

**Analysis of Climate Change Projections (APPENDIX D)
Climate Change Adaptation
Second Round**

**Steve Morley
Regulation Manager
Portsmouth Water Ltd
PO Box 8
West Street
Havant Hants
PO9 1LG**

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6. ANALYSIS OF UK CLIMATE PROJECTIONS

This section of the report summarises our detailed assessment of the UKCP09 data, identifying the climate variables, probability and risk levels, and key time horizons that are relevant to our planning and activities.

The key climate variables of relevance to our activities are:

- sea level rise, for saline intrusion of aquifers and risk to our coastal assets
- precipitation change (annual, winter, summer, August, peak intensity), for aquifer recharge, demand for water, secondary water quality effects, flood risk
- temperature change (winter, summer, August, peak and minimum temperatures), for aquifer recharge, demand for water, water quality, asset performance, asset deterioration
- cloud cover (summer), for raw water quality
- storminess, for asset security and supply chain risks

The relevant planning horizons for Portsmouth Water are principally:

- 25 years, for the Water Resources Management Plan (supply-demand balance impacts)
- 25 years for our Strategic Direction Statement
- 60+ years for options appraisal of capital and operational options for managing the supply-demand balance
- 50+ years when developing new civils assets

This section therefore principally discusses the Projections for the 2030s (2020-2049) and the late Century (2080s, 2070-2099).

6.1 Sea Level Rise

Sea level around the coast of the UK has risen by approximately 1mm per annum in the 20th century and the rate of sea level rise has accelerated in the latter part of the century.

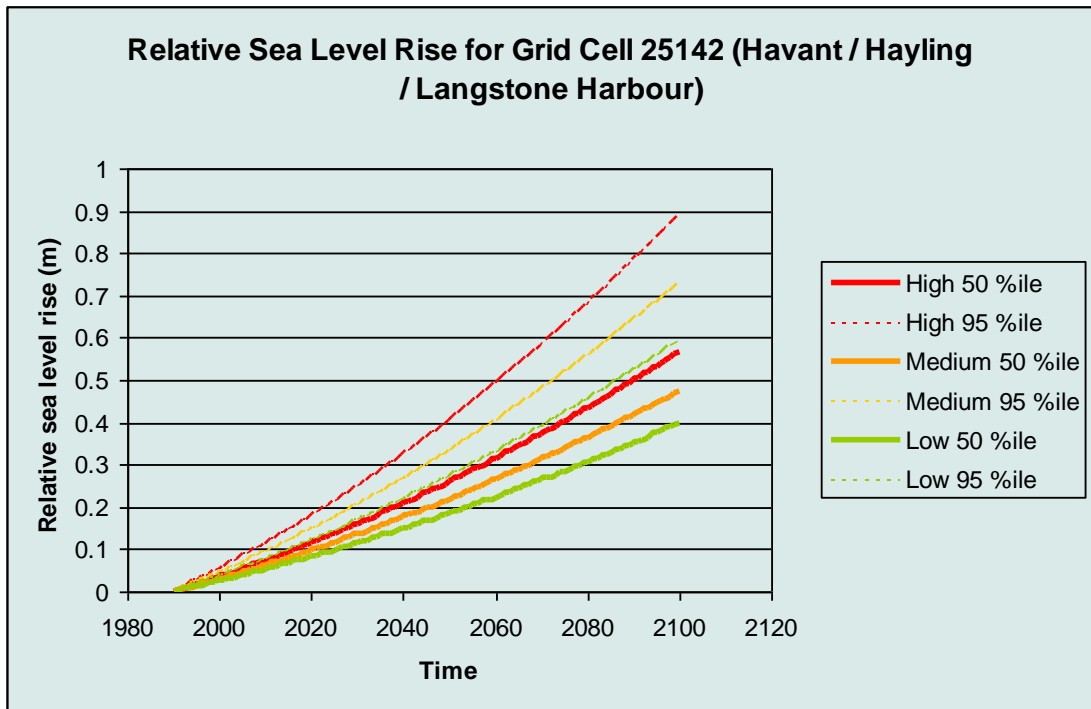
Projections for relative¹ sea level rise for the for the 21st century show a central estimate of 0.47m under the medium emissions scenario for Portsmouth Water's area² by the end of the century. Approximately 17% (0.08m) of this is driven by vertical land movement from glacial isostatic adjustment. The sea level rise resulting from global climate change is modelled from both thermal expansion of the oceans and glacial melt. The 95th percentile (95% probability of non-exceedence) under the high scenario shows a rise of 0.89m.

The figure below shows the 50th and 95th percentiles for the sea level projections under the three emissions scenarios.

UKCP09 also included a "High plus plus (H++)" scenario for sea level rise. This extreme estimate of sea level rise ranges from 0.93-1.90m by 2100 although it must be noted that the probability of such a rise occurring this century is considered to be very low and the scenario was produced for the purposes of contingency planning.

¹ Relative, as opposed to absolute, sea level rise also takes in to account vertical land movement.

² UKCP09 Grid Cell ID 25142 (covering Havant / Hayling Island / Langstone Harbour) has been chosen as the representative point for sea level rise in Portsmouth Water's area.



Coastal change will impact upon a number of Company activities. For example, sea level rise and coastal erosion could result in the loss of Company assets at the coast. The criticality of this for service provision depends upon the asset affected.

