



South East Strategic Reservoir Option
Preliminary Environmental Information Report

Appendix 18.1 - Technical note on observed and projected climate data

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1 Introduction

- 1.1.1 This Technical Note provides an overview of climate data being used on the South East Strategic Reservoir Option (SESRO) for the Preliminary Environmental Information (PEI) Report. This Note covers observed climate data, projected future climate conditions, and climate hazard parameters relevant to the Project's different time periods (construction, mid-operation, and end-operation).
- 1.1.2 This document supports the SESRO preliminary Environmental Impact Assessment (EIA) Climate Change Risk (CCR) assessment, the In-Combination Climate Impact (ICCI) assessment and other assessments requiring climate projections, including modelling, engineering and design decisions. The data sources outlined here aim to ensure consistency in climate assumptions across design, infrastructure resilience, and environmental risk evaluations.
- 1.1.3 There are several sources of climate data; for example, the latest UK Climate Projections 2018 (UKCP18) are comprised of six different products. Various climate datasets have been accessed and reviewed in order to obtain the relevant climate variables for different aspects of the Project.

2 Observed climate data

2.1.1 The climate observations data sources used are set out in Table 2.1. Data from each of these sources is presented in the following sub-sections.

Table 2.1 Observed climate data sources used to inform existing baseline conditions.

Source	Description	Purpose
HadUK-Grid (25km grid dataset)	Collection of gridded climate variables derived from UK land surface observations. Long-term weather data are interpolated from meteorological observations (including Oxford weather station) onto a uniform grid. Historical weather data provided for the 1981-2000 period.	Data produced on a 25km x 25km grid resolution, which aligns with the UKCP18 Probabilistic projection data. The HadUK-Grid observed data can be uplifted using the Probabilistic projections data, provided as future change values, to understand the projected absolute change in climate conditions.
HadUK-Grid (12km grid dataset)		Data produced on a 12km x 12km grid resolution, which aligns with the UKCP18 Regional projection data. The HadUK-Grid data can be used to compare with the Regional projection data, provided as future absolute values, to understand the projected relative change in climate conditions.
Oxford weather station	Long-term climate data recorded from Radcliffe Meteorological Station, located approximately 15 km north-east from the centre of the draft Order limits. This dataset includes historical monthly data such as mean maximum temperature, mean minimum temperature, days of air frost, total rainfall, and total sunshine duration.	Contextual data from the weather station in nearest geographical proximity to SESRO.

2.2 HadUK-Grid (25km grid dataset)

2.2.1 Observed climate data for the period 1981–2000 has been obtained from the HadUK-Grid 25km gridded dataset (CEDA Archive, n.d.a), for the grid square that includes the draft Order limits (centred on E 437500, N 187500 – presented in Figure 18.1). The observed climate variables from HadUK-Grid are presented in Table 2.2.

Table 2.2 HadUK-Grid baseline observations (1980-2000) for temperature and precipitation climate indicators for the 25km grid square that contains the majority of the SESRO draft Order limits.

Variable	Winter	Summer
Mean air temperature (°C)	4.2	15.8
Mean maximum air temperature (°C)	7.2	20.9
Mean minimum air temperature (°C)	1.2	10.7
Mean precipitation (mm)	186*	143
Note: * Autumn was wetter than winter with a mean precipitation of 206mm		

2.3 HadUK-Grid (12km grid dataset)

2.3.1 Additional observed data has been extracted from the HadUK-Grid 12km gridded dataset (CEDA Archive, n.d.b), for the four 12km grid squares that encompass the SESRO draft Order limits (see Figure 18.2). The four grid square values have been averaged for each climate variable. This data is presented in Table 2.3.

Table 2.3 HadUK-Grid baseline observations (1980-2000) for temperature and precipitation climate indicators averaged across the four 12km grid squares that encompass the SESRO draft Order limits.

