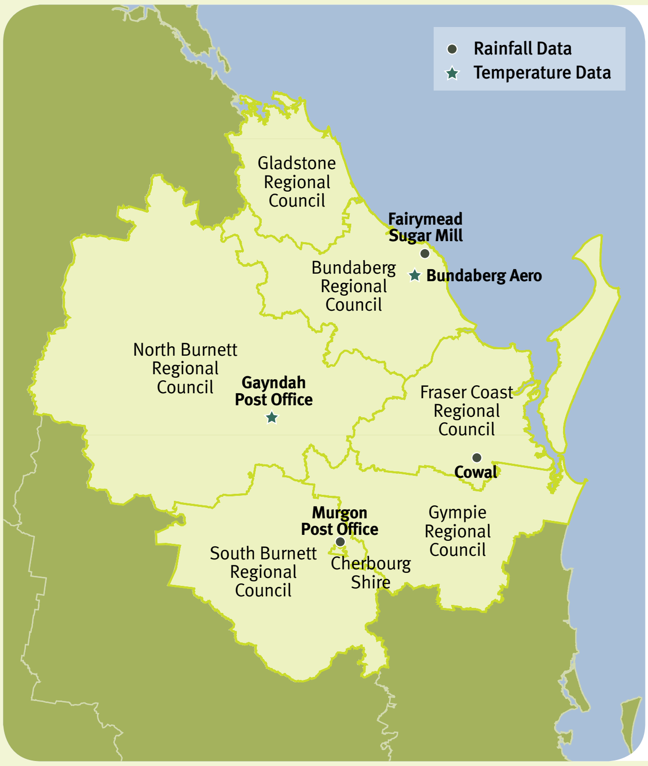
Climate change in the
Wide Bay Burnett Region



This regional summary describes the projected climate change for the Wide Bay Burnett (WBB) region.

Projected average temperature, rainfall and evaporation for 2030, 2050 and 2070 under low, medium and high greenhouse gas emissions scenarios are compared with historical climate records.

Toward Q2 Tomorrow's Queensland

Queensland Government

Photo: Tourism Queensland

Key findings

Temperature

- Average annual temperature in WBB has increased 0.4 °C over the last decade (from 20.5 °C to 20.9 °C).
- Projections indicate an increase of up to 4.1 °C by 2070; leading to annual temperatures well beyond those experienced over the last 50 years.
- By 2070, Bundaberg may have 12 times the number of days over 35 °C (increasing from an average of one per year, to an average of 12 per year by 2070), while Gayndah may have more than triple (increasing from an average of 23 per year, to an average of 81 per year by 2070).

Rainfall

- Average annual rainfall in the last decade fell nearly 12 per cent compared with the previous 30 years. This is generally consistent with natural variability experienced over the last 110 years, which makes it difficult to detect any influence of climate change at this stage.
- Models have projected a range of rainfall changes from an annual increase of 16 per cent to a decrease of 33 per cent by 2070. The 'best estimate' of projected rainfall change shows a decrease under all emissions scenarios.

Evaporation

- Projections indicate annual potential evaporation could increase 7–16 per cent by 2070.

Extreme events

- The 1-in-100-year storm tide event is projected to increase by 50 cm in Hervey Bay if certain conditions eventuate. These conditions are a 30 cm sea-level rise, a 10 per cent increase in cyclone intensity and frequency, as well as a 130 km shift southwards in cyclone tracks.

A regional profile

Climate and landscape

The WBB region enjoys a subtropical climate with warm wet summers and mild winters. Rainfall is highly seasonal, with most rain occurring during the summer months.

The region is renowned for its unique coastal communities, including the World Heritage-listed Fraser Island, the Mackay-Capricorn section of the Great Barrier Reef and the RAMSAR-listed Great Sandy Straits wetlands.

Demographics

In 2007, the region's population was 325 893, and is projected to increase beyond 369 000 by 2026.

