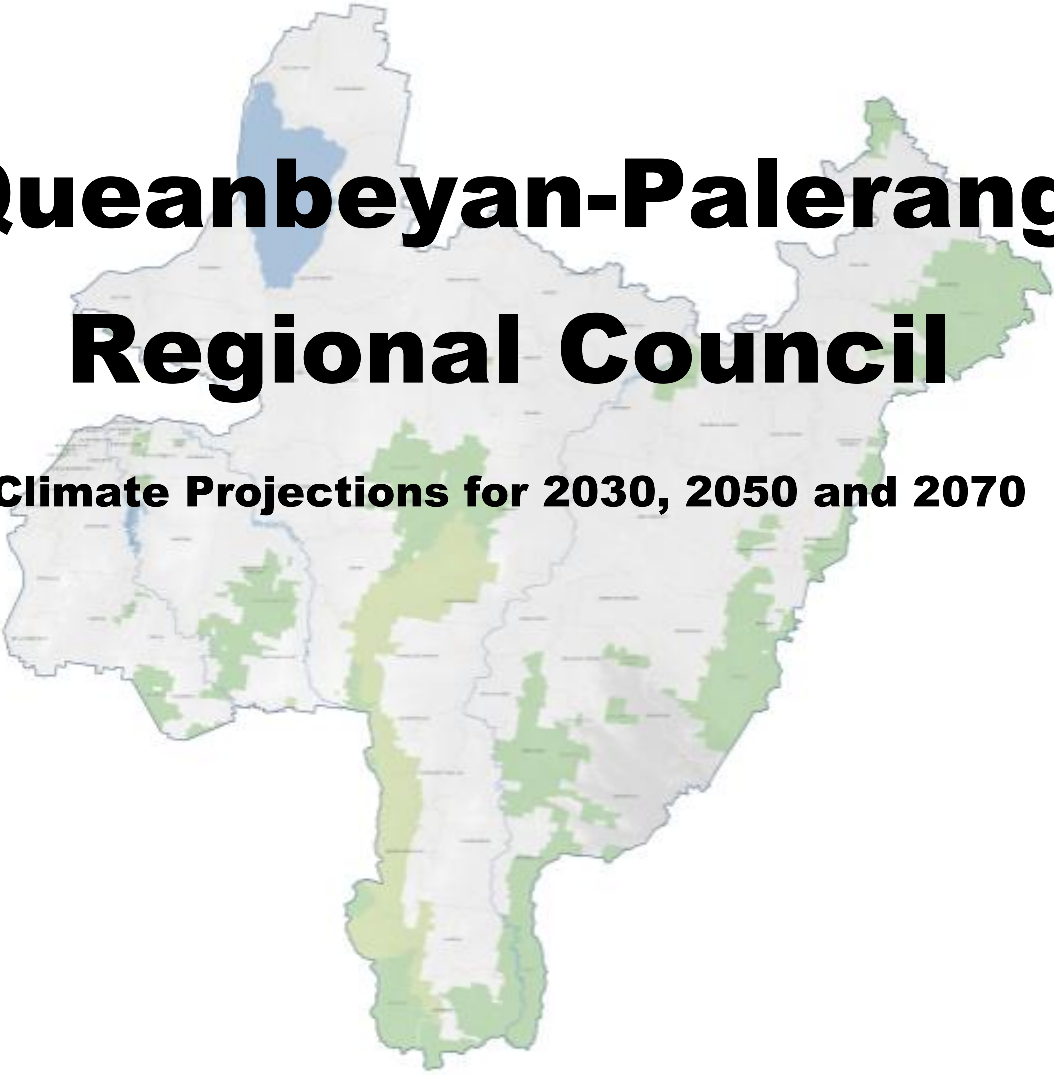
Queanbeyan-Palerang Regional Council



Climate Projections for 2030, 2050 and 2070

File Reference: 51.2.1

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Executive Summary

This report seeks to:

- Provide a simple, but detailed view of the projected climate baselines in 2030, 2050, and 2070 for the local government area.
- Outline the limitations and scope of climate modelling currently available.
- Communicate up-to-date climate science-based projections.
- Summarise the key findings.
- Recommend annual updates and reviews.