Climate Variable	Observed baseline (1980–2000)
Average annual hottest day	29.6°C
Average number of heatwaves per year (3 days above 27°C)	0.8 events/year
Dry spells (10 days or more with no precipitation ¹)	4.7 spells/year
Average annual wettest day (RX1DAY)	27.9mm
Heavy rainfall - annual number of days with >20mm rainfall	2.4 days/year
Number of frost days (night temperature below 0°C)	49.3 days/year

2.4 Oxford weather station

2.4.1 The Oxford weather station (Radcliffe Meteorological Station), the closest monitoring location to the Project, provides observed monthly long-term average climate data for the period 1981–2010. A summary of these values is included in Table 2.4 (Met Office, n.d.).

Table 2.4 Long-term average monthly observations at Oxford weather station (1981-2010).

Month	Maximum temperature (°C)	Minimum temperature (°C)	Days of air frost (days)	Total rainfall (mm)	Days of rainfall >1mm per day (days)
January	7.6	2.1	8.5	56.6	11.5
February	8.0	1.8	9.1	42.5	8.9
March	10.9	3.7	3.8	47.6	10.1

¹ 'No precipitation' is defined as days where total precipitation is less than 0.2mm.

Month	Maximum temperature (°C)	Minimum temperature (°C)	Days of air frost (days)	Total rainfall (mm)	Days of rainfall >1mm per day (days)
April	13.6	5.0	1.7	49.1	9.1
May	17.1	7.9	0.1	57.1	9.7
June	20.3	10.9	0.0	48.0	8.0
July	22.7	13.0	0.0	48.9	7.9
August	22.3	12.9	0.0	56.5	8.1
September	19.1	10.7	0.0	54.1	9.1
October	14.8	7.8	0.9	69.6	10.9
November	10.5	4.6	4.0	66.6	11.3
December	7.7	2.3	9.1	63.1	10.9
Annual	14.6	6.9	37.1	659.7	115.5

3 Future climate projection data

3.1 Methodology

- 3.1.1 Projected climate variables for selected time periods are obtained from the Met Office's UK Climate Projections 2018, UKCP18 (Met Office, 2018), which are the most recent and comprehensive climate change projections for the UK. The UKCP18 data is provided in spatially gridded squares; the climate resilience assessments will use data from the grid squares which cover the draft Order limits.
- 3.1.2 Representative Concentration Pathways (RCPs) are climate change scenarios based on future atmospheric greenhouse gases concentrations that cause radiative forcing. For example, RCP8.5 (the highest scenario available from UKCP18) is the scenario associated with a radiative forcing of 8.5 watts per square metre (W m^{-2}). RCP8.5 represents a future climate in which the global mean temperature is projected to exceed 4°C by 2100 when compared to the pre-industrial period.
- 3.1.3 In line with guidance from Institute of Environmental Management and Assessment (IEMA, 2020), the high-emissions scenario RCP8.5 has been applied to assess potential future changes in key climate variables within the draft Order limits.
- 3.1.4 Two of the UKCP18 products are used to inform the future baseline conditions, as summarised in Table 3.1. Climate variable data is primarily presented for the 50th percentile values, supported by the 10th and 90th percentile values to represent climate model uncertainty and a wider range of possible outcomes.

Table 3.1 Future climate change data sources used to inform future baseline conditions.

Source	Description	Purpose
UKCP18 Probabilistic Projections	Future monthly/seasonal/annual climate change factors derived from 3000 model samples.	The UKCP18 probabilistic projection data provide headline climate change trends for various emissions scenario, including RCP8.5. Given the large number of model samples, the probabilistic projections are useful for showing a wider range of uncertainty than other UKCP18 products.
UKCP18 Regional Projections	Future climate change data provided in daily and monthly timeseries format. Derived from a 12-member ensemble of climate simulations.	The UKCP18 regional projection data provides temporally and spatially coherent future climate projections for the RCP8.5 emissions scenario. The timeseries format enables greater analysis than is possible with the probabilistic projections; for example, the frequency and duration of climate events can be identified, as well as the annual average exceedance of set thresholds (e.g. number of days with a maximum temperature above 35°C).
UK Climate Risk Indicators (UK-CRI)	Future climate change data provided summarised for 30-year timeslices. Produced as part of the UK Climate Resilience Programme, this	The UK Climate Risk Indicators (UK-CRI) provide sector-relevant indicator data adopted in the future baseline as follows:

