Jersey Water

Water Resources and Drought Management Plan

Appendix D. Source Yield: Climate Change Assessment

CONTENTS

JERSEY WATER RESOURCES AND DROUGHT MANAGEMENT PLAN

APPENDIX D. CLIMATE CHANGE ASSESSMENT

1. INTRODUCTION

This appendix describes the approach and the results of the assessment of climate change impacts on the deployable output (yield) of the Jersey Water raw water sources.

2. APPROACH

The approach adopted to assess the potential effects of climate change on water source yield (deployable output) is based on the probabilistic output of the UK Climate Projections 2009 (UKCP09) available on the UKCP09 User Interface[1]. The User Interface provides land-based projections for the Channel Islands of changes in a range of meteorological variables for low, medium and high emissions scenarios over a number of stationary 30-year time periods between the 2020s and the 2080s. The emission scenarios consider different plausible scenarios of greenhouse gas emissions reflecting factors such as socio-economic development and technical change as developed by the Intergovernmental Panel on Climate Change (IPCC). UKCP09 remains the latest official climate change projections for the UK at the time of the assessment (but see later about the review of the UKCP18 projections that became available during finalisation of the Water Resources and Drought Management Plan during 2019).

The approach uses seasonal projections of percentage changes in rainfall and absolute changes in temperature (˚C) for the central estimate (50% chance of being less than this value) of the three emission scenarios for the 2040s (2030 – 2059). The projected changes are presented in Table D.1 and are reported from a 1961 – 1990 baseline.

Potential evapotranspiration (PET) data are used in the HYSIM rainfall runoff model to generate stream source flow data; however, projections for changes in PET are not provided in the UKCP09 projections. The approach adopted for Jersey Water therefore utilises existing temperature data to derive percentage changes in PET as a result of changes in seasonal temperature under the three climate change scenarios. The use of percentage PET changes (from baseline PET) rather than absolute changes in PET ensures consistency with the PET data derived for 1927 to 2007 in the MWH[2] study for Jersey Water and extended back to 1901 for this current Water Resources and Drought Management Plan.

[1] http://ukclimateprojections-ui.metoffice.gov.uk/ui/start/start.php

[2] Jersey Water (2006). Jersey Water Resources Modelling. Water Resources Modelling Report. December 2006. Report by MWH for Jersey Water.

Average seasonal percentage change in PET was calculated for each emission scenario, using data provided of daily average temperature data for nearby Guernsey provided by the Guernsey Meteorological Office (equivalent data were not available for Jersey) and the UKCP09 temperature prediction dataset[3], based on formulae[4] which use mean daily temperature, latitude and longitude locational data, and the time of year). Equivalent long-term daily average temperature time series data for Jersey are not available, hence the use of the Guernsey dataset. The seasonal differences are presented in Table D.1 and are reported from a 1961 – 1990 baseline.

The seasonal changes presented in Table D.1 are applied to the historic rainfall and PET time-series data and are input into the HYSIM rainfall runoff models, as described in **Appendix C** (Water Source Yield Assessment). The rainfall-runoff models are then used to derive climate-change perturbed inflows over the period of historic data (1901 – 2007) which provides the inflows to the Jersey Water storage model (also described in **Appendix C**).

The approach adopted is in line with the Environment Agency's 2013 report on approaches to climate change assessment for water resources planning[5] in that the level of complexity is balanced with data availability.

Table D.1 Seasonal changes to rainfall, temperature and PET for low, medium and high emission scenarios. Seasonal rainfall and temperature changes taken from the UKCP09 climate change projections for the Channel Islands in the 2040s (2030 – 2059)

	Spring (Mar/Apr/May)	Summer (Jun/Jul/Aug)	Autumn (Sep/Oct/Nov)	Winter (Dec/Jan/Feb)
Low Emissions				
Rainfall (% change)	2.39	-12.47	1.14	10.16
Temperature (% change)	1.58	2.08	2.07	1.63
PET (% change)	11.93	10.35	12.52	15.36
Medium Emissions				
Rainfall (% change)	-1.20	-16.23	2.12	12.66
Temperature (% change)	1.7	2.12	2.20	1.74
PET (% change)	12.80	10.54	13.24	16.34
High Emissions				
Rainfall (% change)	1.00	-15.88	2.94	13.57
Temperature (% change)	1.86	2.22	2.27	1.88
PET (% change)	14.06	11.05	13.61	17.72

