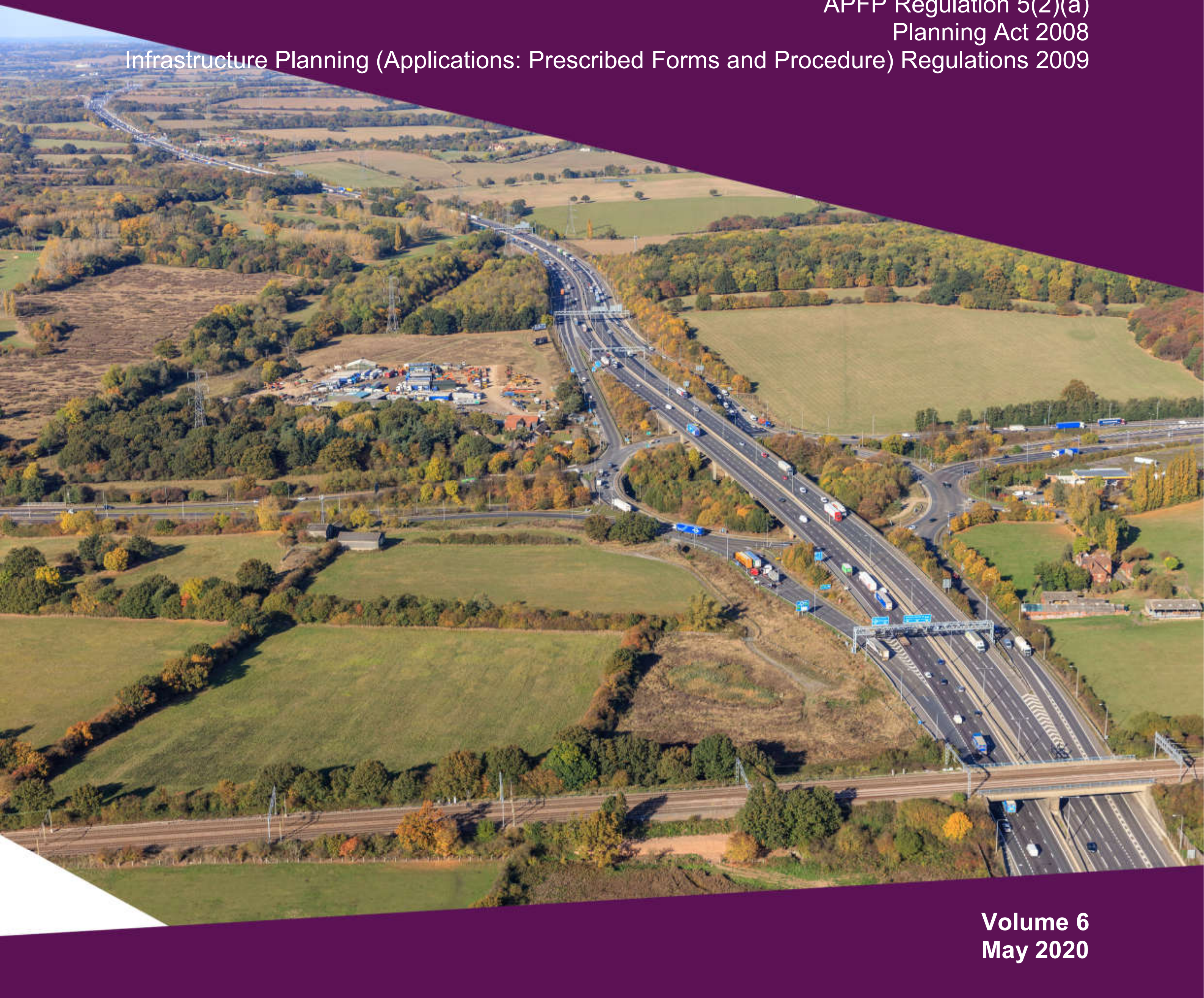
M25 junction 28 improvement scheme
TR010029
6.3 Environmental Statement
Appendix 14.2: Climate vulnerability baseline conditions

APFP Regulation 5(2)(a)
Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009



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Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

M25 junction 28 scheme

Development Consent Order 202[x]

6.3 ENVIRONMENTAL STATEMENT APPENDIX 14.2: CLIMATE VULNERABILITY BASELINE CONDITIONS

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Appendix 14.2
Climate vulnerability baseline conditions

14. Climate vulnerability

14.1 Baseline conditions

Current climate

14.1.1 The Scheme is situated within the River Thames catchment. To inform adaptation decisions this section presents data from the Meteorological Office to summarise the River Thames' 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).