Source	Description	Purpose
	data is derived from UKCP18 Regional Projections, and based on the change from HadUK-Grid observed data (1981-2010). Note this baseline period is different to that used for other climate datasets, due to data availability.	Heat stress: to consider the climate change and extreme heat impact to the health and safety of workers and visitors; and Wildfire: to consider the impact of climate change to site-wide wildfire risk (when weather conditions are favourable for wildfire to spread or intensify were there an ignition).

3.1.5 Climate data have been accessed for two future time periods to inform the future baseline with respect to climate resilience:

- Near-future climate scenario data for the time horizon 2021-2040 covering the expected construction phase.
- Longer-term future climate scenario data covering the expected operational phase. Data is available for the time horizons including 2061-2080 and 2080-2099.

3.1.6 Where UKCP18 probabilistic projection data is used, data is extracted for the grid square that includes the draft Order limits (centred on E 437500, N 187500 – presented in Figure 18.1). The UKCP18 regional data is extracted for the four 12km grid squares that encompass the SESRO draft Order limits (see Figure 18.2). The four grid square values have been averaged for each climate variable.

3.2 Construction phase

UKCP18 Probabilistic projection data

3.2.1 Information on the future projected climate has been obtained from the UKCP18 Probabilistic projections dataset for the 25km grid square that contains the majority of the draft Order limits (grid square centred on E 437500, N 187500, as presented in Figure 18.1). The projected changes in temperatures and precipitation for the period 2019-2039, referred to as the '2030s', are summarised here, with tabulated data presented in Table 3.2. This represents the short-term changes aligned with expected construction phase of SESRO.

3.2.2 The projections indicate the following changes by the end of the 2030s compared to the baseline period (1981–2000):

- The **average summer daily temperature** is projected to increase by 1.4°C (range: +0.4°C to +2.4°C) from a baseline of 15.8°C.
- The **average winter daily temperature** is projected to increase by 0.9°C (range: +0.1°C to +1.7°C) from a baseline of 4.2°C.
- The **average summer daily maximum temperature** is projected to increase by 1.6°C (range: +0.2°C to +2.8°C) from a baseline of 20.9°C.
- The **average winter minimum temperature** is projected to increase by 0.9°C (range: 0°C to +1.8°C) from a baseline of 1.2°C.

- **Total winter precipitation** is projected to increase by 7% (range: -28% to +16%) from a baseline of 186mm. This is the total amount of rainfall falling during the months December, January and February.
- **Total summer precipitation** is projected to decrease by 6% (range: -4% to +20%) from a baseline of 143mm. This is the total amount of rainfall falling during the months June, July and August.

Table 3.2 HadUK-Grid baseline observations (1980-2000) and UKCP18 Probabilistic climate change projections (2019-2039, referred to as the '2030s') for temperature and precipitation climate indicators for the 25km grid square that contains the majority of the SESRO draft Order limits. The climate change projections are based on the RCP8.5 emissions scenario.

Climate variable	Observed baseline (1980–2000)	Future change in climate variable		Future value under RCP8.5 2030s 50th percentile
		Median (50 th percentile)	Model range (10 th to 90 th percentile)	
Average summer daily temperature	15.8°C	+1.4°C	0.4 to 2.4°C	17.2°C
Average winter daily temperature	4.2°C	+0.9°C	0.1 to 1.7°C	5.1°C
Average summer daily maximum temperature	20.9°C	+1.6°C	0.2 to 2.8°C	22.5°C
Average winter daily minimum temperature	1.2°C	+0.9°C	0 to 1.8°C	2.1°C
Average total summer precipitation	143mm	-6%	-28 to 16%	134mm
Average total winter precipitation	186mm	+7%	-4 to 20%	199mm

