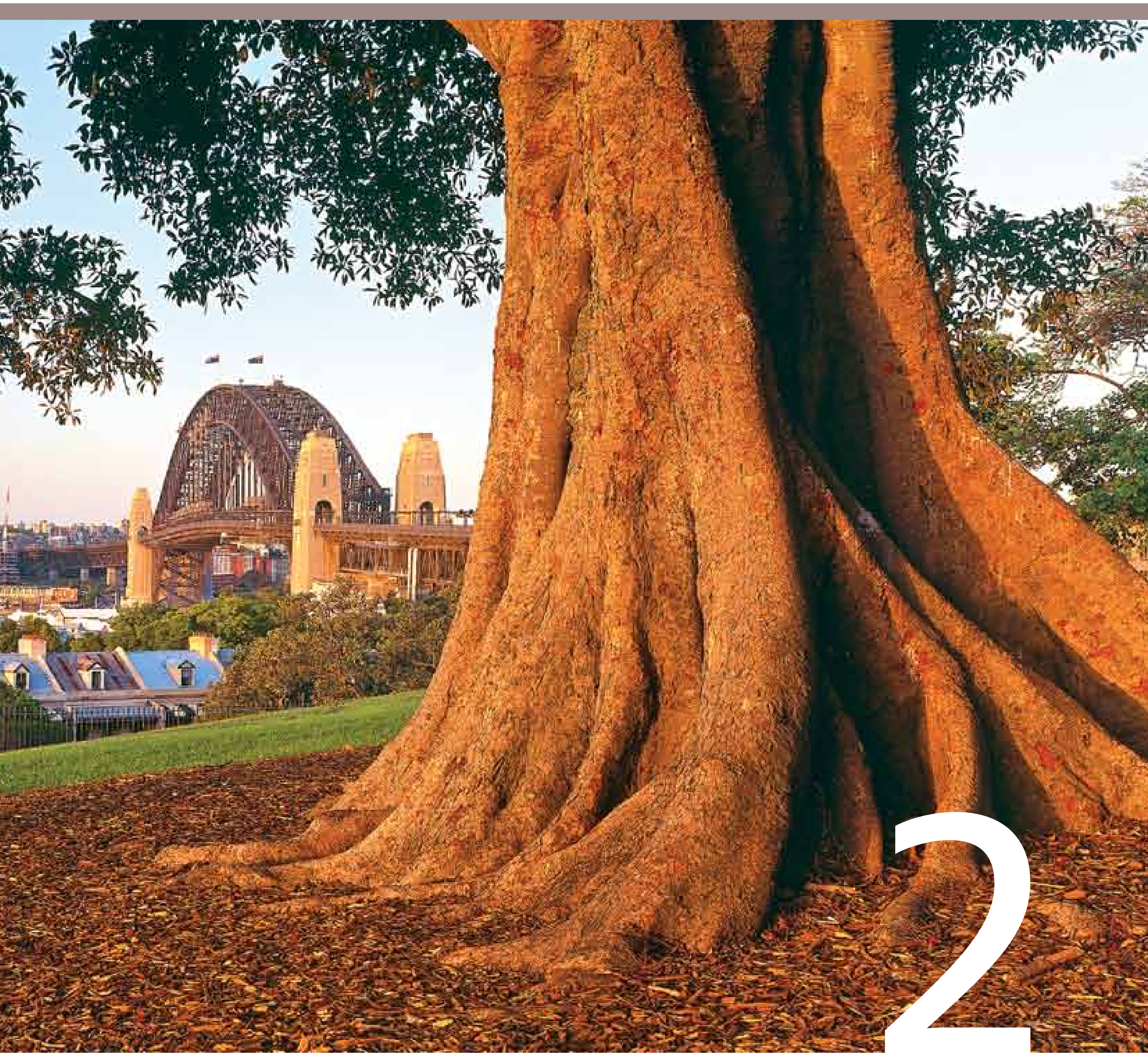
Observatory Hill, Sydney, New South Wales
Photo by Mark Gray

Drivers
of Australia's environment



Key findings

The principal drivers of Australia's environment—and its future condition—are climate variability and change, population growth and economic growth.

Our challenge is to mitigate the degree and potential impacts of climate change, and to decouple national growth from increased pressures on our environment.

Climate variability and climate change have a direct impact on the condition of Australia's environment.

As the driest inhabitable continent, Australia is particularly vulnerable to the potential effects of climate change. We face a significant challenge in understanding the environmental implications of climate change, and how we might mitigate those impacts or adapt to them.

Australia's exposure to climate change is dependent on global greenhouse gas emissions.

In 2000, the Intergovernmental Panel on Climate Change developed emissions scenarios to guide global climate projections. Since 2005, global emissions of greenhouse gases have continued to track above the middle of the scenario range. Based on our current understanding of atmospheric processes, the implication is that current policies will not achieve the significant reductions needed to mitigate profound climate change.

It is likely that we are already seeing the effects of climate change in Australia.

Australian average surface temperatures rose by nearly 1 °C between 1910 and 2009. Warming was modest in the early part of this period, declined slightly between 1935 and 1950, and then rapidly increased. The decade 2000–09 was the nation's warmest on record. Some regions have had temperatures increase by 2 °C since 1960. The frequency of hot nights has increased and the frequency of cold nights has declined. Rainfall trends are more difficult to distinguish, given the large natural variability across regions and over time. During the past few decades, cool season (April to November) rainfall has largely decreased in the south-west and south-east when compared with natural variability, and winter season rainfall in the south-west of Western Australia has declined by about 15% since the mid-1970s. Climate models project that, by 2030, average annual temperatures across Australia are likely to warm by 1 °C (above 1990 temperatures), with warming of 0.7–0.9 °C in coastal areas and 1–1.2 °C inland. Drying is likely in southern areas of Australia, especially in winter, and in southern and eastern areas in spring. Changes in summer tropical rainfall in northern Australia remain highly uncertain.

The Australian economy is projected to grow by 2.7% per year until 2050.