Temperature

14.1.2 Observations for the UK show that the decade leading up to the publication of UKCP18[1] (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 1990.

14.1.3 The River Thames Basin's climate is one of relatively mild winters and warm summers. As shown in Figure 14.1 and Figure 14.2, monthly average and mean maximum temperatures are amongst the highest in the UK. Across the timeseries, 1981-2010, peak summer (July) average maximum temperatures of 22 °C in the River Thames Basin are equal to the maximum across the UK. 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.

[1] UKCP18 Climate Projections https://www.metoffice.gov.uk/research/collaboration/ukcp

Figure 14.1: Long-term average monthly mean temperature (1981-2010)

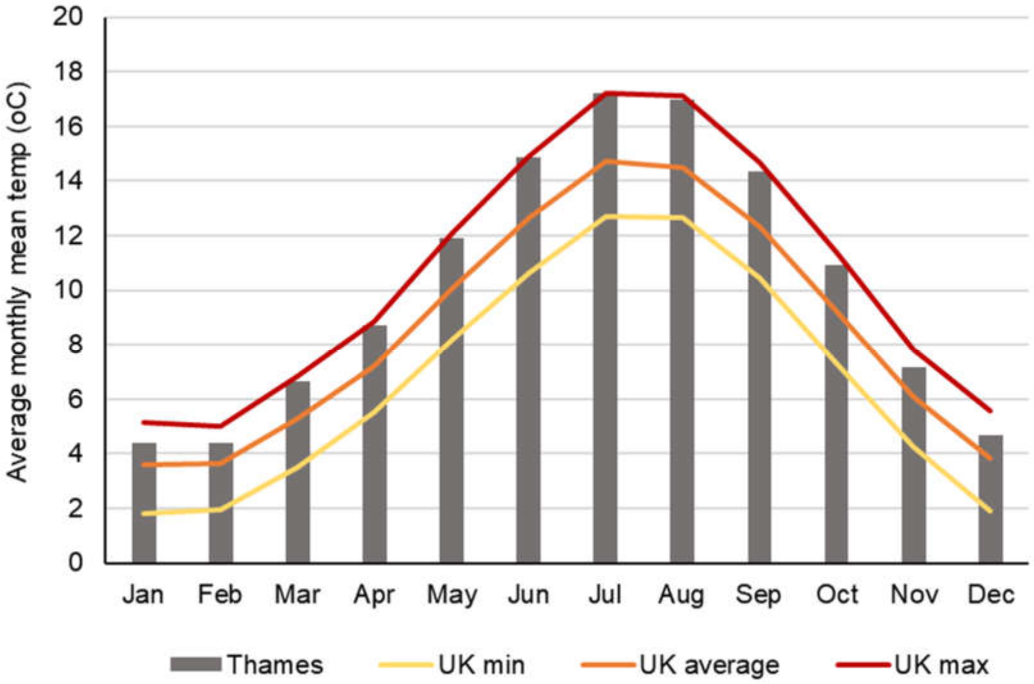
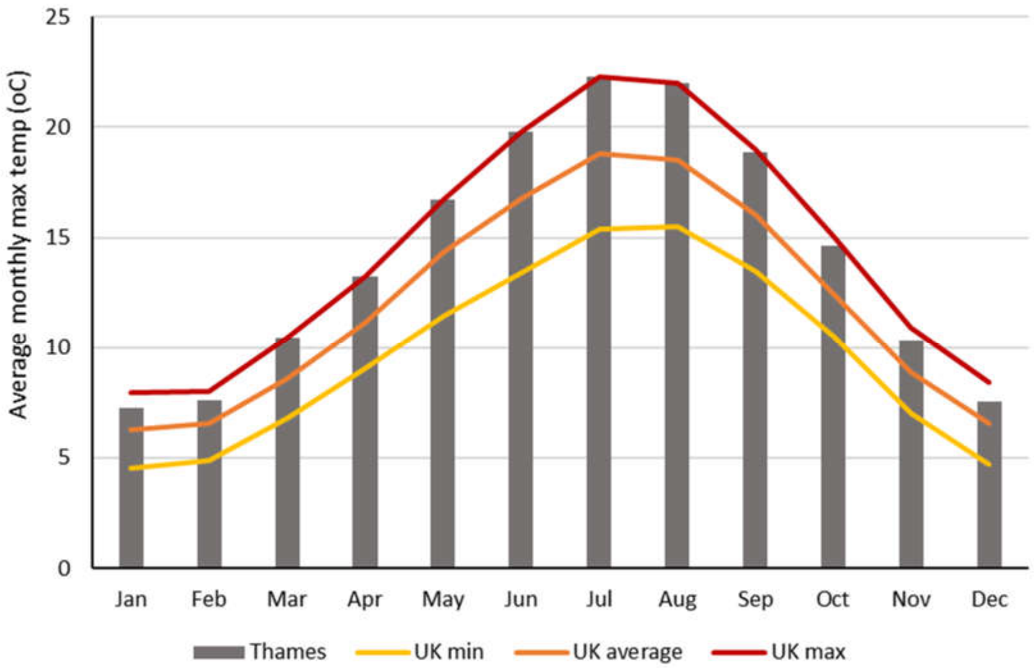