UKCP18 Regional projection data

- 3.2.3 To further support the assessment of potential climate-related risks during the construction phase, additional climate projections from the UKCP18 Regional 12km grid dataset covering the draft Order limits have also been reviewed. Key climate indicators under the RCP8.5 scenario have been extracted for the period December 2020 to November 2040 (referred to as the '2030s') and are shown in Table 3.3, representing anticipated short-term changes aligned with the SESRO Project's construction timeline. As the draft Order limits for SESRO sit across four of the 12km grid squares, data has been averaged from across these grid squares.
- 3.2.4 The projections based on the UKCP18 Regional (12km) data are summarised here, with tabulated data presented in Table 3.3. They indicate the following changes by the 2030s compared to the baseline period (1981–2000):
- The temperature on the **average annual hottest day** is projected to increase by 3.5°C to 33.1°C (range: 32.3°C to 34.4°C), from a baseline value of 29.6°C.
 - **Heatwaves**, defined by the Met Office as three consecutive days with temperatures above 27°C for Oxfordshire, are anticipated to become more frequent. The average number of heatwaves per year is projected to increase from 0.8 events in the baseline

period to 2.1 events (range: 1.5 to 3.3 events/per year). The model range presents confidence in this increasing trend.

- The **average annual wettest day** is projected to become wetter from 27.9mm to 30.8mm (50th percentile), representing a 10% rise. The 10–90th percentile range spans from 28.5mm to 39.8mm.
- The average annual number of **heavy rainfall days**, defined as days with more than 20mm of rainfall, is projected to increase from 2.4 to 3.1 days per year (range: 2.6 to 3.6 days per year).
- The average annual number of **frost days** (nights with temperatures below 0°C) is projected to decrease from an observed baseline (1981–2000) of 49.3 days per year to 31.8 days per year by the 2030s (range: 26.6 to 40.1). The model range presents confidence in this decreasing trend.

Table 3.3 HadUK-Grid baseline observations (1980–2000) and UKCP18 Regional climate change projections (December 2020 – November 2040, referred to as the ‘2030s’) for temperature and precipitation climate indicators, averaged across the four 12km grid squares that cover the SESRO draft Order limits. The climate change projections are based on the RCP8.5 emissions scenario.

Climate Variable	Observed baseline (1980–2000)	Future value - RCP8.5 2030s		Future change (based on RCP8.5 2030s 50 th percentile) compared to observed baseline	
		Median (50 th percentile)	Model range (10 th to 90 th percentile)	Absolute Change	Percentage Difference (where appropriate)
Average annual hottest day	29.6°C	33.1°C	32.3 to 34.4°C	+3.5°C	
Average number of heatwaves per year (3 days above 27°C)	0.8 events/year	2.1 events/year	1.5 to 3.3 events/year	+1.3 events/year	174%
Dry spells (10 days or more with no precipitation)	4.7 spells/year	5 spells/year	4.6 to 5.7 spells/year	+0.2 spells/year	4%
Average annual wettest day (RX1DAY)	27.9mm	30.8mm	28.5 to 39.8mm	+2.8mm	10%
Heavy rainfall - annual number of days with >20mm rainfall	2.4 days/year	3.1 days/year	2.6 to 3.6 days/year	+0.7 days/year	27%
Number of frost days (night temperature below 0°C)	49.3 days/year	31.8 days/year	26.6 to 40.1 days/year	-17.4 days/year	-35%

Table 3.4 HadUK-Grid baseline observations (1981-2010) and UK-CRI indicator data, derived from UKCP18 Regional climate change projections (January 2021– December 2050, referred to as the '2030s') for heat stress and wildfire indicators, averaged across the four 12km grid squares that cover the SESRO draft Order limits. The climate change projections are based on the RCP8.5 emissions scenario.