Higher labour productivity gains could increase this to 3% per year.

We have become, by the power of a glorious evolutionary accident called intelligence, the stewards of life's continuity on earth. We did not ask for this role, but we cannot abjure it. We may not be suited to it, but here we are.

Stephen Jay Gould,
The flamingo's smile: reflections in natural history, 1985

Under the base scenario, Australia's population of 22.2 million people in 2010 is projected to grow to 35.9 million by 2050.

This figure may be 30.2 million under a scenario that assumes less net migration and historically low fertility rates. The projected development of infrastructure (e.g. housing, transport, water supply, energy, communications) strongly correlates with anticipated population growth, reflecting the long-standing pattern of association between these variables. In the absence of effective policies to reduce the impacts of population growth, it will remain an effective indicator of future pressures.

We have opportunities to decouple population and economic growth from pressure on our environment.

There is ample historical evidence of a strong correlation between population and economic growth, and increased resource use and waste production. However, we are not necessarily bound by this history. The opportunities to decouple this relationship through innovation and improved efficiency are many and varied.

In the long run a healthy economy can only exist in symbiosis with a healthy ecology.

Robert Costanza
and Lisa Wainger,
Washington Post,
2 September 1990

Audience at the 2010 Tamworth Country Music Festival, New South Wales
Photo by June Underwood

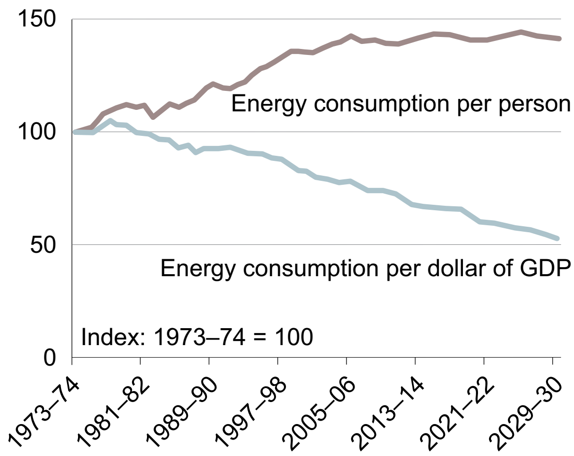
Introduction

The condition, trend and outlook for the Australian environment are subject to some major drivers of change. Understanding and quantifying these drivers is fundamental to understanding the past, present and future state of our environment.

The 2008 Victorian state of the environment report[1] framed the consideration of these drivers particularly well, and this national State of the Environment report builds on their approach in developing our outlook on Australia's environment. This approach recognises three major drivers on the environment.

Climate change is a direct driver of change. *Population growth* (with associated growth in the built environment) and *economic growth* (with associated increases in consumption of resources and generation of waste) are indirect drivers. As a direct driver, climate change has direct and ongoing effects on the environment, as higher temperatures and changing rainfall regimes in some areas can be expected to have profound and pervasive control over a host of natural processes that underpin the condition and trend of ecosystems. The effects of indirect drivers are mediated by other processes, including the policies, culture and technology that we bring to bear on our use of our environment. For example, population growth is likely to continue to drive the need for expanded suburban development. The size of this impact will depend on how sensitive the planning has been towards local environmental assets and values, and on the effectiveness of policies to improve the energy efficiency of housing and transport.

Economic growth will probably include increased demand for energy and other resources, as well as increased waste generation, with all the accompanying environmental implications for resource development, emissions and waste disposal. Alternatively, economic growth may be largely decoupled from increased consumption of resources and increased waste. Improvements in the efficiency of resource use have led to a weakening of the link between economic growth and energy use over recent decades (Figure 2.1).[2]



GDP = gross domestic product

Source: Schultz & Petchey,[3] Cuevas-Cubria & Riwoe[4]

Figure 2.1 Australian energy consumption 1970–2010 and projected consumption 2011–30

Wind turbines, South Australia
Photo by Darren Jew

However, in the short to medium term, continued growth can be expected to lead to further increases in demand for energy, with consequent flow-on effects for resource development and emissions. In the longer term, if emissions of greenhouse gases (GHGs) are to be stabilised and then reduced, economic growth will need to be largely decoupled from increased GHG emission, consumption and waste.

There is no question that human activity, through each of these major drivers, has the ongoing potential to degrade our environment. However, establishing clear and precise relationships between these drivers and environmental impacts is not easy, particularly when we are projecting outlooks. The task is made even more complex when we consider the strong and diverse interactions among climate change, economic growth and population growth.[5] Climate change and economic growth—and, to a smaller extent, population growth—are subject to global processes largely outside the control of Australia. If the collective effect of the GHG emission reduction policies and actions of other nations largely determines the magnitude and rate of climate change, and if Australia's population and economic growth is strongly subject to future unknown domestic policy as well as global conditions, how can we assess the potential impact of these drivers on our environment?

This report considers scenarios of future climate, population and economy (this chapter), and the implications for the environment from those projections (in each of the nine themed chapters). This report uses the best available scenarios for these drivers—as reflected in their scientific pedigree as well as their general recognition by the Australian Government—as the most robust projections applicable to national planning.

Understanding the trends and environmental implications of these drivers is fundamental to establishing what a sustainable Australia might look like.

Climate change

Climate has always been a prime determinant of the Australian environment and its condition, with droughts and floods perhaps more characteristic than for other inhabited continents. The recent drought in south-east Australia is unprecedented in both its length and intensity (lasting from 1997 to 2010 in some areas). Research has shown that changes in the large-scale weather patterns affecting south-east Australia are associated in part with climate change. Therefore, it is likely that climate change, together with natural variability—and potentially land-use change[6]—contributed to this drought. Similarly, research has found that the rainfall decline in south-west Western Australia since the mid-1970s is likely to be at least partly due to anthropogenic (caused by human activity) increases in GHGs.[7] The drought in south-west Western Australia continues unabated. Understanding the causes and consequences of such events is crucial to any assessment of the current state of our environment and its recent trends.