[3] Guernsey Water (2016). Water Resources and Drought Management Plan. Unpublished Plan as provided to Jersey Water.
[4] Kay, A. L.; Davies, H. N. (2008) Calculating potential evaporation from climate model data: a source of uncertainty for hydrological climate change impacts. Journal of Hydrology, 358 (3-4). 221-239.
[5] Environment Agency (2013). Climate change approaches in water resources planning – overview of new methods. Report – SC090017/R3. January 2013.
https://www.gov.uk/government/publications/climate-change-approaches-in-water-resources-planning-new-methods

3. POTENTIAL IMPACT ON WATER SOURCE YIELD

Table D.1 shows that summer rainfall decreases by between 12.47% and 16.23% depending on the emission scenario selected, whereas winter rainfall increases by between 10.2% and 13.6%. Increases in mean PET were predicted for all seasons and range from 10.35% (summer) and 17.72% (winter) for the low and high emission scenarios, respectively.

Table D.2 shows that these changes would have a negative impact on water source yield, with between 1.45 Ml/d (high emission) and 1.67 (medium emission) Ml/d reduction to water source yield when compared to the baseline forecast. The high emission scenario would result in a lesser adverse impact, reflecting the slightly higher autumn and winter percentage increase in rainfall under this scenario compared to the low and medium scenarios (Table D.1).

Table D.2 Potential climate change impact on water source yield for the low, medium and high emission scenarios

Emission Scenario	Baseline Yield[6] (Ml/d)	Projected Yield Impact (Ml/d)
Baseline	20.46	
Low	18.86	-1.60
Medium	18.79	-1.67
High	19.01	-1.45

The impact on source yield is likely to be governed by the projected rainfall and PET changes in spring and summer which are likely to reduce flows in surface water sources. This is likely to be offset, to some degree, by the projected increase in winter rainfall which would increase recharge to groundwater, however, it is recognised that the groundwater contribution to surface water flows is generally minor[7].

The potential effects of climate change and the associated uncertainties are also reflected in the target headroom value (see **Appendix G**), and has also been considered as part of the wider sensitivity testing of the Water Resources and Drought Management Plan (see **Appendix J**).

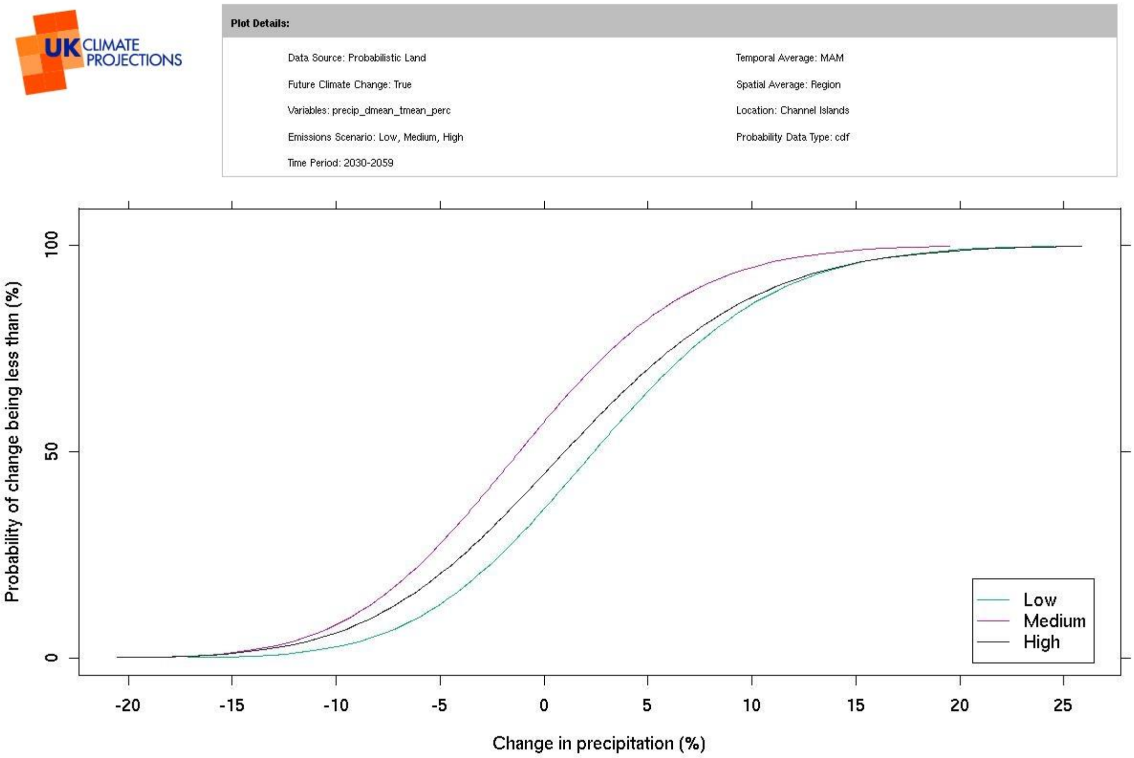
4. UKCP09 USER INTERFACE OUTPUT

The charts below provide summary details of the UKCP09 interface outputs used to inform the climate change assessment for the Water Resources and Drought Management Plan.