Sea level rise may also cause saline intrusion of groundwater and cause rising salinity at our river source works due to the estuarine zone moving upstream.

Population migration away from areas at risk of coastal change may also occur. This may affect local demand for water and require changes to the distribution network and water resources. The policies of planning authorities on shoreline management will be important for spatial planning.

More broadly, the Company will need to accommodate uncertainty in the stability of the shoreline in our long-term planning.

Impacts of sea level rise are assessed in more detail in the risk assessment.

6.2 Precipitation

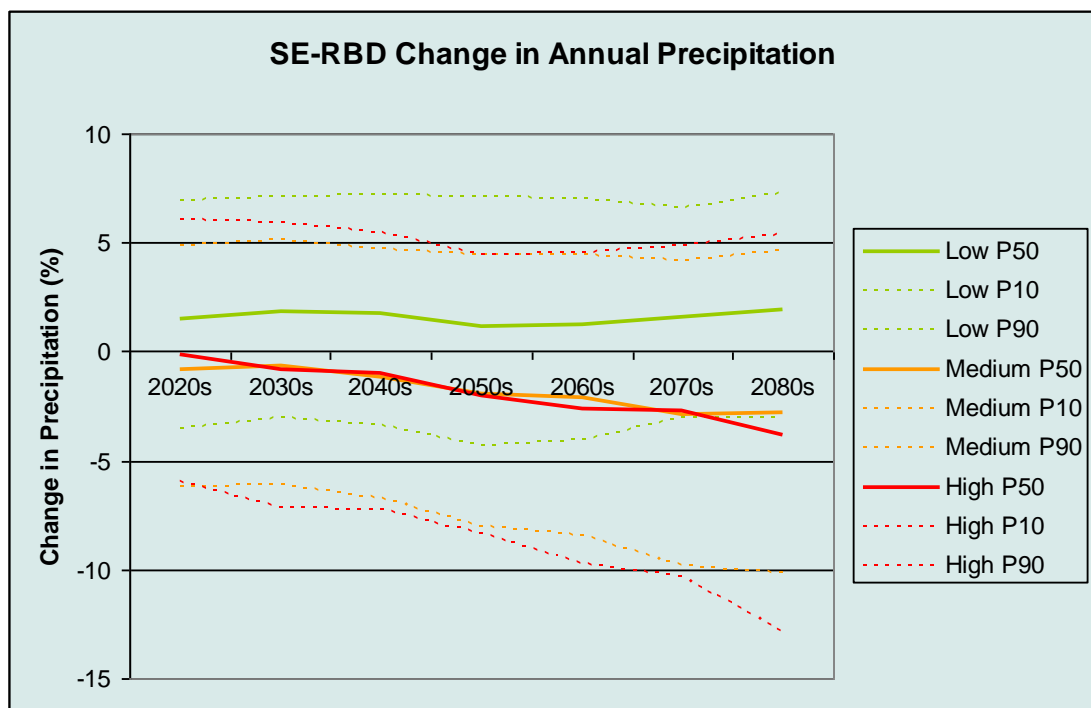
The data presented in this section is averaged over the South East River Basin District area, defined for EU Water Framework Directive delivery. Climate change projections are used, as opposed to absolute projected climate values, and shown as plume plots presenting the forecast over time. In all graphs, the central estimate (50th percentile, P50) is shown as a solid line, and the 10th (P10) and 90th (P90) percentiles (signifying 90% probability of non-exceedence) are shown as dashed lines. These values have been selected to reflect Portsmouth Water's precautionary approach to risk, whilst recognising UKCIP's caution against using data beyond the 10th and 90th percentiles, due to increased uncertainty in the data at the tails of the probabilistic distribution.

Change in precipitation patterns will impact upon a number of the Company's existing activities, such as:

- Water resources: source yield, demand for water, recurrence of drought.
- Flood risk: (fluvial groundwater and pluvial) to assets that may affect the abstraction, treatment, storage and transportation of water
- Water quality: increased turbidity caused by runoff from intense rainfall events, lower river flows causing increased concentration of pollutants

