Queensland Government

Department of Regional Development, Manufacturing and Water

Queensland's water plans in a variable and changing climate

Towards climate resilience and sustainable water management

December 2023

Acknowledgment of Country

The Department of Regional Development, Manufacturing and Water respectfully acknowledges the Traditional Custodians of Country. We recognise the ongoing spiritual and cultural connection Aboriginal peoples and Torres Strait Islander peoples have with land, water, sea and sky. We pay our deep respects to their Elders past and present, support future leaders, and acknowledge First Nations peoples' right to self-determination.

Department of Regional Development, Manufacturing and Water

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General acknowledgments
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Cover image: Awoonga Dam

Contents

Introduction

Water runs through every part of our lives, our communities, our economy and our environment.

Queensland's water resources are vulnerable to climate change. Climate modelling shows us that, overall, Queensland's climate is likely to be drier in the future, with warmer temperatures leading to greater evaporation, longer periods of dry weather and greater intensity in rainfall events. It is likely that we will experience more frequent, longer and potentially more severe droughts and other intense weather events as a consequence.

Sustainable management

Our changing climate presents risks for all Queenslanders. The Queensland Government uses the best available science and modelling to understand and manage current and future climate risks. We are committed to achieving a climate resilient future. Part of achieving that is ensuring water is managed in a sustainable way through our water plans. These plans, which manage both surface water and groundwater, contain rules for allocating and sharing water, including for extreme events such as droughts when water is scarce for extended periods or floods when water may be plentiful for a relatively short time.

The Department of Regional Development, Manufacturing and Water (DRDMW) aims to build a shared understanding in our community of the risk that climate change poses to our water resources and help water users and businesses better manage the risks to water availability from an increasingly variable and extreme climate. Industry is already becoming more resilient. For example, the agricultural sector is planting more climate resilient crop varieties, towns are diversifying water supplies such as desalination plants and industries are innovating to be more water efficient.

Understanding climate impacts on surface water

This report has been prepared to provide stakeholders with a summary of how Queensland's water planning framework incorporates climate science and manages the risks of climate variability and change to surface water.

Climate change also impacts groundwater recharge, sustainable use, storage and interactions with surface water. However, for groundwater, susceptibility to climate change can vary and in some instances groundwater storages are more resilient against impacts, for example as a result of reduced evaporation from aquifers and extraction from deep aquifers.

Therefore, climate risks to groundwater, including the water resources of the Great Artesian Basin and Other Regional Aquifers water plan area (GABORA), have been excluded from the scope of this report.

Other Queensland Government information available online includes climate change projections in the form of an interactive map on the Queensland Future Climate Dashboard[1]. At the time of publishing, the potential climate change trends and impacts within this report are based on the same GCM AR5 models used for the dashboard, with the results framed to be more relevant to the water planning framework. The dashboard will continue to be updated as newer information becomes available.

1 https://longpaddock.qld.gov.au/qld-future-climate/dashboard/

We are committed to achieving a climate resilient future. Part of achieving that is ensuring water is sustainably managed through our water plans.

Texas

Queensland's variable and changing climate

Queensland already experiences significant variability in our climate, including climate extremes such as floods, cyclones, droughts, heatwaves and bushfires. Climate change is likely to make these extreme events more severe and/or more frequent.

Our climate is changing due to the ongoing rise of carbon dioxide and other greenhouse gases in the Earth's atmosphere, leading to increases in the average temperature which drives much of Earth's climate systems. Changing climate such as temperature and rainfall add to Queensland's natural climate variability and affects the water cycle in complex ways. Given the complexity and numerous drivers affecting local rainfall, there is some uncertainty in exactly how rising global temperatures will affect local water cycles. This uncertainty is incorporated into projections, to ensure a full range of potential changes are considered.

Potential impacts to surface water processes

A changing climate is likely to bring about changes to the amount, timing, and intensity of rainfall. This will increase the risk of both heavy rainfall events and extreme droughts. An increase in temperatures will also increase potential evaporation and greater demand for water for purposes such as crop irrigation and human consumption.

This means there may be less runoff when rain does occur, with less water flowing into rivers, streams and groundwater systems, less water in lakes and storages and more water loss from dams. In the south, cool-season rainfall from cold fronts is likely to reduce. In the north, monsoon troughs that deliver widespread rainfall may become less frequent, but more intense, leading to cycles of drought and flood. On the coast, tropical cyclones are likely to become less frequent but more intense and may travel further south. The convective storms that bring rainfall to the coastal mountains in the wet tropics may become less frequent, especially in the cool season[2].

Climate change may cause the timing of flow events in a river system to shift as well. For example, a seasonal flush which traditionally happens around spring may arrive later in summer instead. This can have detrimental effects on the ecology, such as for species that rely on the timing of flows to trigger a spawning event, or agricultural practices that rely on the rainy season starting at a certain time to grow certain crops.

[2] https://climatechangeinaustralia.gov.au

A changing climate is likely to bring about changes to the amount, timing and intensity of rainfall.

This will increase the risk of both heavy rainfall events and extreme droughts.

Queensland's water planning framework

Water plans in Queensland are developed under the *Water Act 2000* (the Act) to sustainably manage and allocate water resources in Queensland.

- Climate variability has long been considered in water plans to manage Queensland's naturally variable climate through the use of hydrological models that incorporate long-term historical flow variability. These water plans are developed with community input and tailored to balance water demands from towns, agriculture activities and industries, with that of the environment and social and cultural values.
- Water plans determine the amount of water available in an area and how it can be allocated and managed. Further details are included in subordinate documents such as water management protocols, resource operations licenses, water supply scheme operation manuals and water entitlement notices.
- A water plan uses the latest science to set out economic, social, cultural and environmental outcomes. It specifies unallocated water reserves (water that may be allocated for future use) and establishes objectives to ensure a level of protection for environmental flows and water allocation holders is maintained. Collaboration is key to identifying and achieving these shared goals, and the water planning framework provides many opportunities for stakeholders to influence the content of water plans during their development and review.
- Decision-support tools, such as hydrological models, allow us to understand current and possible future flows in a catchment and support the development of technical assessments. Using this science, water plans consider the risk posed to the environment and consumptive objectives stated within water plans under different scenarios for managing water, for example under increased take. This information is used to ensure that any changes to a water plan, or shifts in prevailing conditions, do not negatively impact the stated economic, social, cultural and environmental outcomes. Water users and stakeholders are engaged during the development of water plans to help us understand how decision-making might impact stakeholders beyond what our modeling tells us. Technical information and risk assessments are provided to stakeholders for feedback on draft water plans.
- Under the Act, the Minister must consider the "water-related effects of climate change on water availability" when drafting a water plan. The latest climate change projections are part of the many scenarios used to inform the risks when developing a water plan. This helps us to understand how projected changes in temperature, evaporation and rainfall may further influence water flows. This informs whether there are likely to be additional water availability risks posed to the environment and water users over the ten-year water plan life as a result of climate change impacts. This is to:
  - help ensure that water plan strategies and rules are made considering the risk of water-related impacts from climate change during the life of the water plan
  - promote community awareness of the possible longer-term implications of climate change on water availability.

Adaptive water planning

DRDMW approaches water planning using an adaptive water planning cycle (Figure 1). This allows for plans to be risk-based and respond over time to changing conditions or needs.

Implementation of the plan involves application of a wide range of policies, regulations and activities to ensure that the intended outcomes are being met. This includes undertaking appropriate environmental and hydrological data collection as part of a monitoring, evaluation and reporting strategy. Regular evaluation and reporting provides the opportunity to consider the current best available science and information and communicate any identified risks to stakeholders on a regular basis.

DRDMW undertakes a performance assessment of a water plan for the Minister after it has been in place for 5 years. This is an important step in the cycle for ensuring transparency around water plans and indicates whether they are achieving their intended outcomes. As well as the formal water planning process, DRDMW will share information related to water management practices and the measurement and modelling of water resources to help water users plan for their own needs. The most up to date climate information is published at the Queensland Future Climate Dashboard[3].

Figure 1: Adaptive water planning cycle

[3] http://longpaddock.qld.gov.au/qld-future-climate/dashboard/

Each water plan has a life of 10 years but may be amended, replaced or extended for another 10 years by the Minister in consultation with the community. The effectiveness of a water plan and its implementation is also assessed at 5-yearly intervals. Climate change risks are assessed at each of these intervals and incorporated into the plan at the review stage, if necessary. In addition, a plan amendment or review and replacement may be triggered at any time in response to:

- newly identified risks
- the need to accommodate new water management arrangements or water infrastructure
- address issues identified to ensure the plan outcomes are achieved and water is managed sustainably.

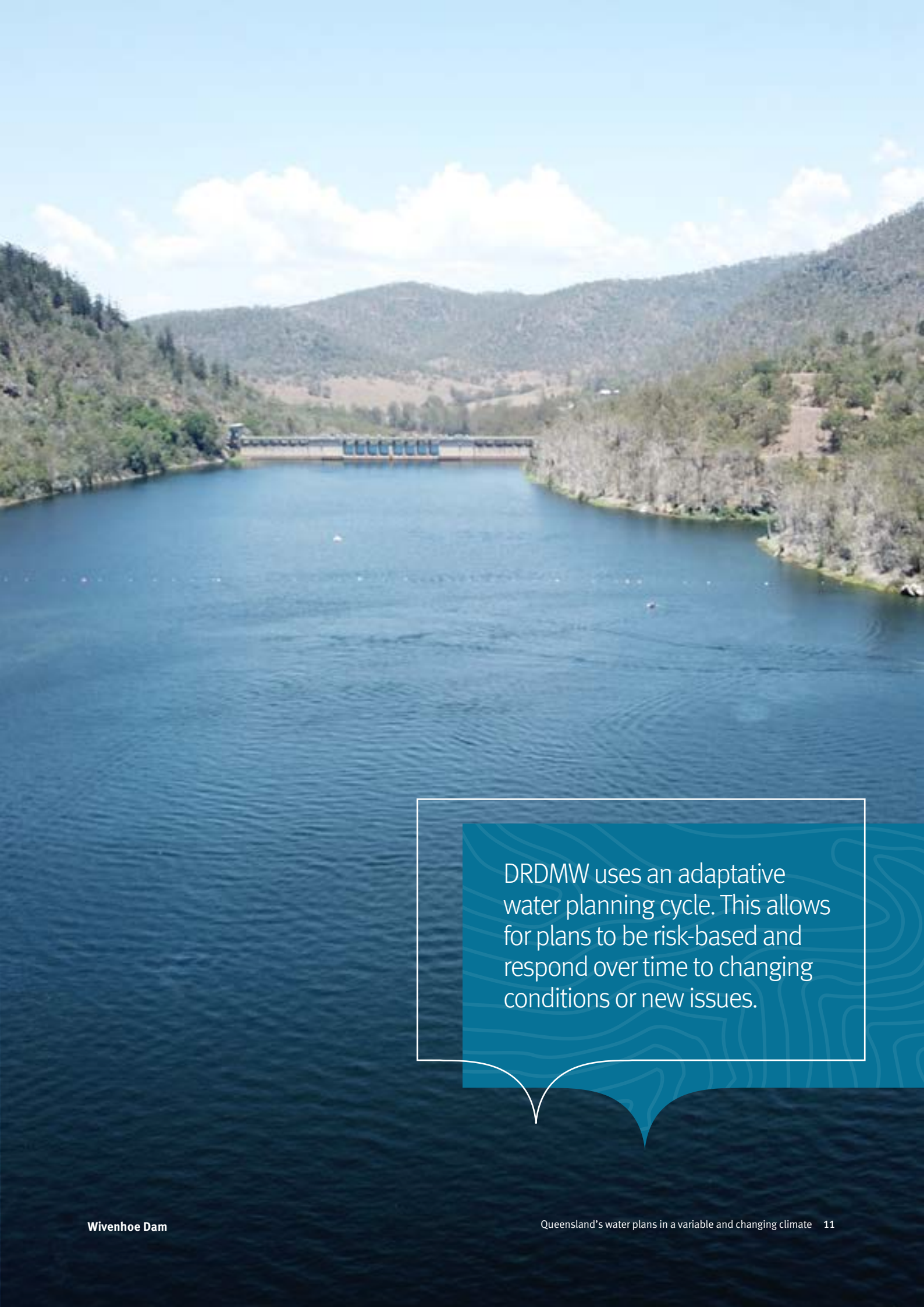
Water plans support responses to climate variability, including by providing for trading water entitlements between different users, and by setting up arrangements for sharing water during extreme droughts to ensure that critical human needs are met. These provisions are incorporated into water plans to suit local circumstances. Each water plan is designed to manage the risk of existing climate variability that will be experienced over the life of the plan. The risks posed by longer-term changes in climate are assessed and incorporated into plans when they are reviewed.

If a water plan is to be replaced, the hydrological model that supports it is updated to include new climate science. This ensures the water related effects of climate change are appropriately considered and up to date. At this part of the cycle, the Queensland community is provided access to the various assessments and draft water plan and invited to give feedback on water-related issues.

This is when potential changes in water availability due to climate change are examined for the new plan. If there is a potential change in water availability, the new draft plan may include different rules and settings compared to the old plan. This includes catering for environmental water needs and essential services, and to support water users to adapt and respond to climate variability. The draft plan will then be shared with the community for consultation and feedback.

In addition to the water planning framework, the Act provides for urgent action to be taken by the Minister or DRDMW if there is a shortage of water, including to safeguard critical human water needs.

More information on water planning in Queensland is available at Appendix D.



DRDMW uses an adaptative water planning cycle. This allows for plans to be risk-based and respond over time to changing conditions or new issues.

Wivenhoe Dam

Water modelling as a support tool and how climate risk is considered

Models are computer driven representations of real-world relationships between different variables, such as rainfall, run-off and flows in a river. These representations allow us to understand how changes in one variable, such as rainfall, might drive changes in another, such as flows in a river.

Global climate modelling

Models are integral to identifying and considering the potential impacts to water from climate change. For water plans, a number of models — starting at the global scale — are used to project how global climate change could impact individual catchments in Queensland. DRDMW collaborates closely with the Queensland Department of Environment and Science (DES) to consider potential implications.

Various models of the global climate, called General Circulation Models (GCMs), are used to project future changes in evaporation and rainfall at the broad scale. There are many models available for use, and DES has selected 11 of these models that best represent key aspects of Queensland's climate. These are used for determining projections for a suite of climatic variables, including evaporation and rainfall, within a water plan area. The latest outputs from these models have been applied at an appropriate scale for water plans through a process called downscaling.

Downscaling uses the outputs from each GCM, which are typically on a broad scale, and uses them as inputs to another model which incorporates finer scale, region-specific parameters. The model used to downscale the GCM outputs is a regional climate model (RCM) that represents the climate patterns that are unique to Queensland, such as the high-rainfall zones on the coastal ranges.

How our global climate will change in the future will be linked to how we respond in managing greenhouse gas emissions. Representative Concentration Pathways (RCP), provide a way to describe alternative future emissions pathways and consider how atmospheric concentrations of greenhouse gases may change under future global policies and interventions.

These pathways are defined by the Intergovernmental Panel on Climate Change (IPCC) and range from 2.6 to 8.5, reflecting the level of action undertaken to mitigate emissions. The level of climate action taken corresponds with the amount of projected change in global temperatures–greater emissions reductions will lead to more modest increases in global temperature (Figure 2). Projected temperatures are similar across all scenarios until approximately 2030. As with all projections, there is a level of uncertainty, which increases into the future.

In recent years, the concentrations of greenhouse gases have been approximating to the pathway RCP8.5. This represents the scenario where the world continues with its existing and high levels of greenhouse gas production and relatively minimal intervention, along with other assumptions about technological advances, industrial trends and land use.

Currently, the level of global action and proposed commitments to mitigate climate change more closely reflects a moderate emissions trajectory (RCP4.5 pathway). Therefore, our future climate scenarios will need to evaluate

both the RCP8.5 and 4.5 pathways as the most likely range of possible climate futures over the coming years.

The GCMs simulate the effect on the planet that these different emissions pathways have and project how that could affect temperatures, evaporation and rainfall into the future. This report provides an overview of the effect of climate change on water plan areas based on both the RCP4.5 and RCP8.5 scenarios, looking approximately 10 years into the future (the year 2030) and 30 years into the future (the year 2050).

Incorporating climate projections into water modelling

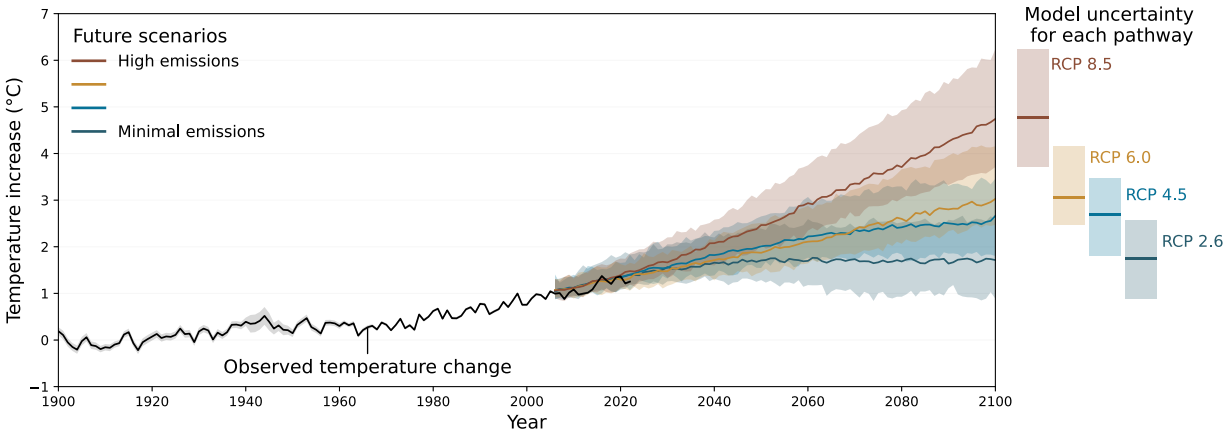
The outputs of the climate models are 'scaled down' to regional level and used as input for the hydrological models that inform water plans. Although climate modelling outputs are at a finer scale, the results are still too coarse to make projections at the property scale.

The models of the water system, including the hydrologic network, are used to determine information about the availability of water in that system at any point in time and over the long term. They are a tool that helps us compare the possible outcomes under different water management scenarios and are essential to assess the potential risk of decisions. They allow us to test and gather information to help inform decision making rather than exactly predicting the future.

The models that are used to inform water plans represent the physical processes within a catchment or river basin that determine how much of the rainfall becomes flow in a river or groundwater in an aquifer, including how that may move and be stored as it flows through the system. As the climate changes, not only does the amount and timing of rainfall change, but some of the physical catchment processes can also change. Given that there is uncertainty around the possible extent and location of the changes, we test different climate scenarios to see what might happen in a range of different climates. The models also represent water supply systems such as dams, pumps, pipelines, and irrigation areas, and are used to assess what would happen if we operated the system in different ways.

In this way, we can compare how much water has been available, using recorded data, with how much water may be available in the future under different possible climate scenarios. We must then make a decision about the consequence of these outcomes to be able to assess risk and make a decision about what to do.

Figure 2: Global projected temperature change for IPCC AR5 Representative Concentration Pathways[4]



[4] All temperature values are reported on relative to the pre-industrial (1850–1900) baseline.

GCM projection data is from the IPCC CMIP5 models (sourced from Climate Explorer http://climexp.knmi.nl/selectfield_cmip5.cgi) and has been bias corrected using the observed 1986–2005 average.

GCM projections are reported using the median temperatures from all CMIP5 models.

These 95 per cent uncertainty bands have been provided for the GCM projection data and represent the variability observed across the different CMIP5 models.

Climate change impacts in water plan areas

In this section, we present a range of climate projections from the 11 GCMs used to represent Queensland's potential future climate, based on the RCP4.5 and RCP8.5 emissions scenarios.

Climate change is already occurring to some extent across the state, with some climate trends common to all areas and others specific to certain regions. The models help us to understand how projected changes in temperature, rainfall and evaporation may further influence water flows in different areas. Appendix A provides a snapshot of potential climate impacts in each water plan area. Appendix B provides the climate projection data specific to each water plan area[5].

In this section, the range of projected changes are described across Queensland.

Temperature projections are presented as the change in average daily temperature in degrees Celsius (^{0}C) in comparison to the reference period from 1986 to 2005[6] (Table B.1). The projections of evaporation and rainfall are presented as a per centage change compared to the average over the period from 1986 to 2005 (See Figures 4 and 5 and Tables B.2 and B.3). Because they represent the change in average conditions, they do not represent the change in probability of extreme events such as floods, cyclones, or extremely dry seasons.

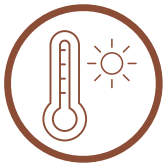
Lower, median and upper projections reflect the uncertainty in the changes projected by our models. It is important to consider this uncertainty so that risks can be managed under a range of possible future scenarios. The median projection represents the middle change we might see, based on all of the 11 model outputs considered. The lower and upper projections are the 10th and 90th per centiles of the spread of the GCM projections, while the median is the 50th per centile. The range of values between the lower and upper projections provides an 80 per cent confidence interval.

[5] Excludes the Great Artesian Basin and Other Regional Aquifers water plan area (GABORA).

[6] This period is adopted to be consistent with the IPCC.

Climate projections from 11 General Circulation Models are used to represent Queensland's potential future climate.

Goondiwindi township on the banks of the Macintyre River



Temperature

Figure 3 shows the lower, median and upper projections from GCMs for the absolute change in average daily temperature across the water plan areas of Queensland for the years 2030 and 2050 for both RCP4.5 and RCP8.5.

In all cases, the temperature projections show an increase in temperature across the state over time, which is more pronounced under the RCP8.5 scenario, particularly over the longer term (also see Table B.1).

Tables 1 and 2 provide summaries of the range of projected temperature changes compared to the reference period (1986–2005), when looking across all water plan areas.

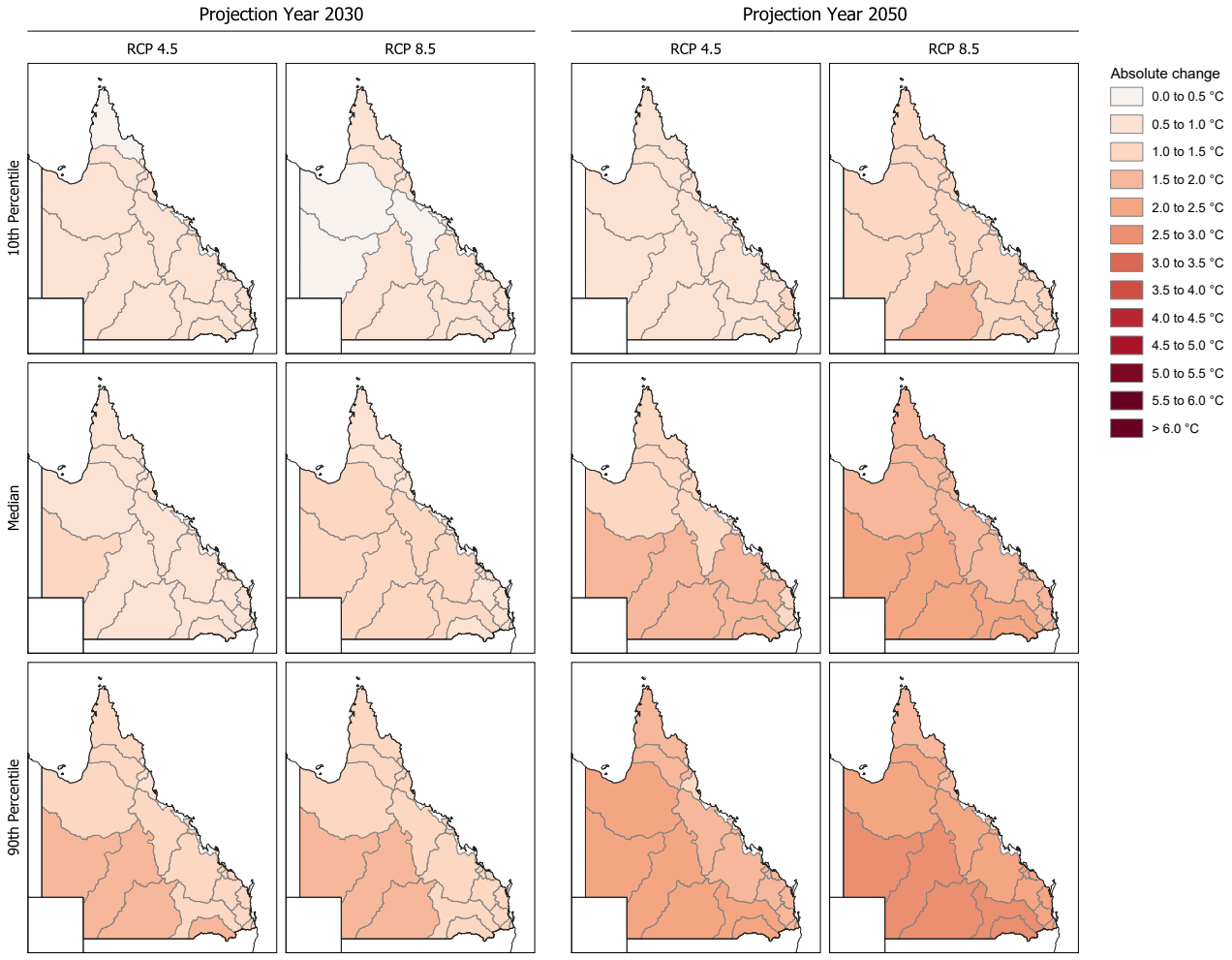
Table 1: Range of projected temperature changes across the state under RCP4.5

RCP4.5	2030	2050
Lower	0.4 to 0.8°C	0.6 to 1°C
Median	0.8 to 1.1°C	1.2 to 1.8°C
Upper	0.9 to 1.6°C	1.5 to 2.2°C

Table 2: Range of projected temperature changes across the state under RCP8.5

RCP8.5	2030	2050
Lower	0.4 to 0.8°C	1.1 to 1.5°C
Median	0.8 to 1.2°C	1.5 to 2.3°C
Upper	1.1 to 1.6°C	2 to 2.8°C

Figure 3: Projected absolute change in daily temperature from the reference period (1986–2005) for the years 2030 and 2050 and emissions scenarios RCP4.5 and RCP8.5 across all water plan areas[7].



[7] The projections and their associated uncertainty are represented by the lower (10th per centile), median and upper (90th per centile) statistics of GCM outputs.
The projections were processed in July 2021 from downscaled GCM outputs sourced from the Queensland Future Climate Dashboard (https://longpaddock.qld.gov.au/qld-future-climate/dashboard/)

Note that uncertainty bands (see Figure 2) are overlapping between RCP4.5 and RCP8.5 resulting in local projected scenarios that may have higher values for RCP4.5 (lower emission scenario) than for RCP8.5 (higher emission scenario) in the 10th and 90th per centile maps.

Evaporation

Figure 4 shows the lower, median and upper projections from GCMs for the relative change in annual potential evapotranspiration (PET) across the water plan areas of Queensland for the years 2030 and 2050 for both RCP4.5 and RCP8.5.

Potential evapotranspiration refers to the combined process of evaporation from surface water, the soil and water released by plants through transpiration under conditions of unlimited soil water supply. This includes water loss from rivers, lakes and open water storages, such as dams.

The projections generally show an increase in annual evapotranspiration across all Queensland catchments.

Tables 3 and 4 provide summaries of the range of projected evaporation changes compared to the reference period (1986–2005), across all water plan areas.

The direction of the evaporation trend is a relatively robust projection, with almost all models projecting a steady increase through time (see Figure 4 and Table B.2). Higher evaporation will lead to greater losses of water from river systems, lakes, dams and storages. It also means crops will require more water as more is lost to both evaporation and transpiration directly from the plants. The highest increases in evaporation are likely to occur in southern, central and inland water plan areas such as the Burdekin, Boyne, Burnett, Fitzroy, Georgina and Diamantina, the Cooper Creek, Gulf, Logan, Moreton, Condamine and Balonne, Border Rivers and the Warrego, Paroo, Bulloo and Nebine water plan areas.