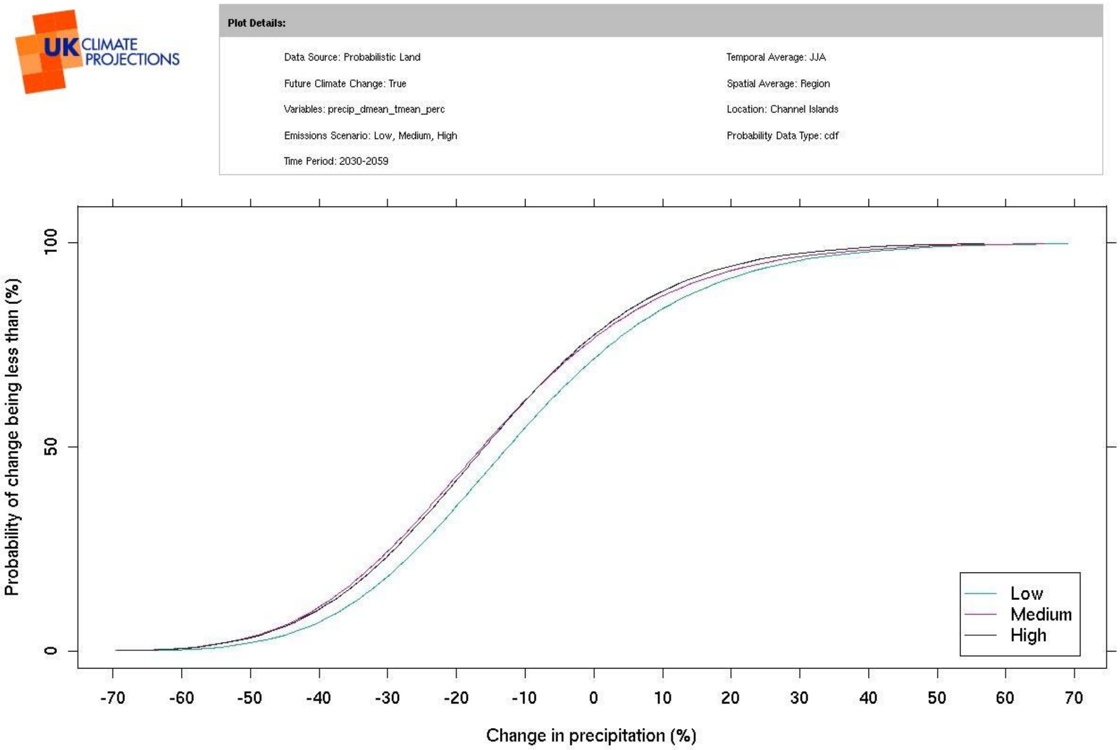
[6] Baseline yield is assumed to include all sources including groundwater and La Rosiere desalination plant at 10.8Ml/d.
[7] Robins, N S, and Smedley P L. 1998. The Jersey groundwater study. British Geological Survey Research Report RR/98/5. 48pp.