Climate variable	Observed baseline (Jan 1981-Dec 2010)	Future change under RCP 8.5 (Jan 2021-Dec 2050)		Future value under RCP 8.5 (Jan 2021-Dec 2050)	
		Median (50 th percentile)	Model range (10 th to 90 th percentile)	Median (50 th percentile)	Model range (10 th to 90 th percentile)
Heat Stress	0.1 days/year	+1.6 days/year	+0.9 to +2.0 days/year	1.7 days/year	1.0 to 2.1 days/year
Met Office Fire Danger: Very High	28.3 days/year	+22.4 days/year	+17.2 to +33.0 days/year	50.6 days/year	45.5 to 61.3 days/year

3.3 Operation phase

UKCP18 Probabilistic projection data

- 3.3.1 Climate data for the operational phase has been obtained from the UKCP18 probabilistic projections for the 25km grid square that contains the majority of the draft Order limits (grid square centred on E 437500, N 187500, as presented in Figure 18.1). To support the assessment of climate risks over the operational lifetime of the SESRO Project, projections of temperature and precipitation have been extracted for the latest available future time slice representing the anticipated end-of-operation period (December 2079 – November 2099, referred to as the '2090s'). These projections are summarised here, with data presented in Table 3.5.
- 3.3.2 By the end of the century (2090s), the following projected changes are anticipated under the RCP8.5 scenario compared to the 1981–2000 baseline:
- The **average summer daily temperature** is projected to increase by 5.9°C (range: +3°C to +8.8°C).
 - The **average winter daily temperature** is projected to increase by 3.4°C (range: +1.4°C to +5.6°C).
 - The **average summer daily maximum temperature** is projected to increase by 6.6°C (range: +2.9°C to +10.4°C).
 - The **average winter daily minimum temperature** is projected to increase by 3.6°C (range: +1.3°C to +6.4°C).
 - **Total winter precipitation** is projected to increase by 23% (range: -1% to +54%) from a baseline of 186mm.
 - **Total summer precipitation** is projected to increase by 41% (range: -71% to 0%) from a baseline of 143mm.

Table 3.5 HadUK-Grid baseline observations (1980-2000) and UKCP18 Probabilistic climate change projections (December 2079 – November 2099, referred to as the ‘2090s’) for temperature and precipitation climate indicators for the 25km grid square that contains the majority of the SESRO draft Order limits. The climate change projections are based on the RCP8.5 emissions scenario.

Climate variable	Observed baseline (1980–2000)	Future change in climate variable		Future value under RCP8.5 2090s 50th percentile
		Median (50 th percentile)	Model range (10 th to 90 th percentile)	
Average summer daily temperature	15.8°C	+5.9°C	+3 to +8.8°C	21.7°C
Average winter daily temperature	4.2°C	+3.4°C	+1.4 to +5.6°C	7.6°C
Average summer daily maximum temperature	20.9°C	+6.6°C	+2.9 to +10.4°C	27.5°C
Average winter daily minimum temperature	1.2°C	+3.6°C	+1.3 to +6.4°C	4.8°C
Average total summer precipitation	143mm	-41%	-71 to 0%	85mm
Average total winter precipitation	186mm	+23%	-1 to +54%	229mm

UKCP18 Regional projection data

3.3.3 As with the construction phase, climate projections from the UKCP18 Regional 12km grid dataset have also been reviewed to support the assessment of potential climate-related risks. Key climate variables under the RCP8.5 scenario for the ‘2070s’ period (December 2060 to November 2080, the latest available future time slice available) have been extracted and are presented in Table 3.6. As the draft Order limits for SESRO sit across four of the 12km grid squares (see Figure 18.2), data has been averaged from across these grid squares.

Table 3.6 HadUK-Grid baseline observations (1980-2000) and UKCP18 Regional climate change projections (December 2060 – November 2080, referred to as the ‘2070s’) for temperature and precipitation climate indicators, averaged across the four 12km grid squares that cover the SESRO draft Order limits. The climate change projections are based on the RCP8.5 emissions scenario.