(OESR, 2007; DIP, 2008)

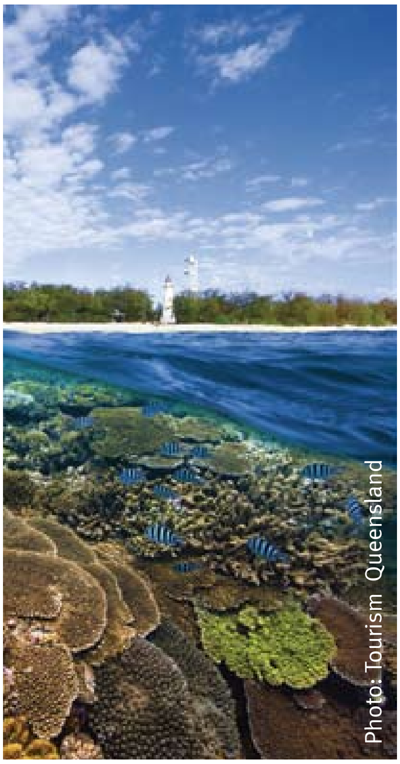


Photo: Tourism Queensland

Important industries of the region

Regional industries include agriculture, timber production, sugar growing and processing, heavy industries, mining and tourism.

Agriculture is the dominant industry, contributing significantly to the state's sugar, beef and peanut production. Other agricultural industries include cereal crops, dairying and fruit and vegetable growing.

Over 60 per cent of the state's forestry plantations are in the WBB region. This represents over six per cent of the total Australian estate.

Tourism is a significant industry in the key tourism areas of Fraser Island, Hervey Bay and South Burnett. There is also a significant number of smaller recreation, accommodation and related services.

While the total area covered by mining and extractive industries is relatively small in the region, they play an important role in regional and state development and energy production.

The Queensland Government has designated Gladstone as a hub for heavy industry and a Centre of Excellence for light metals engineering and manufacturing. Gladstone has been specifically reserved for large-scale resource processing, metals smelting and downstream manufacturing industries.

(Extracted from the Wide Bay Burnett Regional Plan)

Understanding the climate and how it changes

Queensland's climate is naturally variable; however, climate change will lead to shifts beyond this natural variability. To assess the risk of human-induced climate change requires an understanding of the current climate using historical data and future climate scenarios. These future scenarios are prepared using data from Global Climate Models.

Method

Historical climate data

Historical climate data collected by the Bureau of Meteorology (BoM) were aggregated across the WBB region. The fluctuations and trends in the observed data are presented including extremes in temperature and the frequency of cyclones.

Greenhouse emission scenarios

The World Meteorological Organization (WMO) and the United Nations established the Intergovernmental Panel on Climate Change (IPCC) in 1988. The IPCC assesses the latest scientific, technological and socio-economic literature on climate change.

To estimate the potential impacts of future climate change on Queensland, climate change projections were developed using the IPCC low (B1), medium (A1B) and high (A1FI) greenhouse gas emissions scenarios. The low-range scenario (B1) assumes a rapid shift to less fossil fuel intensive industries. The mid-range (A1B) scenario assumes a balanced use of different energy sources. The high (A1FI) scenario assumes continued dependence on fossil fuels.

Greenhouse gas emissions are currently tracking above the highest IPCC emissions scenario (A1FI). The low and medium scenarios are presented to show the potential benefits of action to reduce greenhouse gas emissions.

Climate change projections

Queensland climate change projections were produced by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM) based on the results from 23 Global Climate Models. Projections were provided for 2030, 2050 and 2070. However, as the climate can vary significantly from one year to the next, these projections show changes in average climate for three future 30-year periods centered on 2030, 2050 and 2070. Sea-level rise is also considered.

Current Climate

Temperature (BoM, 2008)

Historical temperature records indicate the average temperature in the WBB region has risen, with this increase accelerating over the last decade (1998–2007). The average annual temperature was 20.5 °C in the 30-year period from 1971–2000, which is a 0.3 °C increase on the 1961–1990 average. However, over the last decade it has risen by a further 0.4 °C, suggesting an accelerated rise in temperature.

The increase in annual maximum temperature is presented in Figure 1. The trend over time is represented by the black line in each graph. The change in maximum temperatures is greater in the summer and autumn, with the average over the last decade increasing by 1.2 °C, compared to the 1961–1990 average.