Percentage Changes in Rainfall – Cumulative Distribution Function

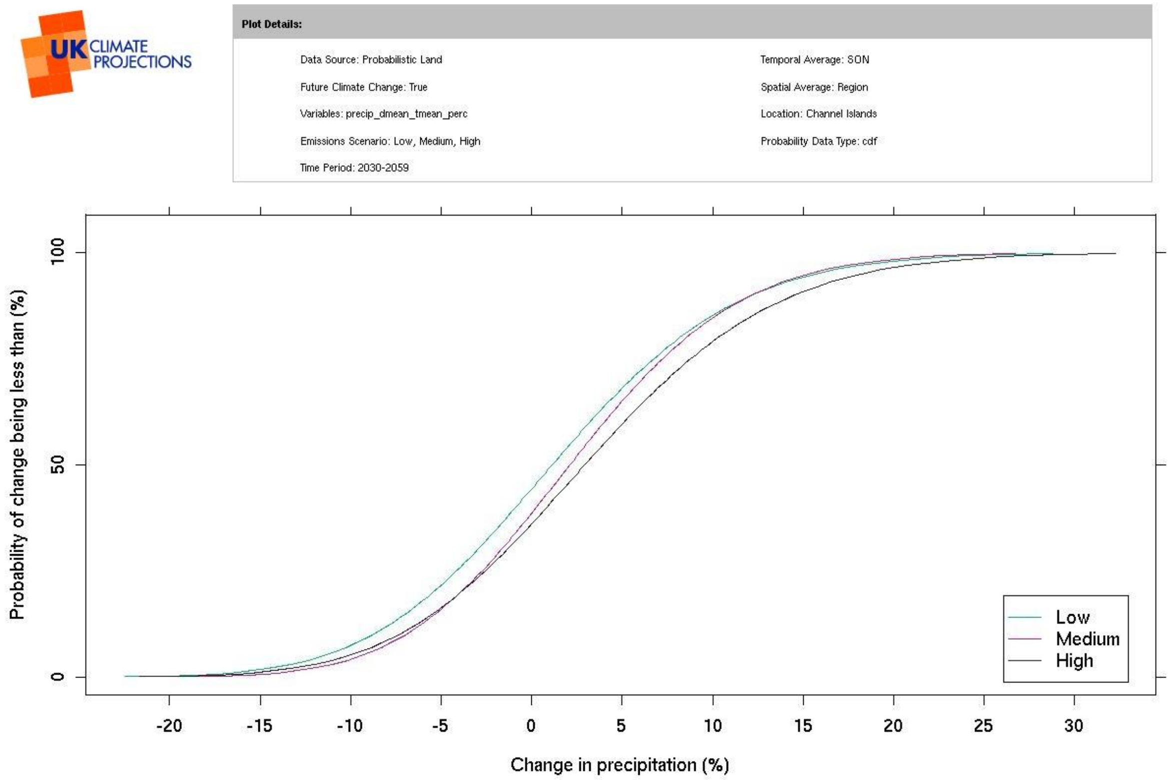
Spring



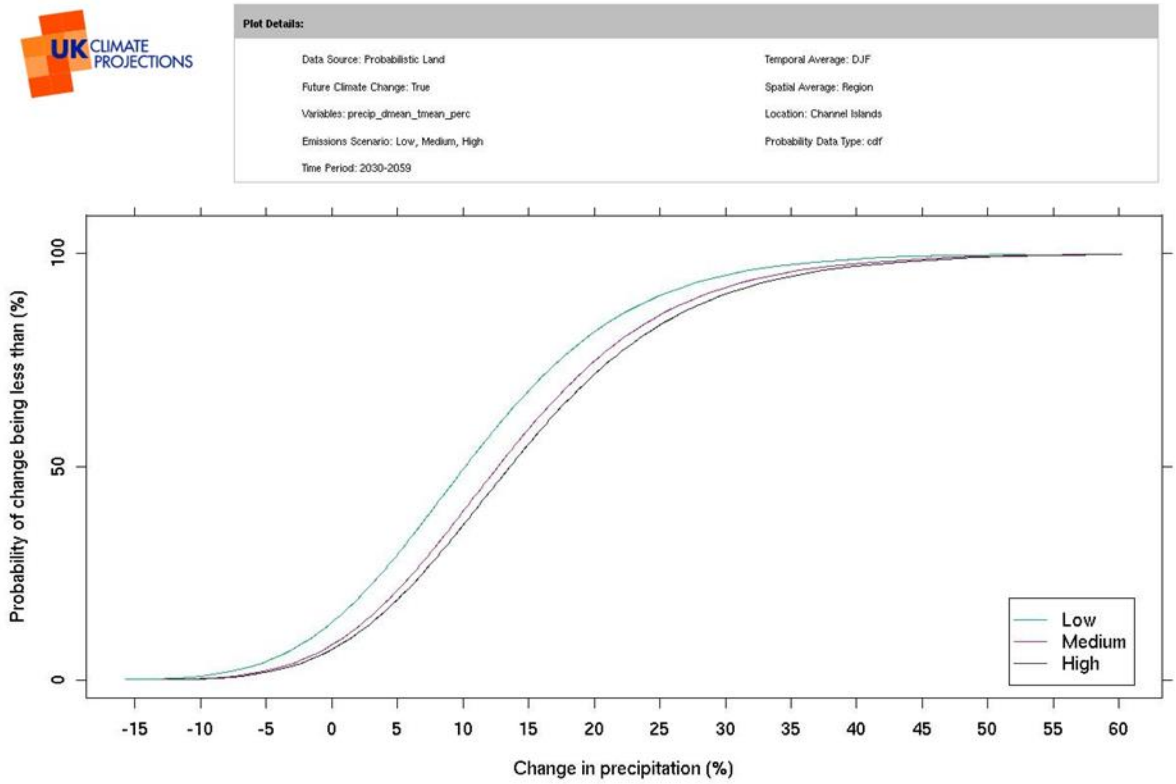
Summer



Autumn