Reason for Report:

Council had a Climate Change Adaptation Internal Audit on 8 March 2024 and came back with a low rating for climate change data. The findings and resolution are below:

- No Singular Vision
- It is recommended that: QPRC develop a unified detailed view/profile of climate change future state for 2030, 2050 and 2070

Following this recommendation, research conducted by the sustainability staff led to the decision to use the NARCliM climate projections tool. This is the industry standard tool for climate projections for NSW. It is considered appropriate to use these projections to inform the community and guide Council's planning and decision making.

The data alone is relatively complex, and this report seeks to provide explanations of climate modelling to communicate the scientific process behind the data.

This full-length report also includes a short form infographic that summarises the key findings (see page 14). This report will help Council staff with projections when developing new projects, particularly for projects that are expected to serve the community for many decades (e.g. buildings and infrastructure) and to support strategic planning decisions (e.g. land use planning). This report should not be used exclusively by staff or the community to predict future climate for specific areas within the LGA due to the spatial variability in the region analysed. Instead, this report can help form a baseline understanding of climate trends throughout the region. Additionally, these scientific projections can be used to support the need for climate mitigation and adaptation measures to be considered in future planning.

National Climate Risk Assessment Report

The Australian Climate Service (ACS) is a government partnership between the Bureau of Meteorology, CSIRO, Australian Bureau of Statistics, and Geoscience Australia. The National Climate Risk Assessment Report, developed by the ACS, identifies that as Australia's climate continues to change, there is an increasing risk of climate extremes and natural disasters impacting Australians' health and wellbeing, food supplies, shelter, transport, economy, and energy supplies.

Patterns and impacts of hazards such as riverine floods, tropical cyclones, high temperatures, coastal hazards (floods, sea level rise, erosion), storms, ocean warming and acidification, bushfires, and droughts are all expected to shift. These climate hazards can compound, for example when drought, heatwave, and fires occur simultaneously or cascade, where for instance fires lead to agricultural loss which then impacts supply chains, human health, and food security.

Compounding and cascading climate hazards pose risks to Australia's national security and negatively impacts the long-term resilience of communities. Overall, this national report highlights the need for local governments to incorporate mitigation and adaptation actions according to their regions changing climate.

Introduction

Region and Introduction to NARCliM

The NSW and Australian Regional Climate Modelling project or NARCliM project uses a combination of global climate models and regional climate models to create detailed regional climate projections. The project takes weather observations from 1990-2009 to create a baseline climate for the year 2000 and then predicts future climate change by certain years (e.g. 2030) using a 20-year average of climate model projections (e.g. 2030 climate predicted using projections from 2020-2039). NARCliM's global climate models produce climate projections (e.g. annual average temperature and rainfall) for NSW split up into grid squares around 100-300km wide with each grid square containing their own individual projections. The data from global climate models are used as input for regional climate models which downscale the data to finer grid squares (4km in the NARCliM project) that are available in NARCliM's interactive map. The models included in NARCliM use the most current climate science research and additionally, the regional climate models have been covered by the World Climate Research Programme (WCRP) framework. All the models used in NARCliM went through testing to ensure they would be able to produce accurate future climate projections. This is done by simulating past climates (with the same set of models that will be used to predict future climate) and then comparing the simulations to the actual observations on record and seeing how different they are. In the NARCliM project the models that simulated past climate differently from the actual historical data were eliminated and the selection of the most suitable models was done.

This document contains data that has been averaged over the Southeast and Tablelands region which is available through a data filter in the NARCliM project. This region includes the Queanbeyan-Palerang Regional Council (QPRC) area and surrounding area to the north and south. The projections in this document should only be used as a guide for the QPRC local government area (LGA) because data specific to local government areas is difficult to calculate using the NARCliM project.

The project predicts climate change down to 4km grid squares, but if only a small area is being analysed (one or a few grid squares), it should be used within the context of the broader area around it. Since an LGA filter is not available, the next best region was used for analysis in this document. Further analysis of towns within the LGA or other specific areas can be done using AdaptNSW's interactive climate change projections map.