Average maximum temperature has risen in the Wide Bay Burnett region

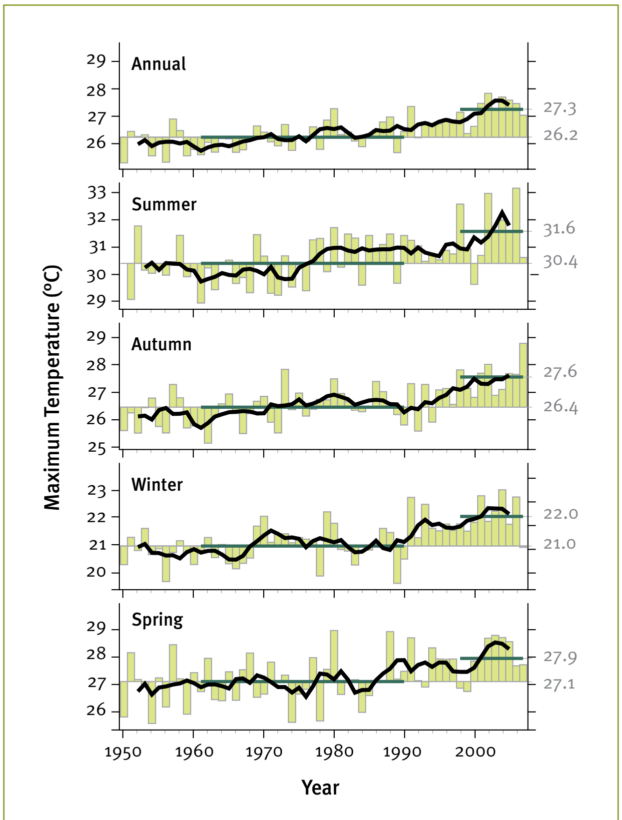


Figure 1: Historical annual and seasonal maximum temperatures for the Wide Bay Burnett region for the period 1950–2007, compared to the base period 1961–1990

The black line is a five-year running average.
The mean for both the baseline of 1961–1990 and the last decade 1998–2007 are shown by the green lines and indicated numerically at the right of the graph.
Note: vertical scales may differ between graphs.

Data source: BoM, 2008

Temperature extremes (BoM, 2008)

Extremes in temperature (such as a number of days exceeding 35 °C) are single events that usually do not extend past a couple of days. Due to the influence of regional topography, proximity to the ocean and prevailing winds, location-specific data are required when considering changes in these extreme events over time.

Historical temperature records for Bundaberg (Figure 2) and Gayndah (Figure 3) show that since the late 1970s, in most years, the number of days where the maximum temperature exceeds 35 °C has tended to increase. Due to its inland location, Gayndah currently experiences more extreme temperature days than coastal Bundaberg and the number of these extreme days is rising.

The number of days over 35 °C has risen in Bundaberg

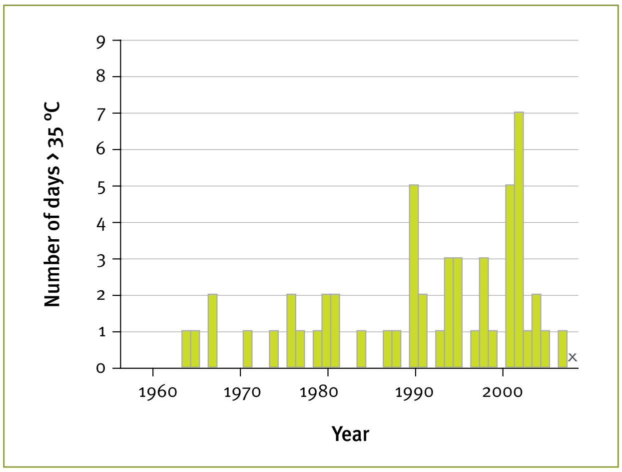


Figure 2: Number of days where the temperature exceeded 35 °C for Bundaberg

Note: Blank spaces are those years where the maximum temperature did not exceed 35 °C.
'X' denotes the year for which the full data set is not available (i.e. the actual values may be greater than what is shown)