There is strong and growing evidence that our climate, with its very high natural variability from year to year, is changing at a rate unprecedented in the geological record. Therefore, any outlook for the environment must incorporate our climate. The implications of climate change are potentially profound, and extend beyond the more obvious and direct impacts on inland waters, terrestrial and marine ecosystems and biodiversity, to our cultural heritage and built environment.

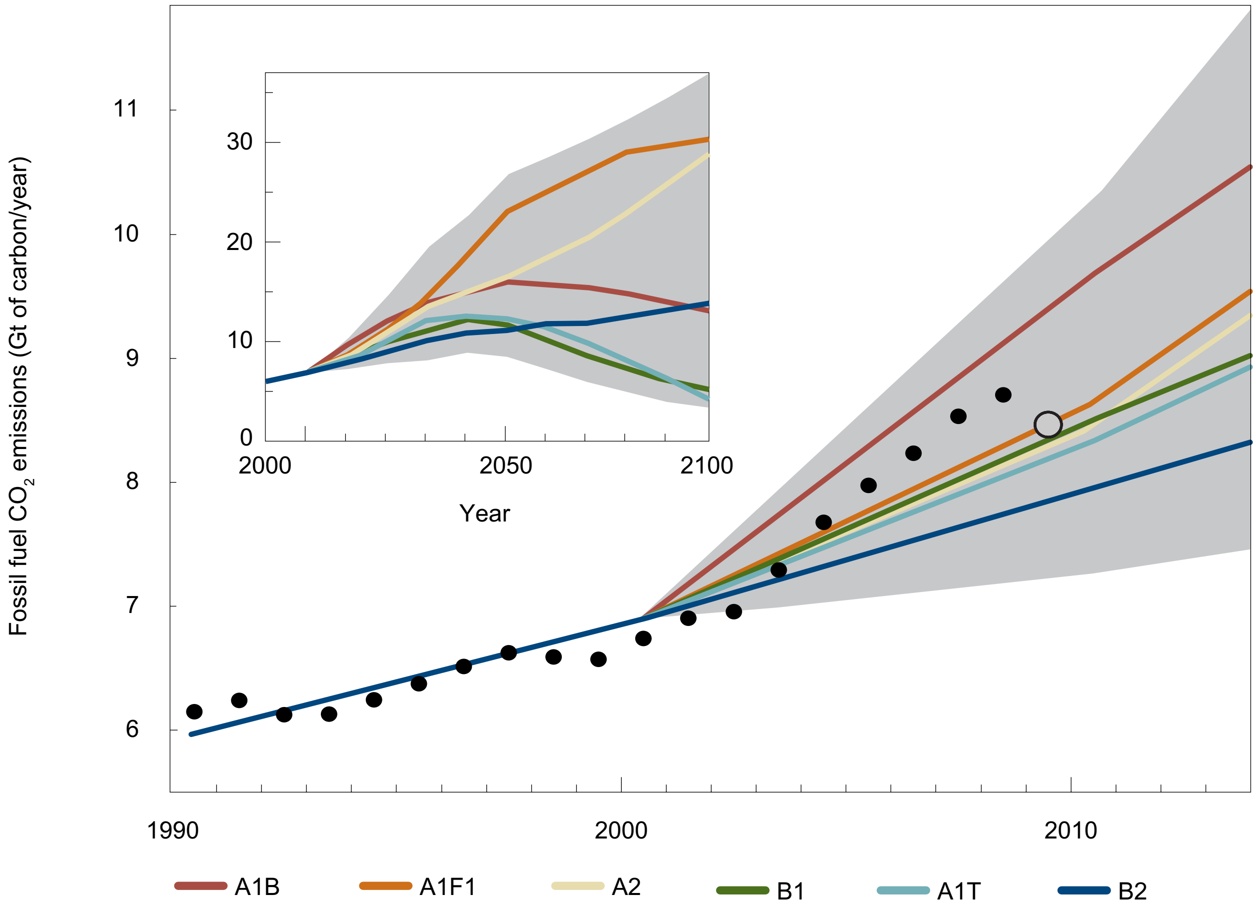
Forward projection of climate is scientifically challenging and inherently uncertain. There is a strong scientific consensus that anthropogenic emissions of GHGs have an impact on climate. New climate science and climate modelling is regularly published. The most robust statements on climate change since the 2006 State of the Environment report[8] reside in the Intergovernmental Panel on Climate Change's (IPCC) fourth assessment report.[9] The significance of this body of work lies not only in the breadth and scope of the science contributing to the assessment, but also in the structured comparison of climate projections based on 23 of the world's global climate models across an agreed set of emissions scenarios.[10] The results of this comparison give us a picture of the strong commonalities among the global climate model predictions, as well as the uncertainties in their predictions of climate and GHG emissions. The IPCC's scientific undertaking to produce and review the material for the fourth assessment report is impressive and unique. In the time since its release, aspects of the reporting process have been challenged, but not the underlying scientific content.

Has the science of climate change, as reported in the fourth assessment report—and now nearly four years old—significantly departed from those findings in that time? In response to the widespread interest in this general question, climate change science and data were reviewed and updated in time for the 2009 Copenhagen Climate Summit.[11] The report reinforced the basic scientific linkages between human activity and climate reported by the IPCC, and found that global carbon dioxide emissions from burning fossil fuel continue to track near the highest scenarios considered by the IPCC. The Climate Commission's 2011 report, *The critical decade: climate science, risks and responses*, makes the reality, certainty and implications of our changing climate clear and immediate.[12]

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Bureau of Meteorology (BoM) summarised the IPCC findings with respect to Australia.[13] Climate projections are available for the nation, and every state and territory, for the years 2030, 2050 and 2070. These projections include seasonal and annual rainfall and temperature estimates relative to the period 1980–99. Uncertainty in these projections for a given emissions scenario reflects the degree of disagreement among the global climate models, uncertainty in the scenarios and underlying uncertainty in our ability to capture natural processes in our climate models.