Climate Variable	Observed baseline (1980–2000)	RCP8.5 2070s		Future change (based on RCP8.5 2070s 50 th percentile) compared to observed baseline	
		Median (50 th percentile)	Model range (10 th to 90 th percentile)	Absolute Change	Percentage Difference (where appropriate)
Average annual hottest day	29.6°C	37.8°C	37 to 39.5°C	+8.2°C	
Average number of heatwaves per year (3 days above 27°C)	0.8 events/year	5.6 events/year	4.4 to 7.2 events/year	+4.8 events/year	646%

Climate Variable	Observed baseline (1980–2000)	RCP8.5 2070s		Future change (based on RCP8.5 2070s 50 th percentile) compared to observed baseline	
		Median (50 th percentile)	Model range (10 th to 90 th percentile)	Absolute Change	Percentage Difference (where appropriate)
Dry spells (10 days or more with no precipitation)	4.7 spells/year	5.9 spells/year	5.5 to 6.8 spells/year	+1.2 spells/year	25%
Average annual wettest day (RX1DAY)	27.9mm	34.4mm	31.4 to 37.7mm	+6.4mm	23%
Heavy rainfall (annual number of days with >20mm rainfall)	2.4 days/year	3.6 days/year	3 to 4.2 days/year	+1.1 days/year	47%
Number of frost days (night temperature below 0°C)	49.3 days/year	16.8 days/year	7.3 to 26.1 days/year	-32.4 days/year	-66%

3.3.4 By the 2070s, the following projected changes are anticipated under the RCP8.5 scenario compared to the 1981–2000 baseline:

- The temperature on the **average annual hottest day** is projected to increase from a baseline average of 29.6°C (1981–2000) to 37.8°C, marking an increase of 8.2°C. The projected range (10th to 90th percentiles) is 37°C to 39.5°C.
- **Heatwaves** are anticipated to become much more frequent. The average number of heatwaves per year is projected to jump from 0.8 events to 5.6 events (4.4 to 7.2 events/year).
- **The average annual wettest day** is projected to become 23% wetter by the 2070s, from an observed baseline of 27.9mm to 34.4mm (31.4 to 37.7mm).
- **Heavy rainfall days** are projected to become more frequent, from an average of 2.4 events/year in the baseline period to 3.6 events/year (3 to 4.2 days/year) by the 2070s.
- The average annual number of **frost days** is expected to decrease from an observed baseline (1981–2000) of 49.3 days per year, to 16.8 days per year by the 2070s (7.3 to 26.1 days per year). This represents an average decrease of 32.4 days per year.

UK Climate Risk Indicator data

Table 3.7 HadUK-Grid baseline observations (1981–2010) and UK-CRI indicator data, derived from UKCP18 Regional climate change projections (January 2071– December 2100, referred to as the '2080s') for heat stress and wildfire indicators, averaged across the four 12km grid squares that cover the SESRO draft Order limits. The climate change projections are based on the RCP8.5 emissions scenario.

Climate variable	Observed baseline (Jan	Future change under RCP 8.5 (Jan 2071–Dec 2100)	Future value under RCP 8.5 (Jan 2071–Dec 2100)
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	1981-Dec 2010)	Median (50 th percentile)	Model range (10 th to 90 th percentile)	Median (50 th percentile)	Model range (10 th to 90 th percentile)
Heat Stress	0.1 days/year	+23.9 days/year	+12.4 to +31.0 days/year	23.9 days/year	12.5 to 31.1 days/year
Met Office Fire Danger: Very High	28.3 days/year	+75.9 days/year	+57.4 to +99.4 days/year	104.2 days/year	85.7 to 127.6 days/year

References

It should be noted that the Institute of Environmental Management and Assessment (IEMA) has recently rebranded as the Institute of Sustainability and Environmental Professionals (ISEP). Guidance that was historically published by IEMA is still referenced under that institute name.

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It's everyone's water