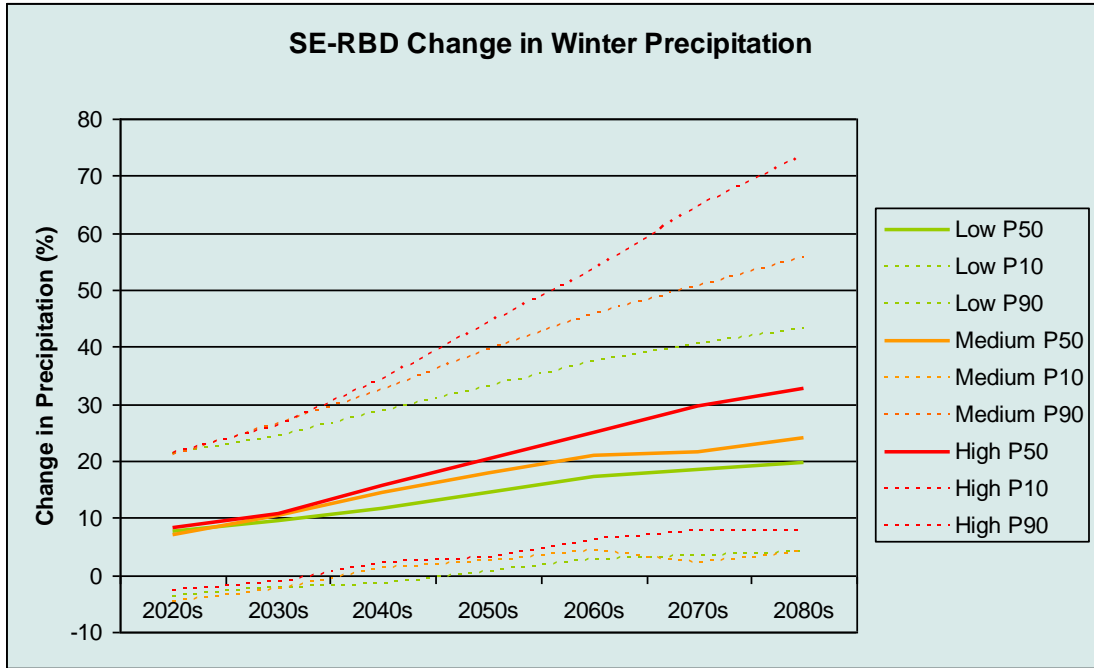
6.2.1 Projected Change in Annual Precipitation

The Projections show no significant change in mean annual precipitation by the end of the Century at the central estimate, with a range of +2% to -4% depending upon emissions scenario. At the most extreme, the 10th percentile under the high emissions scenario shows up to a 13% reduction, whereas the 90th percentile projections are relatively flat at a 5-7% increase.



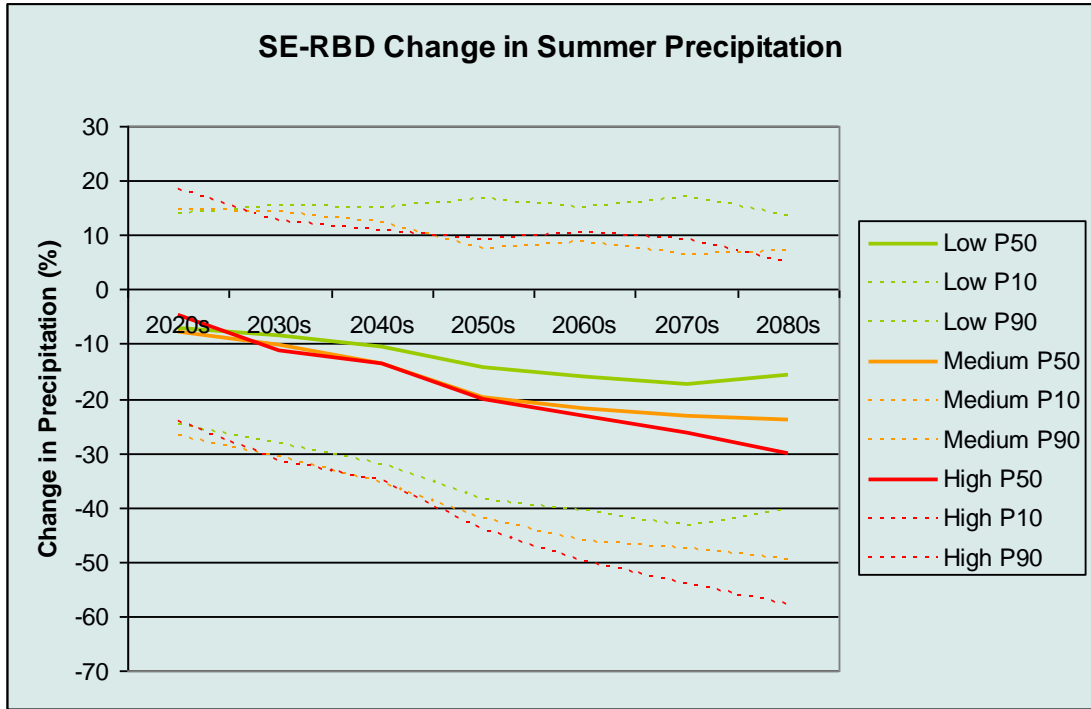
6.2.2 Projected Change in Winter Precipitation

Projections of change in climate are more marked when the data is examined at the seasonal level. For winter precipitation, all emissions scenarios show an increase at central estimate and the 10th and 90th percentiles, all the 10th percentile shows only a marginal impact. The increase is likely to be approximately 10% by the 2030s and 20-32% by the end of the Century (all scenarios, P50 values). The 90th percentile under the high emissions scenario shows a change of 25% by the 2030s.