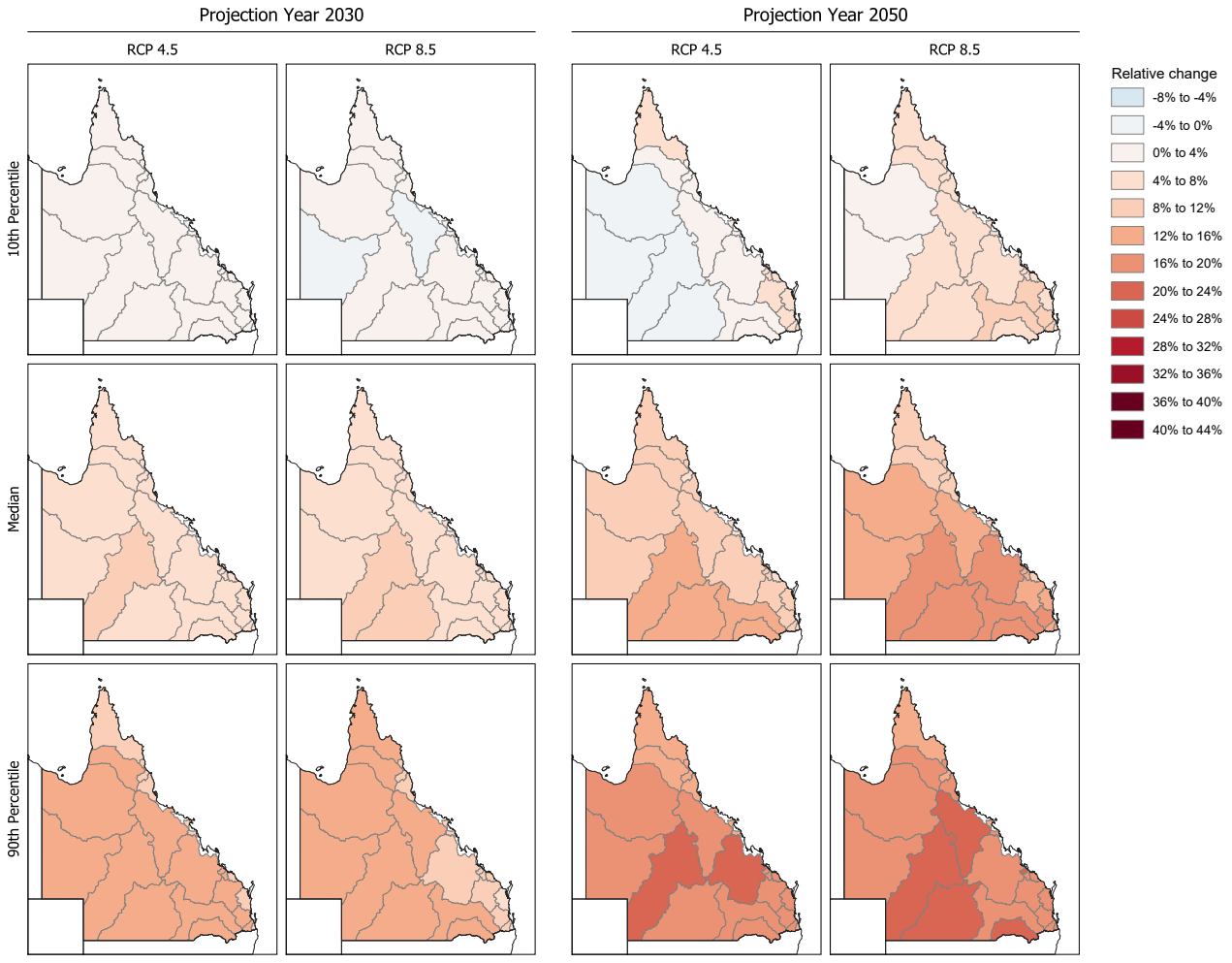
Table 3: Range of projected evaporation changes across the state under RCP4.5

RCP4.5	2030	2050
Lower	0 to 4%	-2 to 6%
Median	3 to 9%	6 to 14%
Upper	9 to 16%	13 to 20%

Table 4: Range of projected evaporation changes across the state under RCP8.5

RCP8.5	2030	2050
Lower	-1 to 3%	3 to 11%
Median	4 to 9%	10 to 18%
Upper	8 to 14%	15 to 21%

Figure 4: Projected relative change in annual potential evapotranspiration from the reference period (1986–2005) for the years 2030 and 2050 and emissions scenarios RCP4.5 and RCP8.5 across water plan areas[8].



8 The projections and their associated uncertainty are represented by the lower (10th per centile), median and upper (90th per centile) statistics of GCM outputs. The projections were processed in July 2021 from downscaled GCM outputs sourced from the Queensland Future Climate Dashboard (https://longpaddock.qld.gov.au/qld-future-climate/dashboard/)

Note that uncertainty bands are overlapping between RCP4.5 and RCP8.5 resulting in local projected scenarios that may have higher values for RCP4.5 (lower emission scenario) than for RCP8.5 (higher emission scenario) in the 10th and 90th per centile maps.

Rainfall

Figure 5 shows the lower, median and upper projections from GCMs for the relative change in annual rainfall across the water plan areas of Queensland for the years 2030 and 2050 for both RCP4.5 and RCP8.5.

The projected impact of climate change on annual rainfall is more variable across water plan areas than evaporation, reflecting uncertainty in the projections The direction of the rainfall trend is relatively uncertain, with some GCMs predicting an increase and others predicting a decrease in rainfall from the reference period (see Figure 5 and Table B.3). In reality, it will likely be difficult to discern a trend in annual rainfall relative to natural variability.

Tables 5 and 6 provide a summary of the range of projected rainfall changes compared to the reference period (1986–2005) when looking across all water plan areas. Most models project that rainfall is likely to decrease slightly in winter when rainfall and streamflow are already low.

Although the likely trend in rainfall is unclear, climate models project that the intensity of extreme rainfall events is likely to increase. In the reef catchments, projections show that tropical storms and cyclones may occur less frequently in the future, but are likely to be more intense. These intense events are projected to occur in coastal catchments further and further south. In northern tropical areas, large monsoon troughs that provide most of the rainfall in northern and inland areas may also occur less frequently but become more intense. The small-scale convective storms that provide much of the rainfall to coastal mountains in the wet tropics are likely to decrease, especially in the cooler months. In the southern catchments, cool season rainfall from cold fronts is also likely to decrease.

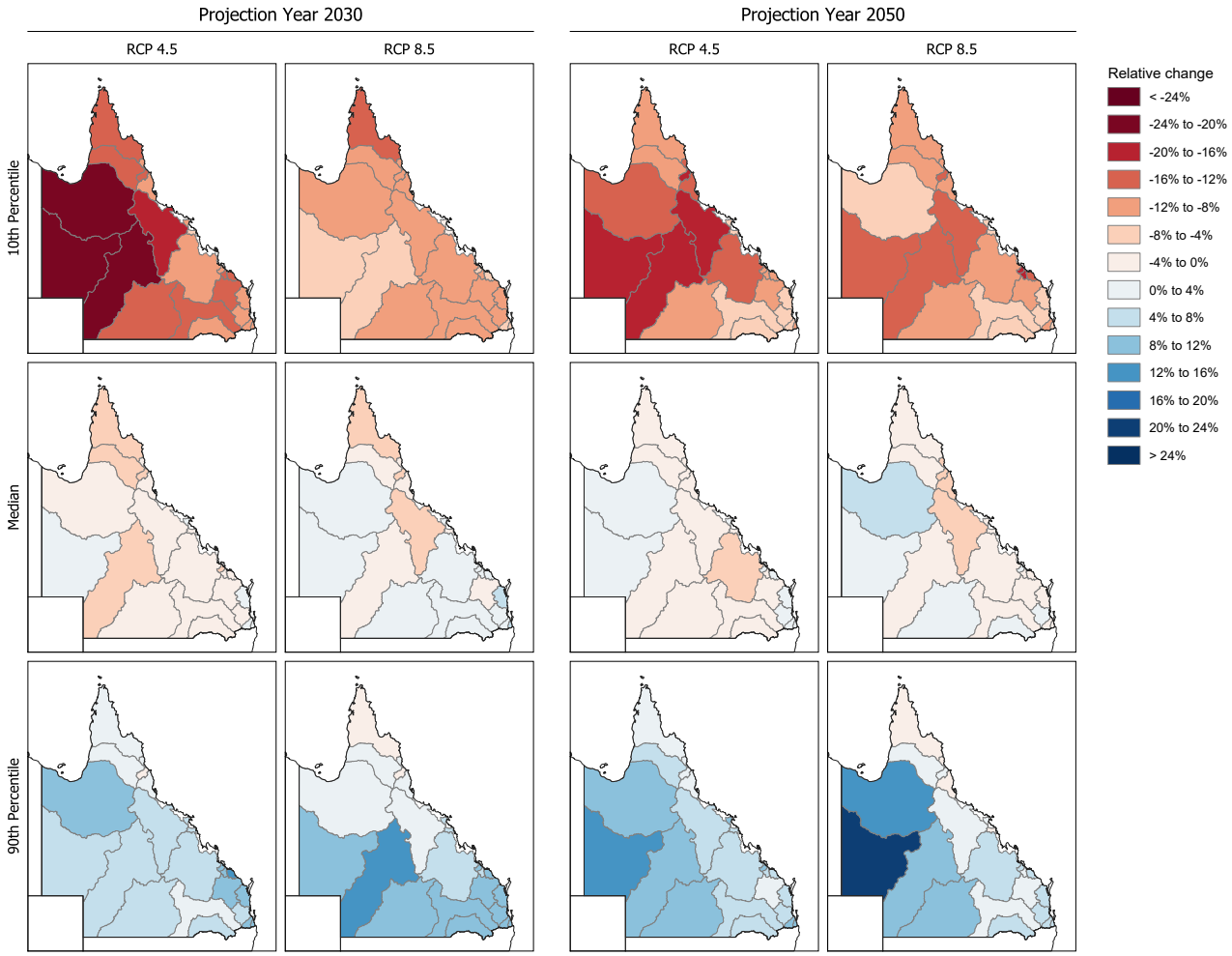
Table 5: Range of projected rainfall changes across the state under RCP4.5

RCP4.5	2030	2050
Lower	-8 to -23%	-20 to -5%
Median	-6 to 4%	-4 to 3%
Upper	0 to 13%	1 to 15%

Table 6: Range of projected rainfall changes across the state under RCP8.5

RCP8.5	2030	2050
Lower	-15 to -4%	-18 to -5%
Median	-6 to 6%	-7 to 4%
Upper	-2 to 12%	-2 to 12%

Figure 5: Projected relative change in annual rainfall from the reference period (1986–2005), for the years 2030 and 2050 and emissions scenarios RCP4.5 and RCP8.5 across water plan areas[9].



[9] The projections and their associated uncertainty are represented by the lower (10th per centile), median and upper (90th per centile) statistics of GCM outputs. The projections were processed in July 2021 from downscaled GCM outputs sourced from the Queensland Future Climate Dashboard (https://longpaddock.qld.gov.au/qld-future-climate/dashboard/)

Note that uncertainty bands are overlapping between RCP4.5 and RCP8.5 resulting in local projected scenarios that may have higher values for RCP4.5 (lower emission scenario) than for RCP8.5 (higher emission scenario) in the 10th and 90th per centile maps.

Summary

Climate change represents a significant challenge for water management in Queensland. By using the latest climate science and incorporating this science into our models, we can better understand climate change impacts and incorporate these insights into our water planning.

Our water planning framework already provides a robust and risk-based process to manage emerging risks to water availability. They are developed with community input and tailored to balance the needs of water users, such as urban water use, agriculture and other industries, with the environment and social and cultural values.

The latest climate change projections are now being combined with our historical hydrological modelling to help us understand how projected changes in temperature, rainfall and evaporation may further influence water flows. This information will assist us with regularly updating our water plans with information on local climate risk assessments, and strategies for adaptation.

Over the next 5 years, 15 of the 23 water plans across the state will expire. This triggers an evaluation of each plan to assess whether it remains fit for purpose. This means Queensland is in an ideal position to incorporate climate science into our water planning to ensure we are adapting to changing conditions.

Each water plan review presents an opportunity to engage with stakeholders to understand the risks and opportunities of a variable and changing climate at the local level. Climate change information will be incorporated into our technical assessments which will then be shared with the community for consultation and feedback.

While this report focuses on water planning, DRDMW is working closely with DES, other departments and stakeholders to address the immediate and long-term impacts of climate change on water. These include:

- building our understanding of water availability impacts on water supply scheme performance, ecological and cultural values, access to water entitlements and water use behaviour
- providing information to water users and the community on likely climate impacts and working with communities, industry, researchers, stakeholder groups and others to continue conversations about adaptation solutions and preparedness
- engaging with people across Queensland and beyond to understand the water interests of our communities, our Aboriginal peoples and Torres Strait Islander peoples, our economies and our diverse environments
- collaborating with other government departments to help Queensland's water users understand their water and its value
- continually updating water monitoring and measurement technologies, including using remote-sensing technology to track how water moves through, and is available in different landscapes

- working across government and with researchers and industry experts to model how our water storage, treatment and distribution infrastructure perform under extreme weather event scenarios and consider new infrastructure solutions
- partnering with water service providers to understand their water supply security risks and the ability of water supply systems to meet future growth, with consideration given to potential climate change impacts
- collaborating with local stakeholders to complete assessments of water needs in some of the State's most significant food bowl regions to identify opportunities to improve water security and support food security planning.

While much progress has been made, climate science and knowledge is continually evolving. We are committed to continually building our understanding of climate impacts to develop better responses to risks for our water resources.

Appendix D provides links to a range of information sources used in this report.

Water plan reviews present an opportunity to engage with stakeholders at a local level to understand the risks and opportunities of a variable and changing climate.

Get in Contact

We are always interested in feedback from communities and stakeholders on our current processes and what people are seeing on the ground. If you have any questions or would like to contribute to the conversation about water plans in a variable and changing climate, please contact info@rdmw.qld.gov.au.

Appendix A

Climate projections for individual water plan areas

Climate science projections

The climate and hydrological forecasting models that underpin our decision-making help us to understand how projected changes in temperature and rainfall may impact water flows in different areas.

Climate change trends and their potential impacts on the environment and water user groups are considered in Queensland water planning, and will be incorporated into the technical assessments undertaken in all future water plan reviews. All plans are regularly assessed to ensure they continue to achieve their objectives in a variable and changing climate.

The 3 main factors the models look at are temperature, rainfall and potential evapotranspiration (PET). Potential evapotranspiration measures the amount of water that would be taken into the atmosphere, if the water were available. It includes water from soil, water courses and plants. It is possible for PET to be higher than actual evapotranspiration if the atmosphere could absorb more water than is available.

These factors are examined under a range of levels of greenhouse gas emissions. The more greenhouse gas emissions, the more heat is trapped in the Earth's atmosphere.

Climate modelling from 11 general circulation models (GCMs) has been used to project the impact of low and high greenhouse gas emission scenarios on Queensland water plan areas for the years 2030 and 2050. The low emission scenario is called RCP4.5. This represents a level of greenhouse gas emissions that would mean that the amount of energy at the Earth's surface is 4.5W/m^2 more than at pre-industrial levels. The high emission scenario is RCP8.5.

The high emission scenario (RCP8.5) shows what might happen if we continue existing greenhouse gas production with relatively minimal intervention, along with other assumptions about technological advances, industrial trends and land use.

Currently, the level of global action and proposed commitments to mitigate climate change more closely reflects a moderate emissions trajectory, which will fall somewhere between the low emissions pathway (RCP4.5) and the high emissions pathway (RCP8.5).

General findings across the state

The climate models predict there will be general overall warming across the state.

The projected temperature increases tend to be similar across both RCP scenarios until approximately the year 2030 or 2040, when the level of impact increases more significantly under RCP8.5. Evaporation, specifically PET, is also projected to increase across the state.

Climate change projections for individual water plan areas

Potential changes in climate are different in each water plan area. The following snapshots provide information to water users and the community on likely climate impacts specific to each water plan area. Each snapshot provides a map of the water plan area, graphs summarising the projected climate impacts, and some high-level statements for that area.

The Future Climate Dashboard[10] uses the same data source. It presents climate change projections for Queensland in an interactive map and complements the information in these snapshots.

[10] https://longpaddock.qld.gov.au/qld-future-climate/dashboard/

Understanding the climate change statements and graphs

The projections for each water plan area are averages across the whole water plan area. The projections are not currently accurate enough to provide information on a smaller scale, for example by town or property.

The long-term trends presented in the snapshots are as compared to the historical period of 1890–1980. Future projections for the time windows at 2030 and 2050 are based on the 20-year reference window 1986–2005.

When we look at climate impacts (projection statements), we look at:

- the direction of projected change (decrease/no trend/increase)
- the magnitude of change (none/slight/small/medium/large)
- the level of confidence in the projection (weak/moderate/strong).

Annual climate graphs (observed values and future projections)

The annual climate graphs include a temperature, rainfall and evaporation chart for each water plan area. There is large uncertainty in the rainfall projections but less uncertainty in the temperature and evaporation projections.

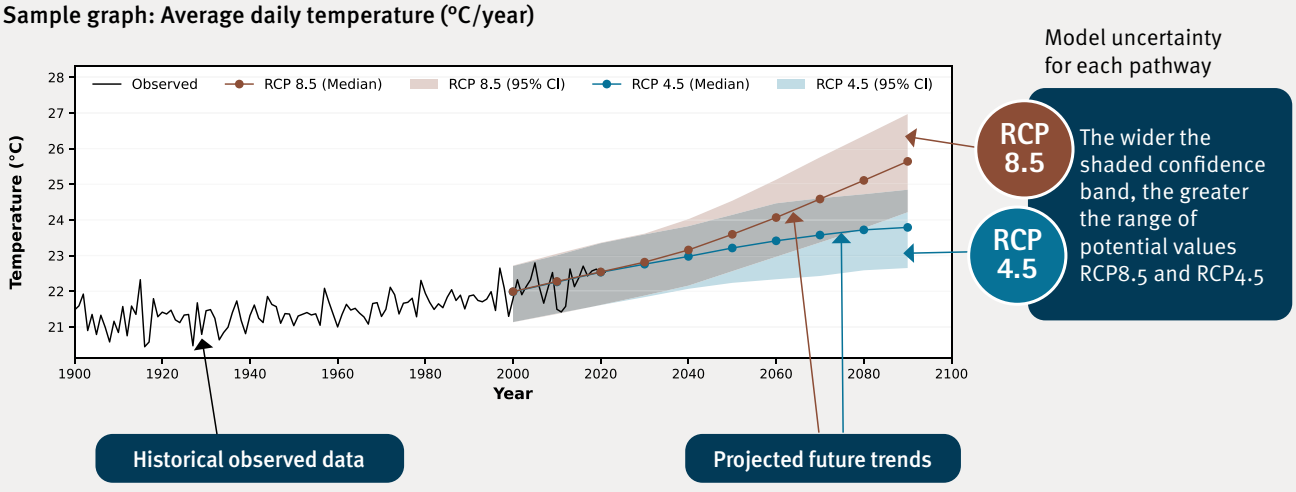
They show the observed data (what has already happened) and the projected future trends out to 2090. The observed data (black line) tracks the actual values giving an indication of the natural variability in the climate. The future trends are shown as shaded bands — red for the high emissions scenario (RCP8.5) and blue for the lower emissions scenario (RCP4.5). The wider the bar, the greater the range of possible values, which means that there is more uncertainty about what the actual result will be.

Comparing the historical average observations with recent average observations can indicate whether there has already been a significant change in climate.

When viewing the annual climate graphs, please note that:

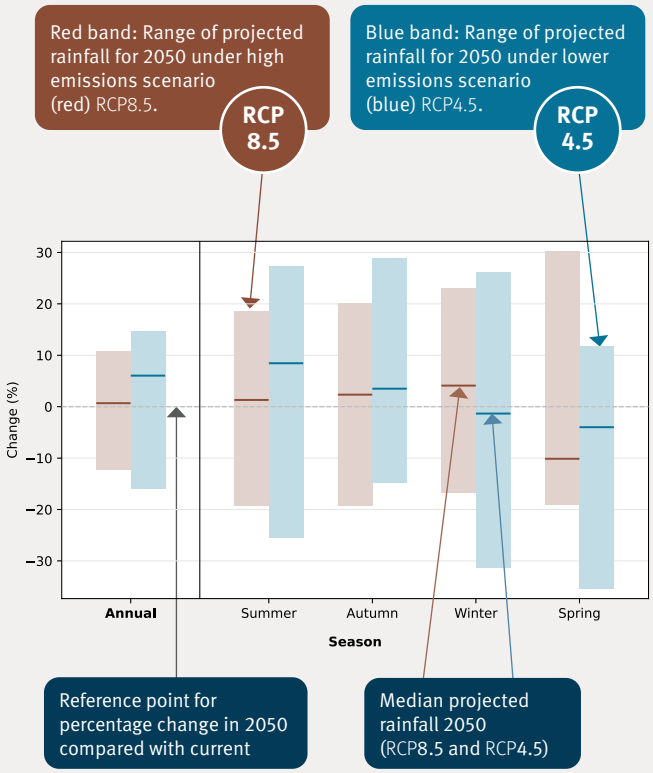
- all observed climate data are from the SILO gridded dataset and have been averaged over the water plan area.
- all projected climate data are from the Queensland downscaled GCM dataset and have been averaged over the water plan area.
- projected changes are from the reference period 1986–2005 to a 20-year window to calculate the median value for the target year, surrounded by the possible ranges.
- all projections have an associated uncertainty with 95 per cent confidence bands provided. These confidence bands capture the range of outputs from the 11 GCMs used, while considering the underlying historical variability.

Sample graph: Average daily temperature (°C/year)



Seasonal projections

Median and range of projected change in average annual and seasonal rainfall in 2050



The statements about seasonal projections summarise the projected future trends for temperature, evaporation and rainfall out to 2090, and rainfall for 2050 specifically.

The seasonal projection graphs show annual and seasonal rainfall only. The annual average rainfall has been included with the seasonal graphs to highlight that in some water plan areas, the seasonal projected increases/decreases may be significant, but across the whole year the changes might not be as pronounced.

The coloured bands show the range of projected rainfall levels for 2050 under the two scenarios: high emissions (red) and lower emissions (blue). There may be a difference in the direction of magnitude of change between the 2050 time-window changes and the overall long-term trend (shown in projected annual climate graphs) due to the large range of projected potential changes up until 2090. The coloured line shows the median amount of rain projected to fall in 2050, based on models run with data between 2040 and 2060. The dotted line is the reference point for per centage change in 2050 compared with current, defined as the average value from the period 1986–2005.

The level of confidence for seasonal projections is weak, so no commentary is provided on the magnitude of the change in 2050.

When viewing the seasonal graphs, please note that:

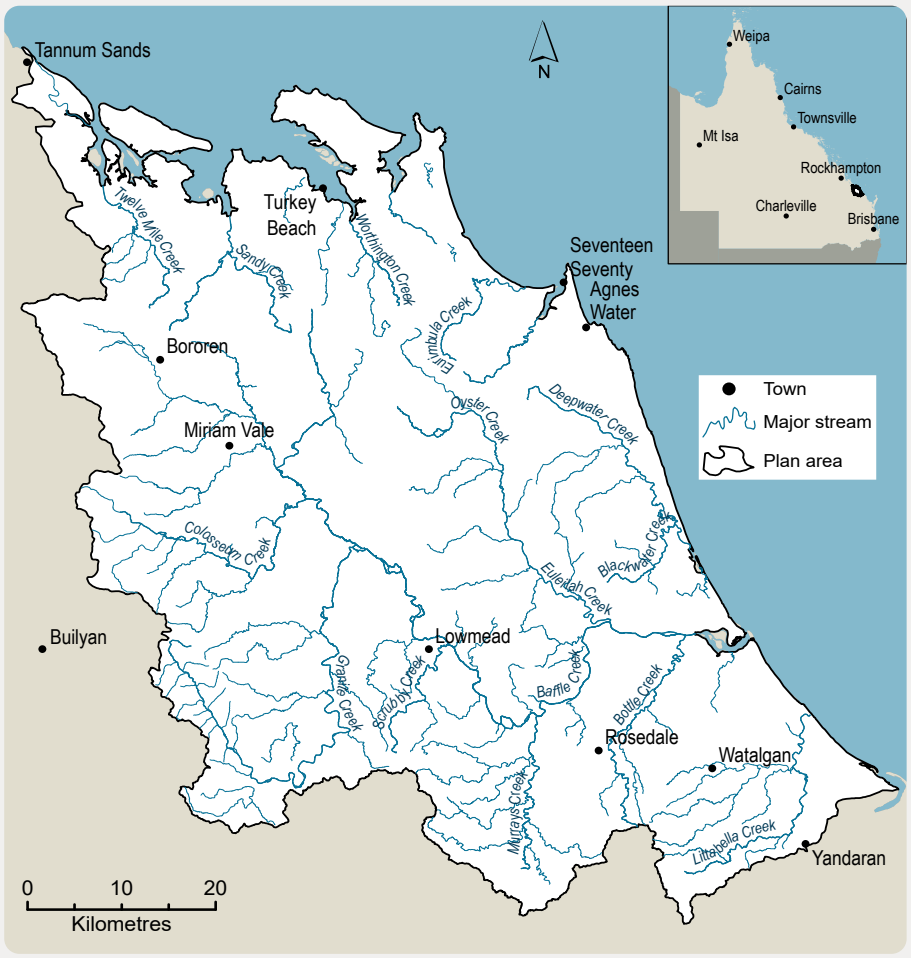
- all projected climate data are from the Queensland downscaled GCM dataset averaged over the water plan area.
- projected changes are from the reference period 1986–2005 to a 20-year window centred on the target year 2050.
- for each season, the median, minimum and maximum projections of the set of GCMs is included.

Comale Lagoons, north of Dirranbandi

Emerging trends in observed data

Where a variable, such as temperature, is said to have an emerging trend, this refers to the point when the underlying climate signal significantly changes from the natural variability. Conversely, 'no emergence of significant change' means any possible trend in the recent historical period is likely to be natural variability or not yet strong enough to indicate a clear change.

Baffle Creek Basin



Average daily temperature °C*

RCP8.5	RCP4.5
+0.9°C 2030	+0.8°C 2030
+1.6°C 2050	+1.3°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+4% 2030	+4% 2030
+12% 2050	+7% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+4% 2030	-1% 2030
-1% 2050	+2% 2050

Baffle Creek Basin water plan area at a glance

The Baffle Creek Basin water plan area is located on the Central Queensland coast and covers approximately 4,100km². The area receives a mean annual rainfall of approximately 1,100mm per annum.

- Agriculture and fisheries are important industries for the area's economy, with tourism increasing in recent times.
- There are relatively low levels of water use in the plan area, with the majority of water used by irrigated dairy farming, fodder and horticulture.
- There are no supplemented water supply schemes in this area.
- The area includes many ecologically important or protected areas including several large national parks, conservation parks, state forests, nature refuges and Directory of Important Wetlands (DIWA) listed wetlands.
- The Baffle Creek water plan area is part of the catchments that drain to the Great Barrier Reef.

The water plan

- sustainably manages the take of water from watercourses, lakes and springs and overland flow
- includes general and strategic unallocated water reserves.

Projected climate change impacts in the Baffle Creek Basin water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

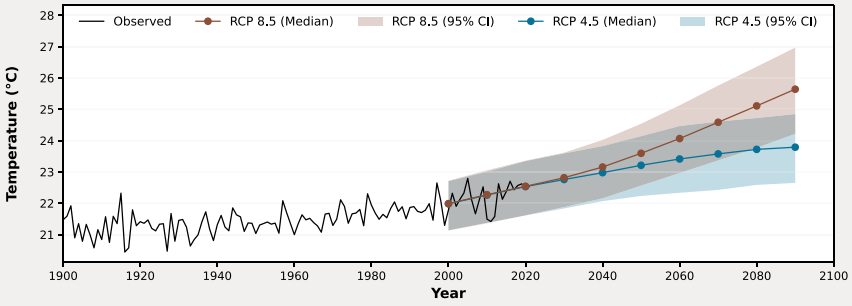
Observed annual climate trends:

- Temperature: medium increase emerged in the 1980s (strong confidence).
- Evaporation (PET): small increase observed with no emergence of significant change (weak confidence).
- Rainfall: small decrease observed with no emergence of significant change (weak confidence).