Data source: BoM, 2008

The number of days over 35 °C has risen in Gayndah

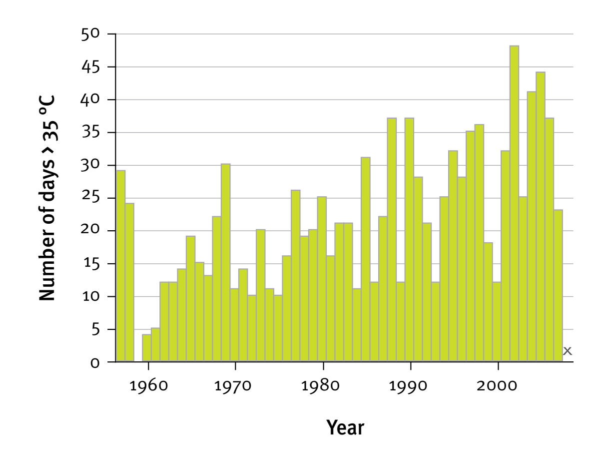


Figure 3: Number of days where the temperature exceeded 35 ˚C for Gayndah

Note: Blank spaces are those years where the maximum temperature did not exceed 35 °C.
'X' denotes the year for which the full data set is not available (i.e. the actual values may be greater than what is shown).

Data source: BoM, 2008

Rainfall (BoM, 2008)

Annual and seasonal average rainfall is strongly influenced by natural variability, local factors such as topography and vegetation, and broader scale weather patterns, for example El Niño-Southern Oscillation (ENSO) events. To understand how this natural temporal variation changes rainfall patterns, long term rainfall records are required. The BoM has been collecting rainfall data for the Wide Bay Burnett region since 1897.

The variability in annual rainfall is shown in Figure 4. The dominant wet period of the 1950s and 1970s contrasts with the dry years that have been experienced for the last two decades.

Figure 4 shows the dominant summer rainfall pattern with a 1961–1990 average rainfall around 360 mm, compared to an autumn average (the next most dominant rainfall period) of around 210 mm.

Over the most recent decade, there has been a 31 per cent decline in the average autumn rainfall compared to the 1961–1990 average. Summer average rainfall has only declined by 15 per cent; however, there has been a fairly consistent decrease since the 1970s, with only eight summers in this period above the 1961–1990 average. This decrease in rainfall has been due to a lack of high rainfall years in recent decades.

The changes in the autumn and summer rainfall are the major contributors to the overall approximate 14 per cent decline in the annual rainfall for the region over the last decade (1998–2007).

Historical rainfall shows high variability

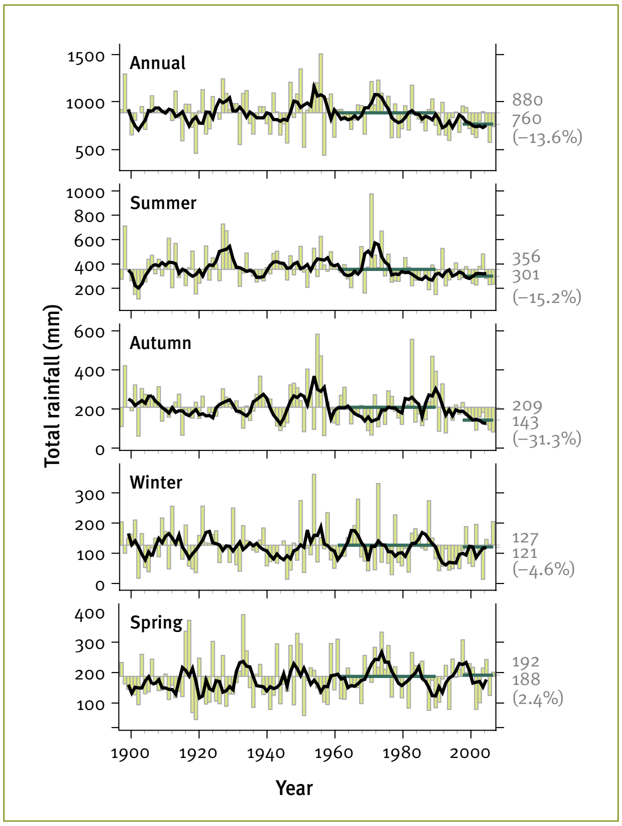


Figure 4: Historical annual and seasonal total rainfall for the Wide Bay Burnett region for the period 1897– 2007

The black line is a five-year running average.
The mean for both the baseline 1961–1990 and the last decade 1998–2007 are shown by the green lines and indicated numerically at the right of the graph.
The difference in rainfall between the baseline and last decade is shown in per cent.
Note: vertical scales may differ between graphs.

Data source: BoM, 2008.

Evaporation

Potential evaporation is a measure of the evaporative (or drying) power of the atmosphere. The potential evaporation rate assumes that there is an unlimited supply of water to evaporate (either from the soil or from water bodies). Although potential evaporation can differ from actual evaporation, a change in potential evaporation gives a good indication of the change in the evaporative power of the atmosphere.