Weather vs. Climate

Weather describes variables such as temperature and rainfall that are measured **day to day**, whereas **climate** refers to **long-term averages** of observed weather or as projections which are typically calculated over 20 years or more. NARCliM predicts future change in climate conditions expected by specific years such as 2030, 2050, or 2070 using 10 years of climate projections either side of the year being considered (e.g. 2020-2039 for 2030, totalling 20 years). Since climate change is calculated as a 20-year average, it does not include the possibility of weather variability that happens on a year-by-year basis or variability occurring throughout the year (frequency and severity of extremes). This short-term variation in weather patterns results from natural variation in climate drivers and climate systems throughout the region (such as El Niño and La Niña) and not from long-term changes in climate, meaning that it is not captured by climate projections. Information relating to Australia's weather systems and climate influences is available on the Climate Change section of the CSIRO's website.

Weather and Climate Variability Within the Region

The QPRC region has different weather and climate conditions across its communities such as those living in farmlands or the various towns. Therefore, it is important that the projections in this document aren't used for predicting changing climate (or weather) at the town level (Braidwood vs Queanbeyan), but instead, is used to provide an understanding of climate change in the broader region. Understanding the regions plausible range of climate change is an important part of future planning at QPRC.

Impacts of Increased Greenhouse Gas Emissions

The main driver of climate change is greenhouse gas (GHG) emissions created by unsustainable human behaviour such as the burning of fossil fuels, which occurs on a global scale.

In general, higher greenhouse gas concentrations in the atmosphere lead to higher temperatures because these gases keep radiation from the sun (felt as heat) close to Earth's surface and slow the rate of radiation escaping back out into space. Greenhouse gases such as carbon dioxide stay in the atmosphere for hundreds to thousands of years before being removed by natural interactions, such as those between the atmosphere and things like plants, animals and water. The removal of greenhouse gases from the atmosphere by these interactions occurs at the same time as the natural release of greenhouse gases from sources such as animals breathing. When humans release large amounts of greenhouse gases into the atmosphere without removing them, there is a disruption to the natural cycle creating a build-up of greenhouse gases in the atmosphere which leads to long-term changes in temperature and other climate systems (climate change).

Even with small changes to temperature and rainfall we expect a significant increase in damage to communities because of the changing climates effect on the severity and frequency of extreme weather events. Climate change in the QPRC region can cause the breakdown of ecosystems, increased heat-related illness, increased frequency of fires, increased damage to infrastructure and communities, more intense rainfall events, and prolonged droughts.

Rainfall vs Temperature

Current climate modelling is more effective at producing predictions of temperature changes rather than predictions of rainfall changes due to the complexity and number of factors that contribute to rainfall patterns. The precision in location and accuracy in rainfall measurements are likely to improve as climate modelling continues to be developed by climate scientists. This report will be updated annually to reflect any new projection data and continually improve our understanding of the regions changing climate.

SSPs

SSPs are Shared Socioeconomic Pathways that describe how societal choices across the globe could affect GHG emissions. These scenarios are developed by the Intergovernmental Panel on Climate Change (IPCC), which is the United Nations (UN) body that assesses scientific, technical, and socio-economic information relating to climate change. They use this information to produce comprehensive climate change assessment reports. Two of the IPCC's emissions scenarios have been considered in this report.

The SSP1-2.6 scenario, which is described by the IPCC as a sustainable pathway with strong, but not necessarily rapid, reductions in GHG emissions. This pathway would ultimately lead to net-zero emissions by 2050, and appropriate measures would be taken after 2050 to stabilise global temperature increases to around 1.8°C. The SSP3-7.0 scenario is characterised by a high level of GHG emissions and low additions to current climate policies. These two scenarios display a variety of global responses to emissions reductions and are used to project a range of possible future climate change.

Current Global and National Climate Change State

2024 was the warmest year on record with the World Meteorological Organisation confirming that average global temperatures reached about 1.55°C above pre-industrial level (1850-1900). Additionally, all the past ten years (2015-2024) were the ten warmest years on record and land and sea/ocean temperatures are already much higher than pre-industrial era. Rising temperatures in both the atmosphere and our oceans/seas have caused increased intensity and/or frequency of extreme weather events such as heatwaves, droughts, storms, and floods.