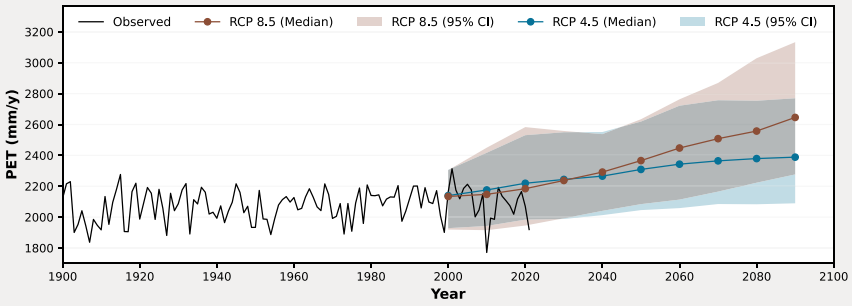
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: slight decrease projected (weak confidence).

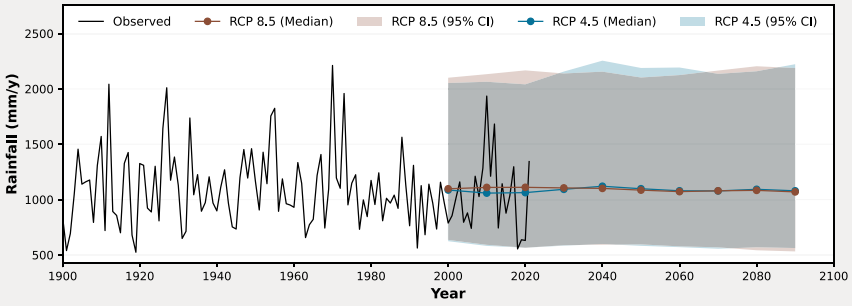
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

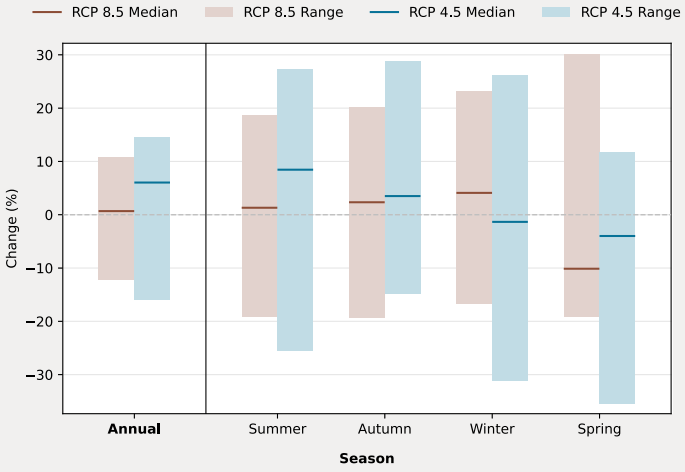


Projected seasonal climate trends:

- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in autumn.
- Rainfall: decrease projected in autumn to spring, and increase in summer.
- Rainfall in 2050 (refer graph): a decrease in spring projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Barron

Average daily temperature °C*

RCP8.5	RCP4.5
+0.9°C 2030	+0.9°C 2030
+1.6°C 2050	+1.2°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+7% 2030	+4% 2030
+10% 2050	+8% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
-6% 2030	-5% 2030
-7% 2050	-3% 2050

Barron water plan area at a glance

The Barron water plan area is situated in Far North Queensland and covers approximately 5,200km². The climate in this area is highly variable including within the Mareeba Dimbulah Water Supply Scheme (WSS) section. Average rainfall ranges from 1,295mm to 1,032mm per annum, typically concentrated over a summer wet season between December-March.

- Water is supplied by the Mareeba Dimbulah WSS, from Tinaroo Falls Dam through a network of channels, pipelines, and supplemented streams. Other major water storages include Copperlode Dam on Freshwater Creek and the Kuranda Weir on the Barron River.
- The plan area supports a range of water uses including town water supply, agriculture, fishing, tourism and hydro-electric power generation.
- Several world heritage, national and state parks and other protected areas cover 17 per cent of the area.
- The Barron water plan area is part of the catchments that drain to the Great Barrier Reef.

The water plan:

- sustainably manages supplemented and unsupplemented water in springs, water courses, lakes and groundwater
- includes general, indigenous and strategic unallocated water reserves.

Projected climate change impacts in the Barron water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

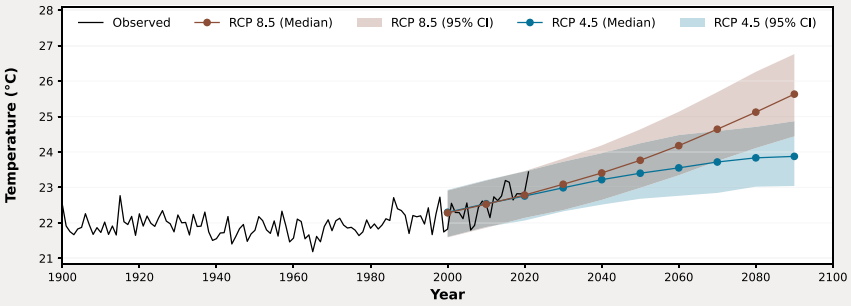
Observed annual climate trends:

- Temperature: medium increase emerged in the 1980s (strong confidence).
- Evaporation (PET): no trend observed.
- Rainfall: slight decrease observed with no emergence of significant change noting particularly dry conditions in the last 10 years (weak confidence).

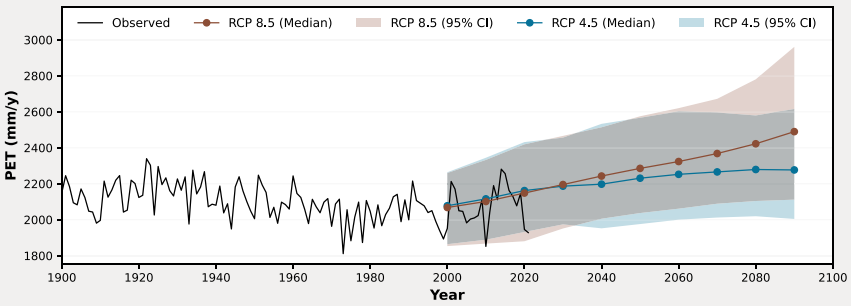
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: no trend projected amongst large uncertainty.

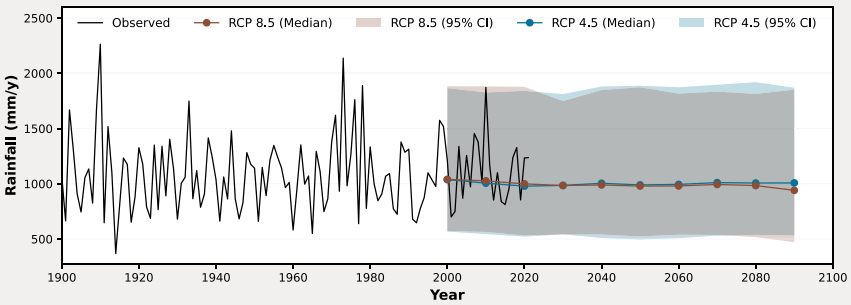
Average daily temperature (°C/year)



Average annual potential evapotranspiration PET (mm/year)



Average annual rainfall (mm/year)

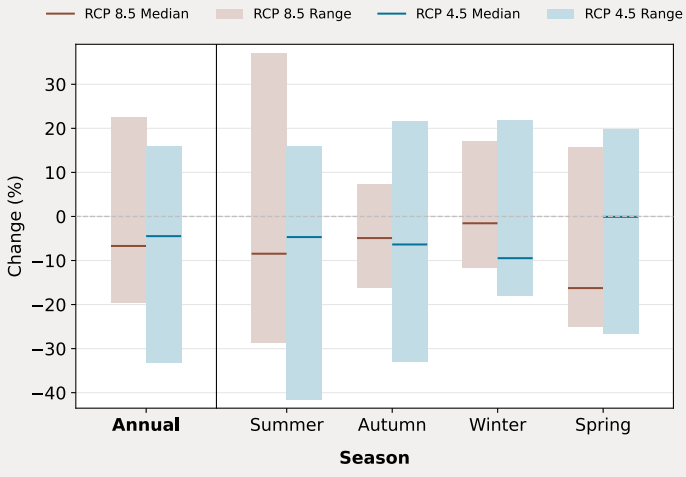


Projected seasonal climate trends:

- Average monthly temperatures: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in autumn.
- Rainfall: inconsistent decrease projected in autumn to spring and increase in summer.
- Rainfall in 2050 (refer graph): decrease across all seasons projected, with a similar decrease when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Border Rivers and Moonie

Average daily temperature °C*

RCP8.5	RCP4.5
+1.0°C 2030	+0.9°C 2030
+2.1°C 2050	+1.6°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+6% 2030	+6% 2030
+18% 2050	+13% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+1% 2030	-4% 2030
+1% 2050	-1% 2050

Border Rivers and Moonie water plan area at a glance

The Border Rivers and Moonie water plan area lies within the Queensland Murray–Darling Basin and covers approximately 40,000km². The area forms part of the Surat Basin, which is a key oil and coal seam gas production region.

- The Border Rivers catchment includes the highly productive Granite Belt region where high value horticultural crops are grown, such as permanent plantings of grapes for wine and seasonal fruits and vegetables.
- Agriculture, particularly grazing and dryland and irrigated cropping, such as cotton, are important for the area's economy.
- The Moonie catchment flows through the endangered southern Brigalow Belt which contains remnants of brigalow forests, poplar box, wilga and white cypress pine.
- Birds breed in the floodplain wetlands in the Moonie River system that includes high biodiversity and unique in-stream systems.

The water plan:

- sustainably manages supplemented and unsupplemented surface water (including overland flow) and groundwater
- includes unallocated water reserves.

Projected climate change impacts in the Border Rivers and Moonie water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

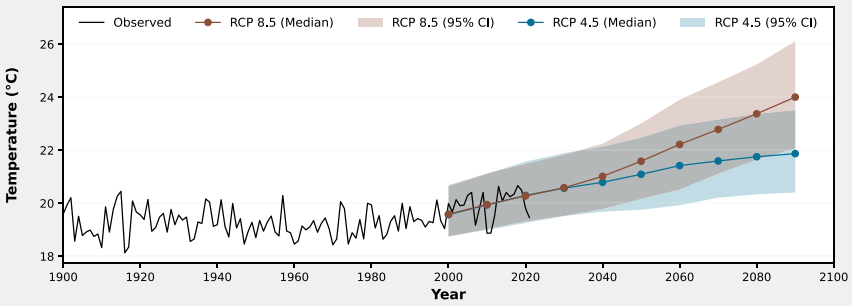
Observed annual climate trends:

- Temperature: medium increase emerged in the 2000s (moderate confidence).
- Evaporation (PET): no trend observed amongst large variability.
- Rainfall: slight decrease observed with no emergence of significant change (weak confidence).

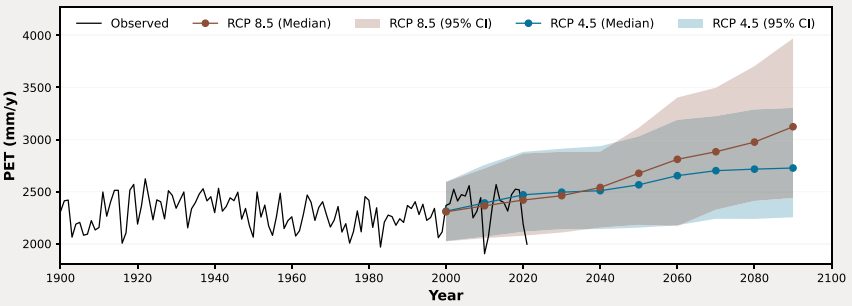
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: no trend projected amongst large uncertainty.

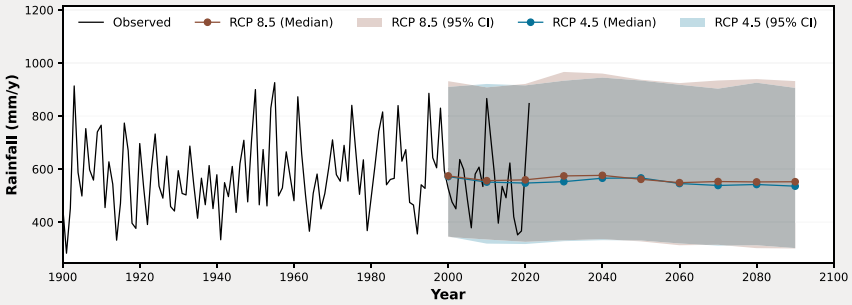
Average daily temperature (°C/year)



Average annual potential evapotranspiration PET (mm/year)



Average annual rainfall (mm/year)

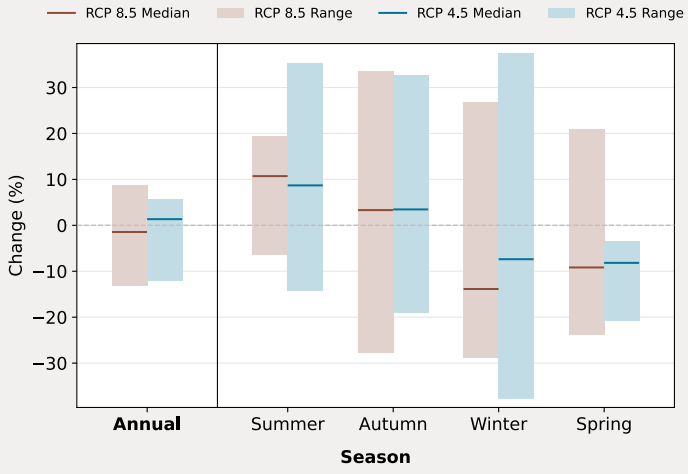


Projected seasonal climate trends:

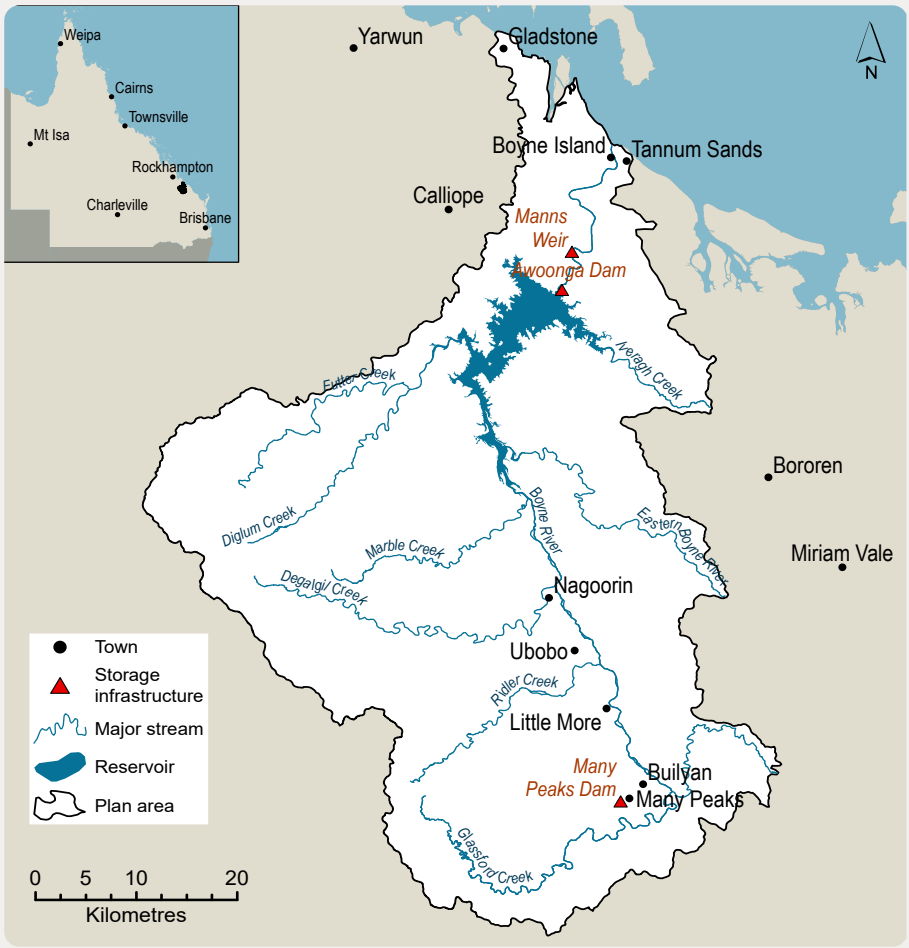
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in winter and spring.
- Rainfall: decrease projected in winter and spring and increase in summer and autumn.
- Rainfall in 2050 (refer graph): decrease in winter and spring projected and an increase in summer and autumn, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Boyne River Basin



Average daily temperature °C*

RCP8.5	RCP4.5
+0.9°C 2030	+0.8°C 2030
+1.7°C 2050	+1.4°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+5% 2030	+5% 2030
+14% 2050	+10% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+1% 2030	-3% 2030
-2% 2050	-2% 2050

Boyne River Basin water plan area at a glance

The Boyne River Basin water plan area is located in Queensland's central coast and covers approximately 2,590km². The climate is sub-tropical with warm to hot summers and mild, dry winters. The average annual rainfall ranges between 800mm and 1,000mm

- Awoonga Dam, located on the Boyne River, is the only major water storage in the plan area.
- Gladstone is the major regional population centre in the area with its metals-processing industries, power generation and port facilities all using water sourced from Awoonga Dam.
- Small-scale agriculture and livestock production, as well as tourism and fishing (recreational and commercial), are important to the area's economy.
- A number of ecologically important or protected areas are both within and adjacent to the plan area. These include the Coral Sea, Great Barrier Reef World Heritage Area, Dugong protection areas, Boyne Island Conservation Park and various national parks and state forests.

The water plan:

- sustainably manages supplemented and unsupplemented surface water
- includes general, strategic and strategic water infrastructure unallocated water reserves.

Projected climate change impacts in the Boyne River Basin water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

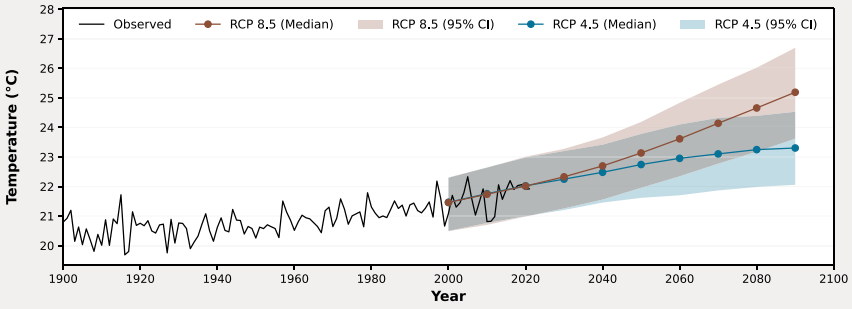
Observed annual climate trends:

- Temperature: medium increase emerged in the 1980s (moderate confidence).
- Evaporation (PET): small increase observed with no emergence of significant change (weak confidence).
- Rainfall: small decrease observed with no emergence of significant change (weak confidence).

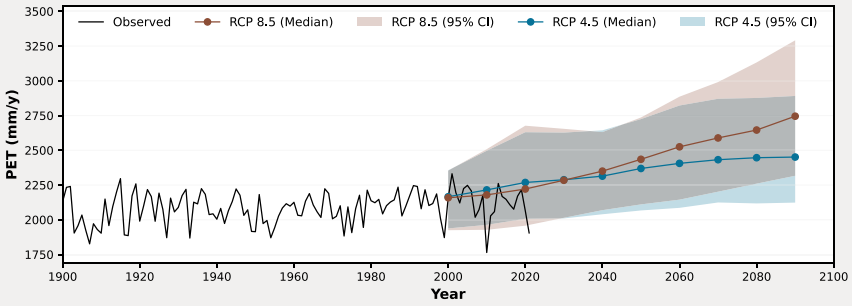
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: slight decrease projected (weak confidence).

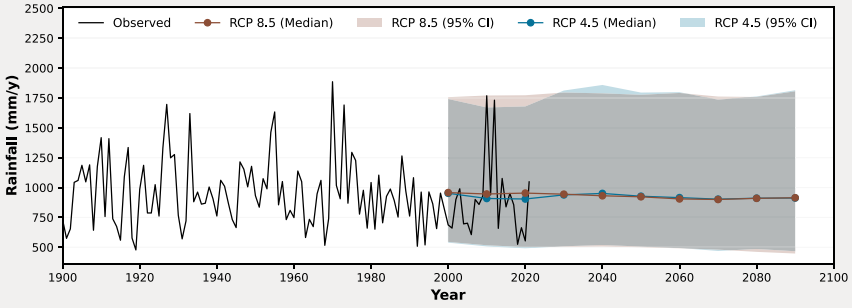
Average daily temperature (°C/year)



Average annual potential evapotranspiration PET (mm/year)



Average annual rainfall (mm/year)

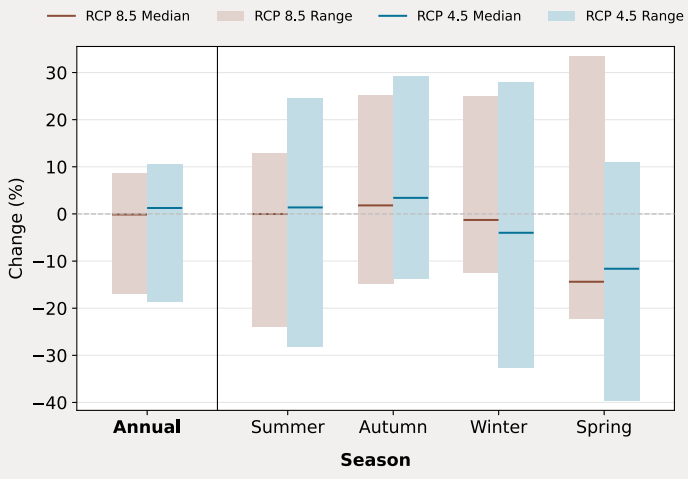


Projected seasonal climate trends:

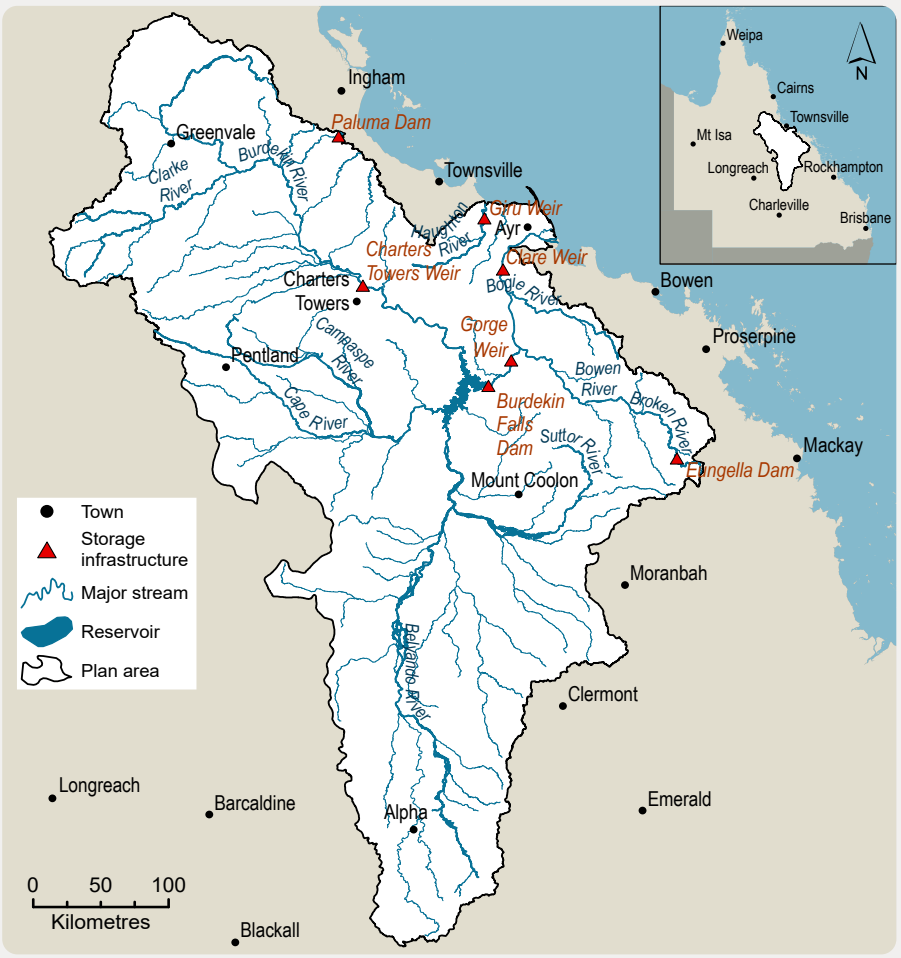
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in summer and spring.
- Rainfall: decrease projected in winter and spring and increase in summer.
- Rainfall in 2050 (refer graph): decrease in spring projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Burdekin Basin



Average daily temperature °C*

RCP8.5	RCP4.5
+1.1°C 2030	+0.9°C 2030
+1.9°C 2050	+1.4°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+7% 2030	+6% 2030
+15% 2050	+10% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
-6% 2030	-3% 2030
-6% 2050	-3% 2050

Burdekin Basin water plan area at a glance

The Burdekin Basin water plan area covers approximately 133,600km². The area has a varied climate ranging from tropical and sub-humid on the coast to semi-arid in the west. Most rainfall occurs during the summer months (January-March), with the least rain falling from July to September. Average annual rainfall in the water plan area ranges from over 1,000mm to less than 500mm per annum.

- Burdekin Falls Dam is the largest water storage in the plan area. It supplies the Burdekin Haughton Water Supply Scheme.
- The Burdekin region is Queensland's largest irrigation region. Water use in the region is primarily for irrigating sugarcane.
- The plan area is experiencing strong mining and agricultural growth. Urban, stock, domestic and industrial demands are approximately 20 per cent of total water use.
- The Burdekin water plan area is the second largest that drains to the Great Barrier Reef, and drains into important floodplains and internationally significant wetlands at Bowling Green Bay.

The water plan:

- sustainably manages surface water (including overland flow) and groundwater
- includes general, strategic and Sunwater unallocated water reserves.

Projected climate change impacts in the Burdekin Basin water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

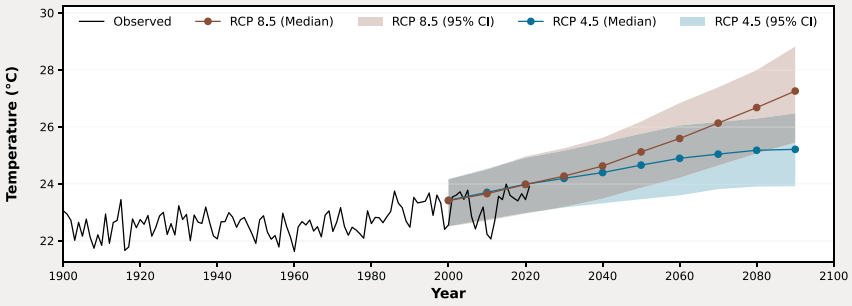
Observed annual climate trends:

- Temperature: medium increase emerged in the 1980s (moderate confidence).
- Evaporation (PET): no trend observed.
- Rainfall: no trend observed amongst large variability.

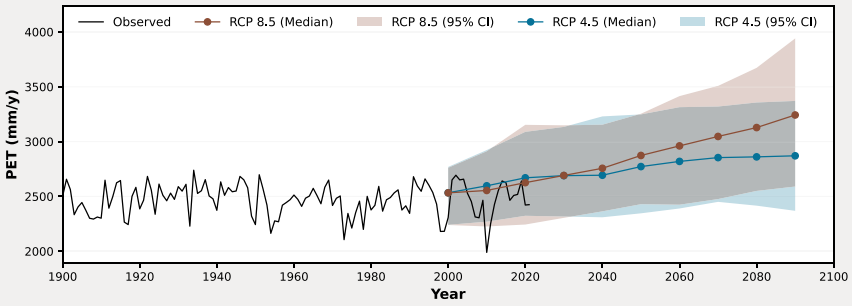
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: no trend projected amongst large uncertainty.

