

Climate and greenhouse



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Key findings

- Queensland's climate is changing. The state's average temperature increased by 1.0°C from 1910 to 2006, primarily due to increased levels of greenhouse gases in the atmosphere. Annual rainfall across much of Queensland appears to have declined since 1950, and it is possible that anthropogenic climate change has contributed to this decline.
- Queensland's per capita greenhouse gas emissions are among the highest in the world. Queensland's overall emissions increased by 4.9% from 1999 to 2004. This basically represents a large increase in energy-related emissions (16.7 Mt CO₂-e) being partially offset by a large decrease in emissions from land use, land use change and forestry (10.7 Mt CO₂-e).
- In June 2007, the Queensland Government launched its \$414 million climate change strategy, *ClimateSmart 2050*, which lays out its long-term plans and investments to meet the climate change challenge and help Queensland move towards a low-carbon future. A major initiative of *ClimateSmart 2050* is *ClimateSmart Adaptation 2007–12: an action plan for managing the impacts of climate change*. *ClimateSmart Adaptation* focuses on initiatives to help Queenslanders adjust to the potential impacts of climate change and capitalise on opportunities to create jobs and build the state's economy.

Indicators and summary of status

Indicator	Status of indicator
Rainfall <ul style="list-style-type: none"> • percentile • annual average 	<ul style="list-style-type: none"> • In the five years to March 2007 nearly all of Queensland received below-average or well below-average rainfall. • Annual rainfall across much of Queensland appears to have declined since 1950, although it is not clear whether this represents a shift in rainfall patterns or merely natural climate variability.
Temperature <ul style="list-style-type: none"> • annual minimum • annual mean • annual maximum 	<ul style="list-style-type: none"> • Queensland temperatures have been higher than the long-term average every year since 2003. • Queensland's mean temperature increased by 1.0°C from 1910 to 2006, and this increase is likely to have been significantly influenced by increasing atmospheric greenhouse gas concentrations.
Evaporative demand <ul style="list-style-type: none"> • Class A pan • vapour pressure deficit • reference crop evapotranspiration 	<ul style="list-style-type: none"> • Three indicators of Queensland evaporative demand were higher than the long-term average for every year from 2002 to 2006. • The indicators do not have the length of record, quality control or spatial completeness to enable assessment of long-term changes in evaporative demand in Queensland.
Greenhouse gas concentrations at Cape Grim <ul style="list-style-type: none"> • carbon dioxide • methane • nitrous oxide 	Atmospheric greenhouse gas concentrations continue to increase. From 2002 to 2005: <ul style="list-style-type: none"> • carbon dioxide concentrations increased by 1.6%; • methane concentrations declined by 0.04%; and • nitrous oxide concentrations increased by 0.8%.
Greenhouse gas emissions	Queensland emissions increased 4.9% from 1999 to 2004. In key sectors: <ul style="list-style-type: none"> • stationary energy emissions increased by 26.3%; • transport emissions increased by 19.9%; • agricultural emissions were steady; and • emissions from land use, land use change and forestry declined by 26.2%.

Importance

Overview

Human activities have significantly altered the composition of the atmosphere, and as a result the global climate is changing. The atmospheric concentration of the most significant greenhouse gas, carbon dioxide (CO₂), was stable at around 280 parts per million (ppm) during the pre-industrial era (Etheridge et al. 1996) but the concentration has grown almost exponentially to 381 ppm in 2006 (NOAA 2006). Instrumental records show that temperatures increased across the globe in the 20th century (Brohan et al. 2006). Most of this rise in global temperature, at least since the mid-20th century, is very likely to have been caused by human activities (IPCC 2007).

Since 2003, Queensland temperatures have been higher than average every year, 2005 being the hottest year since reliable instrumental records began in 1910. Average Queensland maximum and minimum temperatures both increased from 1910 to 2005, and the increase in minimum temperature was greater than the increase in maximum temperature (Della-Marta et al. 2004).

In the five years to March 2007, nearly all of Queensland received below-average or well below-average rainfall. The drought is clearly extensive and severe, although not unprecedented by historical standards. Annual rainfall across much of Queensland appears to have declined since 1950, although it is not yet clear whether this drying trend represents a permanent shift in rainfall patterns or merely natural climate variability.

Queensland directly produces approximately 0.4% of annual global greenhouse gas emissions, and Queensland emissions have increased 4.9% from 1999 levels (AGO 2006b). The Queensland Government is rising to the challenge of climate change with a broad approach involving a range of government agencies in partnership with the community and business.

In June 2007, the Queensland Government released *ClimateSmart 2050*, which lays out its long-term plans and investments to meet the climate change challenge and help Queensland move towards a low-carbon future. This will be achieved by:

- engaging in national and international efforts to establish emissions trading;
- reducing greenhouse gas emissions by investing in technological innovation in clean coal and renewable energy sources; and
- supporting Queenslanders in lowering their emissions and conserving water at home, at work and in their local communities.

ClimateSmart Adaptation is a major initiative of *ClimateSmart 2050*. *ClimateSmart Adaptation* is a five-year plan to provide the foundations for building Queensland's resilience to climate change to ensure that the state's communities, environmental wellbeing and economic performance are all maintained in a variable and changing climate.

Climate change represents a global challenge, with potentially far-reaching direct and indirect impacts for Queensland. The state's future lifestyle and social, economic and environmental health will depend on how Queenslanders collectively respond to the issue of climate change.

Managing for a variable climate

Through its effects on agriculture, forestry and ecosystems, human settlements, water supplies, diseases, pest numbers, tourism, soil erosion, energy use and other factors, our climate has a direct impact on how we manage our economy, our society and our environment. Our natural environments have evolved to cope with the climate variability they have experienced.

Queensland's climate is highly variable. Operating successfully in a variable climate requires climate risk management: that is, operating in such a way as to be successful within the expected day-to-day or year-to-year variations in rainfall, temperature and so on. Typically, climate risk management uses the historical climate record to determine the level of climate variability that should be expected.

With advances in science and modern technologies, it is also possible to incorporate knowledge of the climate system into climate risk management. For example, the El Niño Southern Oscillation (ENSO) phenomenon has a significant influence on Queensland's climate at a seasonal time scale, and, where applicable, knowledge about it can be used to help manage climate risks.

The importance of climate change for Queensland

Global warming

The Intergovernmental Panel on Climate Change (IPCC) was formed in 1988 and plays a vital role in providing impartial and robust assessments of climate change research to governments around the world. IPCC defines climate change as 'any change in climate over time, whether due to natural variability or as a result of human activity' (IPCC 2007).

It is now widely accepted that human activities have altered the composition of the atmosphere, and concern is currently focused on increasing concentrations of greenhouse gases. The atmospheric concentration of the main greenhouse gas, carbon dioxide (CO₂), was stable at around 280 ppm during the pre-industrial era (Etheridge et al. 1996) but the concentration has increased almost exponentially to 381 ppm in 2006 (NOAA 2006). To express this change in a broader historical context, the present CO₂ concentration has not been exceeded during the past 650 000 years (IPCC 2007) and the current rate of increase has been unprecedented for at least the past 20 000 years (Houghton et al. 2001).