Figure 14.2: Long-term average monthly maximum temperature (1981-2010)



Note: maximum data is monthly average of daily maximums

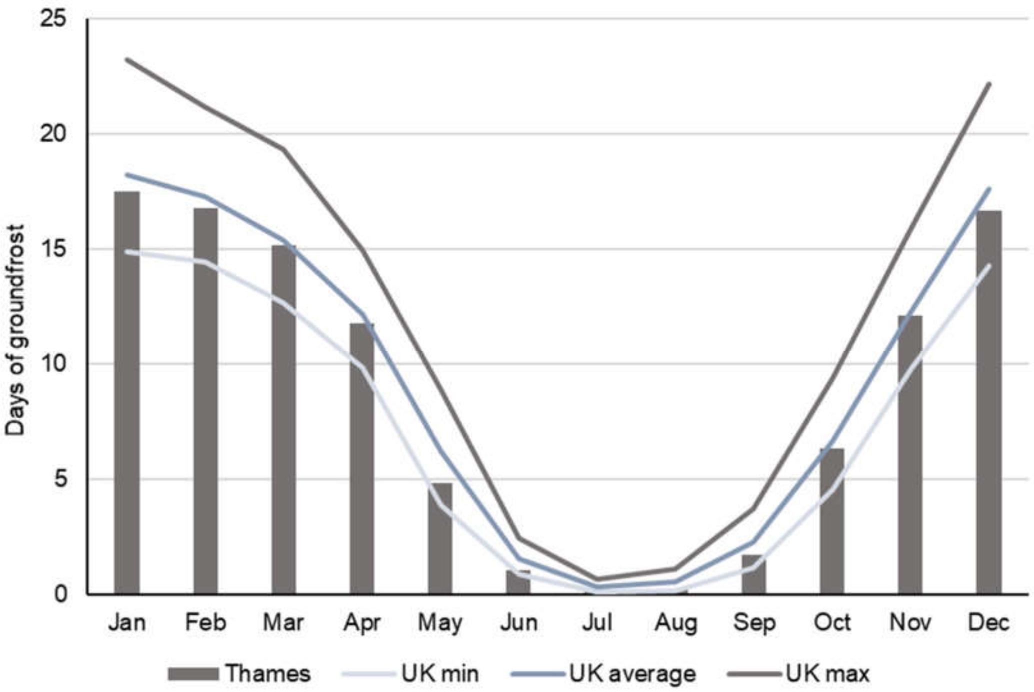
14.1.4 The closest long running climate station to the Scheme is located at Heathrow airport[2]. Since 1948 the highest monthly mean daily maximum temperature (t-max) it has recorded is 28.3 °C in July 2018. Conversely the lowest mean daily minimum temperature (t-min) it has recorded is -4.6 °C in January 1963. January

[2] Historic Met Station Data, https://www.metoffice.gov.uk/research/climate/maps-and-data/historic-station-data

1963 also recorded the stations maximum monthly number of days with air frost, 28 days.

14.1.5 As shown in Figure 14.3 the long-term average days with ground frost (1981-2010) in the Thames River Basin are close to the average for the UK.

Figure 14.3: Long-term average days with ground frost (1981-2010)