Networks to measure potential evaporation are not as well developed as those that measure temperature and rainfall and there are insufficient data available to indicate the changes over time.

Averaged over the Wide Bay Burnett region, the annual mean potential evaporation over the period 1971–2000 (1715 mm) is twice the annual mean rainfall over the same period (862 mm), which contributes to the depletion of soil moisture.

Cyclones

Strong winds, intense rainfall and ocean effects such as extreme waves combine to make the total cyclone hazard. This hazard is greatest in Queensland between January and March, but tropical cyclones in Queensland can occur anytime over the period from November to April.

Although the Wide Bay Burnett region is further south than the main area of tropical cyclone development and occurrence, tropical cyclones still have an impact on the region (Figure 5), either from those that do track further southwards or the heavy rain and strong easterly winds through the region that accompany cyclones to the north.

Fewer cyclones have occurred over the last three decades under El Niño weather patterns

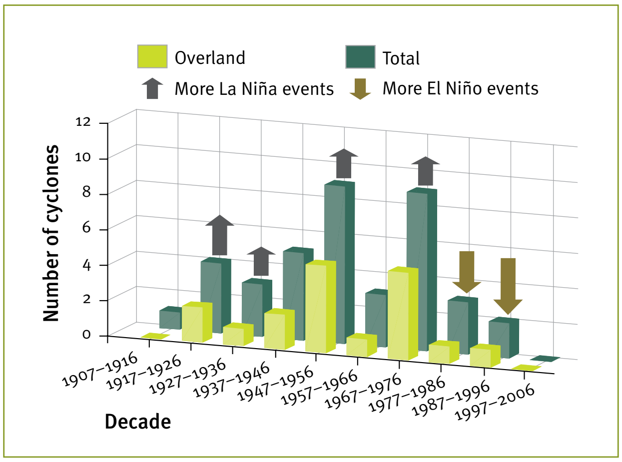


Figure 5: Total and overland number of tropical cyclones for Wide Bay Burnett region for the period 1907–2006

Adapted from BoM, 2008

There is a relationship between the impact of cyclones on eastern Australia and the El Niño-Southern Oscillation (ENSO) phenomenon. This relationship is reflected in Figure 5 with fewer cyclones in the last three decades which is associated with an El Niño pattern (in fact there were none in the last decade) compared to the La Niña dominant decades commencing in the mid 1940s and mid 1960s.

Projected climate change in Wide Bay Burnett

Global Climate Models simulate the earth's climate system using a complex set of mathematical rules that describe the physical processes of the atmosphere, ocean, land and ice. They are currently considered to be the best tools for projecting climate change. CSIRO has recently released climate change projections for Australia (CSIRO & BoM, 2007) based on the results from 23 Global Climate Models. Projections for the Wide Bay Burnett region have been extracted from this dataset for the Queensland Climate Change Centre of Excellence (QCCCE). The projections presented here are relative to the base period of 1980–1999.

The Global Climate Models show little difference under the low, medium and high emissions scenarios to 2030. Therefore, the 2030 climate change projections for the Wide Bay Burnett have been presented on a mid-range emissions scenario.

However, the projections diverge at 2050 under different emissions scenarios. Therefore, the 2050 and 2070 projections are based on low and high emissions scenarios.

The full range of projected changes for temperature, rainfall and potential evaporation for the Wide Bay Burnett in 2030, 2050 and 2070 are described in Table 2. The numbers shown in brackets indicate the range of the results from the Global Climate Models.

Overview of climate projections

In summary, the 'best estimate' changes to temperature and rainfall under the three emissions scenarios are:

2030 (medium emissions scenario)

- **Annual and seasonal temperature**: annual mean temperature (the average of all daily temperatures within a given year) is projected to increase by 0.9 °C. There is little variation in projections across the seasons.

- **Annual and seasonal rainfall**: annual rainfall (the total rainfall received within a given year) is projected to decrease by three per cent (-26 mm). The largest seasonal decrease of six per cent (-12 mm) is projected for spring.
- **Annual and seasonal potential evaporation**: across all seasons the annual 'best estimate' increase is projected to be around 3–4 per cent (51–69 mm), with some models projecting up to a six per cent increase in autumn (23 mm) and winter (16 mm).