The IPCC Fourth Assessment Report (*Climate Change 2007*) reported that ‘warming of the climate system is unequivocal’ (IPCC 2007), the global temperature having increased by 0.74°C over the past 100 years. The report also concluded that ‘most of the observed increase in globally averaged temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations’.

In the past five years the world has seen four of the five hottest years on record (WMO 2006), further increases in carbon dioxide emissions (CSIRO 2006a and 2006b) and stronger observational evidence that human activities are contributing to climate change (Steffen 2006). The five hottest years, in decreasing order, were 1998, 2005, 2002, 2003 and 2004 (WMO 2006). These factors combined have led governments around the world to acknowledge that dangerous levels of global warming are likely to eventuate if greenhouse gas emissions continue to increase (Schellnhuber et al. 2006).

Climate change scenarios and potential impacts

Global warming and the changes in climate that may accompany it have the potential to dramatically increase Queensland’s exposure to climate risks, possibly moving our society to a climate regime that is outside our past experience, and moving elements of our natural environment to climate regimes that are outside their natural tolerance. It is not yet known in detail how global warming will affect Queensland’s climate, but realistic scenarios include:

- average temperatures in various Queensland locations increasing by 0.2–2.1°C by 2030, and by 0.7–6.4°C by 2070 (CSIRO 2006a). These average temperature increases would be accompanied by substantial increases in the frequency of temperature extremes—hot days, warm nights, and heatwaves;
- rainfall changing. Rainfall changes are very uncertain: some climate models suggest that rainfall will increase and others suggest that it will decline. Over much of the state, rainfall could realistically decline by up to 13% by 2030, and by up to 40% by 2070, or increase by up to 7% by 2030, and by up to 20% by 2070. However, rainfall is more likely to decline than increase (CSIRO 2006a);
- increased atmospheric water demand leading to declining soil moisture and runoff (CSIRO 2003), and more severe droughts (Nicholls 2004);
- an increase in the intensity of tropical cyclones (CSIRO 2002);
- sea levels rising by up to 59 cm by 2100 (IPCC 2007); and
- storm surge heights increasing by around 50 cm along the east coast of Queensland (OHA 2004).

Historical extreme climate events in Queensland have shown that we are exposed to climate risk across a wide range of fields including natural systems and biodiversity, health and lifestyle, major infrastructure, industry, transport, water availability and security, the built environment, energy generation and distribution, land use planning, development, and primary industries.

Queensland’s multibillion-dollar tourism industry would be affected by the damage expected to occur in iconic ecosystems, notably the World Heritage-listed Great Barrier Reef Marine Park and rainforest ecosystems of north Queensland.

Climate change may bring about a greater risk of tropical diseases, vector-borne diseases such as dengue fever being of particular concern. Adverse health impacts are also expected to result from changes in the frequency and duration of heatwaves, and possibly from increased toxic blue-green algal blooms in water supplies.

Increasing average temperatures and declining average rainfall would pose significant challenges to current land management practices and agriculture in Queensland. Climate change may influence the suitability of areas for grazing and agricultural production, requiring a re-evaluation of enterprise type and production mix, with flow-on impacts on marketing, distribution and international trade of commodities. However, these changes may also present the agricultural sector with new opportunities.

Climate change thus poses important challenges for Queensland—both the direct challenge of coping with the impacts of changes in climate, and the associated challenge of reducing greenhouse gas emissions while maintaining the state’s lifestyle, economy and natural environment.

Pressure and condition Queensland’s climate

Our knowledge of Queensland’s climate represents an evolving understanding of weather phenomena in our region. It includes our understanding of how often particular weather events and climate patterns will be observed, of climate changes, and of the mechanisms driving climate variability and change.

Because Queensland’s climate is highly variable on annual and longer time scales, climate changes are unlikely to be revealed suddenly, and it is not possible to report on changes in climate within periods of three to five years. Instead, this section summarises recent climate conditions, discusses recent conditions in the context of historical records and known climate drivers, and provides an update of how our understanding of Queensland’s climate has changed since the previous reporting period.

Chapter 6, The coastal zone, provides information on cyclones, storm surge and sea level.



Rainfall

Summary of Queensland rainfall patterns since 2003

Extremely dry conditions were developing across eastern Australia as *State of the Environment Queensland 2003* was being prepared, and the period 2002–03 turned out to be one of the worst short-term droughts in Australia's history (Nicholls 2004). In the year April 2002 to March 2003, 40% of Queensland received extremely low rainfall (Figure 3.1a). Although the El Niño signature was relatively weak during the period, the impact on Australian rainfall was severe (Plummer et al. 2003).

Conditions eased somewhat the following year, near-average rainfall being received across most of the state in 2003–04 (Figure 3.1b). El Niño conditions returned in 2004, however, and the first four months of 2005 were extremely dry across southern Queensland (Figure 3.1c).

Although some areas received useful falls during the winter and spring of 2005, December saw a return of below-average rainfall conditions across southern and central Queensland. Although Figure 3.1d shows average conditions across much of the state, in two-thirds of this area rainfalls were closer to below-average than to above-average.

The rainfall pattern for the remainder of the period was mixed. The late-season tropical cyclone Monica brought anomalously high rainfalls to northern Queensland in April 2006, and many inland regions received good falls in January 2007. However, twelve-month rainfall deficits in the south-east were among the worst on record (Figure 3.1e).

The rainfall plots for individual years given in Figure 3.1 show that the recent climate in Queensland has been characterised by low-rainfall years interspersed with average years. Figure 3.2, which shows the rainfall for the five years to March 2007, reveals the full magnitude of the accumulated rainfall deficit in Queensland. Nearly all of the state had below-average or well below-average rainfall, and 36% of the state received extremely low rainfall in this period. The seriousness of the rainfall deficiencies is shown in Figure 3.3: areas in south-west Queensland, the Whitsunday Coast and some areas in the south-east received the lowest five-year totals on record.

Recent rainfall in the historical context

Queensland average annual rainfall totals show no overall trend since reliable records began in the late 1800s (Figure 3.4, Figure 3.6a). Periods of below-average rainfall occurred in the 1900s, 1930s, 1960s, early 1980s and 1990s, and again this century. Above-average rainfall totals were recorded in the 1890s, 1950s and 1970s.

Although the rainfall deficits for the past few years have had serious social and economic impacts, the magnitude of the five-year rainfall deficit for the period ending March 2006 is not unprecedented by historical standards. Figure 3.5 shows the area (percentage) of Queensland that has experienced very high or very low rainfall over the past century. It is sobering to realise that during the Federation Drought (1898–1903) and during the 1930s and the 1960s, when the area of the state affected by five-year rainfall deficits was comparable with the area affected today,

rainfall deficits persisted for significantly longer than in the current drought. Note that individual regions have experienced severe and protracted droughts that may not show up strongly in this statewide analysis. For example, the accumulated rainfall deficit over the Brisbane dam catchments in the period 2001–07 was more severe than that experienced during the Federation Drought (DNRW 2007).