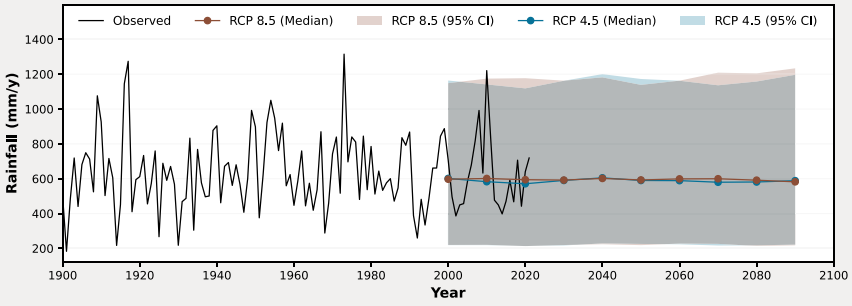
Average daily temperature (°C/year)



Average annual potential evapotranspiration PET (mm/year)



Average annual rainfall (mm/year)

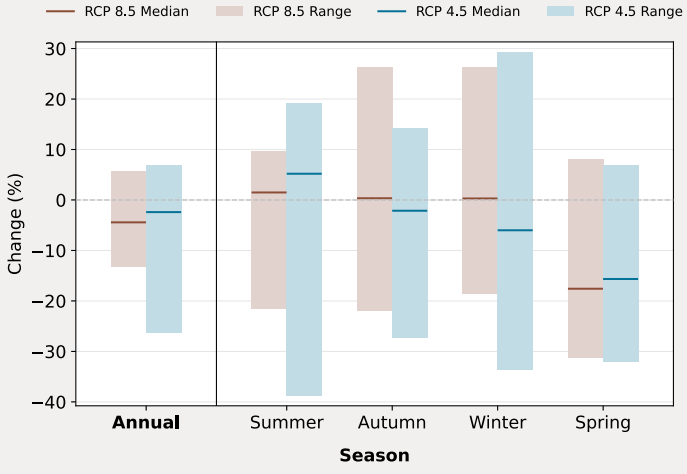


Projected seasonal climate trends:

- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in summer and spring.
- Rainfall: inconsistent decrease projected in autumn to spring and increase in summer.
- Rainfall in 2050 (refer graph): decrease in spring projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Burnett Basin

Average daily temperature °C*

RCP8.5	RCP4.5
+1.0°C 2030	+0.9°C 2030
+1.8°C 2050	+1.6°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+6% 2030	+5% 2030
+15% 2050	+11% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
-1% 2030	-2% 2030
-3% 2050	0% 2050

Burnett Basin water plan area at a glance

The Burnett Basin water plan area covers approximately 38,370km². Rivers and creeks here are characterised by seasonal, naturally variable, and highly irregular flow regimes. Average annual rainfall across the area ranges from 650mm to 1,100mm per year, with higher rainfall over more coastal areas and the higher elevations of eastern Upper Burnett River and eastern Barkers Creek.

- Water is supplied by 5 water supply schemes and used for grazing and agriculture, town water supplies and mining.
- Surface water taken for irrigation is used on crops such as sugar cane, horticultural crops, citrus, fodder and pulse crops.
- The Australian lungfish is one of the numerous significant fauna and flora species of conservation and ecological value living in the area.
- The Burnett water plan area is part of the catchments that drain to the Great Barrier Reef.

The water plan:

- sustainably manages surface water (including overland flow) and groundwater
- includes general, strategic and strategic water infrastructure unallocated water reserves.

Projected climate change impacts in the Burnett Basin water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

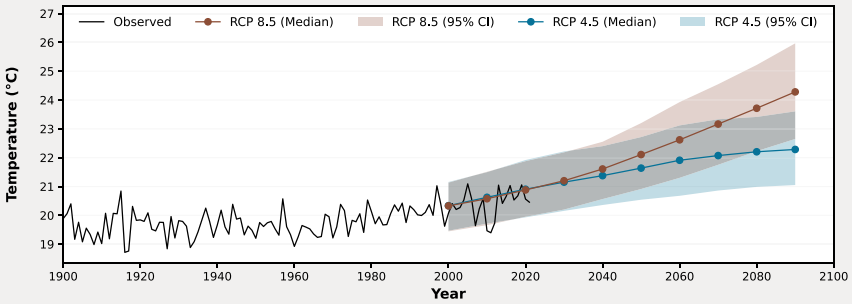
Observed annual climate trends:

- Temperature: medium increase emerged in the 1990s (moderate confidence).
- Evaporation (PET): small increase observed with no emergence of significant change (weak confidence).
- Rainfall: small decrease observed with no emergence of significant change (weak confidence).

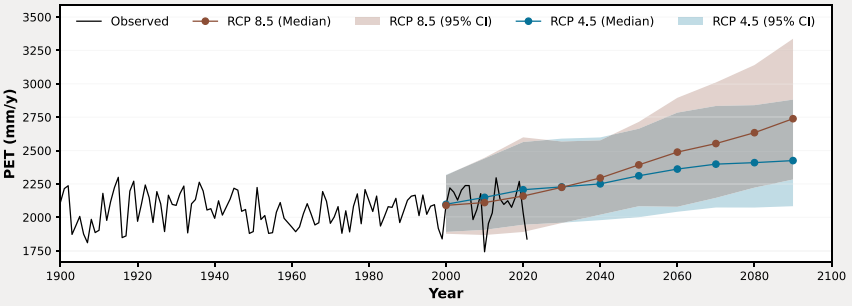
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: slight decrease projected (weak confidence).

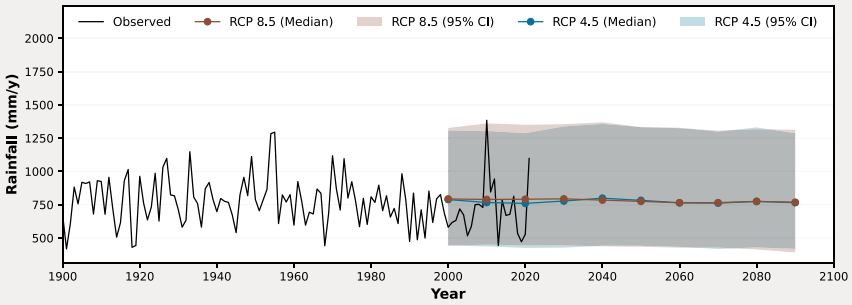
Average daily temperature (°C/year)



Average annual potential evapotranspiration PET (mm/year)



Average annual rainfall (mm/year)

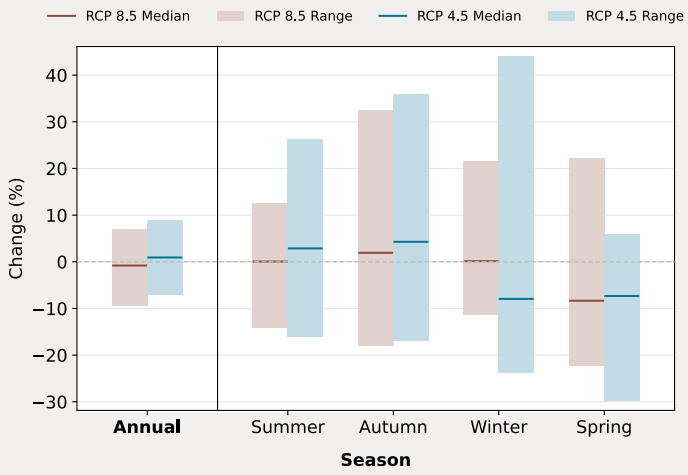


Projected seasonal climate trends:

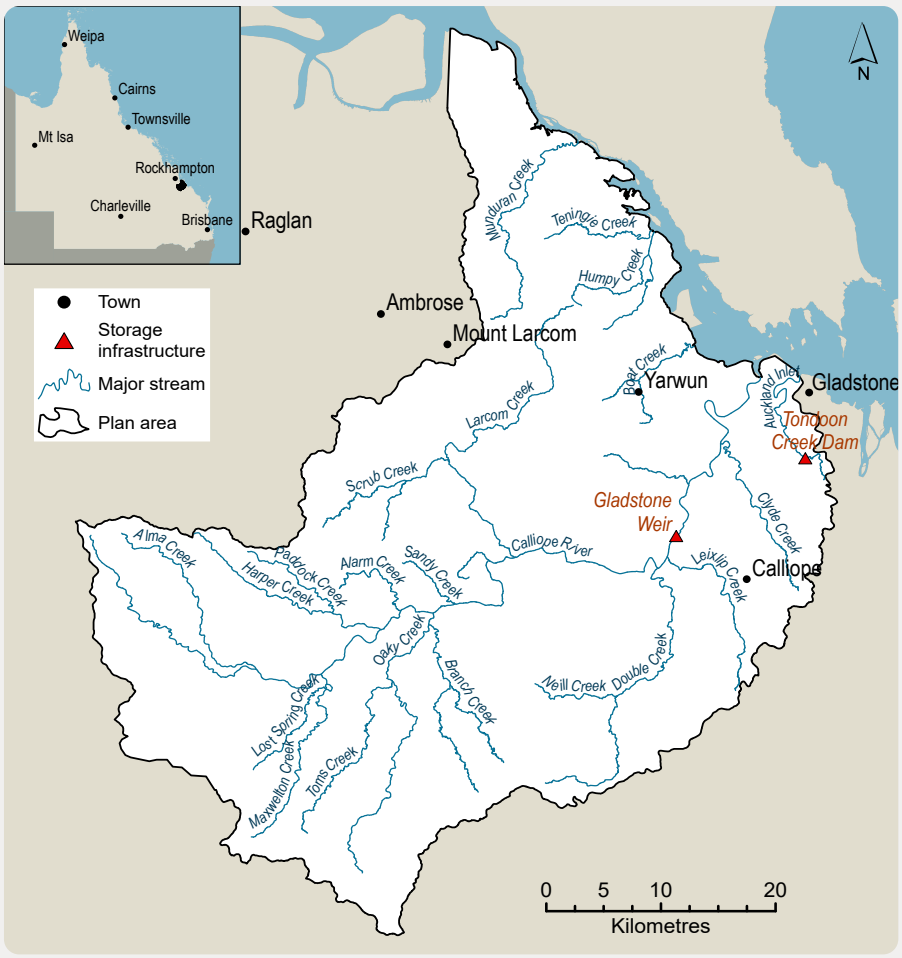
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons.
- Rainfall: decrease projected in autumn to spring and increase in summer.
- Rainfall in 2050 (refer graph): decrease projected in spring, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Calliope River



Average daily temperature °C*

RCP8.5	RCP4.5
+0.9°C 2030	+0.8°C 2030
+1.6°C 2050	+1.4°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+5% 2030	+5% 2030
+14% 2050	+9% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+4% 2030	-4% 2030
0% 2050	0% 2050

Calliope River water plan area at a glance

The Calliope River water plan area is in Central Queensland and covers an area of approximately 2,236km². The rainfall is quite variable compared to other catchments. In the last 10 years, there were 2 very high rainfall years followed by a historically low rainfall year.

- The Calliope River is the largest watercourse in the plan area. Streamflow within the plan area is mostly natural and not modified by large instream structures.
- Town water supply for the towns of Calliope and Gladstone is provided by the Gladstone Area Water Board (GAWB) from Awoonga Dam, which is outside the plan area.
- Grazing and irrigated crops comprise the bulk of water use in the plan area.
- The Narrows, an estuarine passage between Curtis Island and the mainland that extends from Kangaroo Island to the mouth of Raglan Creek, is an area of ecological significance. It also relies on streamflow from other catchments outside this plan area.

The water plan:

- sustainably manages unsupplemented surface water (including overland flow)
- includes unallocated water reserves for any purpose including town water supply.

Projected climate change impacts in the Calliope River water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

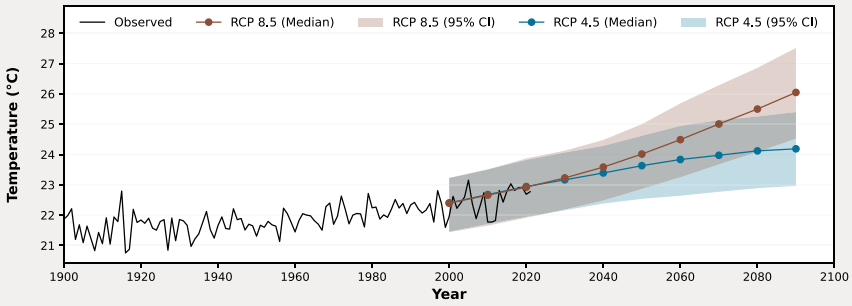
Observed annual climate trends:

- Temperature: medium increase emerged in the 1980s (strong confidence).
- Evaporation (PET): small decrease observed with no emergence of significant change (weak confidence).
- Rainfall: small increase observed with no emergence of significant change (weak confidence).

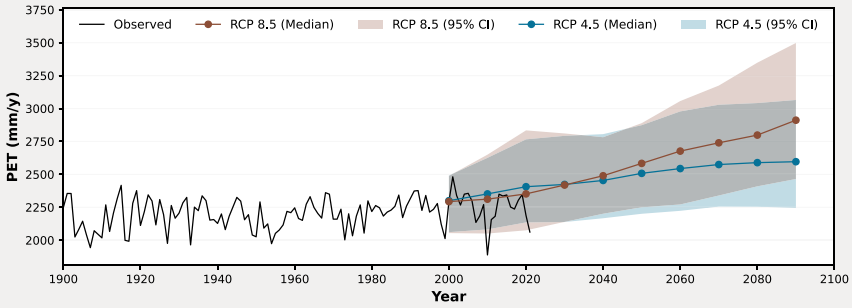
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: no trend projected amongst large uncertainty.

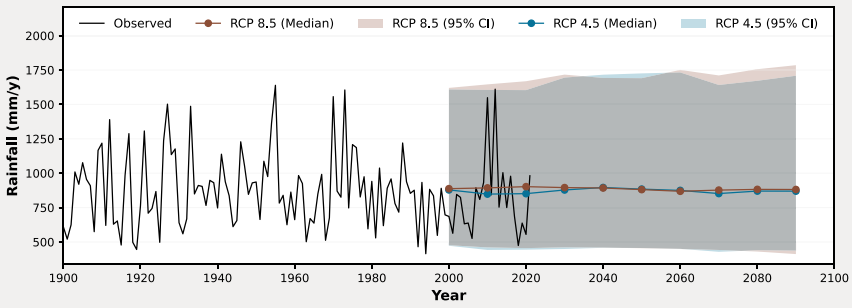
Average daily temperature (°C/year)



Average annual potential evapotranspiration PET (mm/year)



Average annual rainfall (mm/year)

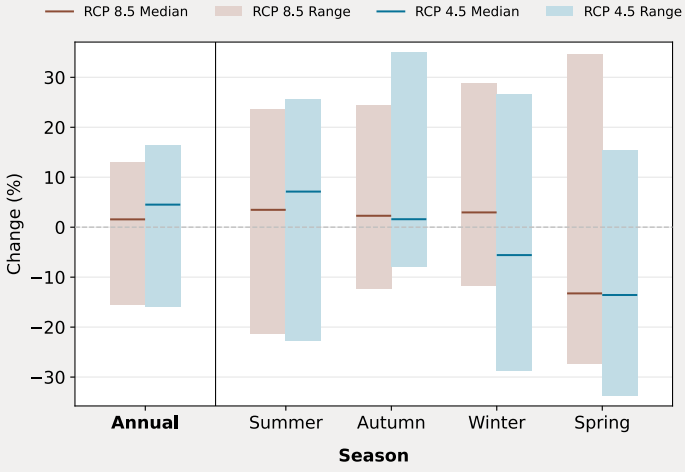


Projected seasonal climate trends:

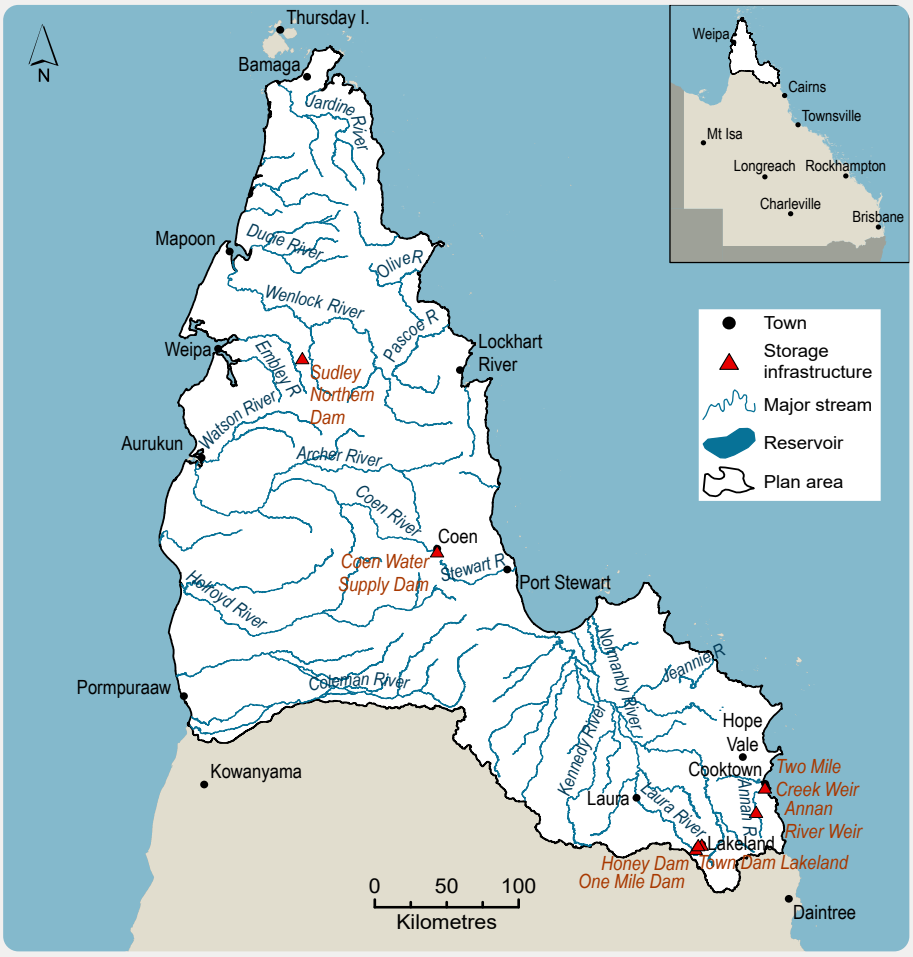
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons.
- Rainfall: decrease projected in autumn to spring and increase in summer.
- Rainfall in 2050 (refer graph): decrease in spring projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Cape York



Average daily temperature °C*

RCP8.5	RCP4.5
+0.8°C 2030	+0.8°C 2030
+1.6°C 2050	+1.2°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+6% 2030	+6% 2030
+10% 2050	+9% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
-5% 2030	-6% 2030
-4% 2050	-4% 2050

Cape York water plan area at a glance

The Cape York water plan area is situated in Northern Queensland and is comprised of 15 different catchments covering approximately 106,805km². Cape York has a tropical climate with distinct wet and dry seasons. The east coast has a hot and humid climate with seasonal south-east trade winds that can generate rainfall across the year. The western regions of Cape York are dry tropical with a true summer monsoon weather pattern from November to April.

- Average rainfall varies greatly across the area from 800mm per annum around Lakeland to more than 3,000mm per annum near the Lockhart River.
- Water in the plan area is used by a number of industries including agriculture, grazing, tourism, mining and town water supplies.
- Many of the catchments have near-natural flow regimes and river systems in pristine condition.
- The area supports significant biodiversity, including threatened species and estuarine and marine habitats of national and state ecological significance, including the Great Barrier Reef World Heritage Area.

The water plan:

- sustainably manages surface water (including overland flow) and groundwater
- includes a general, strategic and Cape York Peninsula Heritage Area unallocated water reserve.

Projected climate change impacts in the Cape York water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

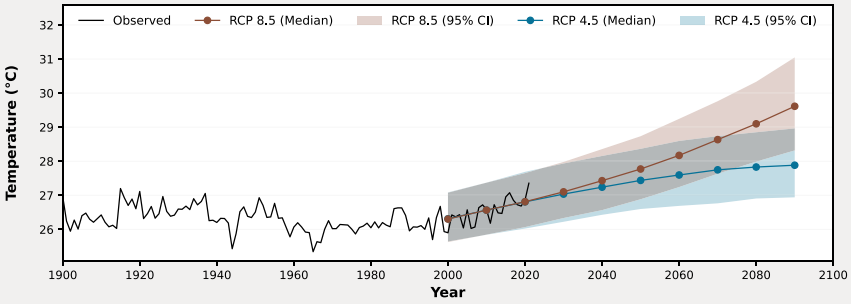
Observed annual climate trends:

- Temperature: small increase emerged in the 2000s (weak confidence).
- Evaporation (PET): small decrease observed with no emergence of significant change (weak confidence).
- Rainfall: small increase observed with no emergence of significant change (weak confidence).

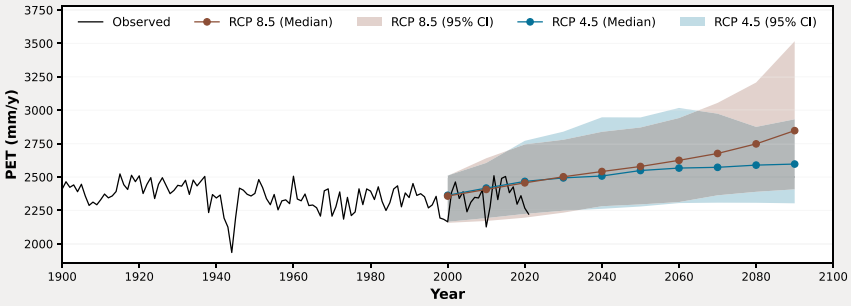
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: small decrease projected (weak confidence).

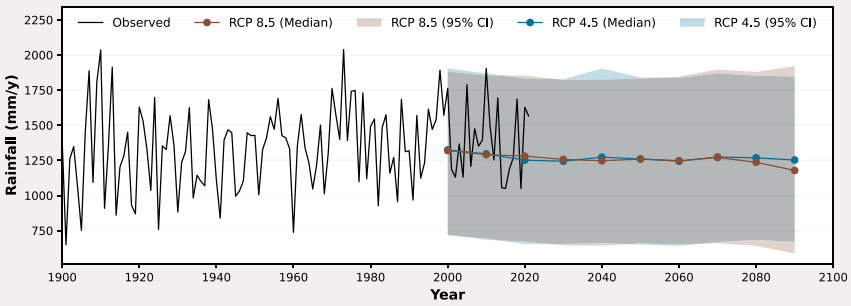
Average daily temperature (°C/year)



Average annual potential evapotranspiration PET (mm/year)



Average annual rainfall (mm/year)

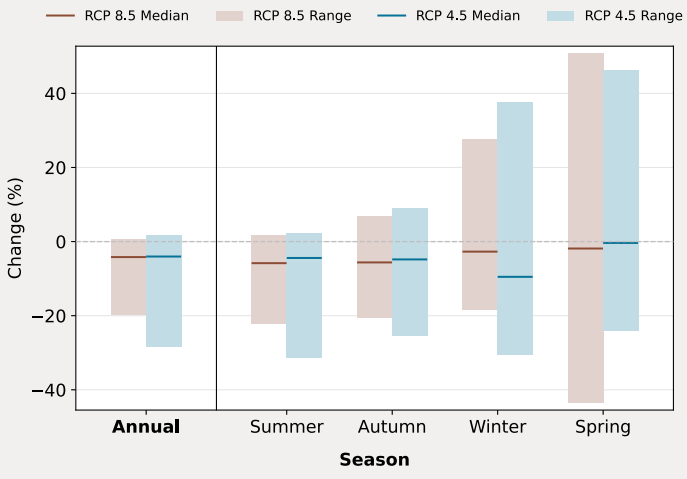


Projected seasonal climate trends:

- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in summer.
- Rainfall: decrease projected in spring to autumn and increase in winter.
- Rainfall in 2050 (refer graph): decrease projected across all seasons, with a similar decrease when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Condamine and Balonne

Average daily temperature °C*

RCP8.5	RCP4.5
+1.0°C 2030	+0.9°C 2030
+2.1°C 2050	+1.6°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+7% 2030	+6% 2030
+18% 2050	+13% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+1% 2030	-3% 2030
-1% 2050	-2% 2050

Condamine and Balonne water plan area at a glance

The Condamine and Balonne water plan area is located within the Queensland Murray–Darling Basin. Spanning 124,500km², it is one of the largest catchments in the Murray-Darling Basin. The area lies within the semi-arid climate zone, where droughts and floods are characteristic. The region experiences sub-tropical weather, with rainfall occurring mainly in the summer months. Annual average rainfall is variable across the catchment, ranging from 1,200mm on the eastern ranges to 400mm in the west.

- Water is supplied by 5 water supply schemes from 17 dams and weirs within the plan area.
- The region is significant for its agricultural diversity, with a wide range of winter and summer crops produced on the Darling Downs, as well as very large cotton production areas in the west.
- Water in the water plan area supports the health and maintenance of areas of ecological significance, including the Culgoa floodplains, the Ramsar listed Narran Lakes Nature Reserve, as well as endangered plant species.

The water plan:

- sustainably manages supplemented and unsupplemented surface water (including overland flow) and groundwater
- includes unallocated water reserves.

Projected climate change impacts in the Condamine and Balonne water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

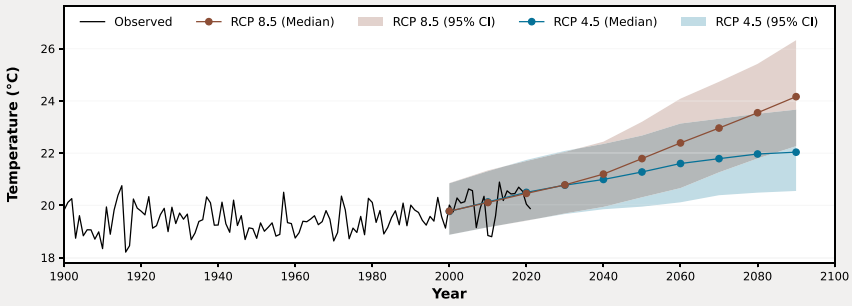
Observed annual climate trends:

- Temperature: medium increase emerged in the 2010s (weak confidence).
- Evaporation (PET): no trend observed.
- Rainfall: small increase observed with no emergence of significant change (weak confidence).

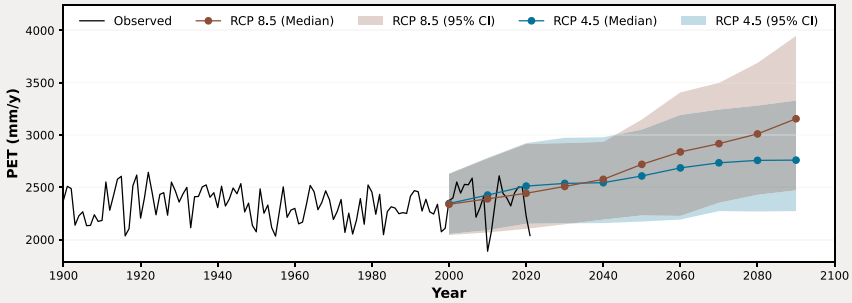
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: no trend projected amongst large uncertainty.