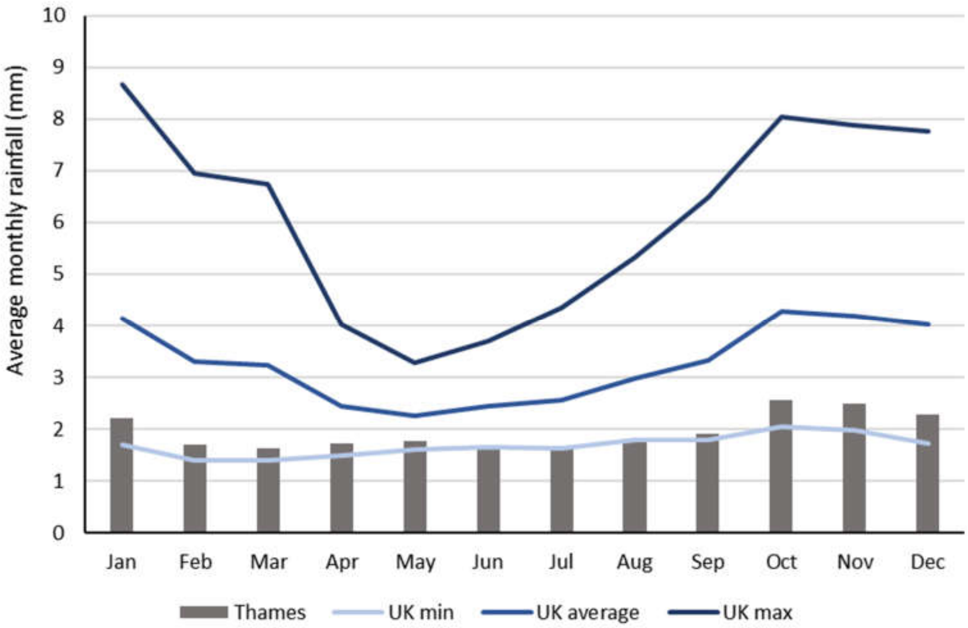
<u>Precipitation</u>

14.1.6 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.

14.1.7 The closest long running climate station to the Scheme is located at Heathrow airport. Since 1948 the highest total monthly rainfall recorded at the station is 174.8 mm in October 1987.

14.1.8 As shown in Figure 14.4, long-term average monthly rainfall (1981-2010) in the River Thames Basin is close to the lowest in the UK.

Figure 14.4: Long-term average monthly rainfall (1981-2010)



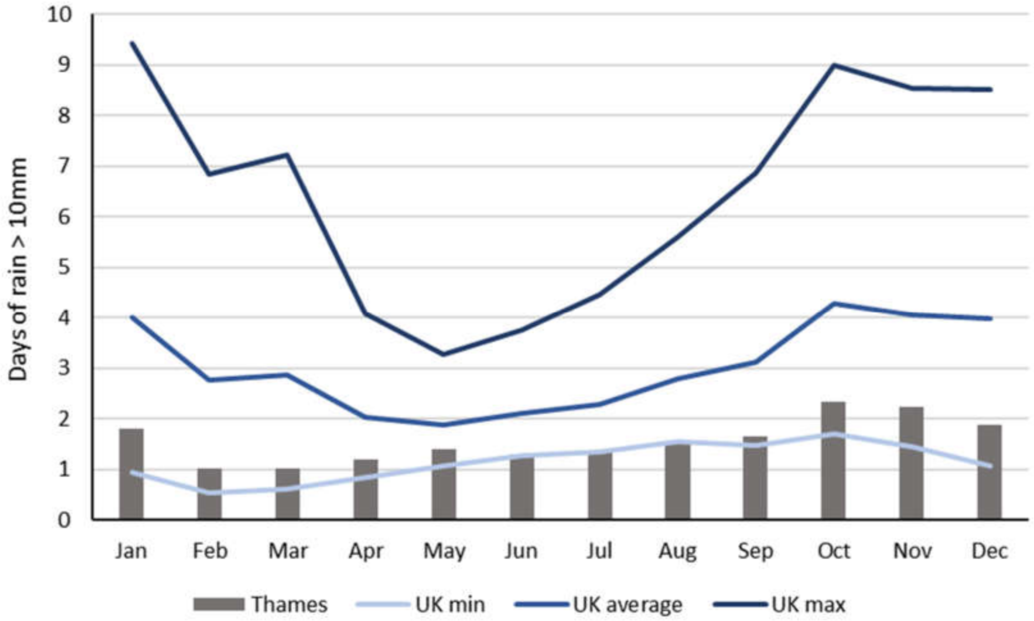
14.1.9 Figure 14.5 shows the long-term average number of days that had rainfall over 10mm. It shows that the River Thames Basin has experienced fewer heavy rainfall days than is usual for the UK.

14.1.10 Across the UK the amount of rain from extremely wet days has increased by 17% when comparing the period 2008-2017 to 1961-1990 period (Met Office, 2018). 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[3].