Rainfall in coastal Queensland

Annual rainfall across much of Queensland appears to have declined since 1950 (Figure 3.6b). The dry has been particularly significant in eastern areas, including the south-east, where a high proportion of the state's population lives. This apparent decline in rainfall has emerged as a major issue since the previous reporting period.

The drying trend over eastern Queensland since 1950 is consistent with an increased frequency of El Niño events since 1976–77; there have been more than twice as many El Niño events as La Niña events since then (Crimp and Day 2003; DNRW 2007). The perceived drying trend since 1950 is accentuated by the wet decades of the 1950s and 1970s, which were associated with strong La Niña events (DNRW 2007).

Although the observed drying trend since 1950 is consistent with ENSO fluctuations, it is also possible that anthropogenic climate change may have contributed to the increased frequency of El Niño conditions since the 1970s. However, global warming-related changes in ENSO are still uncertain (Cane 2005; Collins 2005), and it does not necessarily follow that a general warming of the Pacific associated with global warming will lead to an El Niño-like decline in rainfall in Queensland. It is expected that ENSO will continue to be a cause of year-to-year variability in rainfall.



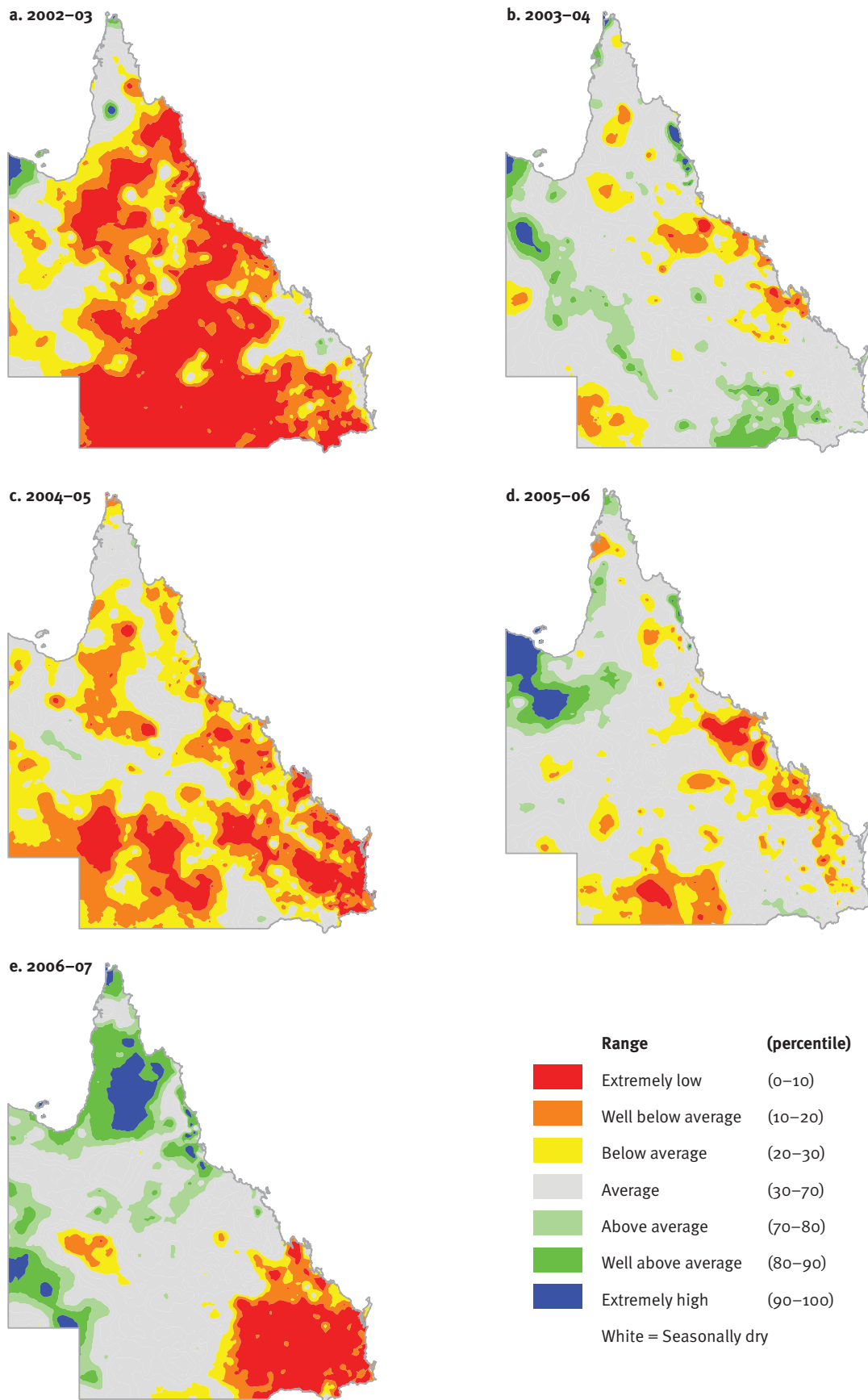


FIGURE 3.1 Recent Queensland rainfall. Maps represent annual rainfall calculated from April one year to March the following year (so that summer rainfall is not split between two years).
Source: DNRW

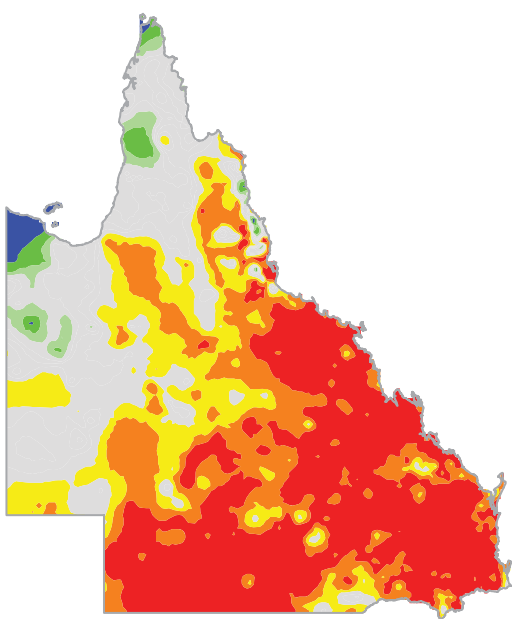
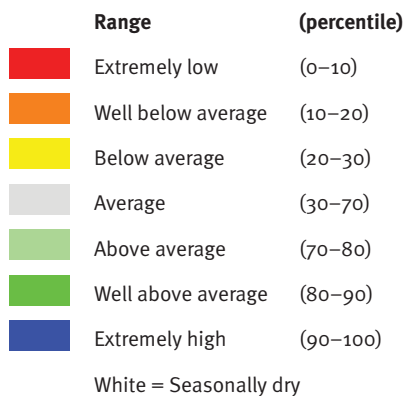


FIGURE 3.2 Queensland rainfall for the five-year period April 2002 to March 2007
Source: DNRW