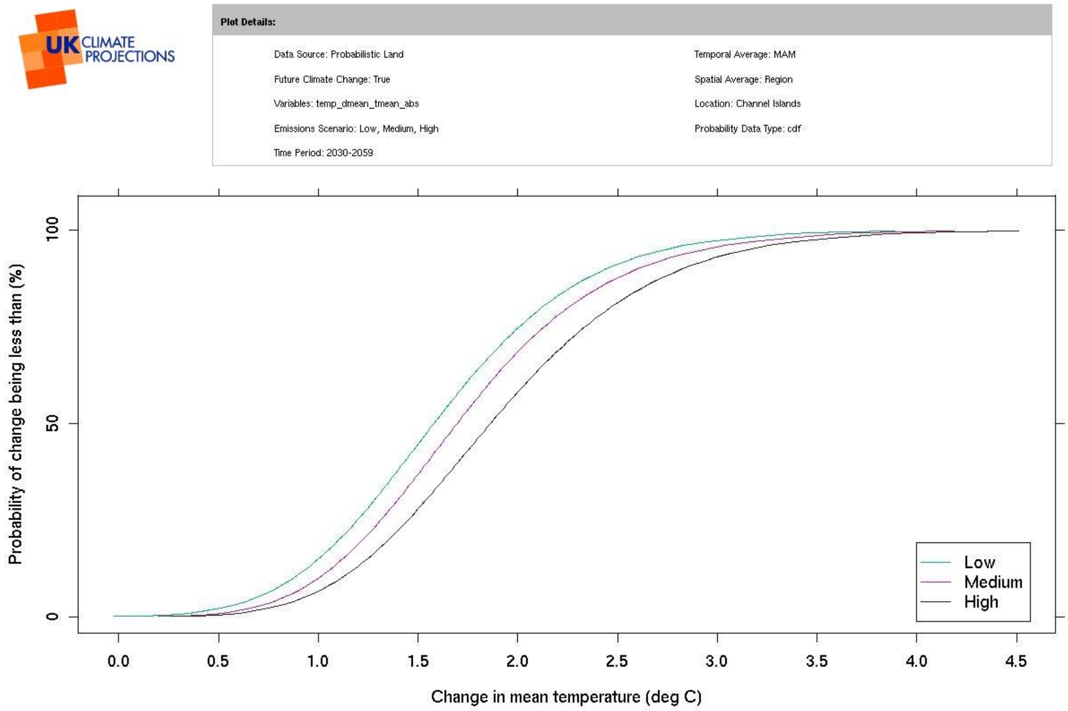


Winter

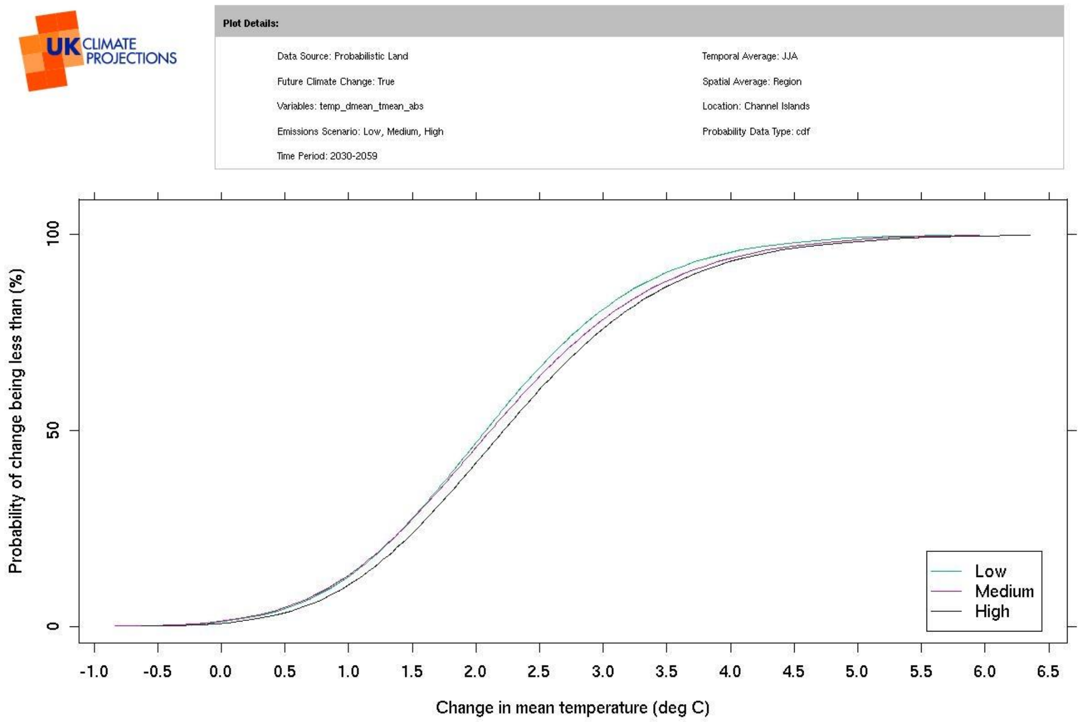


Changes in Mean Temperature – Cumulative Distribution Function (as the basis of the PET perturbation dataset).