Extreme heat in the past decade from climate change has negatively impacted Australians health. It was identified by the Australian Institute of Health and Welfare that extreme heat in the past decade caused the most hospitalisations out of any type of extreme weather. These impacts alone govern the need for emissions reductions in the LGA and for preparing Council and the community for the region’s future climate.

Projected climate

1. 2030 in the QPRC Region

Average Maximum temperatures

	0.5 - 1°C Max temperatures projected to increase by 0.8°C

Average Minimum Temperatures

	0.5 - 1°C Min. temperatures projected to increase by 0.6°C

Average Rainfall

	0 - 15% Rainfall is expected to decrease by 6.6%

Change in Hot Days (35°C or above)

	0 – 5 The number of hot days is expected to increase by 2.3

2. 2050 in the QPRC Region

Average Maximum temperatures

Low emissions scenario (SSP1-2.6)	0.5 - 1.5°C Max temperatures projected to increase by 1.2°C
High emissions scenario (SSP 3-7.0)	1.5 – 2.5°C Max temperatures projected to increase by 2.0°C

Average Minimum Temperatures

Low emissions scenario (SSP1-2.6)	0.5 - 1.5°C Min. temperatures projected to increase by 1.0°C
High emissions scenario (SSP 3-7.0)	1.5 – 2°C Min. temperatures projected to increase by 1.7°C

Average Rainfall

Low emissions scenario (SSP1-2.6)	0 – 15% Rainfall is expected to decrease by 7.7%
High emissions scenario (SSP 3-7.0)	10 – 20% Rainfall is expected to decrease by 14.4%

Change in Hot Days (35°C or above)

Low emissions scenario (SSP1-2.6)	0 – 10 The number of hot days is expected to increase by 3.9
High emissions scenario (SSP 3-7.0)	0 – 10 The number of hot days is expected to increase by 7.0

3. 2070 in the QPRC Region

Average Maximum temperatures

Low emissions scenario (SSP1-2.6)	1 – 1.5°C Max temperatures projected to increase by 1.3°C
High emissions scenario (SSP 3-7.0)	2.5 - 3.5°C Max temperatures projected to increase by 2.7°C

Average Minimum Temperatures

Low emissions scenario (SSP1-2.6)	1 – 1.5°C Min. Temperatures projected to increase by 1.1°C
High emissions scenario (SSP 3-7.0)	2.5 - 3.5°C Min. temperatures projected to increase by 2.5°C

Average Rainfall

Low emissions scenario (SSP1-2.6)	0 – 15% Rainfall is expected to decrease by 10.1%
High emissions scenario (SSP 3-7.0)	5 – 20% Rainfall is expected to decrease by 10.8%

Change in Hot Days (35°C or above)

Low emissions scenario (SSP1-2.6)	0 – 10 The number of hot days is expected to increase by 4.5
High emissions scenario (SSP 3-7.0)	5 – 15 The number of hot days is expected to increase by 10.5

4. Table Explanations:

These tables present plausible future climate baselines for 2030, 2050, and 2070 in the QPRC LGA compared to the baseline average climate calculated from 1990-2009 (year 2000). Every temperature or rainfall prediction contains an estimate and a range (e.g. 1.3°C, 1-1.5°C range). The estimates are compared below, but the ranges around them are not compared for simplicity.

Compared to the 2000 baseline, number of hot days (35°C or above) in a year in the region are predicted to increase by 2.6 by 2030. By 2050, 3.1 more hot days are expected in the SSP3-7.0 emissions scenario compared to SSP1-2.6 (7.0, 3.9 above 2000). By 2070, 6 more hot days are expected in the SSP3-7.0 emissions scenario compared to SSP1-2.6 (10.5, 4.5, above 2000). This shows a clear trend of increased hot days in the future for the region, with a much larger increase in the high emissions scenario.

Compared to the 2000 baseline, average maximum temperatures for a year in the region are predicted to increase by 0.6°C by 2030. By 2050, the high emissions scenario SSP3-7.0 predicts an increase in annual temperatures 2.0°C higher than the year 2000 baseline and SSP1-2.6 predicts a 1.2°C increase (0.8°C difference between scenarios). By 2070, the high emissions scenario SSP3-7.0 predicts an increase in annual temperatures 2.7°C higher than the year 2000 and SSP1-2.6 predicts a 1.3°C increase from the same year (1.4°C difference between scenarios).