Emissions-driven climate change is obviously dependent on the anticipated use of fossil fuels into the future. The IPCC special report on emissions scenarios[10] groups emissions scenarios into four families (A1, A2, B1 and B2). Each of these represent alternative development pathways and resulting GHG emissions under current policies, but with varying rates of population increase, economic growth and increases in resource-use efficiencies. The low, medium and high scenarios referred to in the CSIRO and BoM projections[13] correspond to the B1 (economic growth based on clean, resource-efficient technologies), A1B (economic growth based on a balance between resource-efficient and fossil fuel–intensive industries) and A1F1 (fossil fuel–intensive growth), respectively. The projected emissions from the IPCC special report are shown in Figure 2.2. Since 2005, global GHG emissions have continued to track above the middle of the IPCC's scenario range—between A1B and A1FI, with the temporary consequences of the 2008–09 global financial crisis evident.

The estimated increase in annual average temperature by 2030 (relative to 1990) is around 1.0 °C, with warming of 0.7–0.9 °C in coastal areas and 1–1.2 °C inland. By 2050, projected annual warming ranges from 0.8 °C to 1.8 °C; by 2070, the projected warming ranges from 1.8 °C (low GHG emissions scenario) to 5 °C (high emissions scenario). Figure 2.3a illustrates the low and high probability estimates for warming in 2030. There are indications from climate modelling that temperature extremes may also be changing, with a strong projected increase in warm nights, fewer frosts and longer heatwaves.[15]



Gt = gigatonne

Source: Manning et al.[14]

Figure 2.2 Annual industrial carbon dioxide (CO_2) emissions for 1990–2008 and 2009

Black circles represent the years 1990–2008, and the open circle represents 2009. Emissions fall within the range of all 40 emissions scenarios (grey shaded area) and six illustrative marker scenarios (coloured lines) of the IPCC special report.[10] The inset in the upper left corner shows these scenarios to the year 2100.

Resurfacing and revegetation of former open-cut iron mine, Koolan Island, Western Australia

Photo by Jean-Paul Ferrero

The IPCC climate model results indicate that rainfall is likely to be reduced in southern areas of Australia, especially in winter, and in southern and eastern areas in spring. The contraction in the rainfall belt towards the higher latitudes (Figure 2.3b) would likely cause these variations. Future changes in summer tropical rainfall in northern Australia remain highly uncertain. Nevertheless, it is likely that the most intense rainfall events in most locations will become more extreme and more frequent, driven by a warmer, wetter atmosphere.