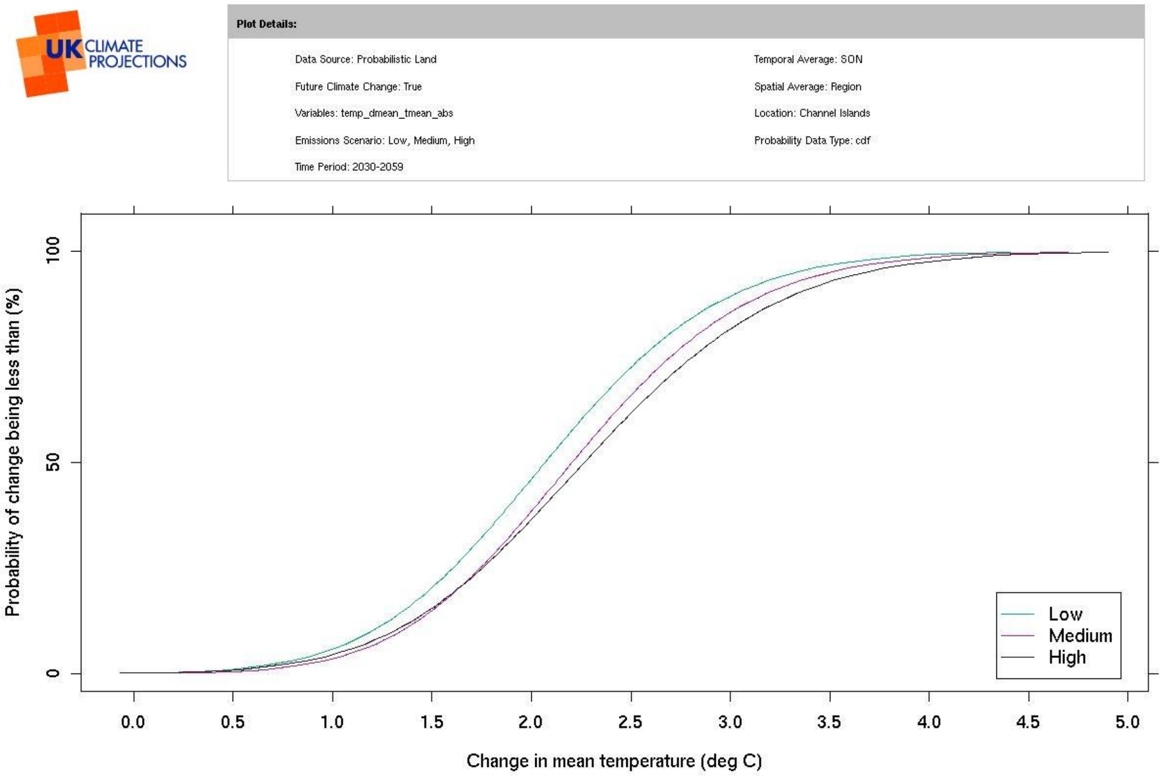
Spring



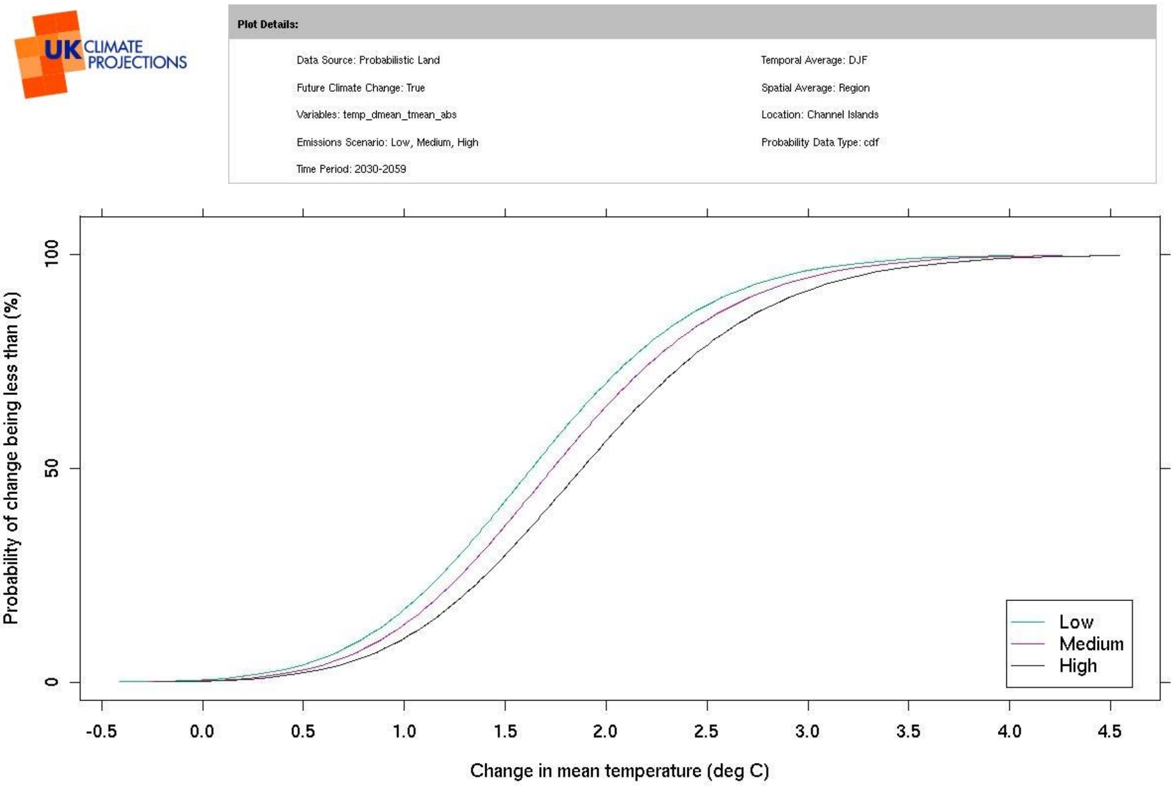
Summer



Autumn



Winter



5. UKCP18 REVIEW

In November 2018, the UKCP18 climate change projections were released to replace the UKPC09. The UKCP18 uses new emissions scenarios, called Representative Concentration Pathways (RCPs), which were presented in the 2014 Intergovernmental Panel on Climate Change's 5th assessment report[8].

The UKCP18 provides the most up-to-date assessment of how the climate of the UK may change over the 21st century. A technical note was produced in 2020[9] to compare the UKPC18 climate change projection scenarios with the UKCP09 scenarios used in this climate change impact assessment to understand the potential for impact on future water supply reliable yield (deployable output).

The technical note identified that the UKCP18 projections (Table D.3) of summer rainfall decreases by between 17% and 20% depending on the emission scenario selected, whereas winter rainfall increases by between 7% and 11%. Increases in mean temperature