2050 (low and high emissions scenarios)

- **Annual and seasonal temperature**: annual temperature is projected to increase by 1.1 °C and 1.8 °C under the low and high emissions scenarios respectively. There is little variation in projections across the seasons.
- **Annual and seasonal rainfall**: annual rainfall is projected to decrease by four per cent (-34 mm) and six per cent (-52 mm) under the low and high emissions scenarios respectively. The largest seasonal decrease of 11 per cent (-21 mm) under the high emissions scenario is projected for spring.
- **Annual and seasonal potential evaporation**: under a high emissions scenario an increase in annual potential evaporation of up to 10 per cent (172 mm) is projected with the best estimate being seven per cent (120 mm). Autumn and winter are projected to have the greatest increases of up to 12 per cent (45 mm and 31 mm respectively).

2070 (low and high emissions scenarios)

- **Annual and seasonal temperature**: annual temperature is projected to increase by 1.5 °C and 2.9 °C under the low and high emissions scenarios respectively. There is little variation in projections across the seasons.
- **Annual and seasonal rainfall**: annual rainfall is projected to decrease by five per cent (-43 mm) and 10 per cent (-86 mm) under the low and high emissions scenarios respectively. The largest seasonal decrease under a high emissions scenario of 18 per cent (-35 mm) is projected for spring.
- **Annual and seasonal potential evaporation**: under a high emissions scenario, annual evaporation is projected to increase by as much as 16 per cent (274 mm). Autumn and winter are projected to be the seasons most impacted with increases up to 19 per cent (72 mm and 50 mm respectively) in some models.

Temperature extremes

Global Climate Models indicate that increasing greenhouse gas concentrations in the atmosphere will increase the likelihood of a record high temperature in a given region. The Global Climate Models project a rise in extreme temperatures (CSIRO & BoM, 2007). Table 1 shows the projected number of days above 35 °C for two observing stations in the Wide Bay Burnett region with good historical records.

Under a high emissions scenario in 2070 for Bundaberg, the number of hot days above 35 °C is projected to increase from one day to 12 days. Under the same scenario for Gayndah, the number of hot days would more than triple from 23 days to 81 days.

Station Name	Current	2030 Mid	2050 Low	2050 High	2070 Low	2070 High
Bundaberg	1	2 (2–3)	3 (2–4)	5 (3–9)	4 (2–6)	12 (5–33)
Gayndah	23	35 (32–44)	41 (34–51)	54 (42–74)	48 (38–64)	81 (58–121)

Table 1: Number of hot days per year above 35 °C projected for 2030 (mid emissions scenario) and 2050 and 2070 (low and high emissions scenarios).

Current number of days calculated using a base period of 1971–2000.

Cyclones and sea-level rise

Extreme weather events, such as cyclones, have a complex link to ocean surface temperatures, characteristics of a region and global climate patterns such as the ENSO, making it difficult to predict their frequency of occurrence. This results in discrepancies in cyclone frequencies between different climate models.

Recent studies have projected a slight decrease (nine per cent) in tropical cyclone frequency off the east coast of Australia by 2070 (Abbs et al, 2006); however, they also simulate an increase in the number of long-lived and severe (Category 3–5) eastern Australian tropical cyclones. Under three different studies the number of severe tropical cyclones is projected to increase by 56 per cent by 2050 (Walsh et al, 2004), 22 per cent by 2050 (Leslie et al, 2007) and 140 per cent by 2070 (Abbs et al, 2006).

Projected southward shifts in the primary regions of cyclone development through the coming century (Abbs et al, 2006, Leslie et al, 2007) could result in a greater cyclone impact in the WBB region. With projected increases in the intensity of cyclones and projected rise in mean sea levels (CSIRO & BoM, 2007), storm surges will be able to penetrate further inland greatly increasing the risk of damage to natural ecosystems and infrastructure and the risk of erosion in low-lying coastal regions.

The 1-in-100-year storm tide event is projected to increase by 50 cm in Hervey Bay if certain conditions eventuate. These conditions are a 30 cm sea-level rise, a 10 per cent increase in cyclone intensity and frequency, as well as a 130 km shift southwards in cyclone tracks (Hardy et al, 2004).