Compared to the 2000 baseline, average minimum temperatures for a year in the region are predicted to increase by 0.6°C by 2030. By 2050, the high emissions scenario SSP3-7.0 predicts an increase in annual temperatures to be 1.7°C higher than the year 2000 baseline and SSP1-2.6 predicts a 1.0°C increase (0.7°C difference between scenarios). By 2070, the high emissions scenario SSP3-7.0 predicts an increase in annual temperatures to be 2.5°C higher than the year 2000 and SSP1- 2.6 predicts a 1.1°C increase (1.4°C difference between scenarios).

Average rainfall for a year in the region is predicted to decrease by 6.6% by 2030 compared to the 2000 baseline. By 2050, the high emissions scenario SSP3-7.0 predicts a decrease in annual rainfall by 14.4% below 2000 and SSP1-2.6 predicts a 7.7% decrease (6.7% difference between scenarios). By 2070, the high emissions scenario SSP3-7.0 predicts a decrease in annual rainfall amount by 10.8% below 2000 and SSP1- 2.6 predicts a 10.1% decrease (0.7% difference between scenarios).

The 2030 table constructed in this report does not present two different emission scenarios due to the 2030 (2020-2039) period being close to the baseline period (1990-2009). Firstly, as the SSPs get analysed further and further from the baseline, there becomes a greater difference in atmospheric greenhouse gas concentrations between them and therefore temperature (rainfall being more complex). Secondly, the world's climate systems can take a while to respond to changing greenhouse gas concentrations (climate inertia), sometimes decades or centuries depending on the source of the delay. These things combined explain why the models predicted minimal differences in temperature between the two SSPs only 30 years after the baseline period (2000 – 2030). For those reasons, it was decided that only one SSP would be presented in the table and infographic for this period. This does not mean that a higher emissions scenario won't ever affect climate differently than a low emissions scenario in only 30 years. It just means that for this region, the impact of differing atmospheric greenhouse gas concentrations accumulated by SSP1-2.6 and SSP3-7.0 in the 30 years from 2000 to 2030, combined with the lag time from climate systems only caused a small difference in temperatures. To further clarify, if the baseline period was 50 years earlier (1940-1959) for example, there might have been a more significant difference in temperature between the two SSPs by the 2030 period (2020-2039).

It may be confusing that in the high emissions scenario SSP3-7.0, rainfall is expected to decrease less from 2000-2070 (10.8%) as it is expected to decrease from 2000-2050(14.4%). Rainfall does not decrease steadily with increasing greenhouse gas concentrations, instead as greenhouse gas concentrations increase the frequency and severity of rainfall events change in a number of ways. The climate models' final outputs don't include rainfall severity and frequency estimates and instead project average rainfall over a year-long period. For example, it is possible that the frequency of rainfall events in 2070 could be the same as those in 2050, although in 2070 they are more extreme (therefore higher rainfall), but this is not explained by the climate projections data alone.

5. Possible Effects in the LGA with Changing Climate

Hot days above 35°C or above are dangerous for human health as the body struggles to cool itself down above this temperature. This increases the chance of developing heat stress conditions. Additionally, increased night-time temperatures are also dangerous for human health because low nighttime temperatures allow the body to rest and recover from hot daytime temperatures. With warmer nighttime temperatures, you increase the likelihood of heat stress conditions developing through extensive exposure to high temperatures.