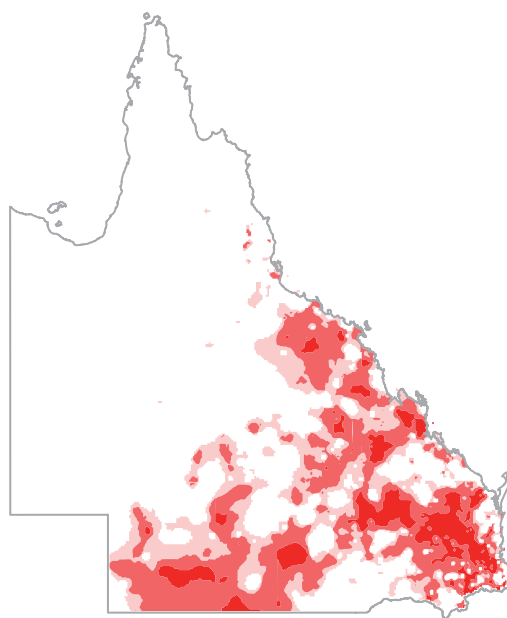
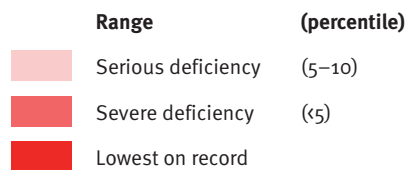


FIGURE 3.3 Rainfall deficiencies for the five years to March 2007
Source: DNRW

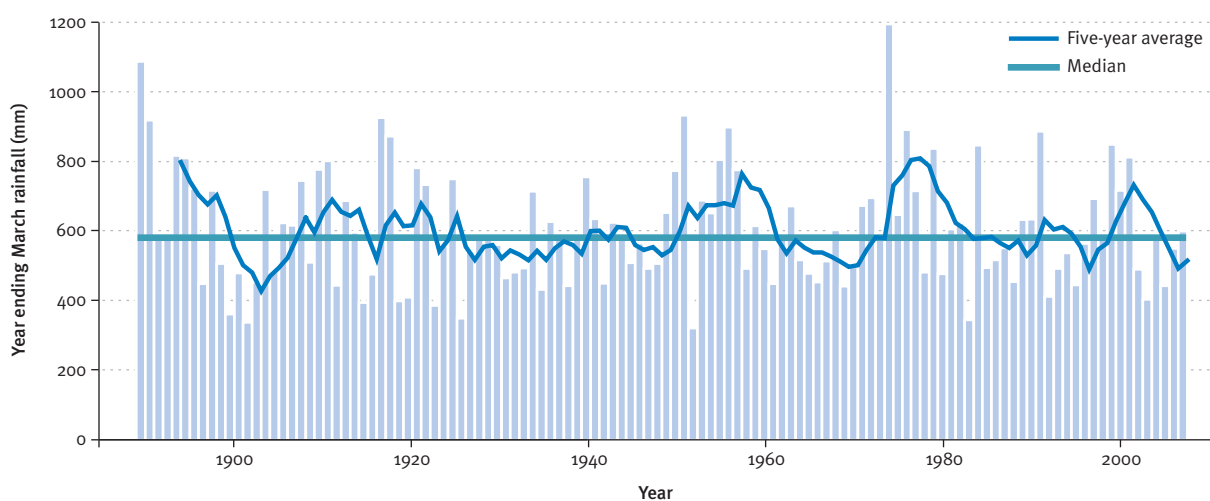


FIGURE 3.4 Historical Queensland rainfall. Bars represent annual rainfall calculated from April one year to March the following year. The dark blue line represents a five-year running average.
Source: DNRW

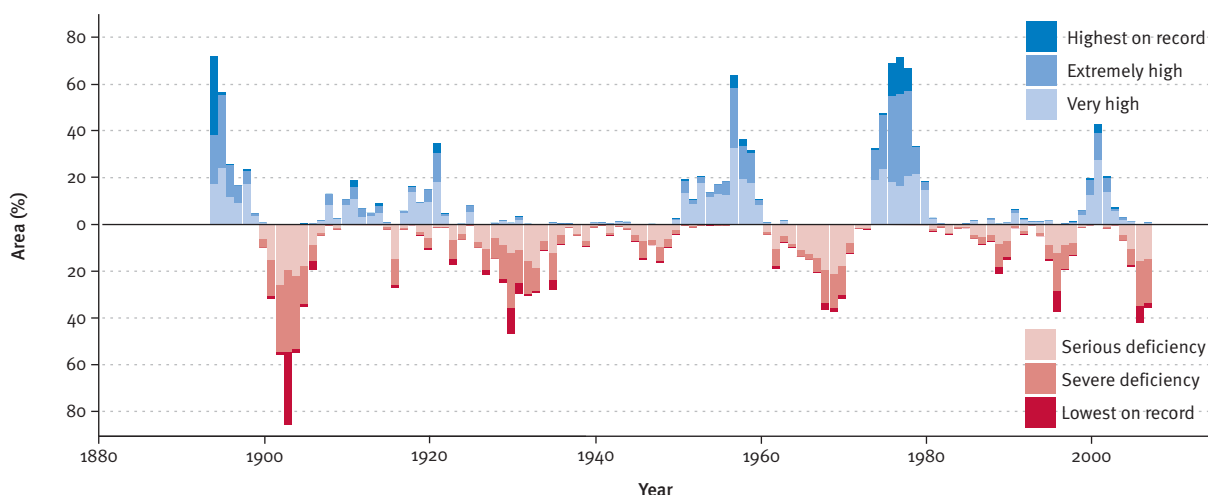
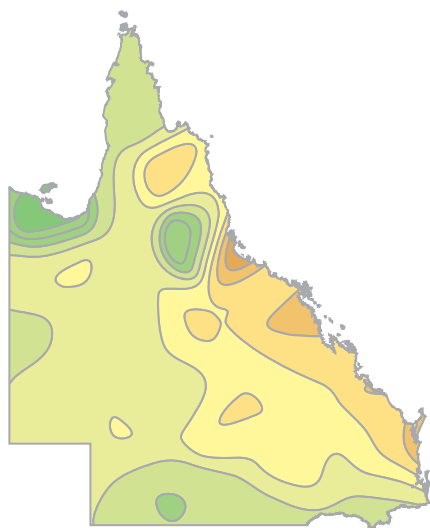
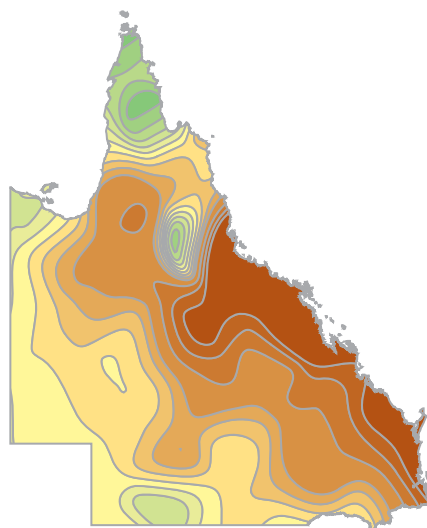