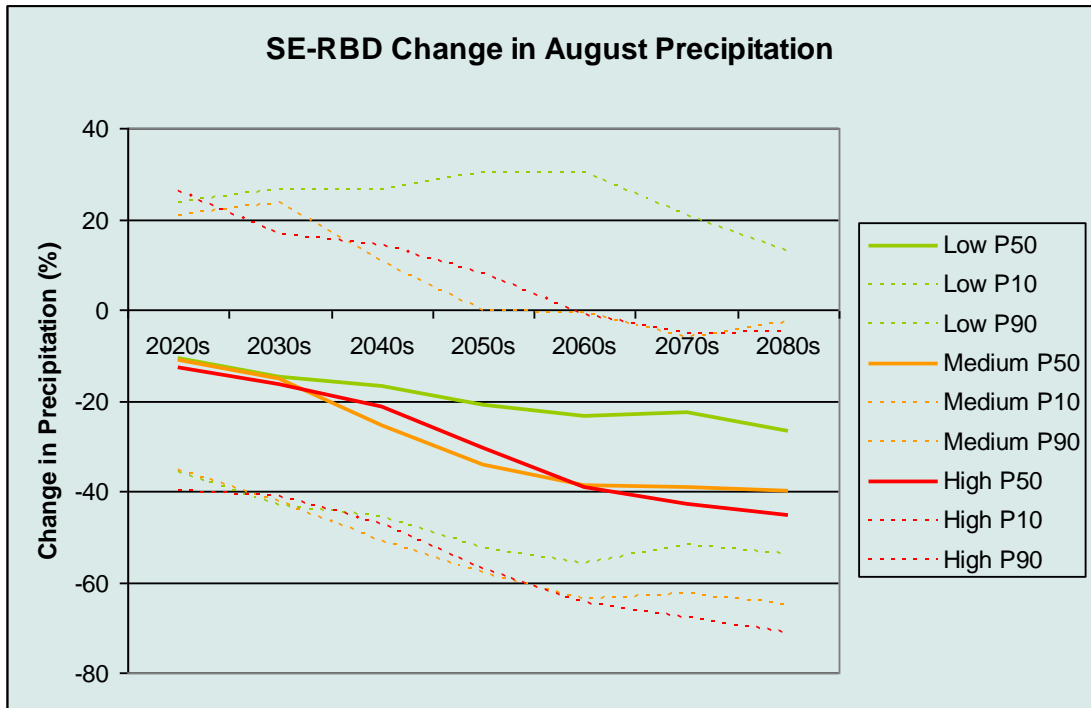
6.2.3 Projected Change in Summer Precipitation

For summer precipitation, all emissions scenarios show a decrease at the central estimate. For the 2030s, the Projections are similar for all scenarios showing approximately 8% to 12% reduction (P50). The P10 values show a 27% to 33% reduction whereas the P90 values are relatively flat at a 15% increase. Central estimates for the 2080s are from -15% to -30%. Reductions in summer precipitation will impact both aquifer recharge and therefore source yields, and demand for water. Lower river flows could also cause pollutants in the river to become more concentrated and present a water quality risk. Lower groundwater levels could also combine with the effects of sea level rise to increase the risk of saline intrusion.



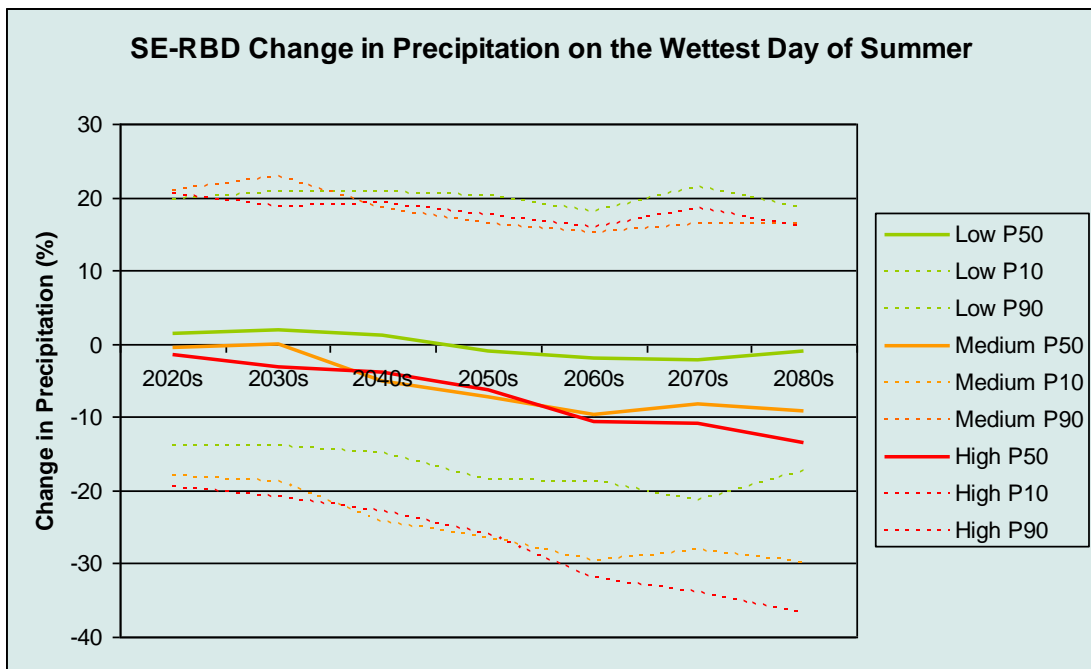
6.2.4 Projected Change in August Precipitation

For the August data, the projected reduction in precipitation is even more marked, showing central estimates of -14% to -16% in the 2030s, with P10 values of over -40%. By the end of the Century, reductions in August precipitation could be as large as 70% (high emissions scenario, P10), although conversely P90 values show little net change. Central estimates for the 2080s are from a 26% to a 45% decrease, and up to 70% at P10 (high scenario). Reductions in August precipitation will impact both aquifer recharge and therefore source yields, and demand for water. Lower river flows could also cause pollutants in the river to become more concentrated and present a water quality risk. Lower groundwater levels could also combine with the effects of sea level rise to increase the risk of saline intrusion.