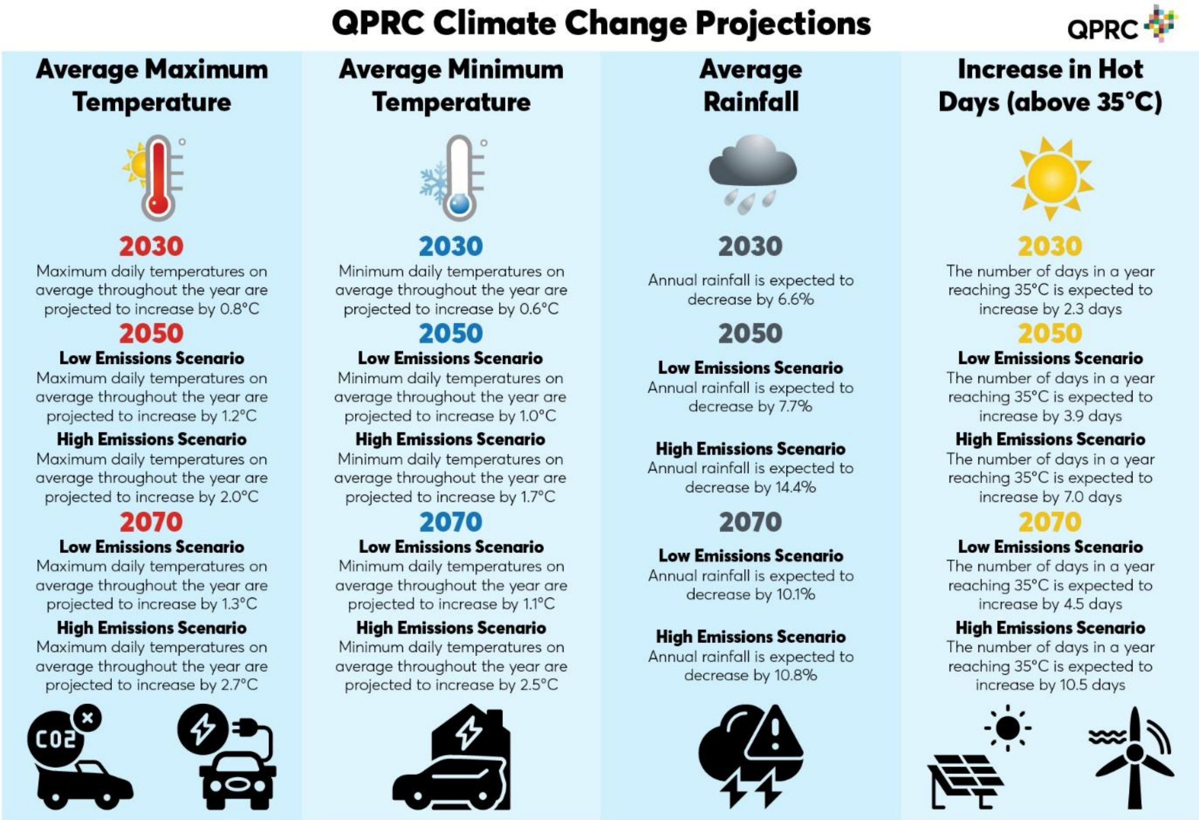
Ultimately, increasing maximum and minimum temperatures as well as hot days would result in increased heat stress and heat-related illness (such as heat stroke) throughout the LGA. This may put additional strain on hospitals, especially when considering extreme heat is currently the dominant extreme weather event causing hospitalisation nationally. This is only expected to increase.

Increased wildfire risk will be observed due to rising temperatures. Drying out of vegetation and soil provides more dry fuel which is easy to burn. This could mean more frequent and intense wildfire seasons across the LGA. This impacts human health by degrading the air quality with smoke as well as damaging agricultural land and ecosystems.

Agricultural stress is expected as temperatures increase and water availability decreases. Crops and livestock are likely to be affected reducing yield for farmers in the LGA causing harm to the economy and farmers wellbeing.

Decreased rainfall will likely cause more severe and frequent droughts impacting the LGAs safe drinking water supply. Additionally, decreased rainfall affects the flow of rivers and streams causing a concentration of pollutants in the water.

6. QPRC Future States Infographic



All these future projections are compared to the baseline average climate calculated from 1990-2009 (representing the year 2000). See full report for more details.

Glossary:

GHG = Greenhouse gases (Carbon dioxide, methane, etc.)

SSP = Shared socioeconomic pathways

QPRC = Queanbeyan-Palerang Regional Council

CO2e = All greenhouse gases combined and calculated at the potency of CO2

LGA = Local government area

IPCC = Intergovernmental Panel on Climate Change

UN = United Nations

NARCliM = NSW and Australian Regional Climate Modelling project

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