Variable	Season	(1971–2000)	2030†	2050†		2070†	
			Emissions Scenarios				
		Current historical mean*	medium	low	high	low	high
			Projected Changes#				
Temperature °C	Annual	20.5 °C	**+0.9** [+0.6 to +1.3]	**+1.1** [+0.8 to +1.6]	**+1.8** [+1.3 to +2.6]	**+1.5** [+1.0 to +2.1]	**+2.9** [+2.0 to +4.1]
	Summer	25.2 °C	**+0.9** [+0.6 to +1.3]	**+1.1** [+0.7 to +1.6]	**+1.8** [+1.2 to +2.6]	**+1.5** [+1.0 to +2.2]	**+2.9** [+1.9 to +4.2]
	Autumn	21.1 °C	**+0.9** [+0.6 to +1.3]	**+1.1** [+0.7 to +1.5]	**+1.8** [+1.2 to +2.5]	**+1.5** [+1.0 to +2.1]	**+2.8** [+1.9 to +4.1]
	Winter	14.8 °C	**+0.9** [+0.6 to +1.3]	**+1.1** [+0.8 to +1.6]	**+1.8** [+1.2 to +2.6]	**+1.5** [+1.0 to +2.2]	**+2.9** [+2.0 to +4.2]
	Spring	20.9 °C	**+0.9** [+0.6 to +1.4]	**+1.2** [+0.8 to +1.7]	**+1.9** [+1.3 to +2.7]	**+1.6** [+1.0 to +2.3]	**+3.0** [+2.0 to +4.4]
Rainfall %	Annual	862 mm	**-3** [-12 to +5]	**-4** [-14 to +6]	**-6** [-22 to +10]	**-5** [-19 to +8]	**-10** [-33 to +16]
	Summer	330 mm	**-1** [-11 to +9]	**-1** [-13 to +10]	**-2** [-21 to +17]	**-2** [-18 to +14]	**-4** [-31 to +27]
	Autumn	208 mm	**-3** [-15 to +9]	**-4** [-17 to +11]	**-6** [-27 to +17]	**-5** [-23 to +14]	**-10** [-40 to +28]
	Winter	112 mm	**-5** [-15 to +5]	**-6** [-17 to +6]	**-10** [-27 to +9]	**-8** [-23 to +8]	**-15** [-40 to +15]
	Spring	194 mm	**-6** [-19 to +6]	**-7** [-21 to +7]	**-11** [-34 to +12]	**-10** [-29 to +10]	**-18** [-49 to +19]
Potential evaporation %	Annual	1715 mm	**+3** [+2 to +5]	**+4** [+2 to +5]	**+7** [+4 to +10]	**+6** [+4 to +8]	**+11** [+7 to +16]
	Summer	575 mm	**+3** [+2 to +5]	**+3** [+2 to +4]	**+7** [+3 to +11]	**+5** [+3 to +9]	**+11** [+6 to +17]
	Autumn	377 mm	**+4** [+2 to +6]	**+4** [+2 to +6]	**+8** [+4 to +12]	**+6** [+4 to +10]	**+12** [+7 to +19]
	Winter	262 mm	**+4** [+2 to +6]	**+5** [+3 to +7]	**+8** [+5 to +12]	**+6** [+4 to +10]	**+12** [+8 to +19]
	Spring	505 mm	**+3** [+2 to +5]	**+4** [+2 to +5]	**+6** [+3 to +9]	**+5** [+3 to +7]	**+9** [+5 to +14]

Table 2: Summary of projections for the Wide-Bay Burnett

* To enable the projections for each of the regions to be referenced against historical climate, observational means have been calculated using a 30-year base period of 1971–2000.

\# Projections represent the change in temperature, relative change in rainfall and potential evaporation relative to the model base period of 1980–1999. The numbers in brackets are the 10th and 90th percentiles and depict the range of uncertainty; the number outside the brackets is the 50th percentile (i.e. the best estimate). The changes are the average change over the region.

† These projections show changes in average climate for three future 30-year periods centred on 2030, 2050 and 2070.

Data source: CSIRO & BoM 2007. Regional summaries prepared by QCCCE.

According to the IPCC, global sea-level is projected to rise by 18 to 59 cm by 2100, with a possible additional contribution from melting ice sheets of 10 to 20 cm (IPCC, 2007).

These rises in sea levels will have serious implications for the coastal communities and ecological assets of the Wide Bay Burnett region, ranging from contaminated fresh water aquifers through to regular inundation of critical infrastructure.