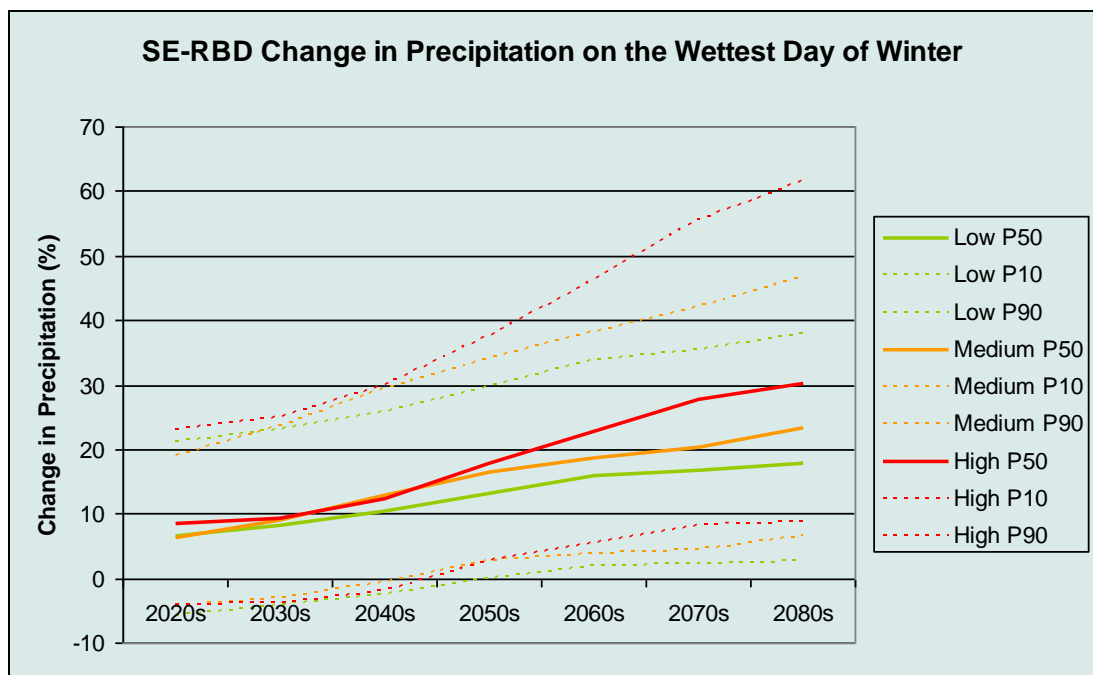
6.2.5 Projected Change in Precipitation on the Wettest Day of Summer

Precipitation on the wettest day of summer is not expected to change significantly by the 2030s. Projections show up to a 13% reduction (high emissions scenario) at the central estimate by the end of the Century.



6.2.6 Projected Change in Precipitation on the Wettest day of Winter

The Projections forecast an upward trend in the amount of precipitation falling on the wettest day of winter. Central estimates forecast up to 10% more rainfall on the wettest day by the 2030s, and 30% more by the end of the Century for the central estimate. P10 to P90 show a range varying from negligible change to over 60% increase by the 2080s. The intensity of the rain will impact aquifer recharge, and therefore source yield, and also affect flood risk both at our assets and more widely across the Company's operational area. This could cause an interruption to normal operations during a flooding event, and in the longer term cause local to regional scale population migration out of the floodplain and away from other areas at risk of flooding. It may also increase raw water quality risk from surface water runoff in areas where this is already a problem.



6.3 Temperature

The data presented in this section is averaged over the South East River Basin District area, defined for EU Water Framework Directive delivery. Climate change projections are used, as opposed to absolute projected climate values, and shown as plume plots presenting the forecast over time. In all graphs, the central estimate (50th percentile, T50) is shown as a solid line, and the 10th (T10) and 90th (T90) percentiles (signifying 90% probability of non-exceedence) are shown as dashed lines. These values have been selected to reflect Portsmouth Water's precautionary approach to risk, whilst recognising UKCIP's caution against using data beyond the 10th and 90th percentiles, due to increased uncertainty in the data at the tails of the probabilistic distribution.