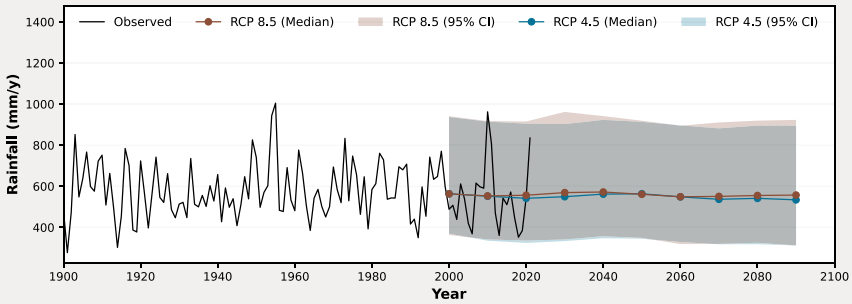
Average daily temperature (°C/year)



Average annual potential evapotranspiration PET (mm/year)



Average annual rainfall (mm/year)

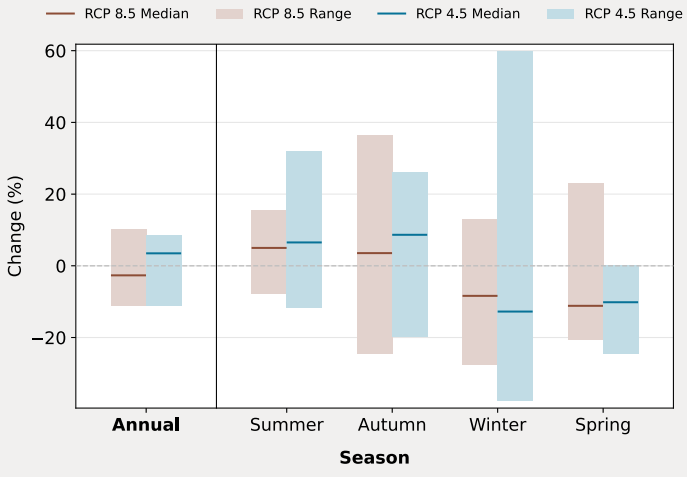


Projected seasonal climate trends:

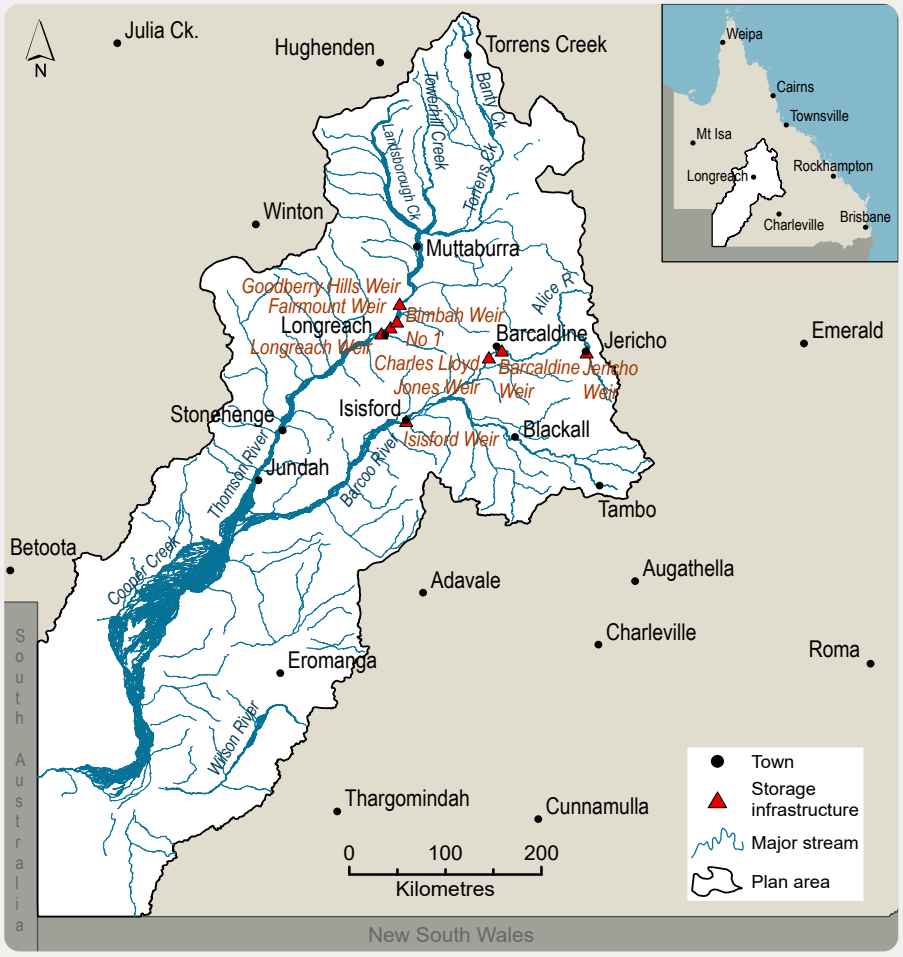
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in winter and spring.
- Rainfall: decrease projected in winter and spring and increase in summer.
- Rainfall in 2050 (refer graph): decrease in winter and spring projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Cooper Creek



Average daily temperature °C*

RCP8.5	RCP4.5
+1.1°C 2030	+1.0°C 2030
+2.2°C 2050	+1.7°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+9% 2030	+9% 2030
+17% 2050	+13% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
-2% 2030	-4% 2030
-2% 2050	-2% 2050

Cooper Creek water plan area at a glance

The Cooper Creek water plan area is located in Central Queensland and covers 243,000km². It is part of the iconic Channel Country Rivers within the Lake Eyre Basin, the largest internal drainage system in Australia. The river system here is ephemeral with highly sporadic rainfall and extended dry periods.

- The natural hydrology of the area is characterised by natural, unrestricted flows in stream channels and across the floodplain, with no significant storages in the plan area.
- There are a network of channels, waterholes, wetlands, extensive floodplains and widely distributed shallow, ephemeral lakes in the plan area. Water is predominantly used for town water supply and grazing, with limited irrigated agriculture.
- The region is of national and international significance as it provides for high economic, social and cultural heritage value, such as a vast indigenous trade network that was established running from north to south.

The water plan:

- sustainably manages surface water (including overland flow) and groundwater
- includes general, strategic, Indigenous, and town and community unallocated water reserves.

Projected climate change impacts in the Cooper Creek water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

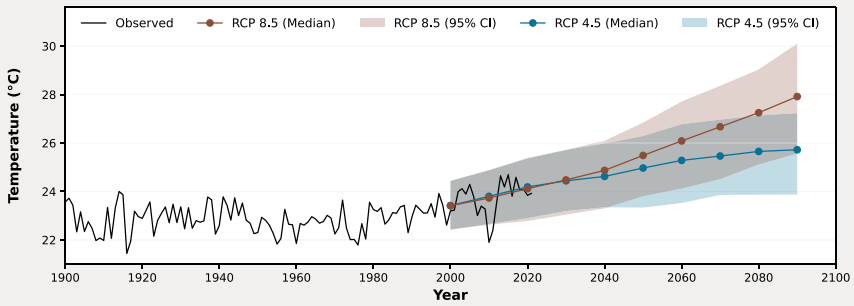
Observed annual climate trends:

- Temperature: medium increase emerged in the 2000s (moderate confidence).
- Evaporation (PET): no trend observed.
- Rainfall: no trend observed.

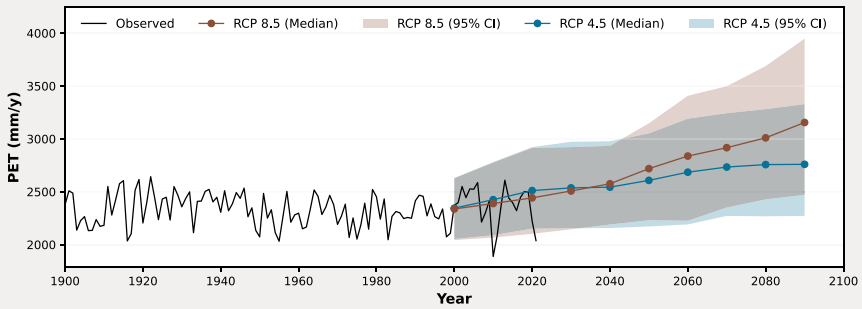
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: no trend projected amongst large uncertainty.

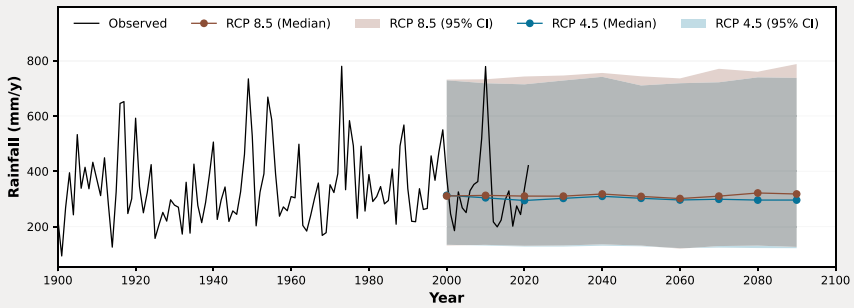
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

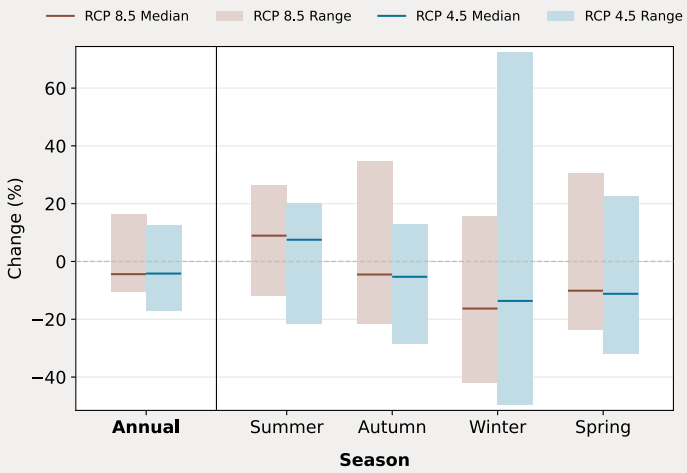


Projected seasonal climate trends:

- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in winter and spring.
- Rainfall: decrease projected in winter and spring and increase in summer and autumn.
- Rainfall in 2050 (refer graph): decrease in autumn, winter and spring and an increase in summer projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Fitzroy Basin

Average daily temperature °C*

RCP8.5	RCP4.5
+1.0°C 2030	+0.8°C 2030
+1.8°C 2050	+1.6°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+7% 2030	+5% 2030
+16% 2050	+11% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+2% 2030	-3% 2030
-3% 2050	-5% 2050

Fitzroy Basin water plan area at a glance

The Fitzroy Basin water plan area covers approximately 142,600km². The area has a tropical to subtropical, semi-humid climate. Rainfall and temperatures here is highly variable and irregular. Rainfall in this region is characterised by distinct wet and dry seasons with tropical cyclones common. The majority of rain falls in the north-east part of the water plan area with average falls of over 1,000mm per annum. The southwest sections receive the least rainfall at approximately 500mm per annum.

- Water is supplied by 5 water supply schemes from several water resource infrastructure reserves.
- Once completed, Rookwood Weir will have the ability to supply 76,000 megalitres of water per annum for the region. This will support agricultural growth and supply industrial and urban water throughout Gladstone and the Capricorn Coast.
- Water in the plan area is used by a number of industries including mining, agriculture and town water supplies.
- The Fitzroy Basin water plan area is part of the catchments that drain to the Great Barrier Reef.

The water plan:

- sustainably manages supplemented and unsupplemented surface water in a watercourse, lake, or spring (including overland flow) and groundwater
- includes general, strategic and strategic water infrastructure unallocated water reserves.

Projected climate change impacts in the Fitzroy Basin water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

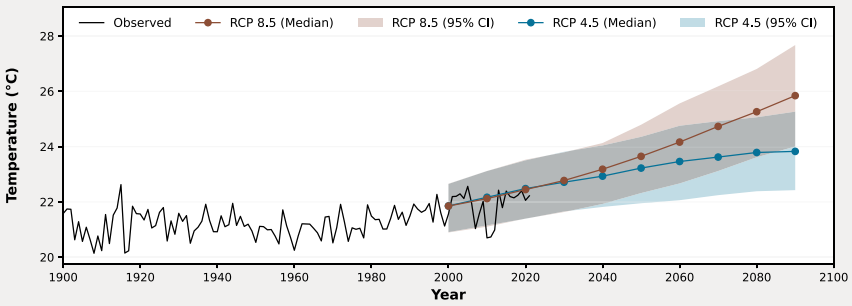
Observed annual climate trends:

- Temperature: medium increase emerged in the 1990s (moderate confidence).
- Evaporation (PET): small increase observed with no emergence of significant change (weak confidence).
- Rainfall: small decrease observed with no emergence of significant change (weak confidence).

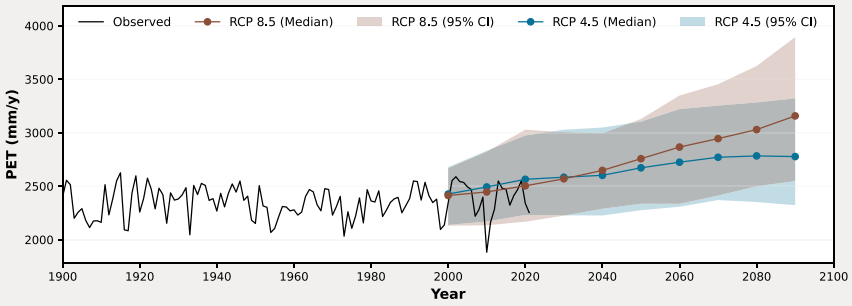
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: slight decrease projected (weak confidence).

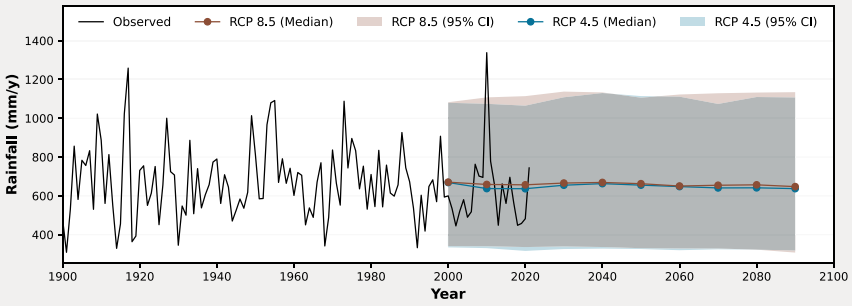
Average daily temperature (°C/year)



Average annual potential evapotranspiration PET (mm/year)



Average annual rainfall (mm/year)

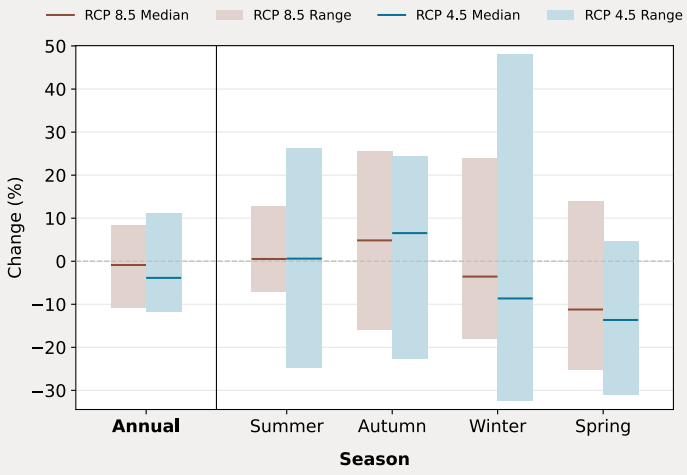


Projected seasonal climate trends:

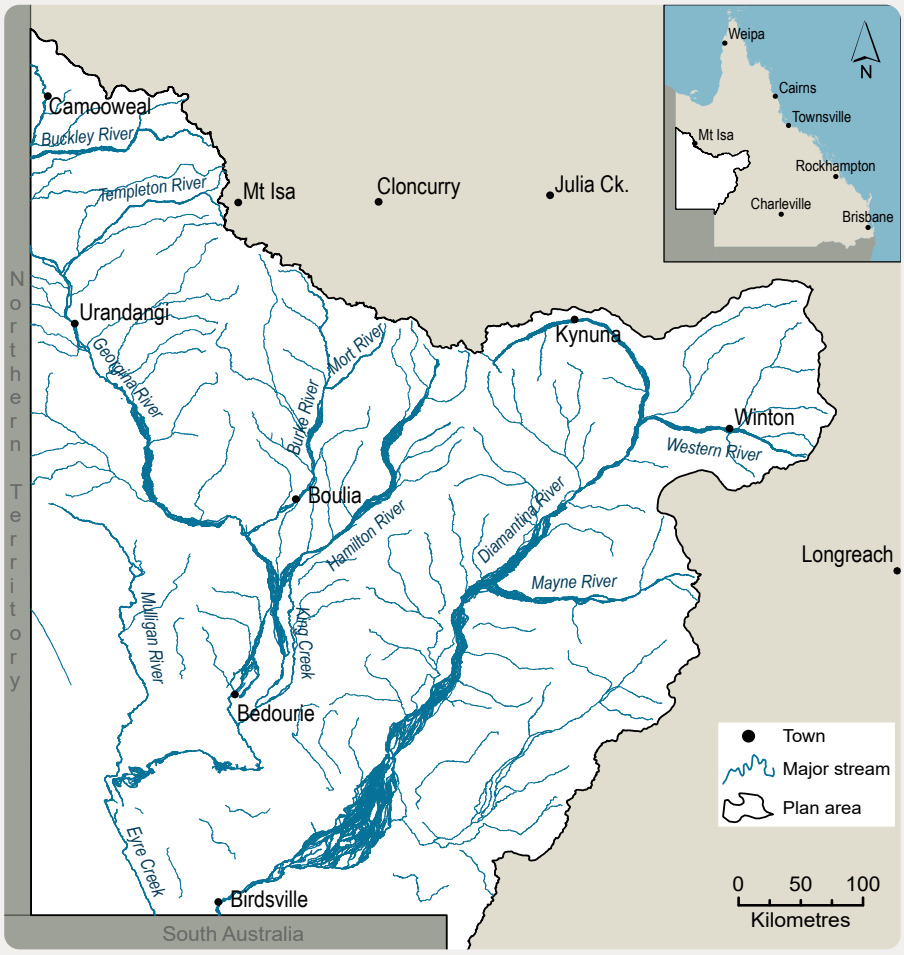
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons.
- Rainfall: decrease projected in winter and spring and increase in summer.
- Rainfall in 2050 (refer graph): decrease in winter and spring and increase in autumn projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios forthe years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Georgina and Diamantina



Average daily temperature °C*

RCP8.5	RCP4.5
+1.2°C 2030	+1.1°C 2030
+2.3°C 2050	+1.6°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+8% 2030	+6% 2030
+15% 2050	+12% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+3% 2030	+4% 2030
+3% 2050	+1% 2050

Georgina and Diamantina water plan area at a glance

The Georgina and Diamantina water plan area and covers approximately 266,000km². Average annual rainfall ranges between 200mm and almost 600mm with the upper areas of the plan area receiving the most rain. Rainfall is highly seasonal with 70 per cent on average falling from December to April. This seasonality is driven by monsoonal weather patterns typified by heavier falls through the summer months, with extended dry winters.

- There are no dams or weirs in the plan area. With few water licences, the Georgina, Diamantina and Hay rivers retain a near natural flow regime.
- All streams in the plan area are ephemeral, with the majority characterised by short periods of flow following rain events, and long periods of no flow.
- Water is predominately used for grazing and town water supply.
- The plan area falls within the Lake Eyre Basin, the largest internal drainage system in Australia.

The water plan:

- sustainably manages unsupplemented surface water (including overland flow) and groundwater
- includes unallocated water reserves for general use and projects of state significance.

Projected climate change impacts in the Georgina and Diamantina water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

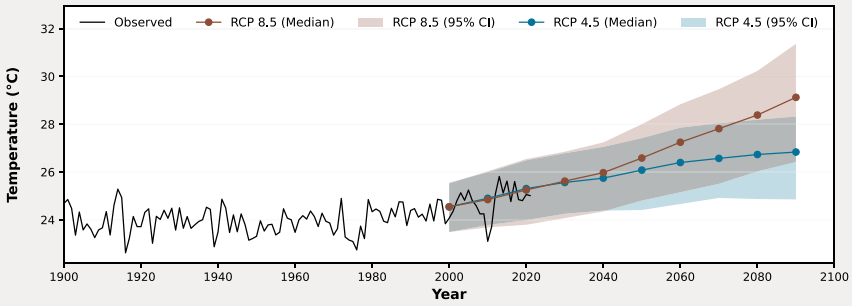
Observed annual climate trends:

- Temperature: medium increase emerged in the 1990s (moderate confidence).
- Evaporation (PET): no trend observed.
- Rainfall: no trend observed.

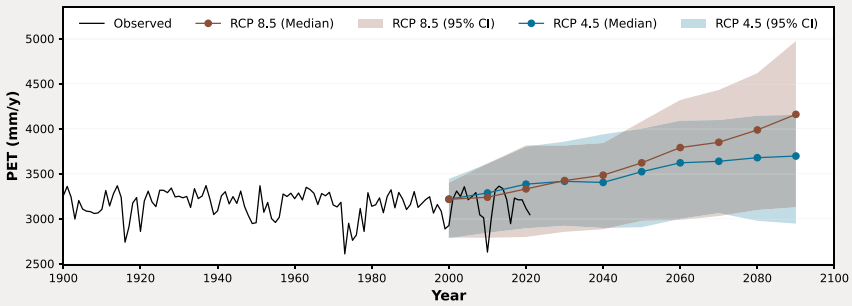
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: slight increase projected (weak confidence).

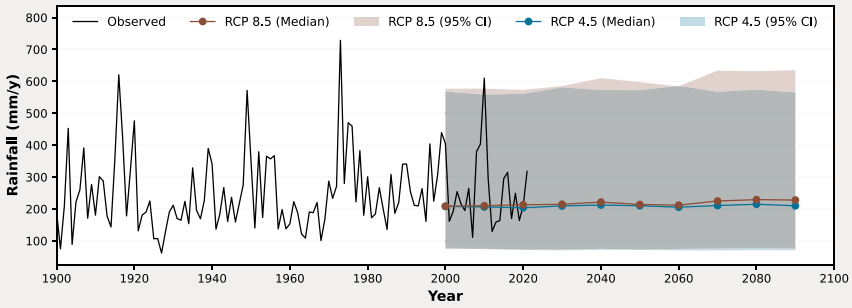
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

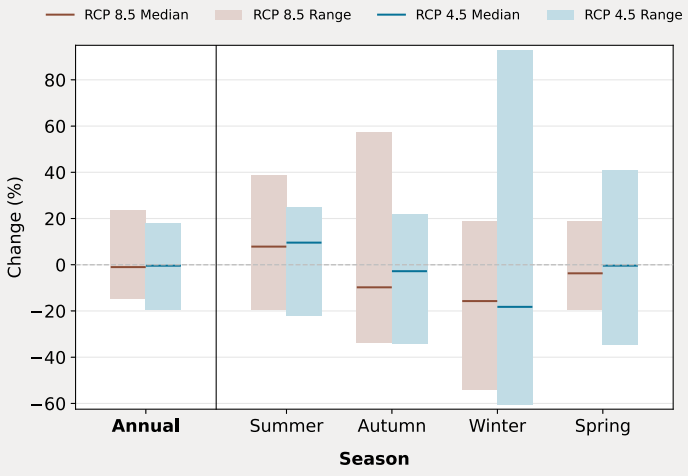


Projected seasonal climate trends:

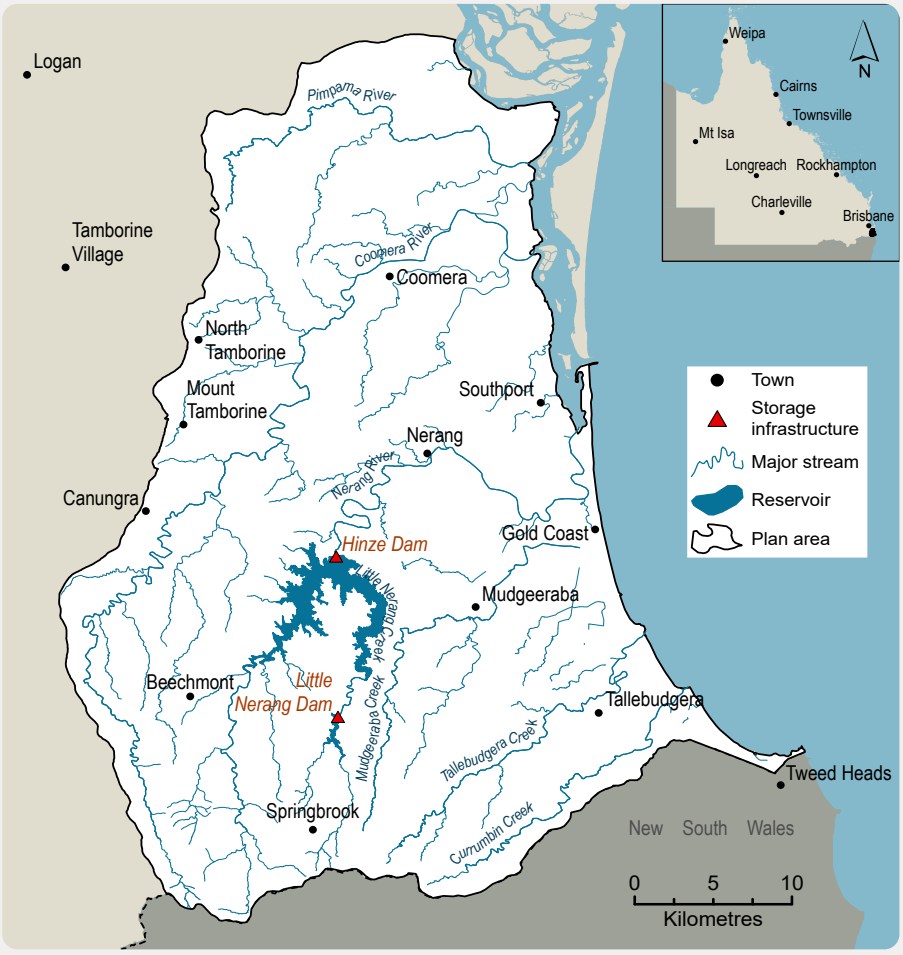
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in winter and spring.
- Rainfall: decrease projected in winter and spring and increase in summer and autumn.
- Rainfall in 2050 (refer graph): decrease in autumn and winter and an increase in summer projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Gold Coast



Average daily temperature °C*

RCP8.5	RCP4.5
+0.9°C 2030	+0.9°C 2030
+1.6°C 2050	+1.3°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+5% 2030	+5% 2030
+12% 2050	+7% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+6% 2030	+3% 2030
-1% 2050	+3% 2050

Gold Coast water plan area at a glance

The Gold Coast water plan area is located in South East Queensland and covers approximately 1,300km². Rainfall is variable, with higher falls occurring along the McPherson Range.

- Water in the plan area is predominately used to support the water needs of several urban centres including those along the coastal strip, Pimpama and Jacobs Well.
- The streamflow throughout the plan area is modified by a number of dams and instream structures including Hinze Dam, the largest water storage in the plan area.
- Surface water is supplemented from Hinze Dam and Little Nerang Dam and supplied through the Nerang Water Supply Scheme. Communities in the hinterland rely heavily on unsupplemented surface water and groundwater as many do not have access to a reticulated supply (e.g. Springbrook and parts of Tamborine Mountain).

The water plan:

- sustainably manages supplemented and unsupplemented surface water (excluding overland flow)
- includes general and strategic unallocated water reserves.

Projected climate change impacts in the Gold Coast water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

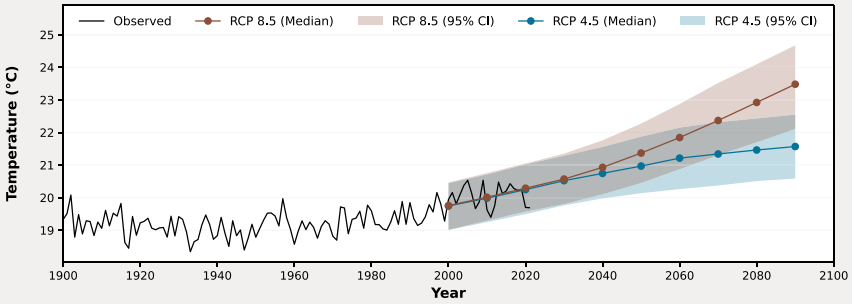
Observed annual climate trends:

- Temperature: medium increase emerged in the 1990s (strong confidence).
- Evaporation (PET): no trend observed.
- Rainfall: no trend observed.

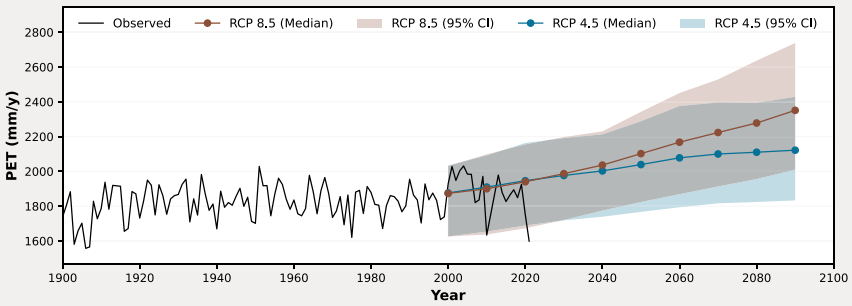
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: slight decrease projected (weak confidence).