14.1.11 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] http://research.ncl.ac.uk/convex/ [accessed 21st February 2018]

Figure 14.5: Long-term average days with rainfall above 10mm (1981-2010)



Climate change projections

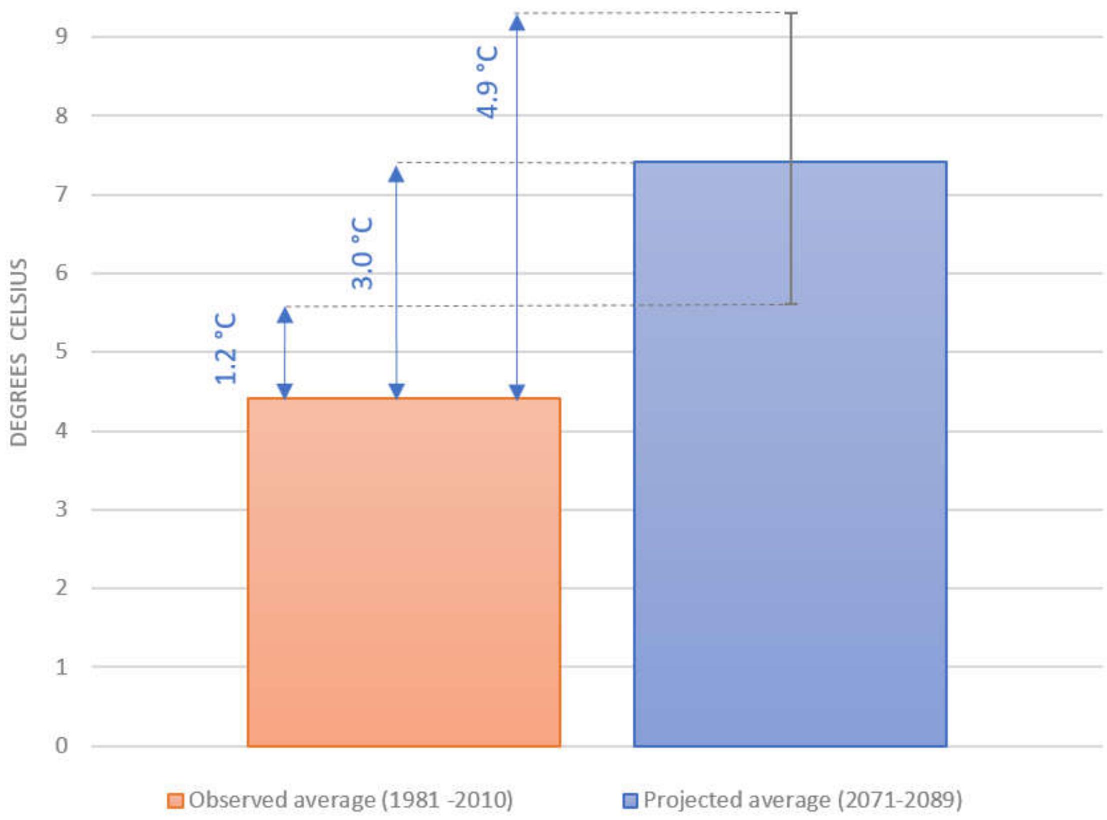
14.1.12 This section presents the output of climate change models that cover the study area. In summary it finds that, on average, the UK is likely to experience hotter and drier summers and warmer, wetter winters. This is a widely agreed finding. Alongside these changes in the average conditions, it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

14.1.13 Future projections are presented from the United Kingdom Climate Projections 2018 (UKCP18) for the River Thames Basin, within which the Scheme is located. The data is presented as averages for 2080 based on climate projections running from 2071 to 2089. For temperature and precipitation seasonal averages are provided for summer and winter, which represent the most extreme changes in response to climate change. The projections are probabilistic, those plotted are for the central estimate (i.e. 50th percentile) and use the emissions scenario RCP8.5 (Relative Concentration Pathway 8.5). This is the most extreme emissions scenario, it represents a future where greenhouse gas emissions continue to rise, and the nations of the world choose not to switch to a low carbon future. This aligns with Highways England Guidance to use a high emissions scenario and is considered appropriate as it provides a precautionary view of possible future climate responses.

Temperature projections – warmer winters

14.1.14 Figure 14.6 shows that under RCP8.5 average winter temperatures in The River Thames Basin are expected to increase from 4.4 ºC (observed average 1981-2010) to 7.4 ºC (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).

Figure 14.6: Projected average mean winter temperatures (2071-2089)



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

14.1.15 In the UK, the heaviest snowfalls tend to occur when the air temperature is between zero and 2°C[4]. The projected increase in winter temperatures are therefore expected to reduce mean snowfall, number of snow days and heavy snow events[5]. While there is less certainty in the magnitude of these changes, there is confidence in the negative direction of the change[6]. 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% / 14% compared to 1961-1990[7].