Change in temperature patterns will impact upon a number of the Company's existing activities, such as:

- water resources: regional evapotranspiration and therefore source yield, and demand for water (including seasonal tourist population)
- water quality: chlorine depletion rate in treated water, biological and bacterial growth
- high ambient temperatures may impact operating efficiency of mechanical and electrical equipment
- extreme heat wave events may cause road-melt and impact operations
- an increase in temperature on the coldest day/night of winter, and a reduction in frost days, may have a positive impact on pipe burst rates

6.3.1 Projected Change in Mean Annual Temperature

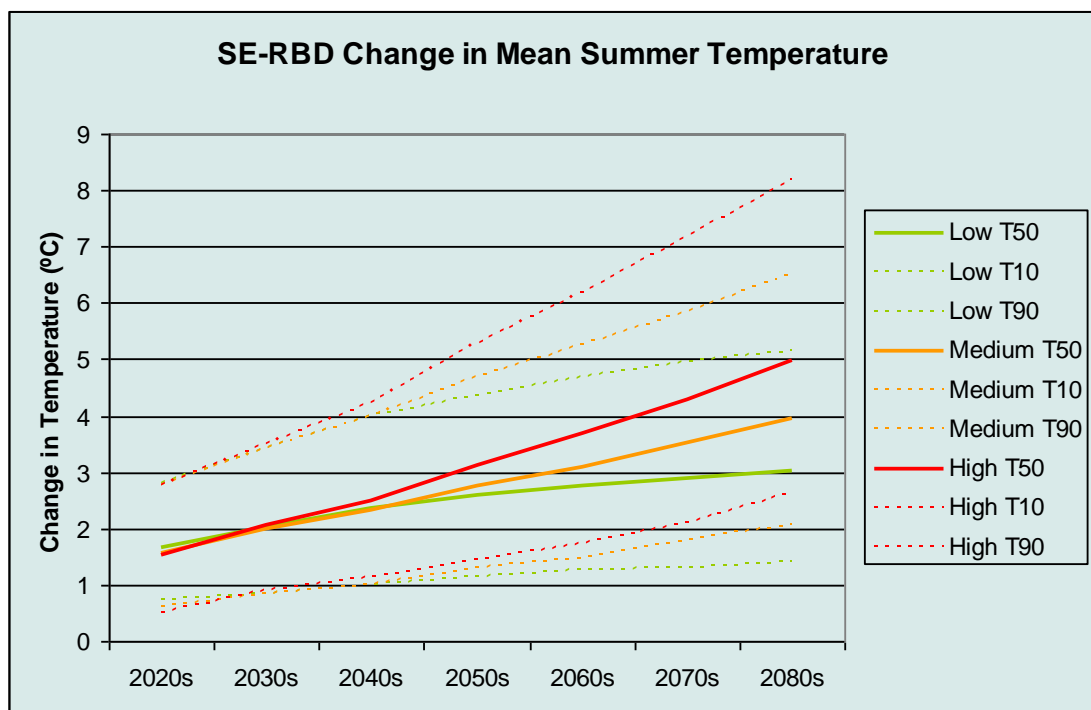
All scenarios show a rise in mean annual temperature at the central estimate as well as the 10th and 90th percentiles. For the 2030s, Projections show that warming will not exceed 2°C at the central estimate, and that the warming will be between 1°C and 2.8°C with 90% certainty (T10 and T90). Towards the end of the Century, central estimates for the three emissions scenarios diverge, ranging from around +2.8°C to +4.4°C at the central estimate.

6.3.3 Projected Change in Mean Summer Temperature

Mean summer temperature is expected to rise by approximately 2°C at the central estimate for all scenarios by the 2030s. The T10-T90 range is a 0.8-3.5°C rise. By the end of the Century, central estimates are from +3°C to +5°C at the central estimate. Changes in summertime temperatures will impact upon demand for water, including through lifestyle changes of the permanent population and though the potential increase in seasonal (e.g. tourist) population. The availability of water may also be affected due to changes in evapotranspiration rates in the catchment.

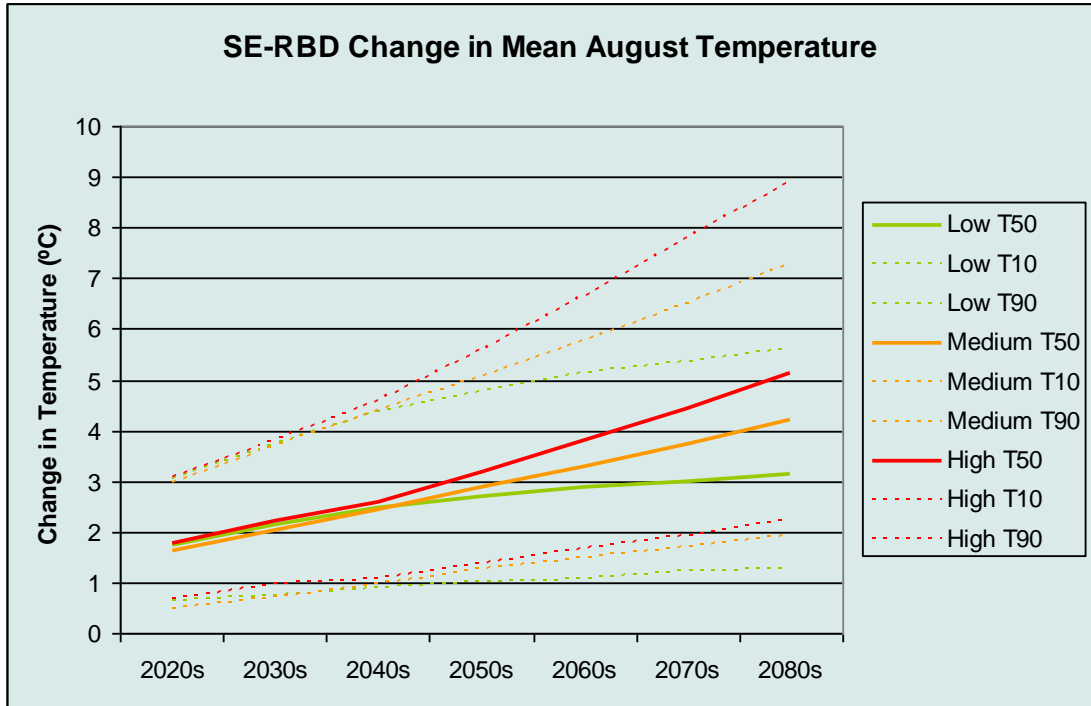
The impact of warmer summers leading to increased tourism will cut across multiple aspects of the business including water resources, potable transportation and distribution.