FIGURE 3.5 Percentage of Queensland with five-year rainfall classified as highest on record, extremely high (>percentile 95), very high (>percentile 90), serious deficiency (<percentile 10), severe deficiency (<percentile 5), and lowest on record. Each bar represents five-year April–March rainfall, so the last bar corresponds to the rainfall deficiencies from April 2002 to March 2007, as shown in Figure 3.3.
Source: DNRW

a. Trend in annual total rainfall 1900–2006 (mm/10 years)



b. Trend in annual total rainfall 1950–2006 (mm/10 years)



Average change in annual rainfall

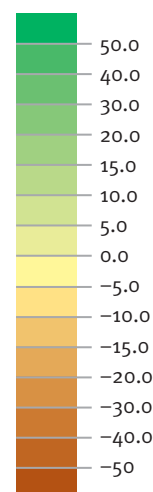


FIGURE 3.6 Rainfall trends in Queensland for (a) 1900–2006, and (b) 1950–2006
Source: BoM

Another question that has emerged since 2003 is whether stratospheric ozone depletion has affected rainfall patterns in Australia. Recent decades have seen the circumpolar westerlies in the Southern Hemisphere strengthen and the mid-latitude westerlies weaken, a trend that has been attributed to Antarctic ozone depletion (Gillett and Thompson 2003; Cai 2006). The possible influences of these changes on Queensland rainfall are the subject of current research. Preliminary results from global circulation

model (GCM) simulations indicate, however, that the combined influence of stratospheric ozone decreases and greenhouse gas increases may have contributed to rainfall deficits in eastern Queensland since the 1970s (Syktus 2005).

Queensland rainfall patterns will continue to be monitored and analysed in an attempt to gain a better understanding of past and possible future changes.

Temperature

Summary of Queensland temperature patterns since 2003

Queensland mean annual temperatures have been higher than the 1961–90 average in every year since 2003. Queensland's mean temperature for 2005 was the highest since reliable, widespread records began in 1910 (Della-Marta et al. 2004). Since these records began, mean annual temperatures in 2003, 2002 and 2004 ranked third, sixth and eleventh highest, respectively.

Historical temperature changes

Figure 3.7 presents Queensland annual maximum, mean and minimum temperature anomaly time-series. In the period 1910 to 2005, Queensland's:

- average maximum temperature increased by 0.5°C;
- average mean temperature increased by 1.0°C; and
- average minimum temperature increased by 1.4°C.

Note that the increase in maximum temperature has been much more rapid in recent decades than over the entire period 1910 to 2005.

Karoly and Braganza (2005) used a number of GCMs to investigate the cause of the changes in Australian temperature over the 20th century. They found that the changes were unlikely to have been due to natural climate variations alone. Instead, the temperature is likely to have been significantly influenced by human activities, especially increasing atmospheric greenhouse gas concentrations. Although no detection and attribution study has been attempted for Queensland alone, the temperature increase over Queensland is consistent with the temperature increase over Australia as a whole. It would seem very likely, then, that human activities are at least partly responsible for the temperature increase in Queensland and that, without mitigation strategies, Queensland's temperature will continue to increase in the future.

Evaporative demand

Evaporative demand (or potential evaporation) describes the maximum rate at which water can be transferred from the landscape to the atmosphere, and affects soil water availability and plant water use efficiency. Evaporative demand is determined by humidity, air temperature, radiation and wind.

Summary of Queensland evaporative demand since 2003

Three of the indicators of evaporative demand available for Queensland are Class A pan evaporation (Jovanovic et al. 2006), vapour pressure deficit (Jeffrey et al. 2001), and reference crop evapotranspiration, or ET_0 (Fitzmaurice and Beswick 2005). Unfortunately, none of these indicators has the long-term records or the quality control and spatial completeness of the rainfall and temperature datasets.

Acknowledging this limitation of evaporative datasets, it is still important to note that all three indicators of Queensland evaporative demand were higher than the long-term average for every year from 2002 to 2006. The five-year average (2002–06) vapour pressure deficit and ET_0 anomalies were the highest since widespread, daily-climate records became available in 1957, suggesting that the current drought may be more severe than the rainfall deficits alone would suggest.

Historical changes in evaporative demand

Pan evaporation rates have been declining in many parts of the world (see Roderick and Farquhar 2002 for a review). It is not yet clear how much of this decline is a consequence of changes in humidity, solar irradiance or wind. Roderick and Farquhar (2004a) reported that pan evaporation rates decreased between 1970 and 2002 at many Australian observing stations, although subsequent correction of the data for instrumental changes showed that, Australia-wide, the trends in pan evaporation were not statistically significant (Roderick and Farquhar 2004b; Jovanovic et al. 2006).

There have been no significant trends in Queensland Class A pan evaporation over the period 1975–2006, or in vapour pressure deficit or ET_0 over the period 1957–2006, although the latter datasets have not been corrected for station location or instrument changes. At first this appears somewhat paradoxical, because there have been significant increases in temperature in Queensland over the past 50 years. However, evaporative demand is more strongly associated with rainfall deficit than with temperature (Jovanovic et al. 2006); wet years tend to be cloudier and more humid, suppressing evaporation, whereas evaporative demand tends to be higher in dry years. Because rainfall is highly variable on annual time scales, the association between rainfall and evaporative demand may mask any overall trends in evaporative demand.

In reality, however, changes in evaporative demand during dry or drought years will have a more significant impact than any overall trend in evaporative demand. The high evaporative demand in the Murray-Darling Basin during the 2002 drought (Nicholls 2004) and the record evaporative demand in Queensland during the current drought raise the possibility that continued global warming may result in future droughts of unprecedented severity in Queensland.

The evolution of the relationship between rainfall, temperature and evaporative demand in Australia should be closely monitored.

Enhanced greenhouse effect

The increased concentration of greenhouse gases in the atmosphere drives global warming through the enhanced greenhouse effect. Increased levels of carbon dioxide (CO_2) have contributed most to the enhanced greenhouse effect, while methane (CH_4), chlorofluorocarbons (CFCs) and nitrous oxide (N_2O) contribute most of the remainder (Houghton et al. 2001). Water vapour contributes indirectly to the enhanced greenhouse effect, because atmospheric water vapour concentration increases as temperatures increase (Dai 2006).