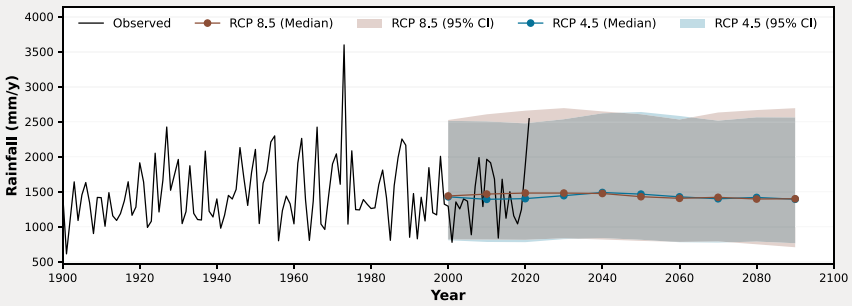
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

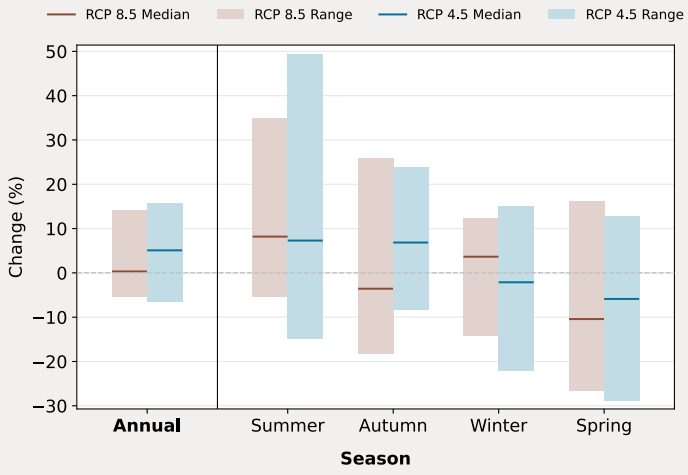


Projected seasonal climate trends:

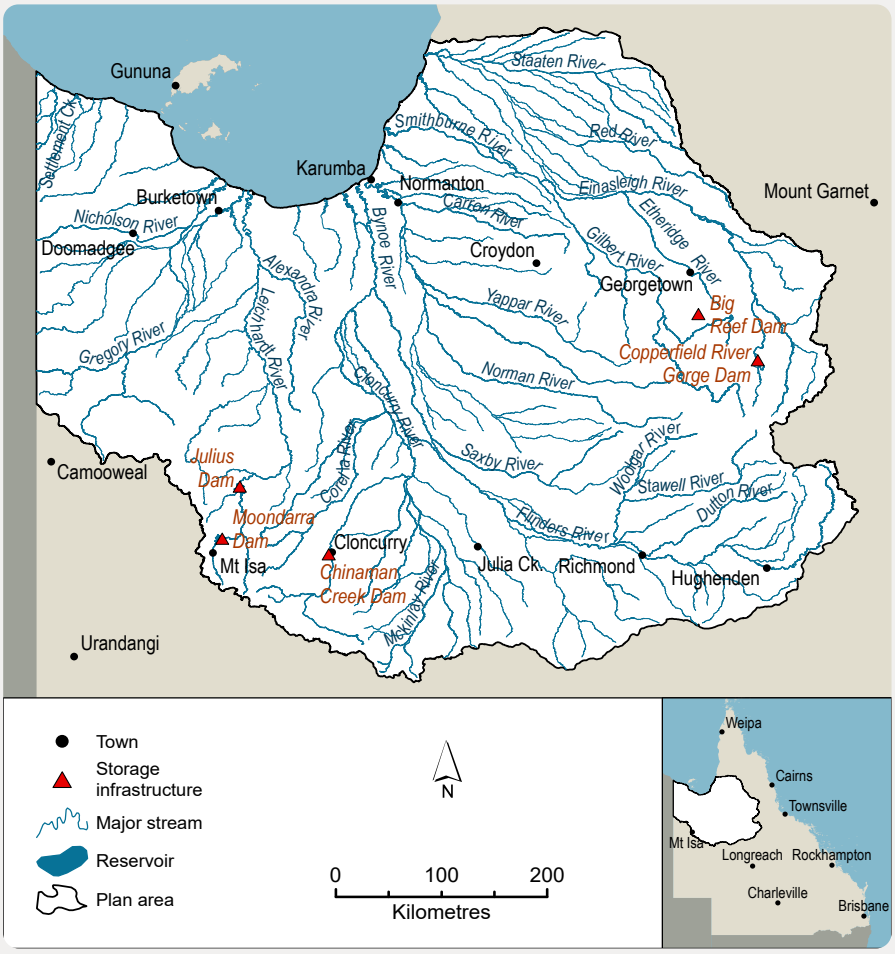
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in spring.
- Rainfall: decrease projected in autumn to spring and increase in summer.
- Rainfall in 2050 (refer graph): decrease in spring and an increase in summer projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Gulf



Average daily temperature °C*

RCP8.5	RCP4.5
+1.1°C 2030	+1.0°C 2030
+2.0°C 2050	+1.4°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+7% 2030	+7% 2030
+13% 2050	+10% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+1% 2030	-1% 2030
+4% 2050	+3% 2050

Gulf water plan area at a glance

The Gulf water plan area covers approximately 315,000km². The catchments of this area account for about 15 per cent of the total state water run-off. This region has predominantly monsoonal rainfall and experiences tropical cyclones.

- Water stored in Julius Dam and Moondarra Dam is used for mining, industrial and urban water use in the Mount Isa–Cloncurry region and is managed through water supply schemes.
- There are a small number of agricultural developments in parts of the Flinders, Gilbert, Nicholson and Leichhardt River catchments.
- The river systems are also important for tourism and commercial and recreational fishing.
- The Gulf water plan area includes numerous wetlands of national significance and migratory shorebird habitat that is internationally recognised.

The water plan:

- sustainably manages surface water (including overland flow) and groundwater
- includes general, indigenous and strategic unallocated water reserves.

Projected climate change impacts in the Gulf water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

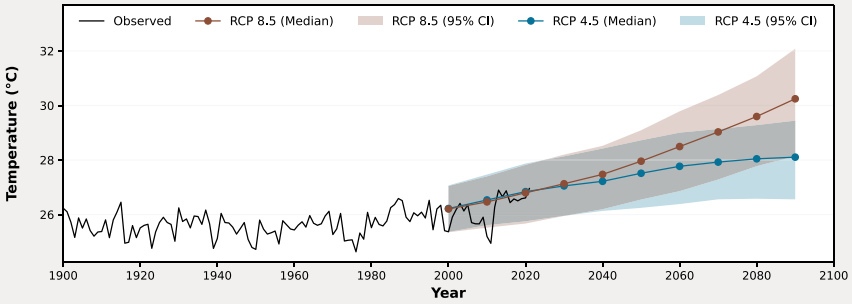
Observed annual climate trends:

- Temperature: medium increase emerged in the 1990s (strong confidence).
- Evaporation (PET): slight decrease observed with no emergence of significant change (weak confidence).
- Rainfall: slight increase observed with no emergence of significant change (weak confidence).

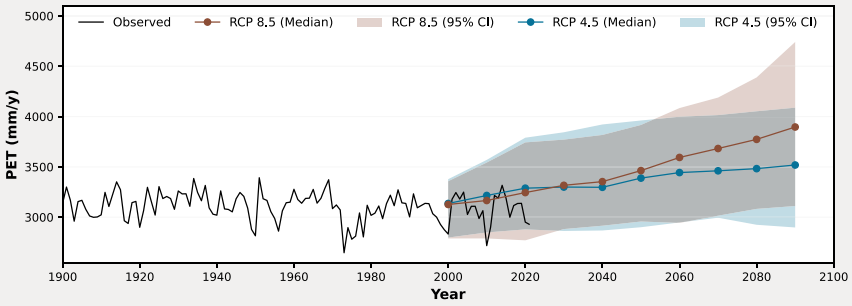
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: slight increase projected (weak confidence).

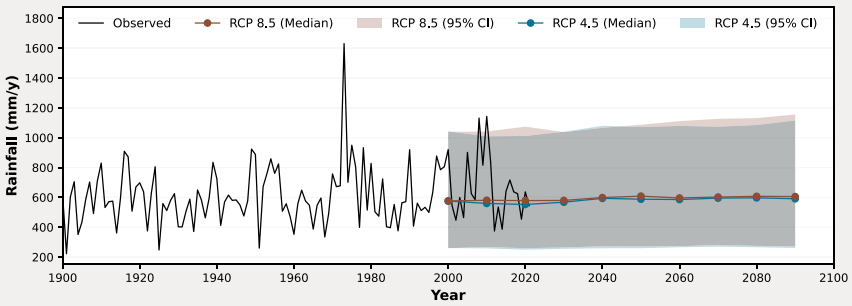
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

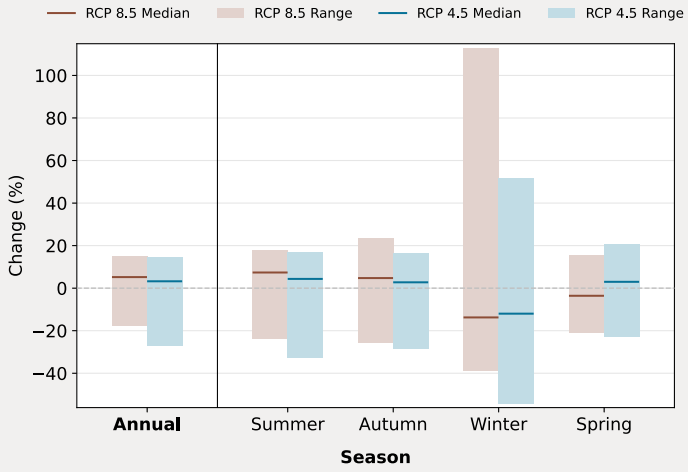


Projected seasonal climate trends:

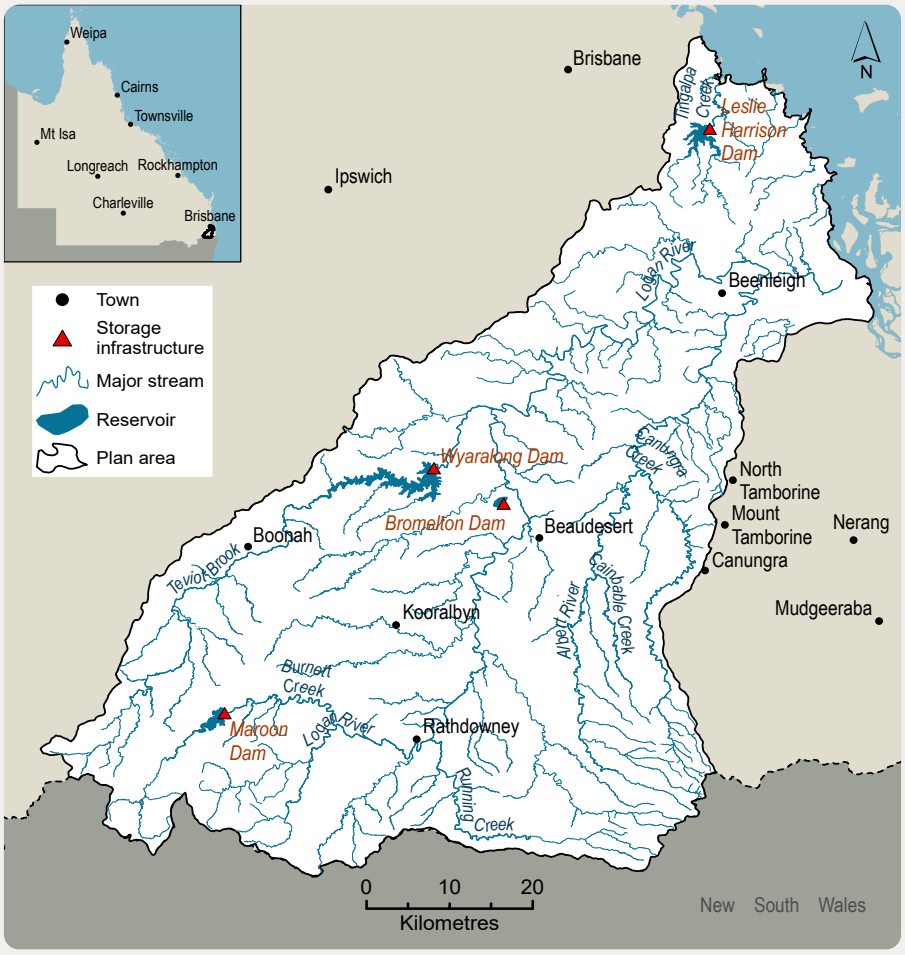
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons.
- Rainfall: decrease projected in winter and increase in summer.
- Rainfall in 2050 (refer graph): decrease in winter projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Logan Basin



Average daily temperature °C*

RCP8.5	RCP4.5
+1.0°C 2030	+0.9°C 2030
+1.7°C 2050	+1.4°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+5% 2030	+4% 2030
+15% 2050	+9% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+2% 2030	+2% 2030
0% 2050	+2% 2050

Logan Basin water plan area at a glance

The Logan Basin water plan area is located in South East Queensland and covers approximately 4,200km2.

- Large water storages such as Wyaralong, Maroon and Leslie Harrison dams supply water to support urban centres such as Logan, Beenleigh, Beaudesert and the Redlands.
- Smaller rural settlements in the area rely on unsupplemented surface water and groundwater, with the hinterland areas of Tamborine Mountain and Canungra having limited access to reticulated water supply.
- Despite the urban centres in the plan area, water is predominantly used for irrigated agriculture.

The water plan:

- sustainably manages supplemented and unsupplemented surface water (excluding overland flow)
- includes general, strategic and town water supply unallocated water reserves.

Projected climate change impacts in the Logan Basin water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

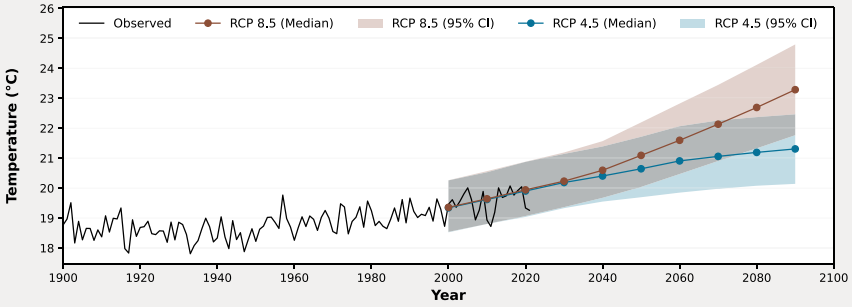
Observed annual climate trends:

- Temperature: medium increase emerged in the 1980s (strong confidence).
- Evaporation (PET): no trend observed.
- Rainfall: slight decrease observed with no emergence of significant change (weak confidence).

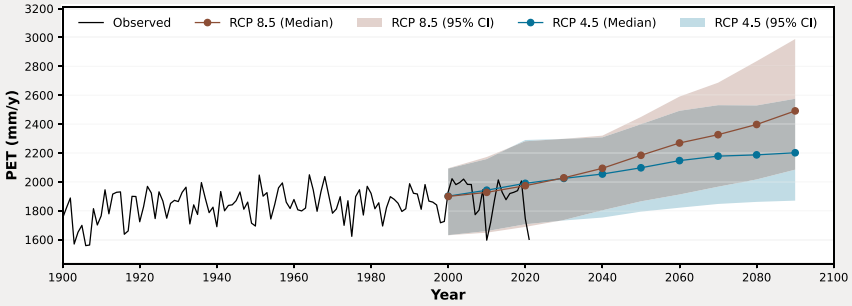
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: slight decrease projected (weak confidence).

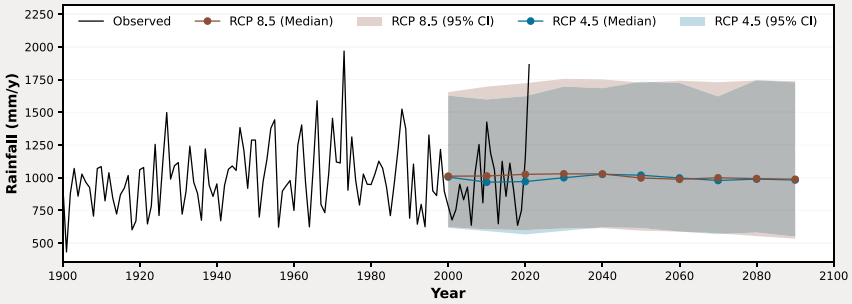
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

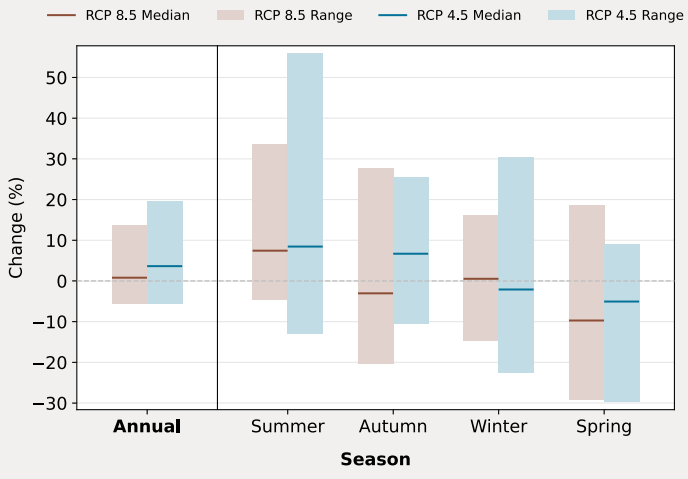


Projected seasonal climate trends:

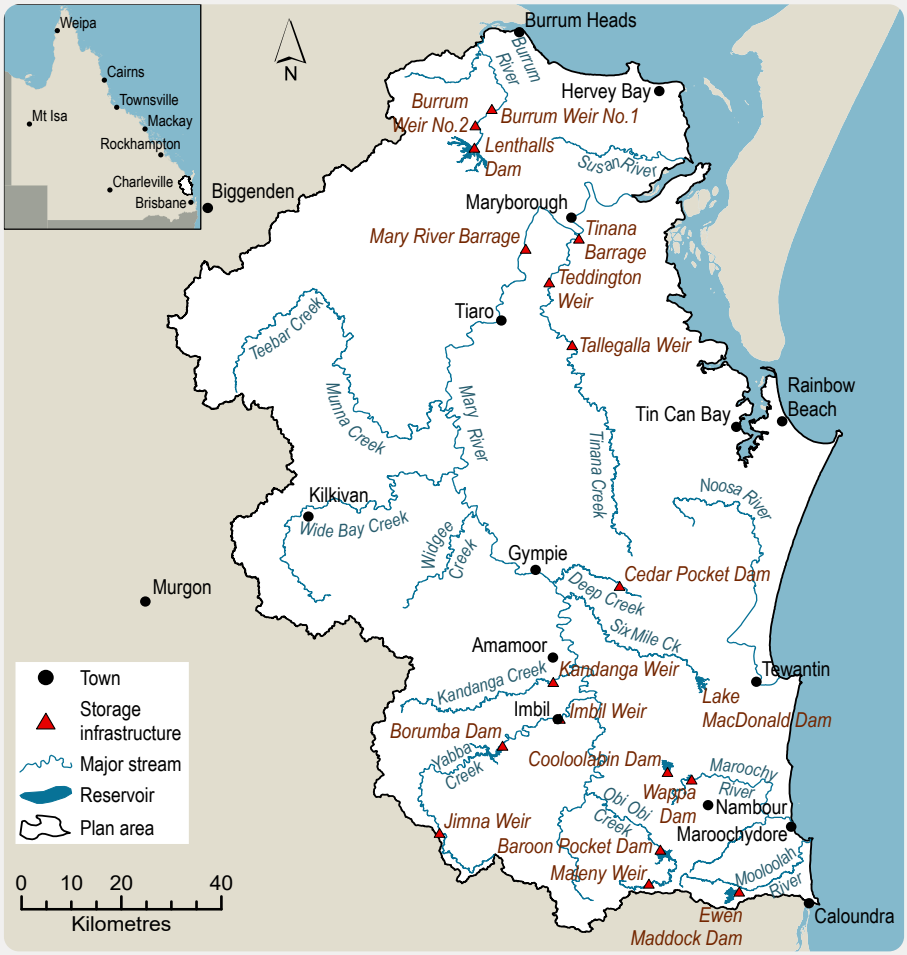
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in autumn.
- Rainfall: decrease projected in autumn to spring and increase in summer.
- Rainfall in 2050 (refer graph): decrease in spring and an increase in summer projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Mary Basin



Average daily temperature °C*

RCP8.5	RCP4.5
+0.9°C 2030	+0.9°C 2030
+1.7°C 2050	+1.4°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+5% 2030	+4% 2030
+14% 2050	+9% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+5% 2030	0% 2030
-1% 2050	+2% 2050

Mary Basin water plan area at a glance

The Mary Basin water plan area is located in South East Queensland and covers approximately 13,400km². It has a tropical to subtropical, semi-humid climate. Rainfall and temperatures in this area are naturally highly variable. The north-east part of the water plan area receives on average 1,000mm of rain per annum, while the south-west receives an average 500mm per annum.

- The area has a significant agricultural industry, with growing tourism and fisheries industries.
- Water is supplied by 6 water supply schemes and used predominantly for irrigation and urban water supply.
- There are 8 major water storages in the water plan area including Ewen Maddock Dam and Lake MacDonald Dam which are part of Seqwater's Southeast Queensland Water Grid.
- Water is accessed by many users in unsupplemented reaches as well as groundwater from the Cooloola Sandmass.
- Threatened species in the waterways include the | Mary River turtle, Mary River cod and Queensland lungfish.
- The Mary Basin water plan area is part of the catchments that drain to the Great Barrier Reef.

The water plan:

- sustainably manages surface water (excluding overland flow water) and one groundwater resource – the Cooloola Sandmass
- includes general, strategic or town water supply reserves.

Projected climate change impacts in the Mary Basin water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

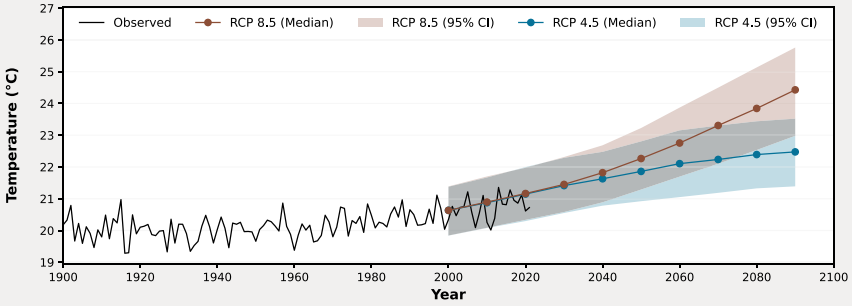
Observed annual climate trends:

- Temperature: medium increase emerged in the 1990s (strong confidence).
- Evaporation (PET): slight increase observed with no emergence of significant change (weak confidence).
- Rainfall: small decrease observed with no emergence of significant change (weak confidence).

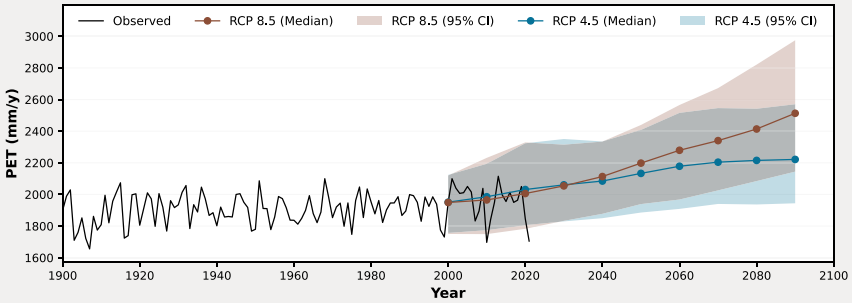
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: slight decrease projected (weak confidence).

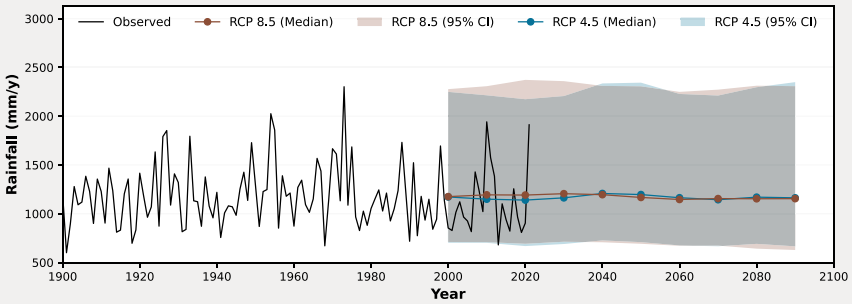
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

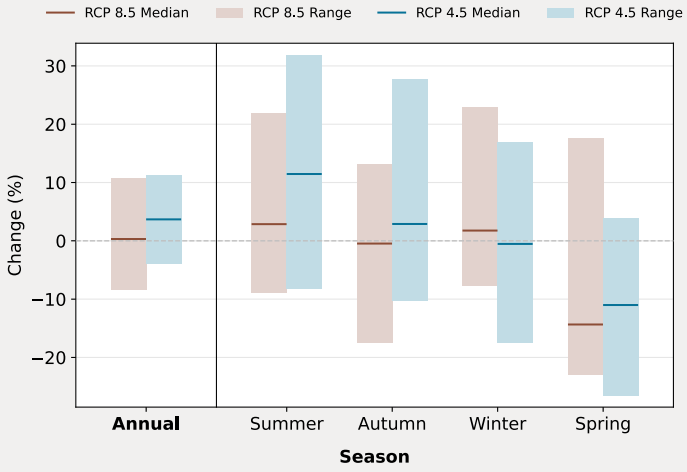


Projected seasonal climate trends:

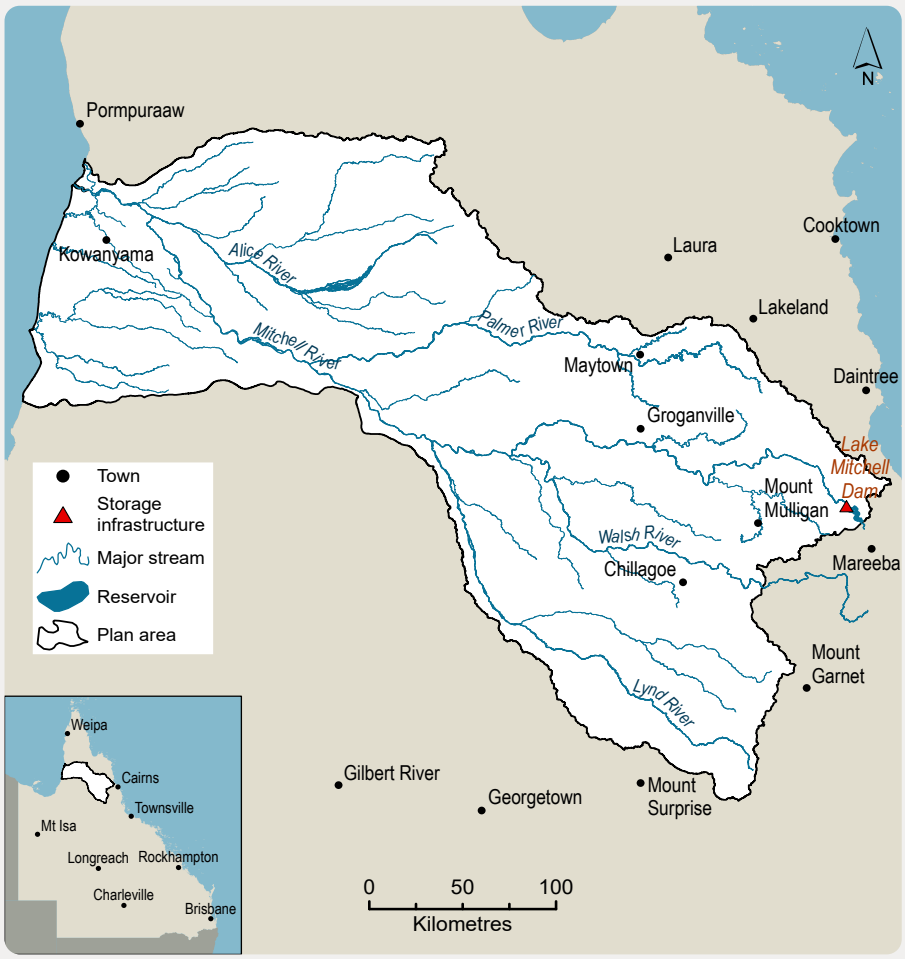
- Average monthly temperatures: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in autumn.
- Rainfall: variability projected across the year with a decrease in autumn and winter and increase in summer.
- Rainfall in 2050 (refer graph): decrease in spring and increase in summer projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Mitchell



Average daily temperature °C*

RCP8.5	RCP4.5
+0.9°C 2030	+0.9°C 2030
+1.7°C 2050	+1.3°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+7% 2030	+6% 2030
+12% 2050	+9% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
-2% 2030	-4% 2030
0% 2050	0% 2050

Mitchell water plan area at a glance

The Mitchell water plan area is located in Far North Queensland and covers approximately 70,000km². It spans the bulk of the Atherton Tablelands region. The area receives most of its rainfall over the summer season and experiences tropical cyclones. Kowanyama is the largest town in the area and has a mean annual rainfall of 1,268mm per annum.