More extreme wetting and drying cycles will also impact asset deterioration.



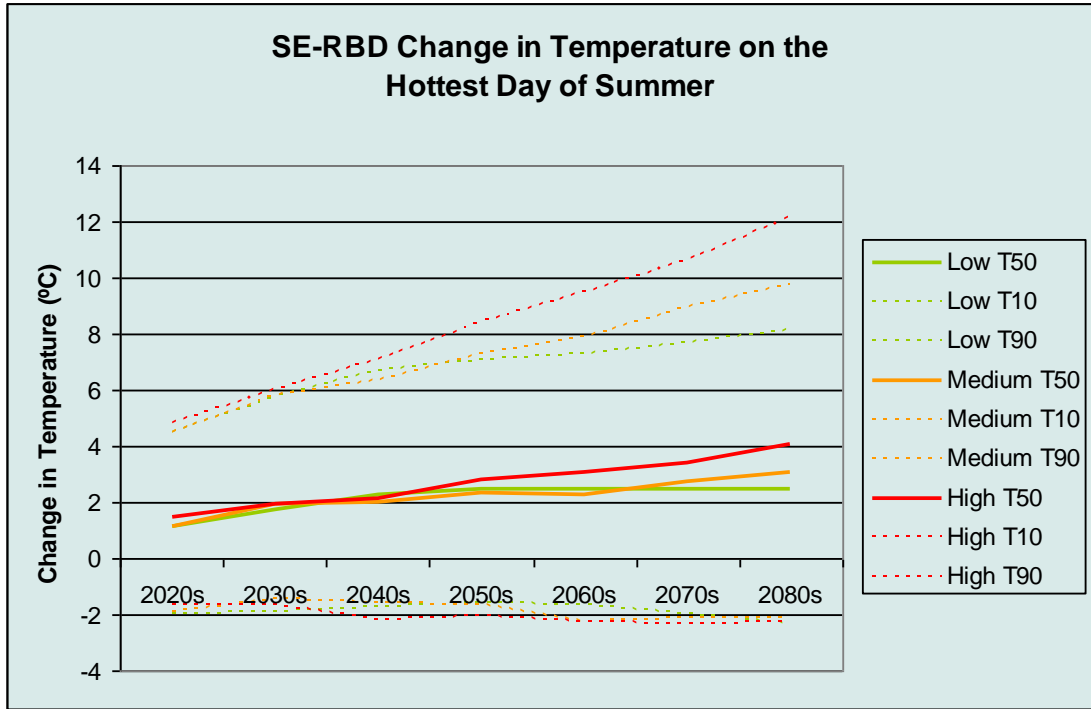
6.3.4 Projected Change in Mean August Temperature

Mean temperatures in August are expected to rise by over 2°C by the 2030s and by just over 3-5°C by the end of the Century (central estimates, all scenarios). T90 values are approximately 3.8°C for the 2030s and 5.6-9°C for the 2080s. T10 values are much lower, only exceeding a 2°C rise in the 2070s. An increase in temperature during August may impact the demand for water through lifestyle change and a seasonal influx of consumers due to tourism. August temperatures are also generally the hottest of the year and are therefore important when assessing the impact of temperature rise on the operating efficiency of our mechanical and electrical assets.



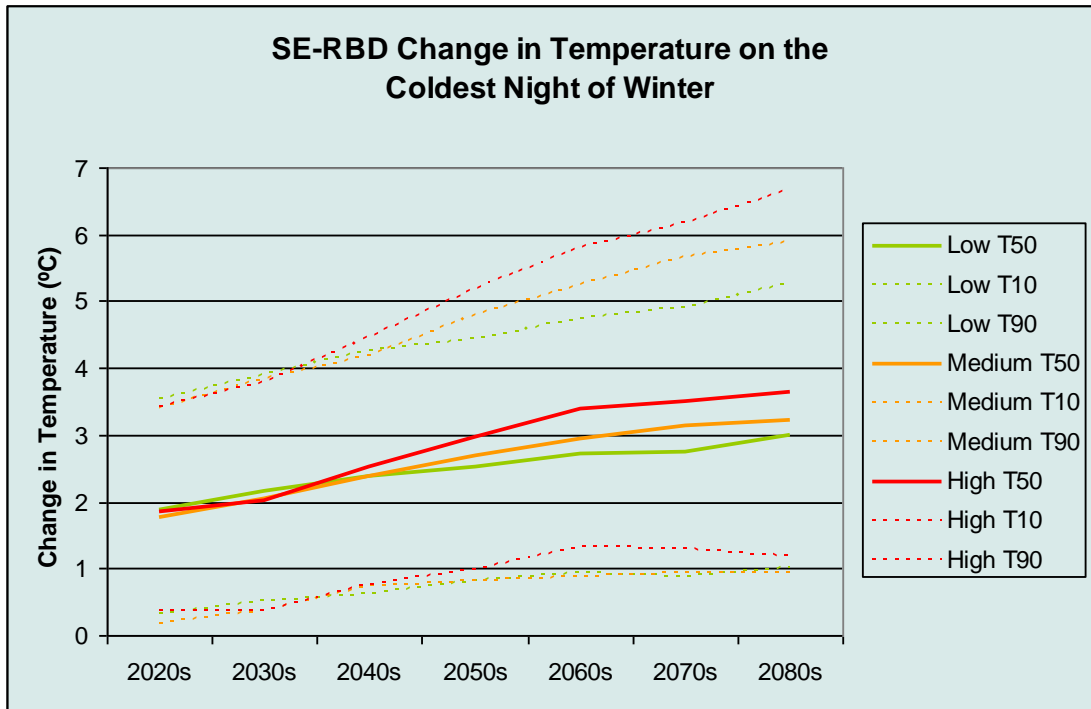
6.3.5 Projected Change in Temperature on the Hottest Day of Summer