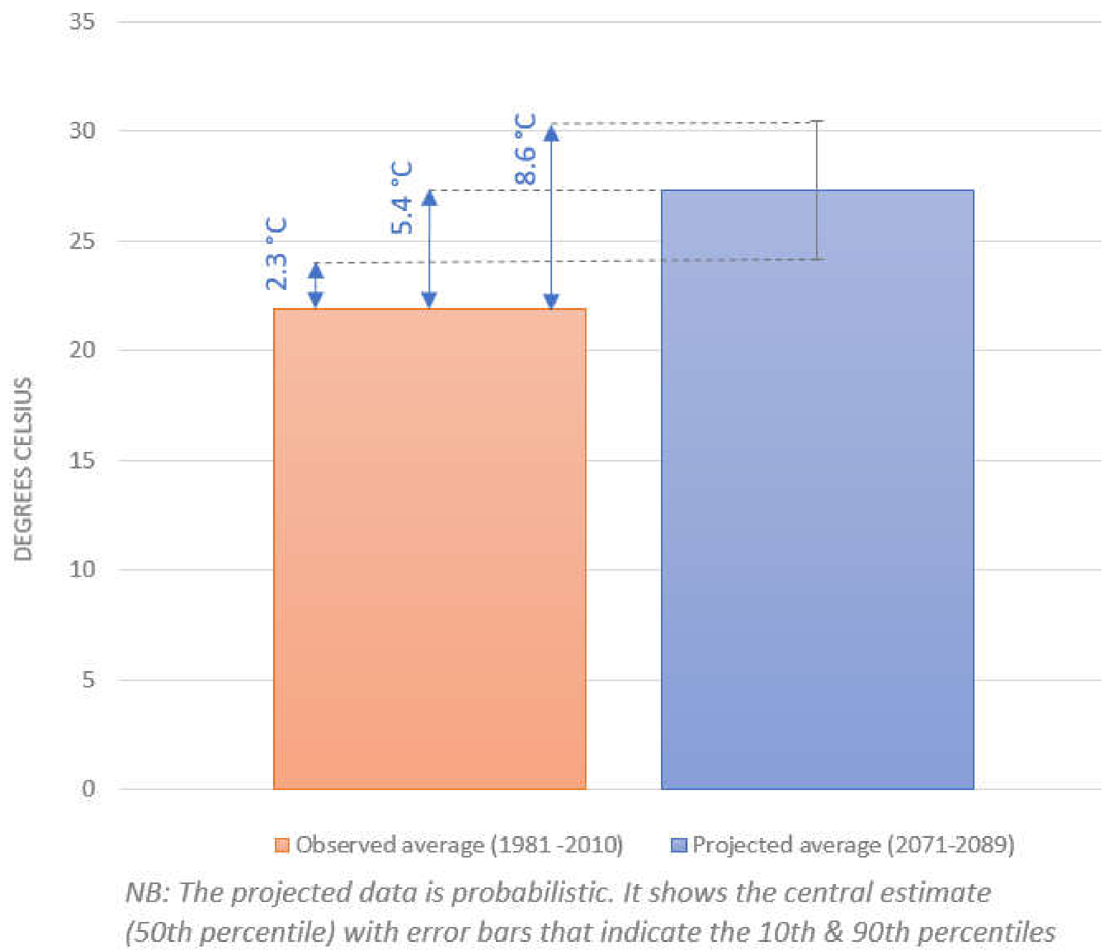
[4] Met Office. (2013). Met Office. [online] Available at: http://www.metoffice.gov.uk/learning/learn-about-the-weather/weather-phenomena
[5] Brown, S., Boorman, P. and Murphy, J. (2010). Interpretation and use of future snow projections from the 11member Met Office Regional Climate Model ensemble. UKCP09 Technical note, Met Office Hadley Centre, Exeter, UK
[6] 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
[7] Met Office, (2019) UKCP18 Science Overview Report, online: https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf

<u>Temperature projections – hotter summers</u>

14.1.16 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) [8].

14.1.17 In the River Thames Basin, 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 daily maximum values it should be noted that some days in this period are likely to be hotter than the values indicated below. Figure 14.7 shows an increase in summer temperatures is expected by the 2080s under RCP8.5. The central estimate (i.e. 50th percentile) projects an increase in summer mean daily maximum temperatures of ~5.4ºC by 2071-89.