range from 1.1 °C to 1.5 °C in winter and 1.5 °C to 2.0 °C in summer depending on the emission scenario selected. Spring had the lowest change in temperature, ranging between 0.7 °C and 1 °C.

Table D.3. Seasonal changes to rainfall and mean temperature for the five emission scenarios from the UKCP18 climate change projections for the Channel Islands in the 2040s (2030 – 2059)

	Spring (Mar/Apr/May)	Summer (Jun/Jul/Aug)	Autumn (Sep/Oct/Nov)	Winter (Dec/Jan/Feb)
RCP 2.6				
Rainfall (% Change)	-4.0	-17.0	2.0	8.0
Temperature (°C Change)	0.8	1.8	1.4	1.1
RCP 4.5				
Rainfall (% Change)	-4.0	-17.0	3.0	8.0
Temperature (°C Change)	0.8	1.6	1.3	1.2
RCP 6.0				
Rainfall (% Change)	-4.0	-16.0	3.0	7.0
Temperature (°C Change)	0.7	1.5	1.2	1.1
RCP 8.5				
Rainfall (% Change)	-4.0	-20.0	4.0	11.0
Temperature (°C Change)	1.0	2.0	1.6	1.5
SRES A1B				
Rainfall (% Change)	-5.0	-18.0	3.0	9.0
Temperature (°C Change)	0.8	1.8	1.4	1.2

Note: MAM = March, April and May. JJA = June, July and August. SON = September, October and November. DJF = December, January and February.