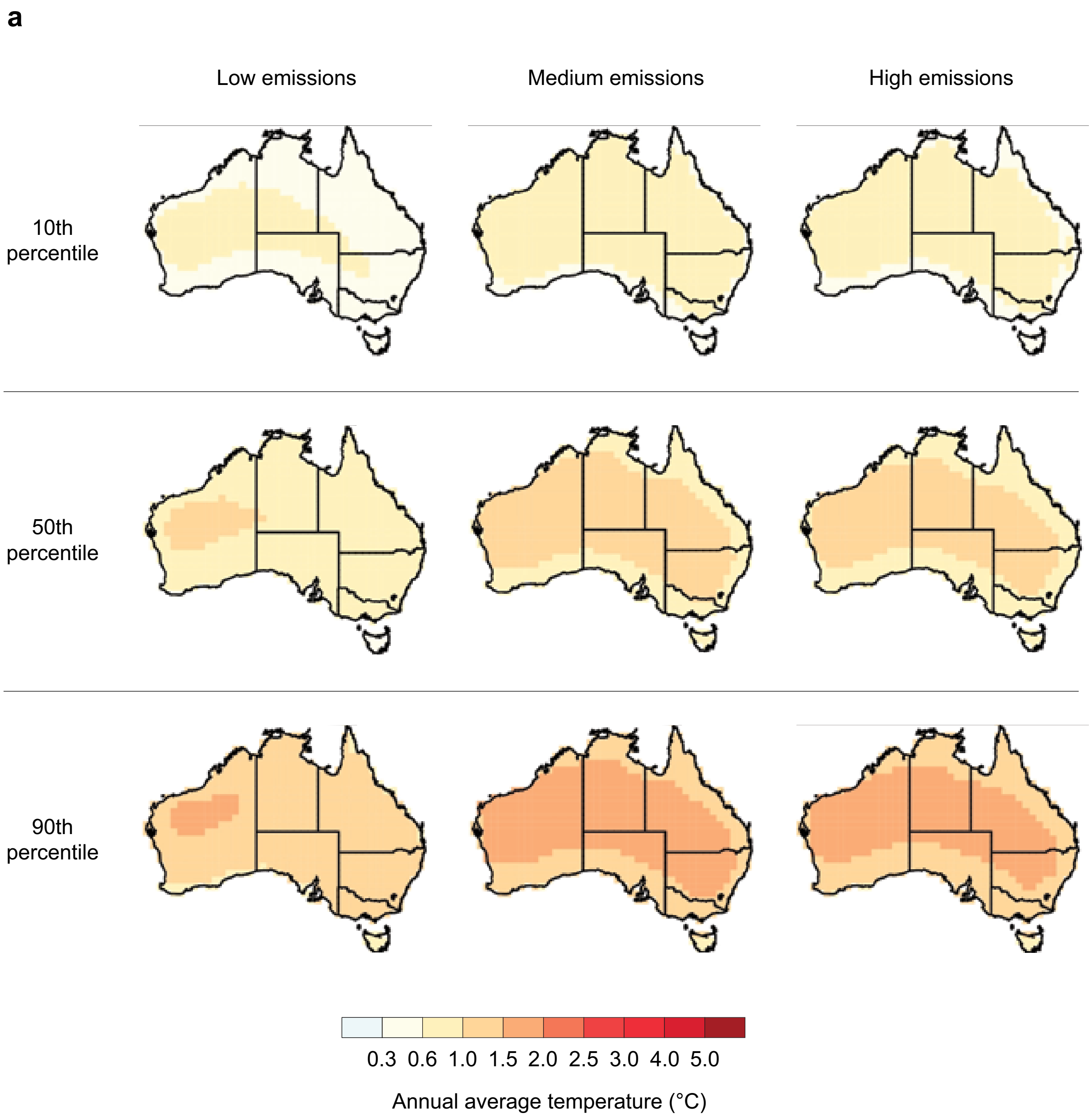
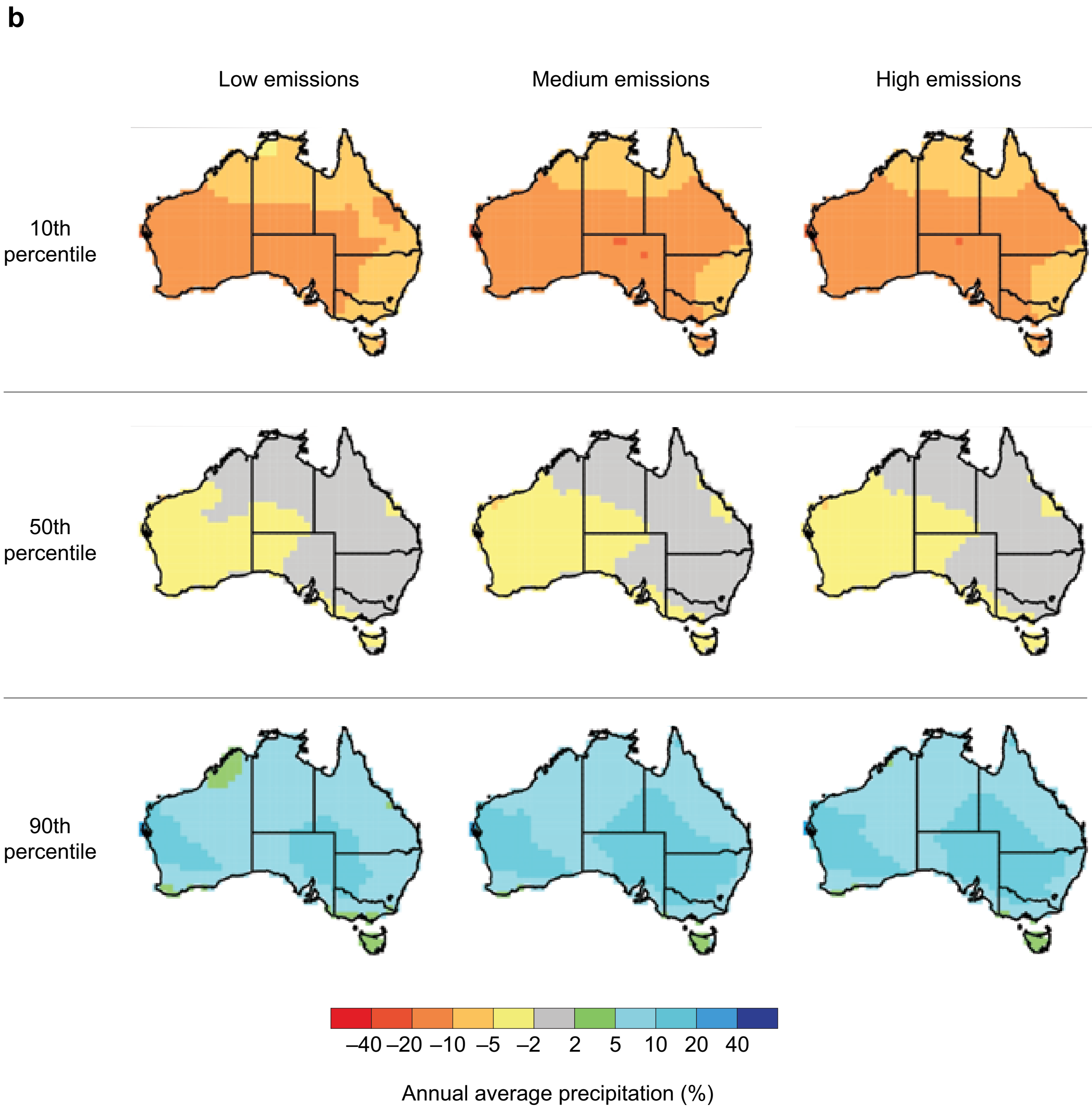


Figure 2.3 Projected changes across Australia in (a) annual average temperatures between 1980–99 and 2030, and (b) annual average precipitation in 2030 (compared with the period 1980–99)

The projections give an estimate of the average climate around 2030 considering consistency among climate models. Individual years will show variation from this average. The 50th percentile (the midpoint of the spread of model results) provides a best-estimate result. The 10th and 90th percentiles (lowest 10% and highest 10% of the spread of model results) provide a range of uncertainty. Emissions scenarios are from the IPCC *Special report: emissions scenarios*.[10] Low emissions is the B1 scenario, medium is A1B and high is A1FI.



Source: CSIRO Climate Change in Australia website (www.climatechangeinaustralia.gov.au): Australia's future climate for (a) national temperature change 2030, annual and (b) national rainfall change 2030, annual

Figure 2.3 *continued*

Population growth and distribution

Human population growth is a potential cause of environmental change worldwide, including Australia, even without considering the impact of changes on living standards or resource use per capita. Historically, a higher population has generally translated into an amplified demand for resources, a larger physical footprint for our settlements and more waste going back into the environment. At the global scale, the Millennium Ecosystem report[16] states that, over the past 50 years, humanity has changed ecosystems more rapidly and extensively than any comparable time in human history, largely to meet increased demands for resources.