- Water in the area is managed by the Mareeba-Dimbulah Water Supply Scheme.
- The Mitchell river catchment is one of the largest flowing river systems in the state, accounting for about 8 per cent of total water run-off in Queensland.
- The annual wet season revives the environment of the region, supports its grazing industry and triggers prawn and barramundi breeding that maintains the productivity of the Gulf of Carpentaria fisheries.
- Environmental flows are particularly important in maintaining the health of lakes and springs in the water plan area.

The water plan:

- sustainably manages surface water (including overland flow) and groundwater
- includes general, Indigenous and strategic unallocated water reserves.

Projected climate change impacts in the Mitchell water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

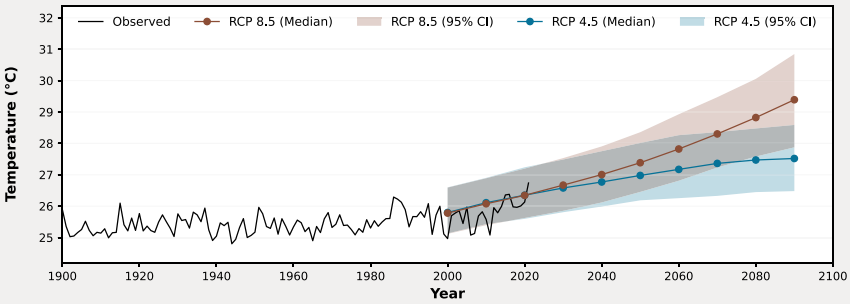
Observed annual climate trends:

- Temperature: medium increase emerged in the 1990s (moderate confidence).
- Evaporation (PET): small decrease observed with no emergence of significant change (weak confidence).
- Rainfall: slight increase observed with no emergence of significant change (weak confidence).

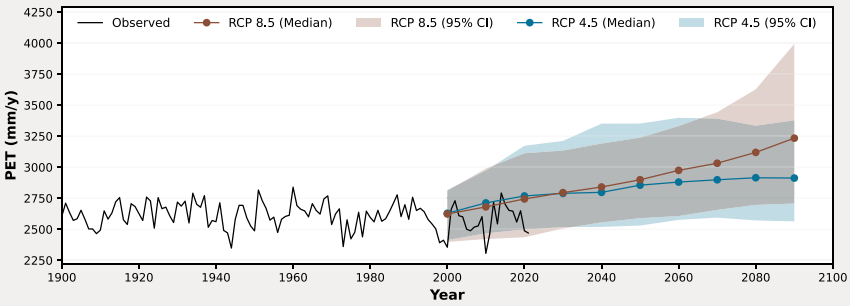
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: no trend projected amongst large uncertainty.

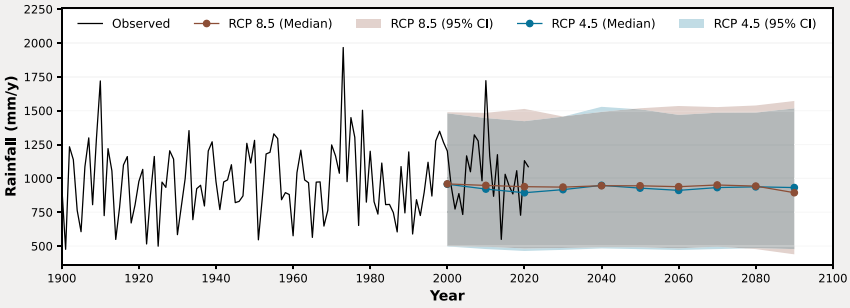
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

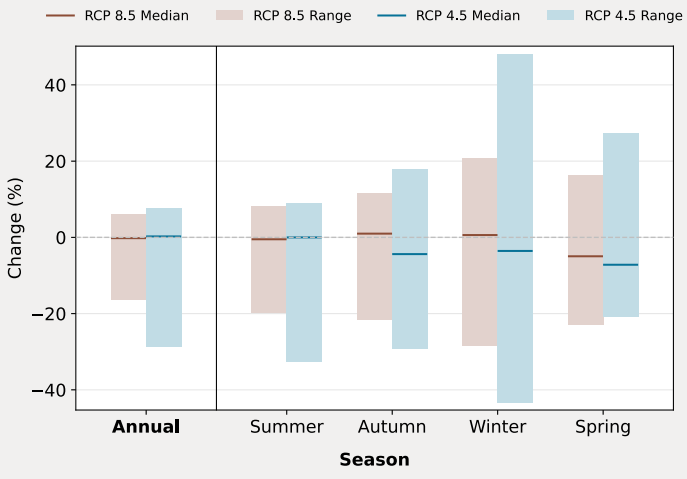


Projected seasonal climate trends:

- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly in autumn.
- Rainfall: decrease projected in summer and inconsistent increase projected in winter and spring.
- Rainfall in 2050 (refer graph): decrease in spring projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Moreton

Average daily temperature °C*

RCP8.5	RCP4.5
+1.0°C 2030	+0.8°C 2030
+1.7°C 2050	+1.4°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+6% 2030	+5% 2030
+17% 2050	+10% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+2% 2030	-1% 2030
+1% 2050	+1% 2050

Moreton water plan area at a glance

The Moreton water plan area covers approximately 15,630km² and contains the largest urban area within Queensland. It experiences hot, wet summers and mild, dry winters.

- Streamflow throughout the plan area is modified by several dams and instream structures. Important water storages for urban and agricultural purposes include Somerset, Wivenhoe, North Pine, Moogerah, Clarendon, Atkinson, Perseverance and Cressbrook dams, as well as Lake Dyer.
- In addition to these storages, there are many smaller storages and weirs throughout the plan area that supply reticulated town water supplies and some agricultural water.
- Some rural communities rely heavily on unsupplemented surface water and underground water as many do not have access to a reticulated supply.
- Water use in the plan area is predominately for urban and industrial use, however approximately 25 per cent is allocated to rural purposes.
- The water plan area drains into Moreton Bay, which is recognised as an internationally important Ramsar site.

The water plan:

- sustainably manages supplemented and unsupplemented surface water (including overland flow) and groundwater
- includes general and strategic unallocated water reserves.

Projected climate change impacts in the Moreton water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

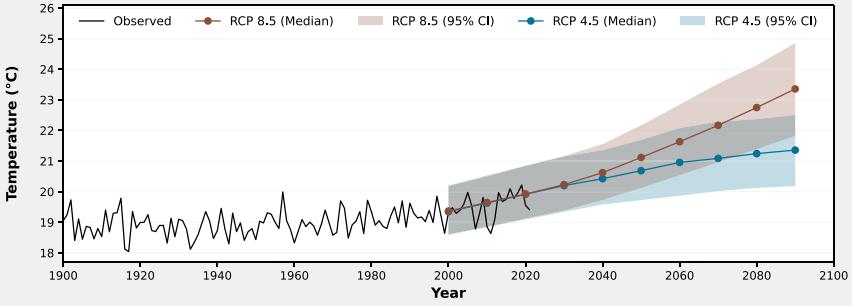
Observed annual climate trends:

- Temperature: medium increase emerged in the 2000s (moderate confidence).
- Evaporation (PET): small increase observed with no emergence of significant change (weak confidence).
- Rainfall: small decrease observed with no emergence of significant change (weak confidence).

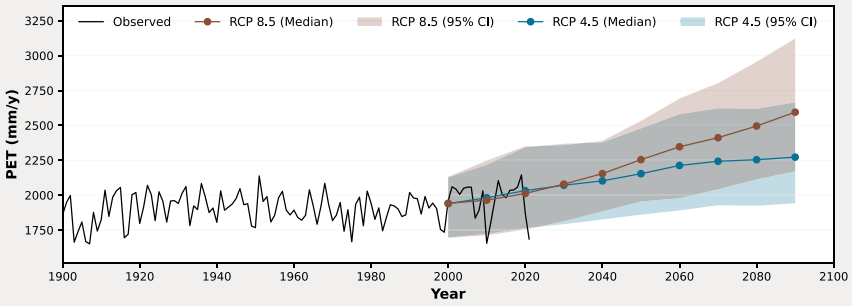
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: slight decrease projected (weak confidence).

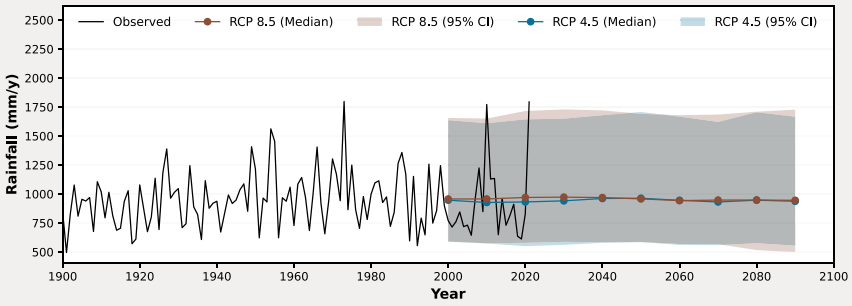
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

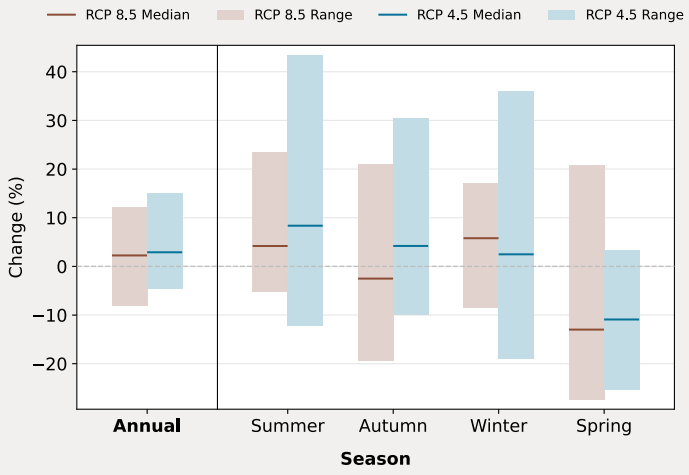


Projected seasonal climate trends:

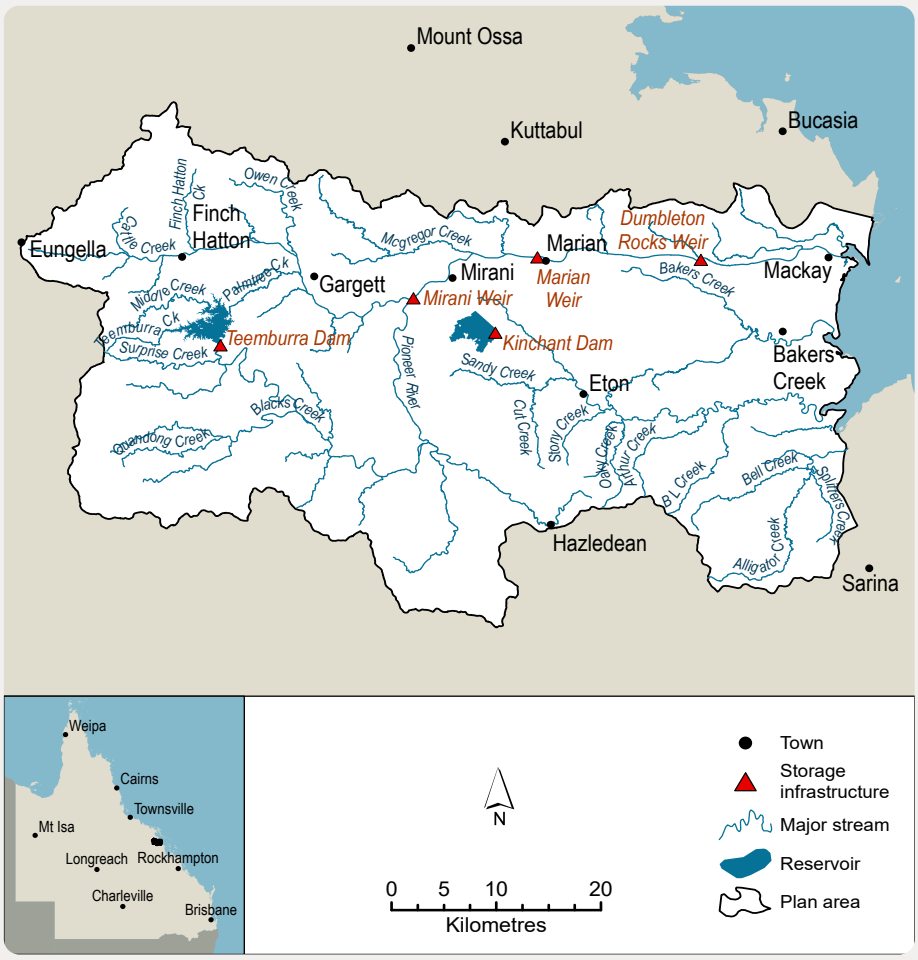
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons.
- Rainfall: decrease projected in winter and spring and increase in summer.
- Rainfall in 2050 (refer graph): decrease in spring and an increase in winter and summer projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Pioneer Valley



Average daily temperature °C*

RCP8.5	RCP4.5
+0.9°C 2030	+0.8°C 2030
+1.6°C 2050	+1.3°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+5% 2030	+3% 2030
+13% 2050	+7% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
0% 2030	0% 2030
-4% 2050	-3% 2050

Pioneer Valley water plan area at a glance

The Pioneer Valley water plan area covers approximately 2,400km² and includes the Pioneer River and the Cattle, Finch Hatton, Owens, Sandy, Bakers and McGregor creeks. Rainfall here is highly variable with hot, wet summers and mild, dry winters. Mean annual rainfall ranges from 1,600mm to 2,000mm per annum.

- Water in the area is managed by the Pioneer and Eton Water Supply Schemes.
- The largest water storage within the plan area is Teemburra Dam.
- Major water uses are irrigated agricultural production and urban supply for Mackay. This area is one of the prime sugar cane growing areas in Australia.
- A pumped hydro energy storage facility has been proposed in the western Pioneer Valley.
- The Pioneer Valley water plan area is part of the catchments that drain to the Great Barrier Reef.

The water plan:

- sustainably manages supplemented and unsupplemented surface water and groundwater
- includes general unallocated water reserves.

Projected climate change impacts in the Pioneer Valley water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

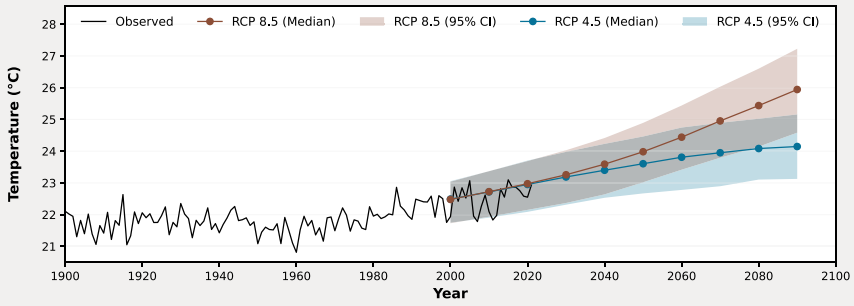
Observed annual climate trends:

- Temperature: medium increase emerged in the 1980s (strong confidence).
- Evaporation (PET): no trend observed.
- Rainfall: no trend observed.

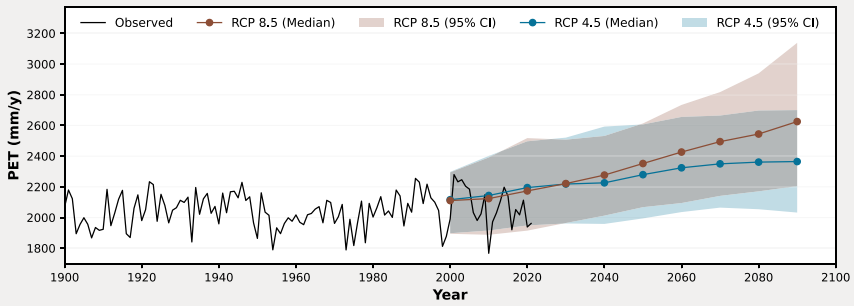
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: no trend projected amongst large uncertainty.

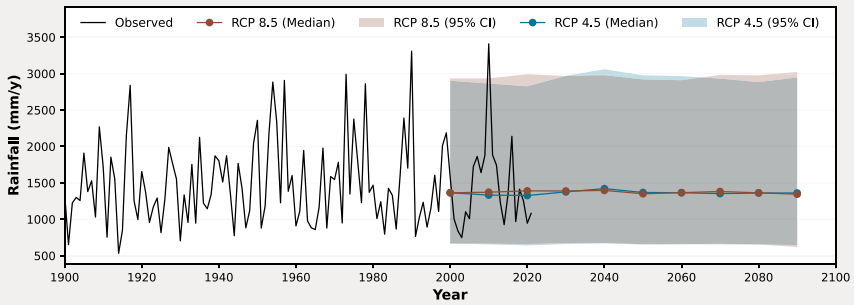
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

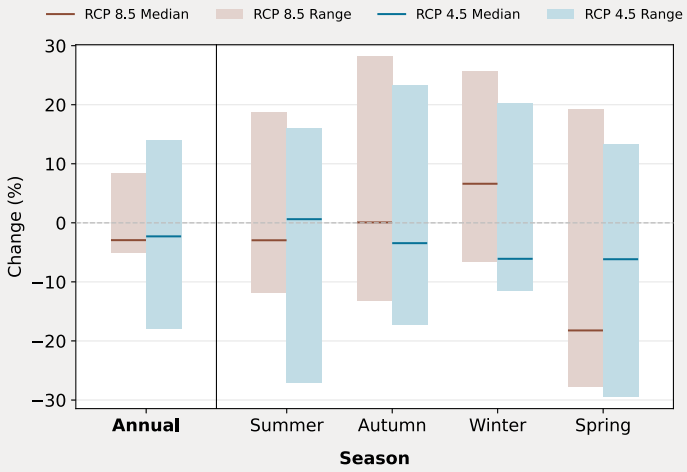


Projected seasonal climate trends:

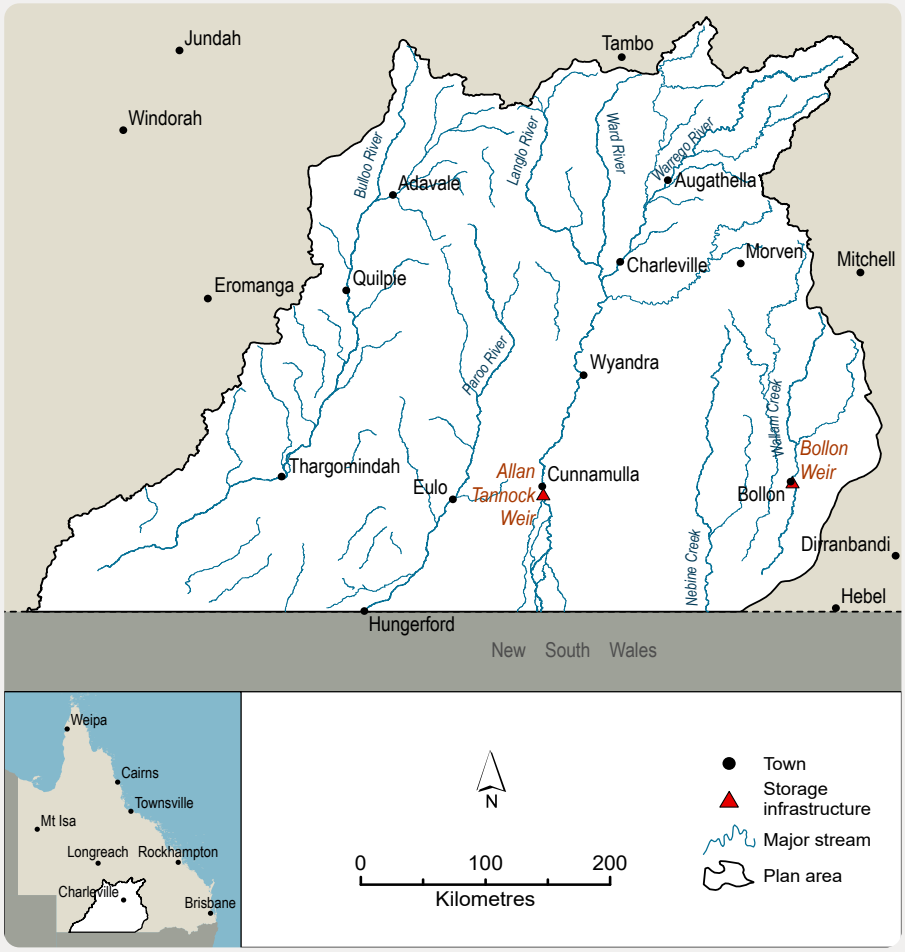
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly autumn and summer.
- Rainfall: decrease projected in autumn and spring and increase in winter.
- Rainfall in 2050 (refer graph): decrease in spring projected, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Warrego, Paroo, Bulloo and Nebine



Average daily temperature °C*

RCP8.5	RCP4.5
+1.1°C 2030	+1.0°C 2030
+2.3°C 2050	+1.8°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+9% 2030	+8% 2030
+17% 2050	+14% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+1% 2030	-3% 2030
+1% 2050	-2% 2050

Warrego, Paroo, Bulloo and Nebine water plan area at a glance

The Warrego, Paroo, Bulloo and Nebine water plan area is located in South West Queensland and covers an area totalling approximately 190,965km². The area experiences a semi-arid climate with highly variable rainfall, high temperatures and high evaporation (PET) rates. The topography is predominantly flat and the rivers have an intermittent and highly variable 'boom-bust' flow regime. The plan area forms part of the Murray-Darling Basin, flowing across the state border into New South Wales and the catchments of the Darling and Culgoa rivers.

- Urban centres in the area include Charleville, Cunnamulla and Quilpie.
- The main land use is grazing, with the remainder being for conservation, small-scale irrigation and small urban centres.
- Major watercourses include the Warrego, Paroo and Bulloo rivers, Nebine, Wallam, Mungallala and Cuttaburra creeks. The Bulloo River is a closed drainage system, ending in the Bulloo Lakes.

The water plan:

- sustainably manages supplemented and unsupplemented surface water (including overland flow) and groundwater
- includes unallocated water reserves for community, Indigenous and general purposes.

Projected climate change impacts in the Warrego, Paroo, Bulloo and Nebine water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

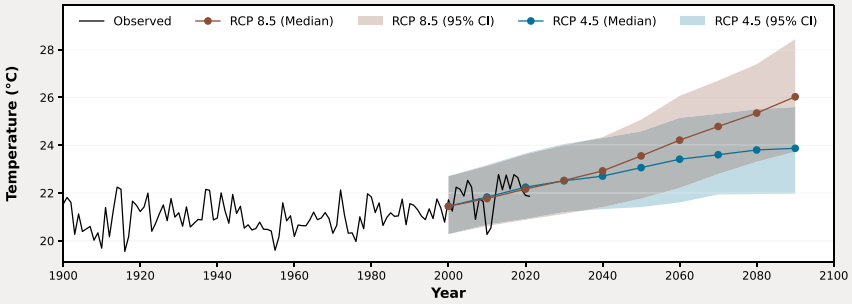
Observed annual climate trends:

- Temperature: medium increase emerged in the 2000s (moderate confidence).
- Evaporation (PET): slight increase observed with no emergence of significant change (weak confidence).
- Rainfall: no trend observed.

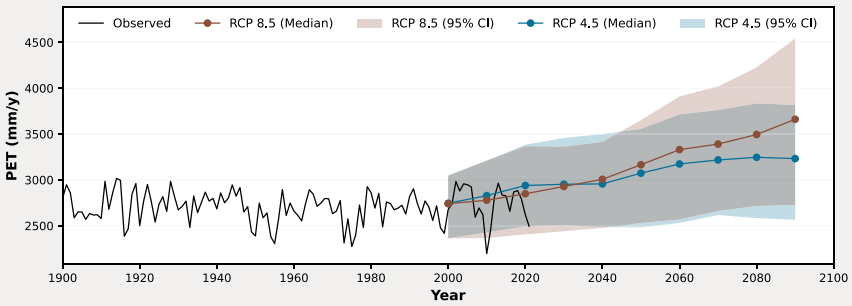
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: no trend projected amongst large uncertainty.

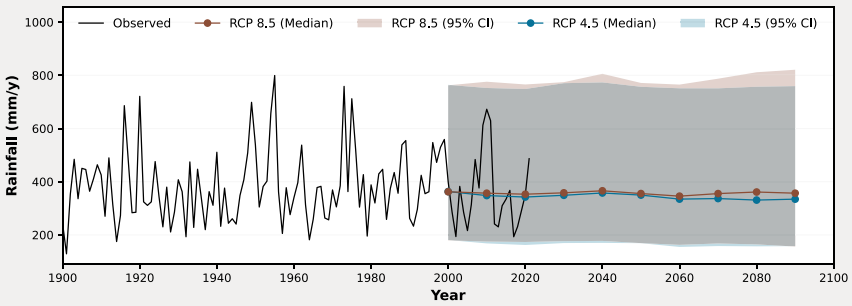
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

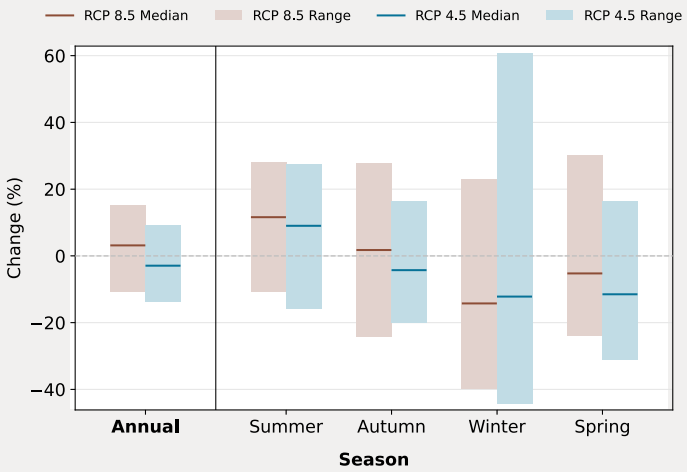


Projected seasonal climate trends:

- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly autumn and summer.
- Rainfall: decrease projected in winter and spring and increase in summer and autumn.
- Rainfall in 2050 (refer graph): decrease projected in winter and spring, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Wet Tropics

Average daily temperature °C*

RCP8.5	RCP4.5
+0.9°C 2030	+0.8°C 2030
+1.5°C 2050	+1.2°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+6% 2030	+5% 2030
+10% 2050	+8% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
-3% 2030	-3% 2030
-6% 2050	-2% 2050

Wet Tropics water plan area at a glance

The Wet Tropics water plan area is located in Far North Queensland and covers approximately 19,920km². The area has the highest rainfall in Australia with areas near Bellenden Kerr recording a mean annual rainfall exceeding 8,000mm. The rainfall reduces markedly from east to west across the coastal ranges. Mean annual rainfall reduces to around 800mm in the Upper Herbert River Basin.

- The only major water storage in the plan area is Koombooloomba Dam, on the headwaters of the Tully River, which supplies the Kareeya hydroelectric station further downstream.
- Agriculture is a major water user in the area. Bananas and sugarcane are the region's major agricultural outputs, with the banana industry relying heavily on water for irrigation. Grazing and dairying are also significant industries in the area.
- The area contains some of Queensland's richest biodiversity hotspots and key areas of ecological significance. A large proportion of the plan area comprises the Wet Tropics World Heritage Area – one of the largest rainforest wilderness areas in Australia.
- The Wet Tropics water plan area is part of the catchments that drain to the Great Barrier Reef.

The water plan:

- sustainably manages surface water and groundwater
- includes general, strategic, high flow and Cape York Indigenous unallocated water reserves.

Projected climate change impacts in the Wet Tropics water plan area

Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.