Figure 14.7: Projected average maximum summer temperature (2071-2089)

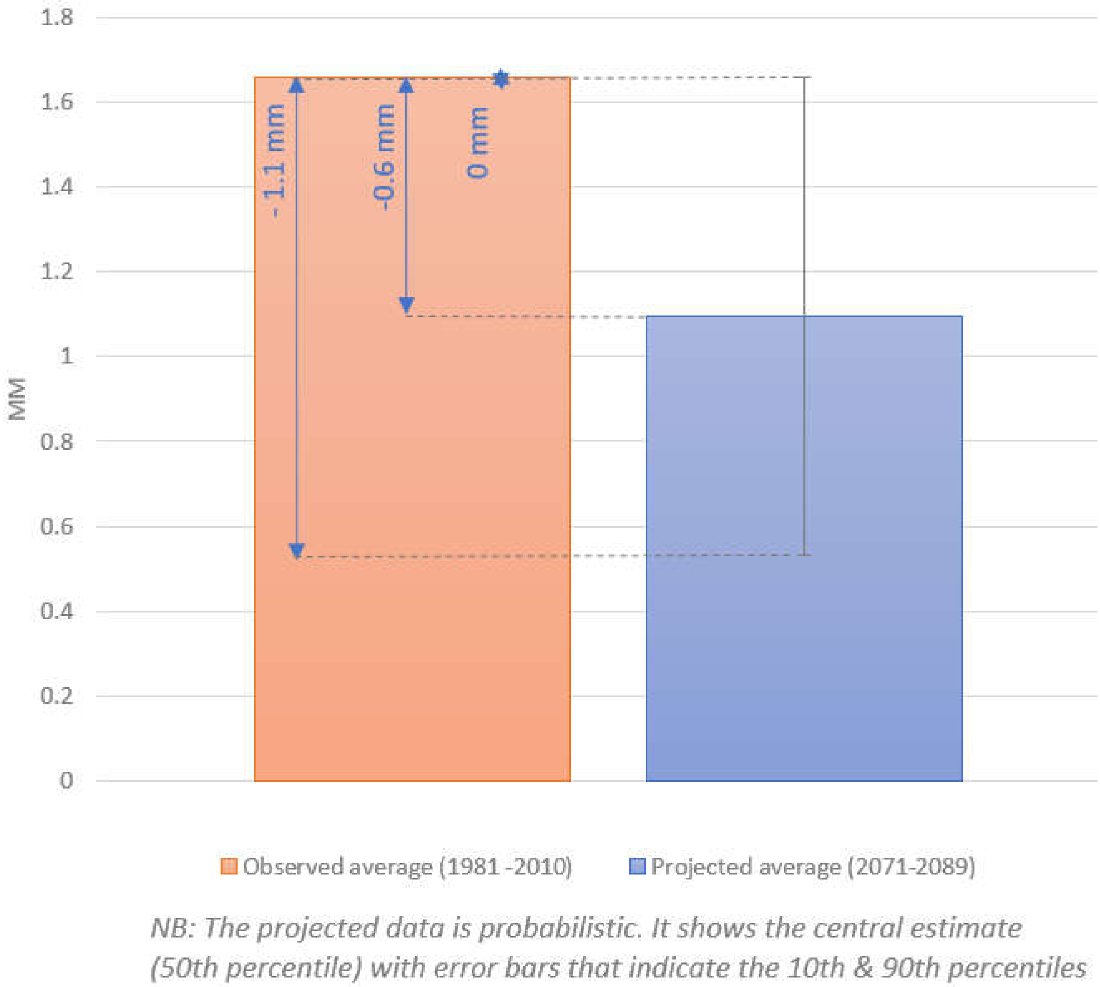


[8] Met Office (2019) UKCP18 Science Overview Report, online, available: https://www.metoffice.gov.uk/pub/data/weather/uk/ukcp18/science-reports/UKCP18-Overview-report.pdf

Precipitation projections – drier summers

14.1.18 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 RCP 8.5 have been averaged across the River Thames Basin, 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 14.8 by 2071-89 this range amounts to -68% to 0% 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 -34%. These projections suggest that future average rainfall trends are uncertain, but it is more likely than not that summer rainfall will decrease.