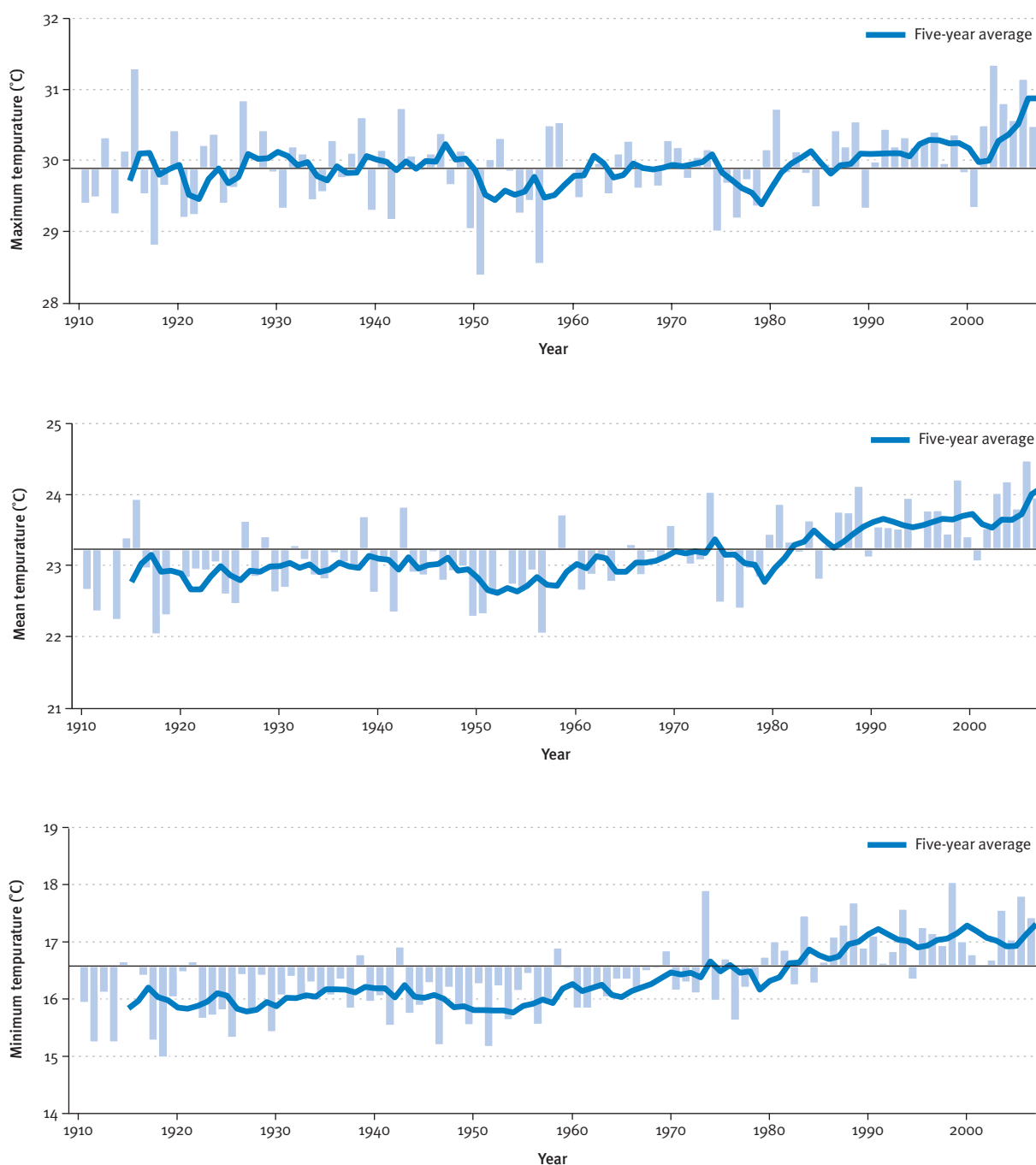


FIGURE 3.7 Queensland annual temperature anomalies (differences from the 1961–90 average)
Source: BoM

Atmospheric greenhouse gas concentrations since 2003

Figure 3.8 shows the trends in atmospheric greenhouse gas concentrations measured at the Cape Grim Baseline Air Pollution Station in Tasmania. Greenhouse gas concentrations measured at Cape Grim will differ slightly from the average global values reported by NOAA (2006). (Trends in CFC concentrations are discussed in ‘Stratospheric ozone depletion’, page 62.)

Carbon dioxide concentrations continue to increase, driven primarily by combustion of coal, oil and gas. Annual average carbon dioxide concentrations increased from 371 ppm in 2002 to 377 ppm in 2005, an increase of 1.6%.

After several centuries of increases (Etheridge et al. 1998), atmospheric methane concentrations appear to have plateaued. Annual average methane concentrations declined slightly, from 1708 parts per billion (ppb) in 2002 to 1707 ppb in 2005. There is no consensus on why this has occurred. Human activities that cause methane emissions

include agriculture (especially rice farming and livestock raising), landfills, biomass burning, mining, and the use of coal, oil and gas. Natural wetlands contribute significantly to methane emissions, and recent research suggests that terrestrial forests may also be a significant source of methane emissions (Keppler et al. 2006). Possible reasons for the current methane stabilisation include a reduction in emissions from the production and distribution of natural gas, increased recovery of landfill methane, or changes in agricultural practices (AGO 2005). Increasing atmospheric NO_x concentrations may also act to destroy methane high in the atmosphere (Schneider 2006).

Nitrous oxide concentrations continue to rise. Annual average nitrous oxide concentrations increased from 317 ppb in 2002 to 319 ppb in 2005, an increase of 0.8%. Nitrous oxide is produced naturally by bacterial breakdown of nitrogen in soils and oceans, but human agricultural management practices (especially the use of fertilisers) and fossil fuel combustion have led to increasing atmospheric concentrations. The causes of the year-to-year fluctuations in the concentration of this long-lived greenhouse gas are not well understood (Houghton et al. 2001).

Queensland greenhouse gas emissions

Globally, greenhouse gas emissions result primarily from the burning of fossil fuels, while lesser contributions result from deforestation and other land use changes (Houghton et al. 2001). Queensland's greenhouse gas emissions are similarly influenced by a historical reliance on energy derived from fossil fuels, a transportation system orientated towards motor vehicles, and an expanding economy with significant industrial and rural sectors.

The Australian Greenhouse Office publication *Queensland Greenhouse Gas Inventory 2004* (AGO 2006b) reported estimates of greenhouse gas emissions for the period 1990 to 2004, and was prepared according to the international rules and procedures applicable to Australia's Kyoto Protocol emissions target. This report contained the first consistent annual time-series of Queensland greenhouse gas emissions reported by the AGO.

Queensland per capita greenhouse gas emissions are among the highest in the world, at approximately 41.3 tonnes CO_2^e per person per year (EPA 2006; Turton 2004). The Queensland Government has stated a commitment to reducing greenhouse gas emission levels and has initiated projects and implemented policies to this end (see Response). Future trends in Queensland greenhouse gas emissions as reported by the AGO will, over time, indicate whether these projects and policies are succeeding.

Queensland greenhouse gas emission sectors and trends

Queensland's net greenhouse gas emissions in 2004 were 158.5 Mt CO_2^e , representing approximately 28% of Australia's net emissions, and approximately 0.4% of global emissions. Queensland emissions for 1999 were reported in *State of the Environment Queensland 2003*, and the 2004 emissions represent an increase of 4.9% on 1999 levels (AGO 2006b). Table 3.1 and Figure 3.9 show the level, trend and sectoral composition of these emissions.