When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

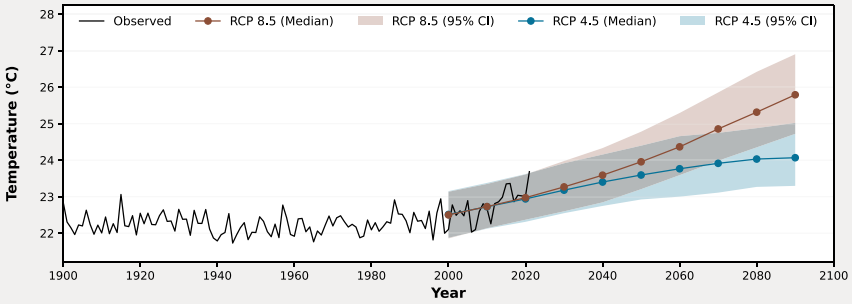
Observed annual climate trends:

- Temperature: medium increase emerged in the 1990s (strong confidence).
- Evaporation (PET): small decrease observed with no emergence of significant change (weak confidence).
- Rainfall: small increase observed with no emergence of significant change (weak confidence).

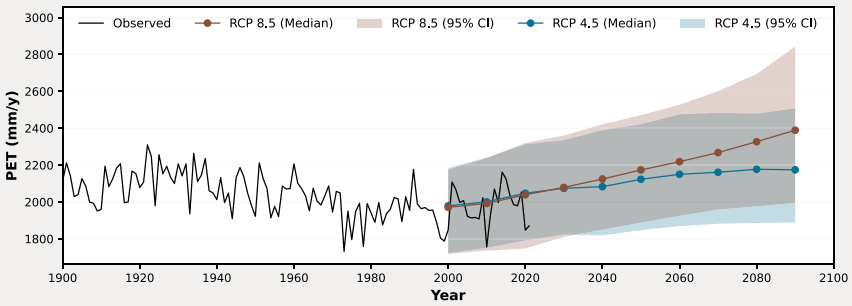
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: small decrease projected (weak confidence).

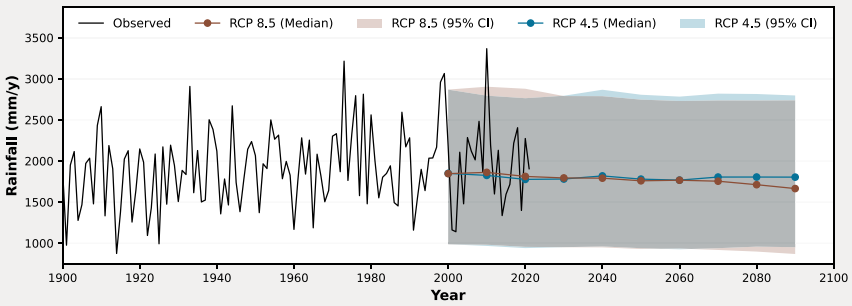
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

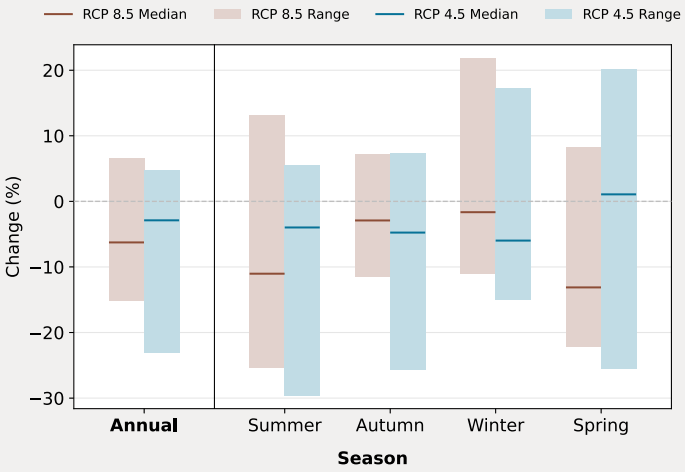


Projected seasonal climate trends:

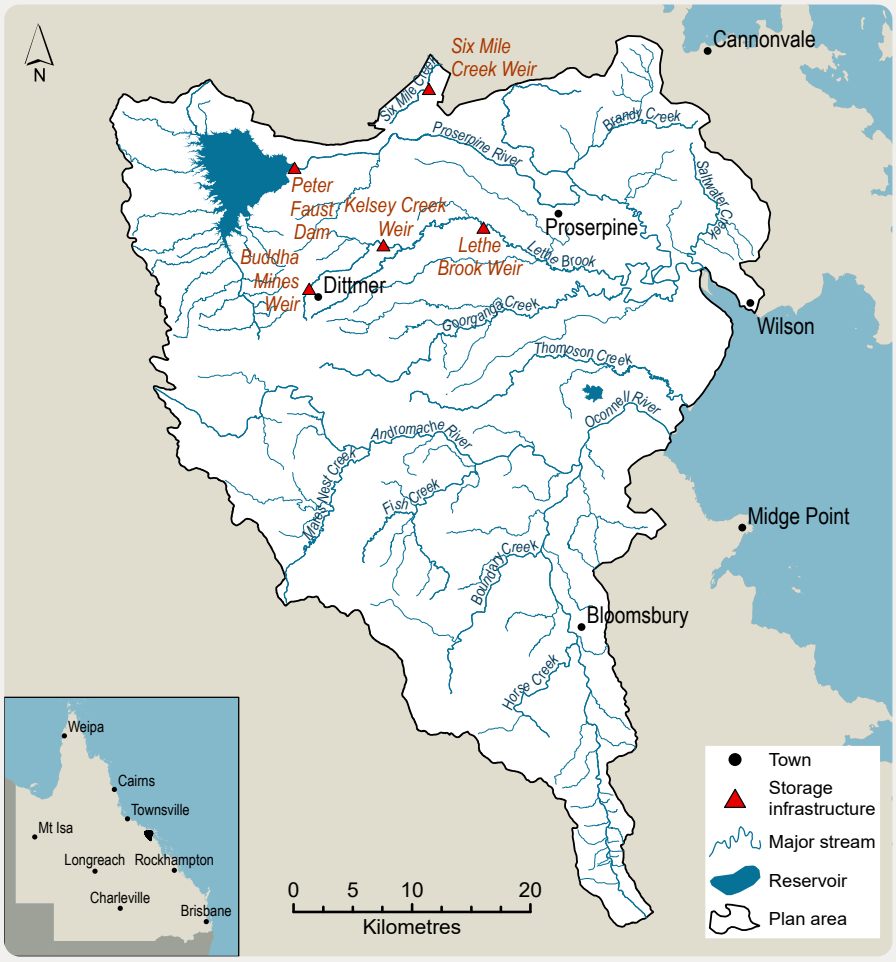
- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons, particularly summer.
- Rainfall decrease projected in spring to autumn and increase in winter.
- Rainfall in 2050 (refer graph): decrease projected across all seasons, with a similar decrease when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Whitsunday



Average daily temperature °C*

RCP8.5	RCP4.5
+0.9°C 2030	+0.8°C 2030
+1.6°C 2050	+1.2°C 2050

Average annual PET %*

RCP8.5	RCP4.5
+5% 2030	+3% 2030
+11% 2050	+6% 2050

Average annual rainfall %*

RCP8.5	RCP4.5
+2% 2030	+1% 2030
-3% 2050	+1% 2050

Whitsunday water plan area at a glance

The Whitsunday water plan area is located on the east coast of Queensland and covers approximately 2,050km². Rainfall is highly seasonal and varies considerably due to the influences of tropical cyclones and the inter-tropical convergence zone.

- Peter Faust Dam is the only major water storage in the plan area and is managed under the Proserpine River Water Supply Scheme.
- Water is important for the economic success of the key industries within the plan area including tourism, sugar cane, beef, aquaculture and fishing.
- The main water uses in the plan area are for agriculture (both stock and crop irrigation), industry and urban supply.
- The Whitsunday water plan area is part of the catchments that drain to the Great Barrier Reef.

The water plan:

- sustainably manages supplemented and unsupplemented surface water (including overland flow) and groundwater
- includes general and strategic unallocated water reserves.

Projected climate change impacts in the Whitsunday water plan area

- Climate modelling has been used to project the impact of high (RCP8.5) and lower (RCP4.5) greenhouse gas emission scenarios on the water plan area for the years 2030 and 2050. Climate change trends and the potential impact on the environment and water user groups are considered in Queensland water planning.
- When we look at climate impacts (projection statements), we look at the direction of projected change (no trend/increase/decrease), the magnitude of change (none/slight/small/medium/large) and the level of confidence in the projection (weak/moderate/strong).

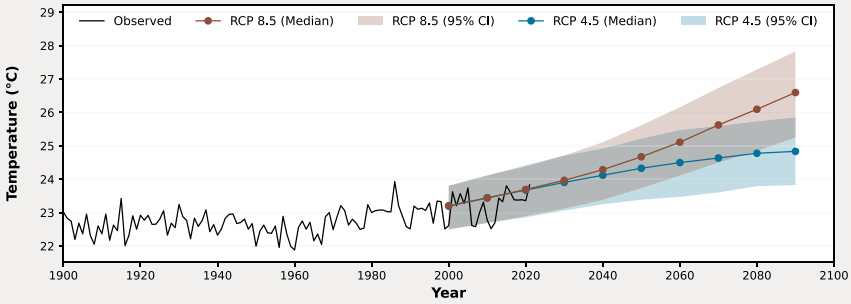
Observed annual climate trends:

- Temperature: medium increase emerged in the 1980s (strong confidence).
- Evaporation (PET): no trend observed.
- Rainfall: no trend observed.

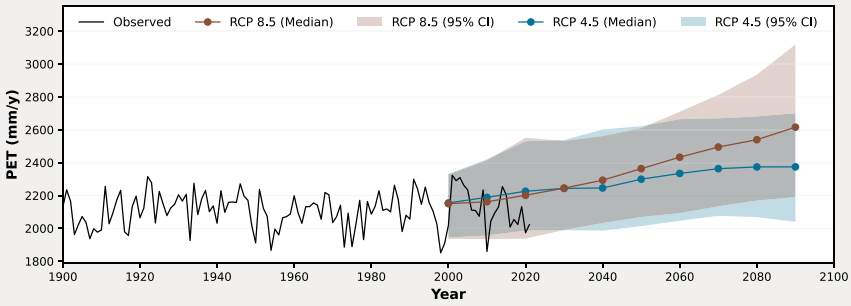
Projected annual climate trends:

- Temperature: large increase projected (strong confidence).
- Evaporation (PET): medium increase projected (strong confidence).
- Rainfall: no trend projected amongst large uncertainty.

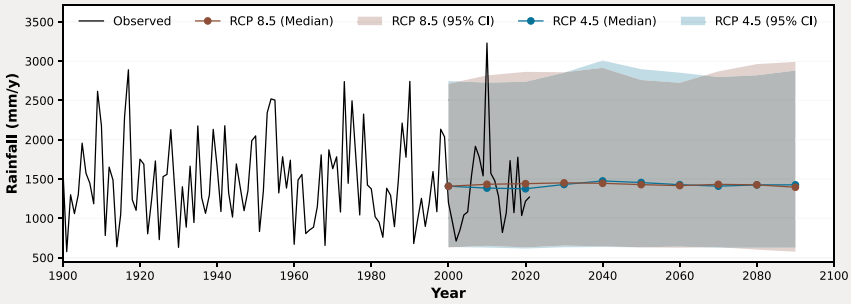
Average daily temperature (°C/year)



Average annual potential evapotranspiration (PET) (mm/year)



Average annual rainfall (mm/year)

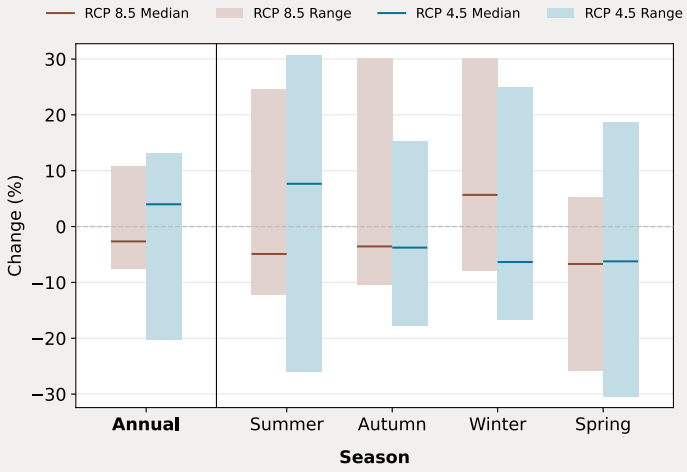


Projected seasonal climate trends:

- Average monthly temperature: increase projected for all seasons.
- Evaporation (PET): projected to increase for all seasons.
- Rainfall: inconsistent decrease projected in spring to autumn and increase in winter.
- Rainfall in 2050 (refer graph): a decrease projected in autumn and spring, however rainfall changes are smaller when considered annually.

* These infographics illustrate the change in median values for average annual temperature, potential evapotranspiration (PET) and rainfall for high (RCP8.5) and lower (RCP4.5) emissions scenarios for the years 2030 and 2050. Additional data is included in Appendix B.

Median and range of projected change in average annual and seasonal rainfall in 2050



Appendix B

Summary of climate projection data used in this report

Table B1: Average daily temperature

Lower, median and upper projections of relative change in average daily temperature (°C) for the years 2030 and 2050, relative to the 1986–2005 reference period (projections based on model runs from July 2021)[11]

Water plan area	RCP4.5 at 2030			RCP8.5 at 2030			RCP4.5 at 2050			RCP8.5 at 2050		
	2030 Lower	2030 Median	2030 Upper	2030 Lower	2030 Median	2030 Upper	2050 Lower	2050 Median	2050 Upper	2050 Lower	2050 Median	2050 Upper
Baffle Creek Basin	0.6	0.8	1.1	0.6	0.9	1.1	1.0	1.3	1.6	1.3	1.6	2.1
Barron	0.5	0.9	1.0	0.6	0.9	1.1	0.9	1.2	1.5	1.2	1.6	2.0
Border Rivers and Moonie	0.7	0.9	1.5	0.7	1.0	1.4	1.0	1.6	2.1	1.4	2.1	2.6
Boyne River Basin	0.6	0.8	1.2	0.6	0.9	1.3	1.0	1.4	1.7	1.3	1.7	2.2
Burdekin Basin	0.5	0.9	1.4	0.4	1.1	1.4	0.9	1.4	1.9	1.2	1.9	2.3
Burnett Basin	0.6	0.9	1.3	0.5	1.0	1.3	0.9	1.6	1.8	1.4	1.8	2.4
Calliope River	0.6	0.8	1.2	0.6	0.9	1.2	1.0	1.4	1.7	1.2	1.6	2.2
Cape York	0.5	0.8	1.1	0.6	0.8	1.1	0.9	1.2	1.6	1.2	1.6	1.9
Condamine and Balonne	0.7	0.9	1.5	0.7	1.0	1.4	0.9	1.6	2.1	1.5	2.1	2.6
Cooper Creek	0.7	1.0	1.5	0.6	1.1	1.6	0.8	1.7	2.2	1.4	2.2	2.8
Fitzroy Basin	0.6	0.9	1.4	0.6	1.0	1.4	0.9	1.6	1.9	1.3	1.8	2.4
Georgina and Diamantina	0.7	1.1	1.5	0.5	1.2	1.6	0.6	1.6	2.2	1.3	2.3	2.8
Gold Coast	0.6	0.9	1.1	0.7	0.9	1.2	1.0	1.3	1.6	1.3	1.6	2.2
Gulf	0.5	1.0	1.4	0.5	1.1	1.5	0.8	1.4	2.0	1.1	2.0	2.3
Logan Basin	0.6	0.9	1.2	0.7	1.0	1.1	1.0	1.4	1.8	1.4	1.7	2.3
Mary Basin	0.6	0.9	1.2	0.6	0.9	1.1	1.0	1.4	1.6	1.4	1.7	2.2
Mitchell	0.5	0.9	1.2	0.6	0.9	1.2	0.9	1.3	1.8	1.2	1.7	2.1
Moreton	0.6	0.8	1.2	0.7	1.0	1.2	1.0	1.4	1.8	1.4	1.7	2.3
Pioneer Valley	0.6	0.8	1.1	0.6	0.9	1.2	0.9	1.3	1.6	1.2	1.6	2.0
Warrego Paroo Bulloo and Nebine	0.8	1.0	1.6	0.7	1.1	1.6	0.8	1.8	2.3	1.5	2.3	2.8
Wet Tropics	0.5	0.8	0.9	0.5	0.9	1.1	0.9	1.2	1.5	1.1	1.5	1.9
Whitsunday	0.5	0.8	1.0	0.5	0.9	1.1	0.9	1.2	1.5	1.1	1.6	2.0

[11] The projections and their associated uncertainty are represented by the lower (10th per centile), median and upper (90th per centile) statistics of GCM outputs. The projections were processed in July 2021 from downscaled GCM outputs sourced from the Queensland Future Climate Dashboard (https://longpaddock.qld.gov.au/qld-future-climate/dashboard/)

Table B2: Annual potential evaportranspiration

Lower, median and upper projections of relative change in annual potential evaportranspiration for the years 2030 and 2050, relative to the 1986–2005 reference period (projections based on model runs from July 2021)[12]

Water plan area	RCP4.5 at 2030			RCP8.5 at 2030			RCP4.5 at 2050			RCP8.5 at 2050		
	2030 Lower	2030 Median	2030 Upper	2030 Lower	2030 Median	2030 Upper	2050 Lower	2050 Median	2050 Upper	2050 Lower	2050 Median	2050 Upper
Baffle Creek Basin	1%	4%	11%	1%	4%	8%	4%	7%	16%	5%	12%	17%
Barron	3%	4%	10%	2%	7%	10%	4%	8%	13%	7%	10%	16%
Border Rivers and Moonie	2%	6%	14%	1%	6%	14%	2%	13%	17%	8%	18%	21%
Boyne River Basin	2%	5%	13%	2%	5%	9%	6%	10%	18%	6%	14%	20%
Burdekin Basin	1%	6%	13%	0%	7%	13%	1%	10%	20%	6%	15%	21%
Burnett Basin	2%	5%	13%	2%	6%	11%	5%	11%	19%	9%	15%	20%
Calliope Basin	1%	5%	13%	1%	5%	9%	5%	9%	18%	6%	14%	20%
Cape York	3%	6%	12%	2%	6%	13%	4%	9%	12%	5%	10%	15%
Condamine and Balonne	2%	6%	14%	1%	7%	14%	1%	13%	18%	8%	18%	20%
Cooper Creek	2%	9%	14%	1%	9%	12%	-1%	13%	20%	6%	17%	20%
Fitzroy Basin	2%	5%	13%	1%	7%	11%	3%	11%	21%	7%	16%	20%
Georgina and Diamantina	1%	6%	13%	-1%	8%	13%	-2%	12%	19%	3%	15%	20%
Gold Coast	2%	5%	9%	3%	5%	8%	5%	7%	13%	6%	12%	17%
Gulf	1%	7%	13%	0%	7%	12%	0%	10%	18%	3%	13%	20%
Logan Basin	3%	4%	12%	3%	5%	10%	5%	9%	16%	9%	15%	20%
Mary Basin	2%	4%	11%	3%	5%	8%	5%	9%	17%	7%	14%	17%
Mitchell	4%	6%	13%	2%	7%	12%	4%	9%	14%	5%	12%	17%
Moreton	3%	5%	13%	3%	6%	12%	6%	10%	17%	11%	17%	19%
Pioneer Valley	1%	3%	11%	1%	5%	9%	2%	7%	16%	6%	13%	16%
Warrego Paroo Bulloo and Nebine	3%	8%	16%	1%	9%	12%	-2%	14%	19%	4%	17%	20%
Wet Tropics	2%	5%	9%	1%	6%	11%	1%	8%	13%	6%	10%	16%
Whitsunday	0%	3%	10%	0%	5%	8%	0%	6%	14%	4%	11%	15%

[12] The projections and their associated uncertainty are represented by the lower (10th per centile), median and upper (90th per centile) statistics of GCM outputs. The projections were processed in July 2021 from downscaled GCM outputs sourced from the Queensland Future Climate Dashboard (https://longpaddock.qld.gov.au/qld-future-climate/dashboard/)

Table B3: Annual rainfall

Lower, median and upper projections of relative change in annual rainfall for the years 2030 and 2050, relative to the 1986–2005 reference period (projections based on model runs from July 2021)[13]

Water plan area	RCP4.5 at 2030			RCP8.5 at 2030			RCP4.5 at 2050			RCP8.5 at 2050		
	2030 Lower	2030 Median	2030 Upper	2030 Lower	2030 Median	2030 Upper	2050 Lower	2050 Median	2050 Upper	2050 Lower	2050 Median	2050 Upper
Baffle Creek Basin	-15%	-1%	13%	-7%	4%	10%	-10%	2%	7%	-14%	-1%	6%
Barron	-14%	-5%	0%	-11%	-6%	-2%	-19%	-3%	4%	-16%	-7%	2%
Border Rivers and Moonie	-11%	-4%	5%	-9%	1%	10%	-5%	-1%	5%	-8%	1%	6%
Boyne River Basin	-13%	-3%	9%	-12%	1%	7%	-10%	-2%	5%	-18%	-2%	0%
Burdekin Basin	-17%	-3%	8%	-9%	-6%	2%	-16%	-3%	5%	-13%	-6%	3%
Burnett Basin	-14%	-2%	9%	-9%	-1%	9%	-8%	0%	3%	-10%	-3%	2%
Calliope River	-11%	-4%	12%	-8%	4%	11%	-9%	0%	10%	-17%	0%	6%
Cape York	-15%	-6%	1%	-15%	-5%	-1%	-9%	-4%	1%	-12%	-4%	-2%
Condamine and Balonne	-14%	-3%	4%	-11%	1%	8%	-6%	-2%	5%	-6%	-1%	4%
Cooper Creek	-21%	-4%	8%	-7%	-2%	12%	-20%	-2%	10%	-13%	-2%	11%
Fitzroy Basin	-10%	-3%	6%	-9%	2%	6%	-13%	-5%	6%	-11%	-3%	4%
Georgina and Diamantina	-23%	4%	8%	-8%	3%	10%	-20%	1%	15%	-15%	3%	21%
Gold Coast	-11%	3%	9%	-7%	6%	9%	-8%	3%	9%	-6%	-1%	7%
Gulf	-20%	-1%	10%	-8%	1%	4%	-15%	3%	10%	-6%	4%	12%
Logan Basin	-9%	2%	8%	-8%	2%	10%	-6%	2%	10%	-8%	0%	6%
Mary Basin	-10%	0%	8%	-11%	5%	12%	-5%	2%	7%	-7%	-1%	6%
Mitchell	-16%	-4%	2%	-11%	-2%	1%	-11%	0%	6%	-12%	0%	1%
Moreton	-9%	-1%	6%	-8%	2%	9%	-6%	1%	6%	-7%	1%	6%
Pioneer Valley	-8%	0%	5%	-4%	0%	4%	-7%	-3%	4%	-5%	-4%	-1%
Warrego Paroo Bulloo and Nebine	-15%	-3%	5%	-10%	1%	9%	-11%	-2%	9%	-11%	1%	8%
Wet Tropics	-12%	-3%	2%	-10%	-3%	1%	-13%	-2%	2%	-12%	-6%	-1%
Whitsunday	-8%	1%	7%	-4%	2%	6%	-6%	1%	10%	-7%	-3%	2%

[13] The projections and their associated uncertainty are represented by the lower (10th per centile), median and upper (90th per centile) statistics of GCM outputs. The projections were processed in July 2021 from downscaled GCM outputs sourced from the Queensland Future Climate Dashboard (https://longpaddock.qld.gov.au/qld-future-climate/dashboard/)

Appendix C Glossary

The Act	*Water Act 2000* (Qld)
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DES	Department of Environment and Science
DRDMW	Department of Regional Development Manufacturing and Water
Downscaling	A process to achieve higher spatial resolution in climate projections data which runs the outputs from a GCM, through a further model which incorporates finer scale region-specific parameters.
Ephemeral	Refers to streamflows and wetland water levels that are not permanent but can be periodically dry throughout parts of the year.
GABORA	Great Artesian Basin and Other Regional Aquifers
GCM	General Circulation Model
IPCC	Intergovernmental Panel on Climate Change
Median prediction	From the range of predictions from all GCMs, the median prediction is the middle prediction when sorted from lowest prediction to highest prediction.
PET	Potential Evapotranspiration
Radiative forcing	Radiative forcing is the difference between the energy that enters and leaves Earth's atmosphere, affecting it's climate.
RCM	Regional climate models explicitly stimulate the interactions between the large scale weather patterns simulated by a global model and the local terrain. Climate models are broader than weather predictions and analyse long time spans.
RCP	Representative Concentration Pathways are scenarios that outline how greenhouse gas concentrations are expected to change over time — these then relate to the amount of energy present at the Earth's surface that will drive global climatic changes.
RCP4.5	Representative Concentration Pathway with an increase in radiative forcing of 4.5W/m^2 in 2100 relative to pre-industrial values. This represents a moderate emissions scenario with some curbing of emissions.
RCP8.5	Representative Concentration Pathway with an increase in radiative forcing of 8.5W/m^2 in 2100 relative to pre-industrial values. This represents a high emission scenario or a future with little curbing of emissions.

Appendix D Information sources

Water planning in Queensland

The DRDMW and Business Queensland websites provide a wide range of information with links to maps, data and reports for water users and water planners.

https://www.business.qld.gov.au/industries/mining-energy-water/water

https://www.rdmw.qld.gov.au/water/how-it-works

Maps and data

Access surface water and groundwater data, maps, models and applications including the Queensland Globe, Water monitoring information portal, Watercourse identification map and more.

https://www.business.qld.gov.au/industries/mining-energy-water/water/maps-data

Catchments (water plan areas) and planning

Access information on water planning and management across Queensland including water plan areas and the water planning framework.

https://www.business.qld.gov.au/industries/mining-energy-water/water/catchments-planning

Climate risk information for rural Queensland

The Long Paddock is a website that provides seasonal climate and pasture condition information for rural landowners who rely strongly on climate and weather forecasts to manage the water use on their properties.

https://longpaddock.qld.gov.au/

Understanding the data

Find a detailed explanation of how global climate models are downscaled to state and region-specific models to estimate climate projections across different areas of Queensland.

https://longpaddock.qld.gov.au/qld-future-climate/understand-data/

Queensland future climate

The Queensland Future Climate Dashboard summarises information on 11 climate models with regional scale simulations. Users can customise, visualise and export summarised future climate information according to their interest using drop-down menus, maps, plots and tables.

https://longpaddock.qld.gov.au/qld-future-climate/dashboard/

Climate change in Australia

The climate change projections for Australia released in 2015 (and updated regularly) are useful for Australia's natural resource management sector planning. They provide information to assist climate adaptation processes.

https://climatechangeinaustralia.gov.au

Water courses geography information

The Australian Hydrological Geospatial Fabric (Geofabric) is a specialised Geographic Information System (GIS). It registers the spatial relationships between important hydrological features such as rivers, water bodies, aquifers and monitoring points.

http://www.bom.gov.au/water/geofabric

Water resources assessment model

The Australian Water Outlook is an interactive website that provides Australia-wide information on key landscape water balance components including soil moisture, runoff, evapotranspiration and precipitation. The website provides access to information over different timescales.

https://awo.bom.gov.au/about/overview

Adapting to climate change

Adaptation action is essential for the continued prosperity of our communities, our environment and our economy. The Queensland Climate Adaptation Strategy 2017–2030 (PDF, 2MB) (Q-CAS) provides a framework to ensure Queensland becomes more climate resilient and manages the risks associated with a changing climate.

https://www.des.qld.gov.au/climateaction/theplan/climate-adaptation

Water modelling

The Australian Water Resources Assessment (AWRA) modelling system supports reporting and assessment of water flows and storage on a daily time scale at a spatial resolution of 5 kilometres. It combines in-situ and satellite observations with state-of-the-art hydrological modelling.

https://www.csiro.au/en/research/natural-environment/water/Water-resource-assessment/WIRADA/Research/Water-accounting

Best practice water modelling in Queensland

The Queensland Water Modelling Network is improving the state's capacity to model its surface and groundwater resources and their quality. This website has tools, information and collaborative platforms to support best-practice use of water models.

https://watermodelling.org/

Hydrological modelling methodology

This report provides a critical review of the range of modelling approaches currently used in Queensland to assess climate change impacts.

Critical review of climate change and water modelling in Queensland (des.qld.gov.au)

Assessment reports (IPCC AR5)

The IPCC Fifth Assessment Report (AR5) provides an overview of the science of climate change. It is used in this report for the interpretation of climate models.

https://www.ipcc.ch/report/ar5/syr/

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