Impacts of climate change on the Wide Bay Burnett region

Projections for the Wide Bay Burnett region include a decline in rainfall with increasing temperature and evaporation, in conjunction with more extreme climate events, such as sea-level rise and cyclonic weather. The temperature projections for inaction on climate change suggest a temperature increase well outside the range of temperatures ever experienced over the last 50 years. The projections for temperature and hot days are all in the same direction—increasing.

With more than 80 per cent of the region's population located in the five major centres of Bundaberg, Hervey Bay, Gympie, Maryborough and Kingaroy, and with the remaining residents located in predominantly rural shires, planning for the future is imperative. In the last 20 years, the Wide Bay Burnett region has experienced significant population growth, particularly in the coastal region, as some 85 000 new residents moved to the area. Climate change will affect the region's economy, development and urban planning—particularly in such a rapidly growing region as Wide Bay Burnett.

Agriculture is very important to the Wide Bay Burnett region, with a value in excess of $A1.1 billion (DIP, 2007), representing more than 10 per cent of Queensland's total agricultural production of $A9.5 billion (OESR, 2008). Variable and declining rainfall, combined with rising temperatures and increased evaporation could have a significant impact on primary production.

For example:

- In the winter of 2050, under the high emissions scenario, the predicted decline in rainfall (-8 per cent), increasing high temperatures (+1.8 °C) and an increase in evaporation (+10 per cent) could result in significant challenges in supplying sufficient water to meet the demand of the region.
- Increased evaporation will have a negative impact on water storage, including greater losses from dams and storages. Industrial water demand represents 15 per cent of current total water use in the WBB region and this could increase by 15–25 per cent through increased demand for evaporative cooling at major industrial sites such as Tarong Power Station and various sugar mills.
- Heatwaves characterised by extreme temperatures—high 30s or even 40s—persisting for a number of days, can result in significant health impacts such as heat exhaustion and increased mortality among vulnerable sectors of the community such as the very young or old. It may be more difficult for locations that have not typically experienced these extremes on a regular basis (such as Bundaberg) to adapt to these conditions. Warmer conditions may also help spread vector-borne disease further south. These health issues could place further pressure on medical and hospital services.
- Further population growth is expected, with WBB having an estimated 90 000 new residents by the year 2026, all of which will require infrastructure in place. In addition, two very climate-sensitive industries, agriculture and tourism, will continue to play a significant role in the region's economy.

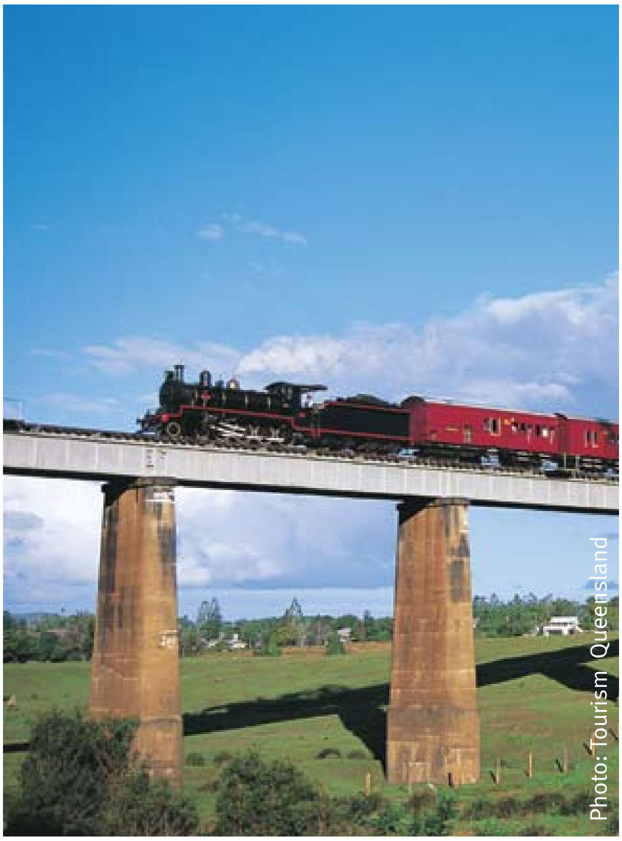


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Photo: Tourism Queensland