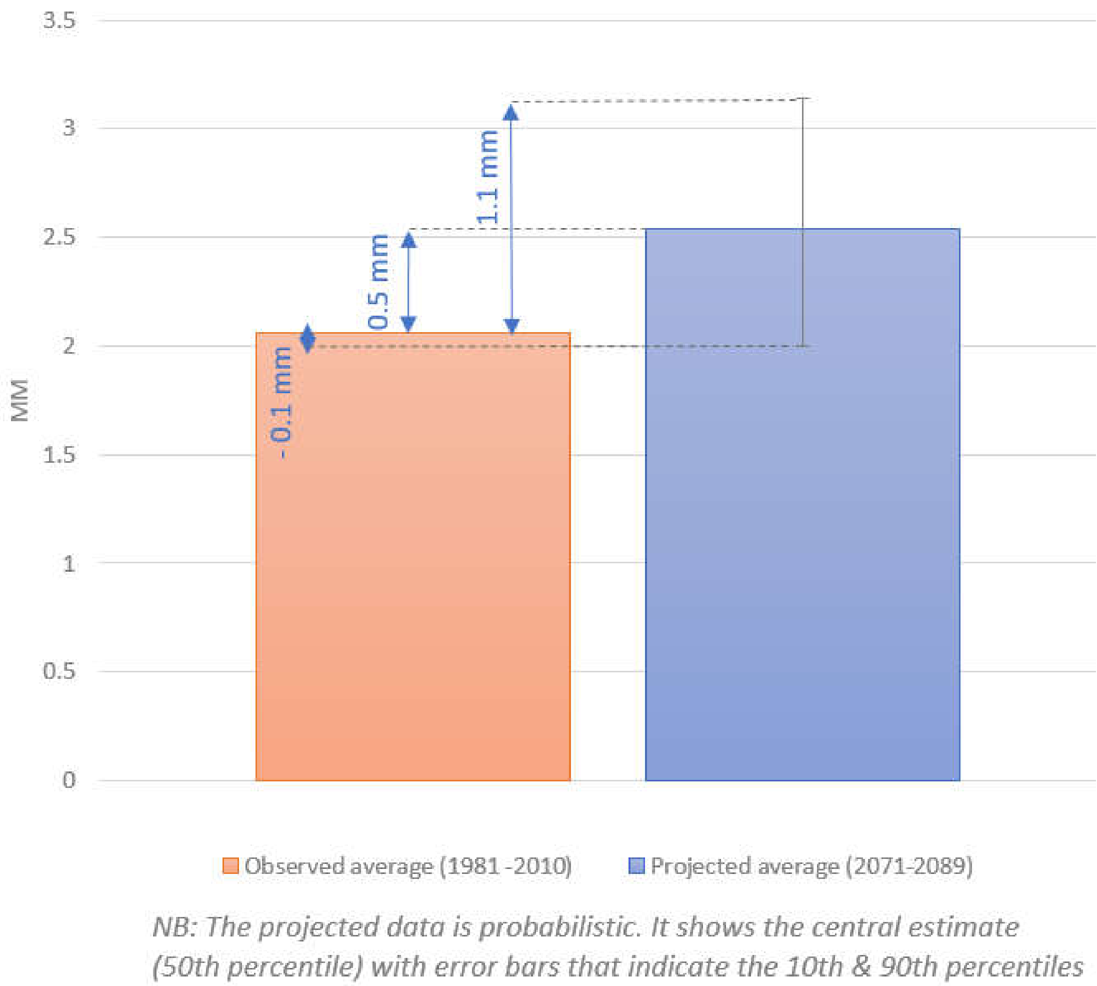
Figure 14.8: Projected average summer precipitation (2071-2089)



Precipitation projections – Heavier rainfall and wetter winters

14.1.19 Figure 14.9 shows that UKCP18 climate projections forecast that by 2071-89, under RCP8.5 central estimate (i.e. 50th percentile), winter mean precipitation will increase by 0.5mm. However, it should be noted that year to year levels are expected to continue to vary widely. This is demonstrated in the 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.

Figure 14.9: Projected average winter precipitation (2071-2089)



14.1.20 Across the UK the amount of rain from extremely wet days has increased by 17% when comparing 2008-2017 with the 1961-1990 period[9]. 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.

[9] Met Office, UK extreme events, 2018, https://www.metoffice.gov.uk/research/climate/understanding-climate/uk-extreme-events-heavy-rainfall-and-floods

Extreme weather projections

14.1.21 The Met Office identifies eight different types of extreme weather[10]. This section focuses on those related to storms. Future projections of storms are uncertain, for example they depict a wide spread of future changes in mean surface wind speed[11]. This is partly due to large uncertainty in projected changes in circulation over the UK and also because of wide ranging natural climate variability[12]. It is therefore difficult to represent extreme winds and gusts within regional climate models[13]. 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[14]. These studies suggest that climate-driven storm changes are less distinct in the Northern than Southern hemisphere[15]. There is some agreement of a projected poleward shift in storm tracks across the Atlantic Ocean[16]. However, for mid-Atlantic storms, such as those that affected the UK in early 2014 projections are less certain[17]. 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[18]. 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.

[10] Met Office. (2019). Extreme Weather . [online] Available at: www.metoffice.gov.uk/weather/learn-about/met-office-for-schools/other-content/other-resources/extreme-weather
[11] Thornton, H. (2010) Future UK circulation and wind projections and their relevance for the built environment. Met Office Hadley Centre, Exeter, UK. Crown copyright
[12] 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
[13] Ibid
[14] Met Office, UKCP18 Factsheet: Wind, www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-wind.pdf
[15] 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
[16] 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
[17] 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
[18] Ibid

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