However, it is not appropriate to attribute all past Australian environmental degradation to the direct or indirect effects of population growth. Many of our historical environmental impacts are related to poor land and water practices, poor development policies or phenomena such as introduced pests.[17] None of these are directly related to population growth, nor would they be immediately remedied if Australia had fewer people. Nevertheless, many of the pressures on the Australian environment do scale to some degree with:

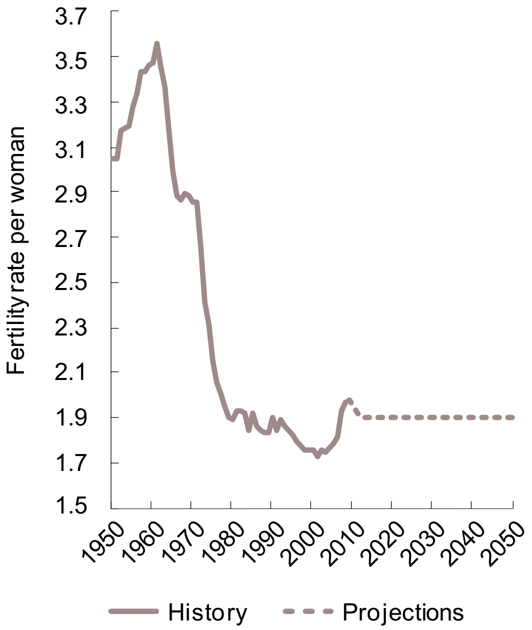
- how many of us there are or will be
- where most of us live or are likely to live in the future (i.e. near the coast and in the suburbs of large metropolitan centres)
- the material demands that our lifestyles place on the environment
- the technologies and practices used in interacting with the environment.

Australia's population is growing. The factors that determine this growth are mortality, fertility and net migration. The largest factor influencing population growth over the past decade has been net overseas migration rather than natural increase, although less so than over previous decades. Scenarios of future growth developed by the Australian Bureau of Statistics and by the Australian Government Treasury use plausible ranges of each of these factors in combination to generate population projections, although to some degree these are constrained by historical trends. The best recent synthesis of these analyses for both population and associated economic projections is the 2010 intergenerational report (IGR) by the Treasury.[5] The population projections in the IGR build on those published by the Australian Bureau of Statistics in 2008.[18]

Australian mortality rates have fallen significantly over the past century; these falls have added to population growth and the proportion of older people in the Australian population. Australia's crude mortality rate has fallen from 9.1 deaths per 1000 people per year in 1968 to 6.7 deaths per 1000 people per year in 2008. Mortality rates have fallen for both sexes, particularly for those aged 50 or more, since 1970. The life expectancy for Australians remains among the highest in the world. The 2006–08 life tables indicated that life expectancy at birth for men had risen to 79.2 years and for women to 83.7 years (an increase of 24.0 and 24.9 years, respectively, since 1901–10).

The total fertility rate is the average number of children a woman gives birth to in her lifetime; 2.1 is considered to be the fertility rate needed to keep the long-term population stable in the absence of changes in mortality rates and if there is no net migration. The 2008 estimate of the world total fertility rate is 2.5, ranging from 1.2 to 7.1. Most developed countries have fertility rates below the replacement rate.

Australian fertility peaked at 3.5 births per woman in 1961 (the end of the post–World War 2 baby boom). Subsequently, the total fertility rate of Australian women declined rapidly during the 1960s and 1970s, stabilised during the 1980s, then declined further until 2001. Since that time, fertility has been generally increasing to reach almost two births per woman in 2008, the highest since 1977 (Figure 2.4). The IGR base scenario projects fertility to fall slightly to 1.9 by 2013, and stay at that level for the remainder of the projection period. Although the fertility projection is below the natural replacement rate, natural increase remains positive throughout the projection period because relatively more women are currently in the younger rather than older age groups.

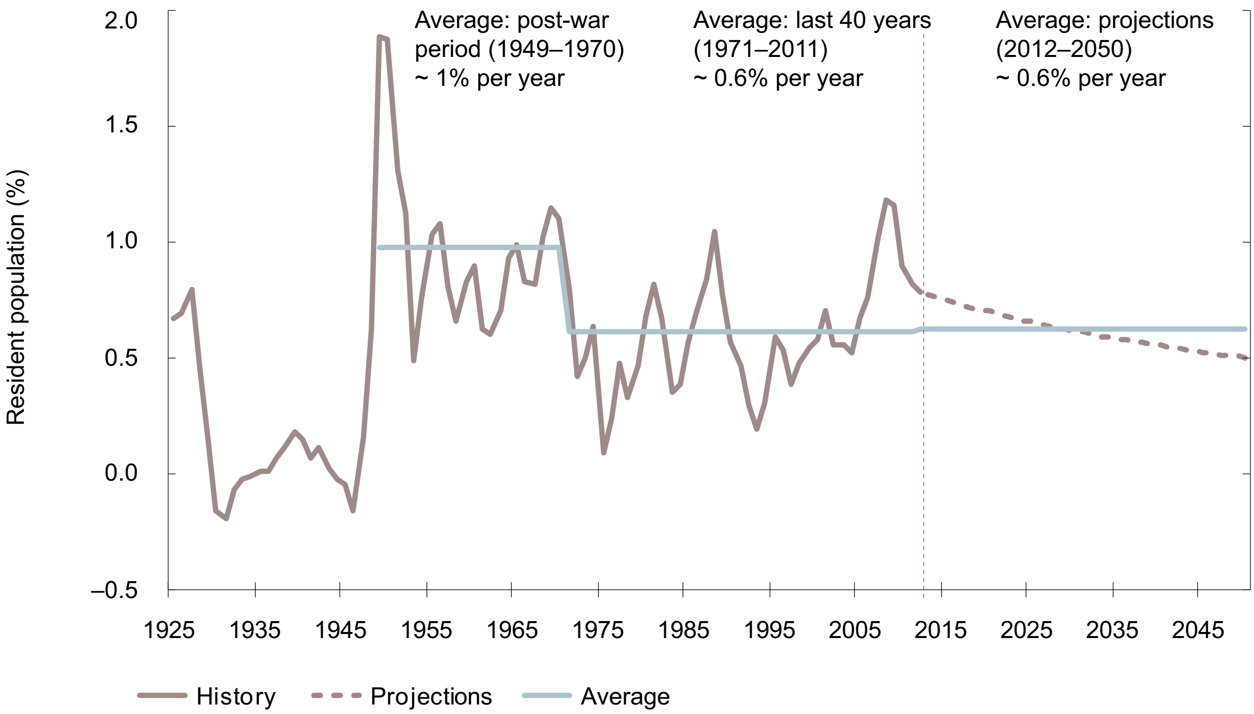


Source: Australian Government Treasury[5] including projections developed by the Australian Bureau of Statistics and the Treasury

Figure 2.4 Australian fertility rates since 1950

Australia's current fertility rate is higher than many Organisation for Economic Co-operation and Development (OECD) countries, including Italy, Germany, Japan and Canada, and is well above the OECD average of 1.68 (2007 data). It remains below those of New Zealand (2.18 in 2008) and the United States (OECD estimate of 2.12 in 2007).