The temperature on the hottest day of summer is expected to be just under 2°C warmer by the 2030s (central estimates). Under the low emissions scenario there is projected to be little further change beyond this, although under the high emissions scenario the increase reaches 4°C by the 2080s. T10 values are approximately -2°C throughout the Century. T90 values rise sharply from 4.5-5°C in the 2020s to up to 12°C in the 2080s (high scenario). A rise in temperature on the hottest day of summer may lead to impacts on peak demand for water and also indicate the increased risk of heat waves, leading to road melt, which may temporarily impact upon operations.



6.3.6 Projected Change in Temperature on the Coldest Night of Winter

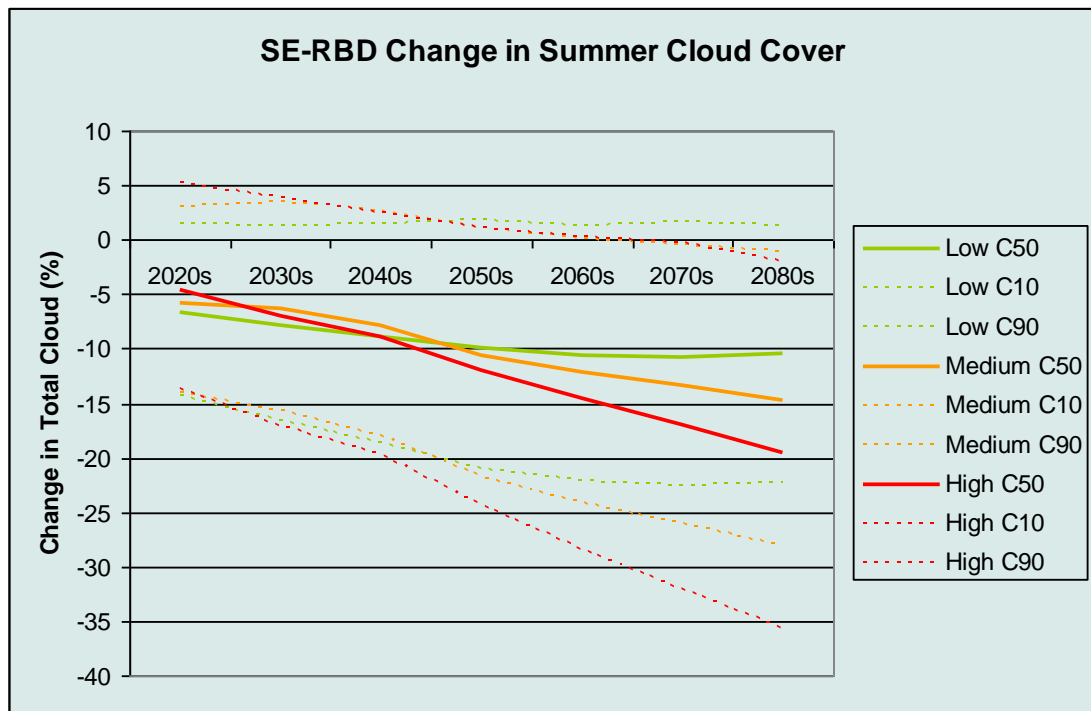
The temperature of the coldest night of winter is expected to rise by 2°C by the 2030s and 3°C or more by the 2080s (central estimate figures). Combined with increased mean winter temperatures overall and UKCIP's projections of reductions in the number of frost days, this could lead to a reduction in the number of burst mains associated with cold weather.



6.4 Cloud Cover

6.4.1 Projected Change in Summer Cloud Cover

Projections show that we can expect a 6-8% reduction in summer cloud cover by the 2030s at the central estimate, reaching 10-20% by the 2080s (depending upon emissions scenario). Reduced cloud cover and the resulting increase in sunlight received may cause an increase in organic growth in surface water sources and raw water storage and treatment assets.



6.5 Storminess

The UK Climate Impacts Programme forecast an increase in the frequency and severity of storms. This may impact Company telecommunications and operations.