" model (CPM) from the Met Office is considered. This high-resolution model gives a significantly better representation of rainfall and forecasts a 27% increase in average winter precipitation across the UK compared to the 16% increase projected using the UKCP18 Regional Climate Model (RCM)[6].

It should also be noted that year to year levels are expected to continue to vary widely. This is demonstrated in the UKs recent historical record in which the winters of 2013-14 and 2015-16 stand out as having particularly high amounts of rainfall, each with over 150% of the 1981-2010 average UK winter rainfall. More recently, whilst both

[6] https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP-Convection-permitting-model-projections-report.pdf Last accessed: December 2020.

December 2019 and January 2020 received typical rainfall, February 2020 saw 350% of the 1981-2010 average UK winter rainfall in the North West[7] making the winter of 2019-2020 the 5th wettest on record[8].

Across the UK, the number of rainfall days exceeding 10 mm has increased by 10% when comparing the period 2010-2019 to 1961-1990. Other extreme rainfall indices exhibit large inter-annual variability but are broadly consistent with increased rainfall over the UK, particularly during the last decade which has recorded more heavy rain events than any earlier decades.

During 2019, northern England experienced its ninth wettest year since 1962. The three highest rain-gauge records in this year were all in the Lake District in North West England where 5,217 mm were recorded at Styhead[9] (approximately 100 miles north of the Site).

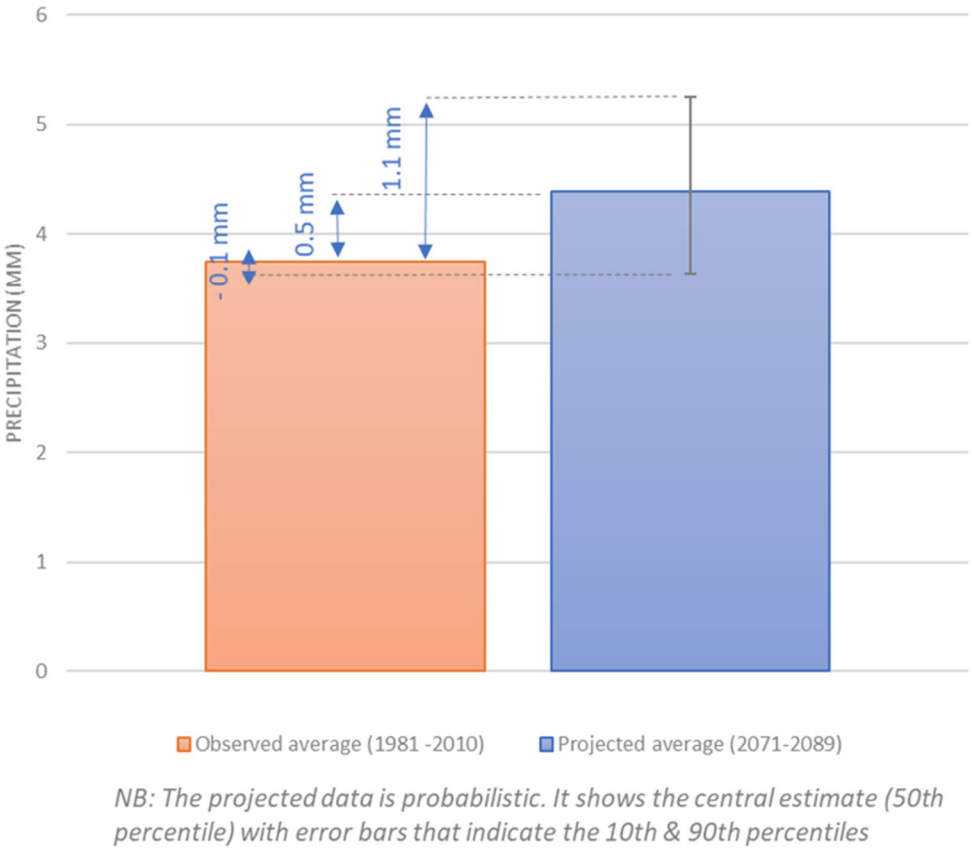


Figure A.9.9 Projected average winter precipitation (2071-2089)

Extreme weather projections

The Met Office identifies different types of extreme weather10. This section focuses on those related to storms. Future projections of storms are uncertain; global projections using the members of the Met Office Hadley Centre model over the UK suggest an increase in near surface wind speeds during winter over the second half of the 21st

[7] https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/summaries/uk_monthly_climate_summary_winter_2020.pdf Last accessed: December 2020.

[8] https://www.metoffice.gov.uk/about-us/press-office/news/weather-and-climate/2020/2020-winter-february-stats Last accessed: December 2020.

[9] https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/joc.6726 Last accessed: December 2020.

[10] www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/other-content/other-resources/extreme-weather Last accessed: December 2020.

century, with a projected increase in winter storm frequency. However, the overall increase to wind speed is small when compared to the interannual variability11 and other global climate models suggest that changes are influenced by natural variability as opposed to climate change[12].

[11] https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-wind.pdf Last accessed: December 2020.

[12] https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf Last accessed: December 2020.

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