Of the three basic factors determining population (fertility, mortality and migration), the net migration rate is most subject to policy intervention, and thus the most uncertain in projections. Again, the most current scenario is provided by the IGR, which assumes in the base scenario that net migration will fall relatively sharply from an average of around 244 000 people per year from June 2006 to June 2009, to 180 000 people per year from 2012 and beyond, with an unchanged age–gender profile. To illustrate the long-term historical trends and future projections in migration, it is useful to express migration relative to the resident population (Figure 2.5). The average rate of net overseas migration assumed over the IGR projection period is around the average observed over the past 40 years; to project population growth this far into the future naturally has its uncertainties, but is nevertheless useful for anticipating potential implications for our environment.



Source: Australian Government Treasury[5]

Figure 2.5 Rate of absorption of net overseas migration

Historical trends 1925–2010, and projected rates to 2050.

Table 2.1 Australian population history and base scenario projections

	1970	2010	2020	2030	2040	2050
Age range	Population in millions (% of total population)					
0–14	3.6 (28.8)	4.2 (19.1)	4.9 (19.0)	5.4 (18.3)	5.7 (17.4)	6.2 (17.2)
15–64	7.9 (62.8)	15.0 (67.4)	16.6 (64.7)	18.2 (62.4)	20.0 (61.3)	21.6 (60.2)
65–84	1.0 (7.8)	2.6 (11.7)	3.7 (14.3)	4.8 (16.6)	5.6 (17.2)	6.3 (17.6)
85 and over	0.1 (0.5)	0.4 (1.8)	0.5 (2.1)	0.8 (2.7)	1.3 (4.0)	1.8 (5.1)
Total[a]	**12.5**	**22.2**	**25.7**	**29.2**	**32.6**	**35.9**

a Rounded to nearest 100 000
Note: Population as at 30 June
Sources: Australian Government Treasury,[5] Australian Bureau of Statistics,[19] Treasury projections

Taking these three factors together, Australia's population in all age groups is projected to increase (Table 2.1). Over the next 40 years, the rate of growth is projected to slow slightly to 1.2% annually, compared with the 1.4% experienced over the previous 40 years. At the same time, the population will continue to age.

The low population growth scenario is based on net overseas migration of 100 000 per year, which is lower than the 30-year historical average to 2008 of 109 000, and total fertility of 1.7 births per woman, which reflects the historical minimum reached in 2001. This gives an annual growth rate of 0.8%, lower than the 1.2% annual population growth that is projected under the base scenario (Table 2.2).

Table 2.2 Australian population projections—low and base case

	2010	2050	
	Population in millions (% of total population)		
Age range		Projected low	Projected base
0–14	4.2 (19.1)	4.6 (15.1)	6.2 (17.2)
15–64	15.0 (67.4)	17.8 (58.9)	21.6 (60.2)
65–84	2.6 (11.7)	6.1 (20.0)	6.3 (17.6)
85 and over	0.4 (1.8)	1.8 (6.0)	1.8 (5.1)
Total[a]	**22.2**	**30.2**	**35.9**

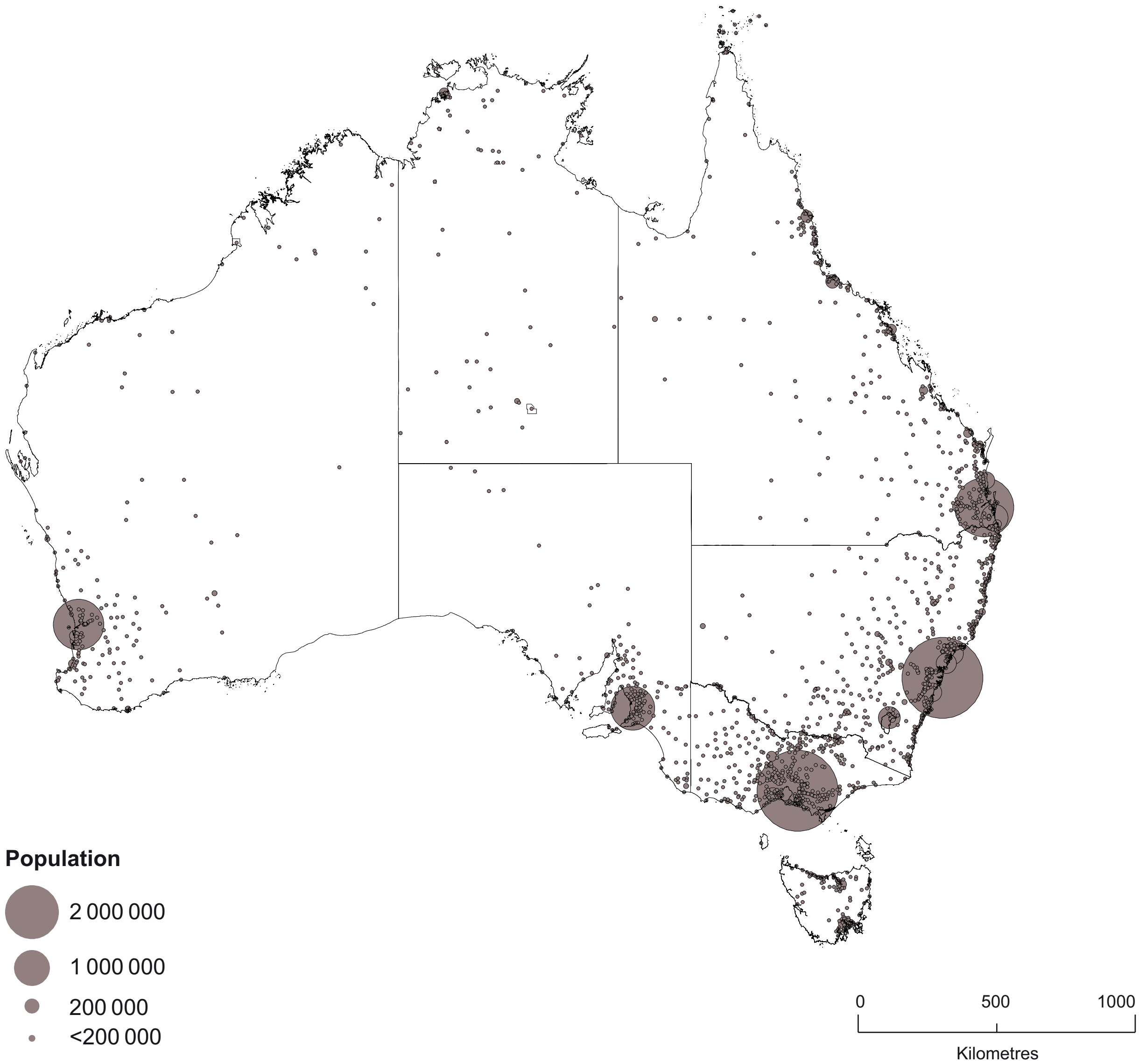
a Rounded to nearest 100 000
Note: Population as at 30 June
Sources: Australian Government Treasury,[5] Treasury projections