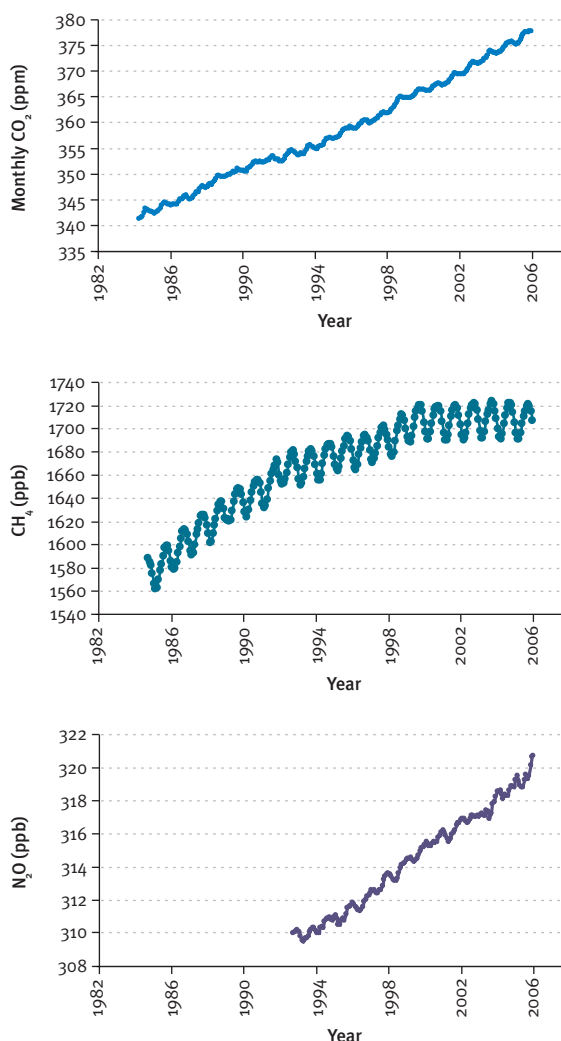


FIGURE 3.8 Concentrations of the greenhouse gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) at the Cape Grim Baseline Air Pollution Station, Tasmania
Source: WMO

Considerable year-to-year variability exists in the emissions from land use, land use change and forestry (LULUCF), but it is clear that emissions have declined significantly since 1990, and continued to decline from 1999 to 2004. It is not clear how much of this reduction occurred as the result of the introduction of the *Vegetation Management Act 1999* (Qld) and how much would have occurred in any case under the pre-1999 legislative framework.

Further LULUCF emissions reductions are expected as a direct result of the introduction of amendments to the Vegetation Management Act, which phased out broadscale clearing of remnant vegetation by December 2006. The Australian Greenhouse Office estimates that, under the new regulatory environment, emissions from regrowth clearing, fodder harvesting, thinning of encroaching tree cover and other land clearing exemptions in Queensland will be approximately 22.5 Mt CO_2^e per year during the 2008 to 2012 Kyoto target period (AGO 2006b). This represents a reduction in emissions from land use change activities of 20 Mt CO_2^e per year compared with 1995–2002 emissions.

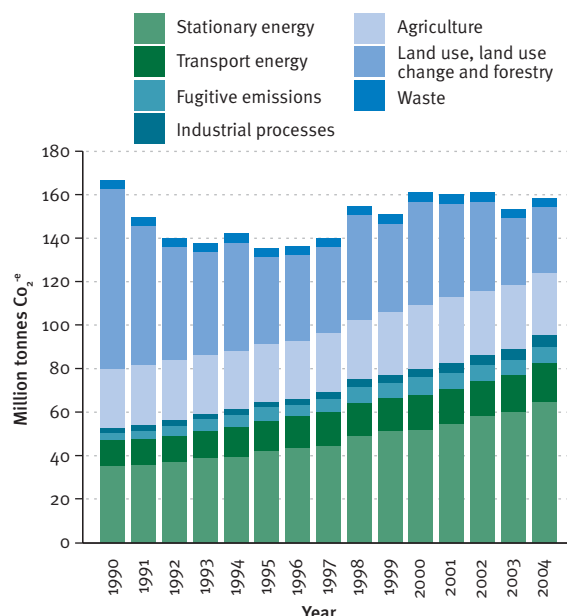


FIGURE 3.9 Greenhouse gas emissions from major Queensland sectors (net carbon dioxide equivalents), 1990–2004
Source: AGO 2006b

TABLE 3.1 Queensland greenhouse gas emissions, 1999 and 2004. For consistency, both the 1999 and 2004 data are taken from AGO 2006b.

Sectors/key subsectors	Queensland emissions (million tonnes CO ₂ -e)		Percentage change 1999 to 2004
	1999	2004	
Energy	73.7	90.3	+22.7
Stationary energy	51.3	64.8	+26.3
Transport	15.1	18.1	+19.9
Fugitive emissions	7.3	7.4	+1.4
Industrial processes	3.5	5.1	+45.7
Agriculture	29.0	28.9	-0.3
Livestock	24.5	23.9	-2.4
Other agriculture	4.5	5.0	+11.1
Land use, land use change and forestry	40.9	30.2	-26.2
Waste	4.1	4.0	-2.4
Total	151.1	158.5	+4.9

Source: AGO 2006b



High-rise buildings, Broadbeach
Photo: Tourism Queensland

Response

International and national responses

United Nations Framework Convention on Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC) sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognises that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention enjoys near universal membership, 191 countries currently having ratified it.

Under the Convention, governments:

- gather and share information on greenhouse gas emissions, national policies and best practices;
- formulate national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries; and
- cooperate in preparing for adaptation to the impacts of climate change.

Australia ratified the Convention in December 1992, and was one of the first countries to do so. The Convention entered into force in 1994 after a requisite 50 countries had ratified it. There are now 191 Parties to the UNFCCC, almost all of the members of the United Nations. Parties to the Convention have agreed to work towards achieving the Convention's ultimate aim of stabilising 'greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'. In December 2005, Australia submitted its Fourth National Communication on Climate Change under the UNFCCC, providing a comprehensive progress update on implementation of the country's international obligations to deal with climate change.

Kyoto Protocol

The Kyoto Protocol builds on the UNFCCC, setting legally binding targets and timetables for cutting the greenhouse gas emissions of industrialised countries. The text of the Kyoto Protocol was adopted unanimously in 1997, and entered into force on 16 February 2005.

The Protocol's major feature is that it has mandatory greenhouse gas emissions targets for the world's leading economies which have accepted it. These targets range from -8% to +10% of the countries' individual 1990 emissions levels 'with a view to reducing their overall emissions of such gases by at least 5 per cent below existing 1990 levels in the commitment period 2008 to 2012'. Future mandatory targets are expected to be established for 'commitment periods' after 2012.

Australia signed the Kyoto Protocol in 1997 but it was not ratified by the succeeding Australian Government (AGO 2007). The instrument of ratification was finally signed in

December 2007, with the ratification taking effect in March 2008. The Australian Government remains committed to meeting its emissions target agreed in the Kyoto Protocol negotiations of 108% of net 1990 emissions levels over the period 2008–12. Current analysis projects Australia's greenhouse gas emissions to be 109% of net 1990 emissions for the commitment period (AGO 2006c).

Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is an international panel of scientists and researchers established in 1988 by the World Meteorological Organization and the United Nations Environment Programme to assess available information on climate change, its impacts and management options, as well as to act as an advisory body on these matters to the Conference of Parties to the UNFCCC (Houghton et al. 2001).

The IPCC produces a series of assessment reports, the preparation and review of which involve hundreds of scientists from many countries over several years (Houghton et al. 2001). Because of such scrutiny in the development process these reports are acknowledged by governments around the world, including the Australian Government, as an authoritative source of advice on climate change science.

The IPCC is currently finalising its Fourth Assessment Report (AR4). Components of AR4 are being released throughout 2007 and provide comprehensive, up-to-date information about climate change causes, impacts and possible response measures based on the latest scientific, technical and socioeconomic literature (IPCC 2006). The first AR4 document released, *Climate Change 2007: The Physical Science Basis. Summary for Policymakers* (IPCC 2007) reports that research now shows that it is 'very likely' (with a probability of over 90%) that human activities have contributed to global warming. It also notes that 'discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns'.

Council of Australian Governments actions

The Council of Australian Governments (COAG), the peak jurisdictional forum in Australia, is taking action to tackle climate change, agreeing to adopt a national Climate Change Plan of Action. This outlines an approach focusing both on reducing greenhouse emissions and responding to the environmental, social and economic impacts that may result from climate change. A high-level interjurisdictional Climate Change Group has been established to oversee implementation of the plan's recommendations. One such recommendation has led to the development of a National Climate Change Adaptation Framework to better prepare Australia for the inevitable impacts of climate change and to provide business with an informed and more certain environment for investment decisions.

COAG Ministerial Councils are also considering climate change implications with regard to their own agendas. Two key examples are the development of the National Biodiversity and Climate Action Plan 2004–2007, and the National Agriculture and Climate Change Action Plan 2006–2009.

Council for the Australian Federation

On 9 February 2007, the Queensland Premier and the premiers and chief ministers of the other state and territory governments signed the Declaration on Climate Change, paving the way for an enduring national response. The Declaration is supported by a series of high-priority actions that include:

- beginning to implement a national emissions trading scheme;
- strengthening standards and ensuring consistent accreditation for the *GreenPower* national accreditation program and emission offsets;
- accelerating the National Framework on Energy Efficiency;
- developing a national mandatory energy efficiency system;
- exploring incentives for the take-up of decentralised renewables; and
- promoting the adoption of new technologies.

Queensland responses

State greenhouse gas emissions reduction target

In April 2007 the Premier announced that Queensland would play its part in meeting a national greenhouse gas emissions target of 60% below 2000 levels by 2050. This action commits the Queensland Government to ensuring the long-term prosperity of the state.

ClimateSmart 2050

ClimateSmart 2050 outlines a diverse range of short-, medium- and long-term actions that the Queensland Government is committed to delivering now to make a real difference for future generations. This policy contains a long-term strategy of reducing Queensland's greenhouse gas emissions from fossil fuel consumption by moving towards a low-carbon future based on the development and deployment of clean coal technologies. The Queensland Climate Change Fund and the Queensland Renewable Energy Fund have been established to support future climate change initiatives and emerging renewable energy sources such as geothermal and solar thermal technologies respectively. Key initiatives of ClimateSmart 2050 include:

- a \$300 million Queensland Climate Change Fund to provide an ongoing annual funding source for future climate change initiatives;
- a \$50 million Renewable Energy Fund to provide support for the development of emerging renewable technologies;

- setting a renewable and low-emission energy target of 10% by 2020;
- increasing the existing 13% Gas Scheme target to 18% by 2020;
- a \$55 million Smart Energy Savings Program to help business become more energy-efficient;
- ClimateSmart Homes rebates to help people living in remote areas install energy-efficient and greenhouse-friendly products;
- introducing new planning standards for commercial buildings by 2010;
- phasing out electric hot water systems from existing homes from 2010; and
- making all Queensland Government office buildings carbon-neutral by 2020.

ClimateSmart Adaptation action plan

In June 2007, *ClimateSmart Adaptation 2007–12: an action plan for managing the impacts of climate change*, a major initiative in the Queensland Government's *ClimateSmart 2050* strategy, was released. As the climate changes, we need to change or adapt to it—this is the focus of *ClimateSmart Adaptation*. Under the plan, the Queensland Government will implement a wide range of climate adaptation actions in a number of priority sectors, including water planning and services, agriculture, human settlements, natural environment and landscapes, emergency services and human health, tourism, business and industry, and finance and insurance. *ClimateSmart Adaptation* is being implemented by the Queensland Climate Change Centre of Excellence.

Establishment of the Office of Climate Change

The Office of Climate Change is leading the development of climate change policy and programs that are based on the best available science and information. The Office comprises the expertise of the Queensland Climate Change Centre of Excellence and specific climate change policy functions. It has commenced a program of climate change policy development, program implementation and scientific work. This includes:

- coordinating the implementation of ClimateSmart 2050, Queensland's climate change strategy 2007 and its 24 initiatives;
- analysing Queensland's greenhouse gas emissions projections out to 2050 and developing policy recommendations for achieving further cuts to our emissions profile;
- administering the \$300M Queensland Climate Change Fund, which will provide approximately \$20M per year for future climate change initiatives;
- coordinating the implementation of ClimateSmart Adaptation 2007–12, an action plan for preparing Queensland communities and industries for the impacts of climate change, and its 62 actions;
- facilitating Queensland's input into Professor Ross Garnaut's analysis of the likely impacts of climate change on Australia's economy, environment and

resources, and his assessment of the costs and benefits of various possible policy interventions; and

- managing a research project to determine whether cloud seeding is able to increase rainfall in south-east Queensland and its potential to increase water storage in Wivenhoe and Somerset dams.

Queensland Government Climate Change Summit

On 25–26 July 2006, the Queensland Government hosted a summit to critically review the issue of climate change. This provided a platform for industry, government and community representatives to discuss climate change in Queensland, including finding methods of tackling greenhouse gas emissions and ways to meet the challenges posed by climate change, such as water shortages. An on-line survey was also available to the public to put forward ideas on reducing greenhouse emissions and adapting to climate change. Key outcomes of the summit included the implementation of a Biodiesel Industry Action Plan and the allocation of \$300 million from the \$1 billion Queensland Future Growth Fund to support further development of clean coal technology.

Vegetation Management Act

In accordance with the *Vegetation Management Act 1999*, the government stopped broadscale land clearing of native vegetation on 1 January 2007. As a result, it is estimated that up to 20 million tonnes of greenhouse gas emissions were saved from entering the atmosphere. This landmark Queensland initiative is largely responsible for assisting Australia to meet its Kyoto targets. Many local governments also protect and manage vegetation through planning scheme mechanisms and local laws.

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