[8] IPPC (2014) 5th Assessment Report (AR5).
[9] Jersey Water 2020. Water Resources and Drought Management Plan: UKCP18 Climate Change Projections Review: Technical Note

Spring rainfall is predicted to show a reduction of the order of 4% to 5% across all scenarios in the UKCP18 output – this is between 3 and 6 percentage points higher compared to the UKCP09 data. Summer rainfall tends to show greater reductions for UKCP18 and winter rainfall tends to show smaller increases for UKCP18 (+7% to 11%) when compared to UKCP09 (+10.2% to +13.6%) across scenarios. Temperature increases tend to be slightly lower across all seasons and all scenarios for UKCP18 output.

For further comparison, Table D.4 shows UKCP18 projections for the 2080s where significantly greater increases in winter rainfall and significantly greater decreases in summer rainfall are projected when compared to the 2040s across all scenarios. As would be expected, the predicted mean temperature is expected to increase further for the 2080s scenarios when compared to the 2040s scenarios.

Table D.4. Seasonal changes to rainfall and mean temperature for the five emission scenarios from the UKCP18 climate change projections for the Channel Islands in the 2080s (2070 – 2099)

	Spring (Mar/Apr/May)	Summer (Jun/Jul/Aug)	Autumn (Sep/Oct/Nov)	Winter (Dec/Jan/Feb)
RCP 2.6				
Rainfall (% Change)	-5.0	-24.0	2.0	11.0
Temperature (°C Change)	1.0	2.1	1.6	1.3
RCP 4.5				
Rainfall (% Change)	-6.0	-31.0	3.0	17.0
Temperature (°C Change)	1.5	3.1	2.6	2.0
RCP 6.0				
Rainfall (% Change)	-6.0	-34.0	3.0	19.0
Temperature (°C Change)	1.8	3.6	2.9	2.3
RCP 8.5				
Rainfall (% Change)	-6.0	-46.0	4.0	27.0
Temperature (°C Change)	2.4	4.9	4.0	3.2
SRES A1B				
Rainfall (% Change)	-6.0	-36.0	3.0	21.0
Temperature (°C Change)	1.7	3.6	2.8	2.3

Note: MAM = March, April and May. JJA = June, July and August. SON = September, October and November. DJF = December, January and February.

There is a 50% probability that the seasonal changes in temperature and rainfall will be the same or less than presented above. The probabilistic nature of the climate change projections, however, mean that it would not be unexpected to see changes more (or less) extreme than this.

The further reduction of future spring and summer rainfall under UKCP18 will reduce spring and summer stream source catchment flows. Winter rainfall is still likely to increase under UKCP18, but by a smaller amount when compared to UKCP09. The increase in temperature under UKCP18 is still likely to increase evapotranspiration (which will affect soil water availability for stream flow and groundwater recharge) but the increase may reduce when compared to UKCP09 (subject to soil water availability differences amongst other factors).

The UKCP18 projections are likely to lead to a higher magnitude of impact on future yield compared to those indicated by UKCP09, but not to any material extent and they will not provide any greater certainty as to the impact compared to the UKCP09 projections; there remains considerable variability of the different projections and consequently uncertainty in both the UKCP09 an UKCP18 projections. Whilst the UKCIP18 data represents the most up-to-data (as at 2019) they are based on climate change evidence from 2014. There will be a further update due in 2022 following the next Inter-governmental Panel Report (IPCC) due in 2021 which is due to published in advance of the Glasgow Climate Change Conference (COP26) in November 2021.

6. RECOMMENDED CLIMATE CHANGE IMPACT VALUES FOR WATER RESOURCES AND DROUGHT MANAGEMENT PLAN

It is recommended that the central best estimate of the climate change effects on yield by 2045 used in the Water Resources and Drought Management Plan is **1.7 Ml/d** (based on the UKCP09 medium emission scenario projections). A linear glide path from 2020 to 2045 should be applied starting from zero impact at 2020 (any earlier climate change effects prior to 2020 are already reflected in the recent historic flow records used for the deployable output modelling).

Further modelling work should be carried out following the updated IPCC projections that will be available from mid-2021 to assess whether this value remains appropriate. This will enable Jersey Water to use more up-to-date evidence than the 2014 data used for UKCP18. Given the considerable uncertainties that will remain in climate projections even after the next (2021) IPCC Report, it is recommended that the target headroom allowance and emergency storage allowance are retained in the supply-demand balance forecast which, in part, provide an additional water resource security "buffer" against actual climate change effects by 2045 potentially being greater than the central best estimate of 1.7 Ml/d in the supply-demand balance forecast.