It is not just the size of the Australian population that determines the impact on the environment. The geographical distribution and composition of the population may also be important factors. For example, the population may be growing more rapidly in areas of particular environmental sensitivity, such as the coasts, than in other areas. Changes in the age structure of the population or household sizes may have implications for the consumption of particular natural resources as a result of 'lifecycle' effects, where different age groups have different demand profiles (e.g. an ageing population is likely to increase demands for health services).

The Australian population is highly urbanised, tends to live close to the coast and is concentrated in metropolitan urban areas (Figure 2.6). In 2006, 88% of Australians lived in metropolitan urban areas compared with 58% in 1911.[20] Some rural areas, and some small urban areas, have experienced and continue to experience population declines. Australia's biggest cities are mostly located near the coast, meaning that the vast majority of the Australian population (85%) lives within 50 kilometres of the coast.

According to the most recent Australian Bureau of Statistics population projections,[18] under the 'middle case' assumptions, the proportion of people living in the capital cities will increase from 64% in 2006 to 67% in 2056. Population projections are not available for other geographical dissections, but it is logical to assume that much of the remaining population growth will also continue to occur within coastal regions.

Where in Australia this population growth is likely to occur and its implications for the built environment of our cities and regions, heritage and natural environment is considered throughout this report.

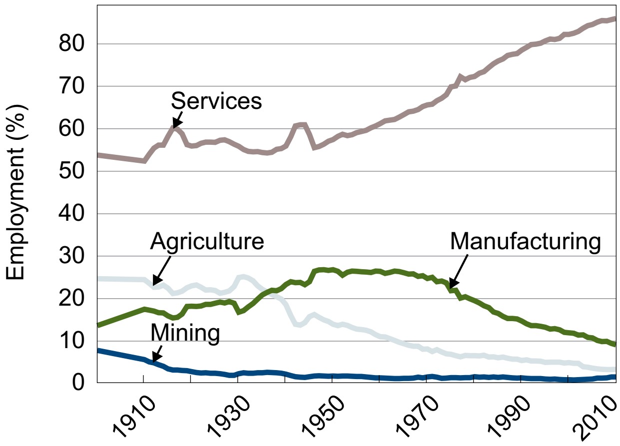


Source: Generated 24 June 2011 using data provided by the Australian Bureau of Statistics

Figure 2.6 Population distribution of Australia, excluding Cocos (Keeling) and Christmas islands, 30 June 2010

Economic growth

Over the past century, the structure of the Australian economy (as reflected in employment by industry) changed markedly. The significance of agriculture reduced, manufacturing declined from peak levels reached in the 1950s and 1960s, and there has been a steady rise of the already dominant service sector since 1950 (Figure 2.7).



Source: Reproduced from the Reserve Bank of Australia[21]

Figure 2.7 Employment by industry

Data are interpolated between 1900 and 1910.

Australia's real gross domestic product (GDP) grew by an average of 3.3% per year between 1970 and 2010, and GDP per capita grew by 1.9% between 1970 and 2010. Our national standard of living, at least in economic terms, continues to grow faster than our population; we are an increasingly affluent society. The structure of Australia's economy has also changed over this period, with an increased share of the economy driven by the services and resources industries (Figure 2.8). Since different industries exert different pressures on the environment, future structural changes in the economy can be expected to have an impact—either positively or negatively—on the environment.

Economic growth is supported by population, productivity and participation in the economy. The 2010 IGR projections of economic growth are based in part on the population projections discussed in Section 3 (see Table 2.1). Economic growth will, to some extent, offset the economic implications of an ageing population. It is also assumed that labour productivity will continue to increase at the 30-year historical average of 1.6% per year for the next 40 years.

Under these assumptions, the base scenario for Australia's economic outlook is an average annual growth in real GDP of 2.7% to 2050, with per capita increases of 1.5%. This scenario indicates a somewhat slower economic growth than currently, largely due to the consequences of an ageing population on participation rates. A more optimistic scenario in the 2005 IGR of Australia's future economy is based on maintaining productivity gains of 2% per year; under these assumptions, real annual GDP growth would average 3% to 2050.

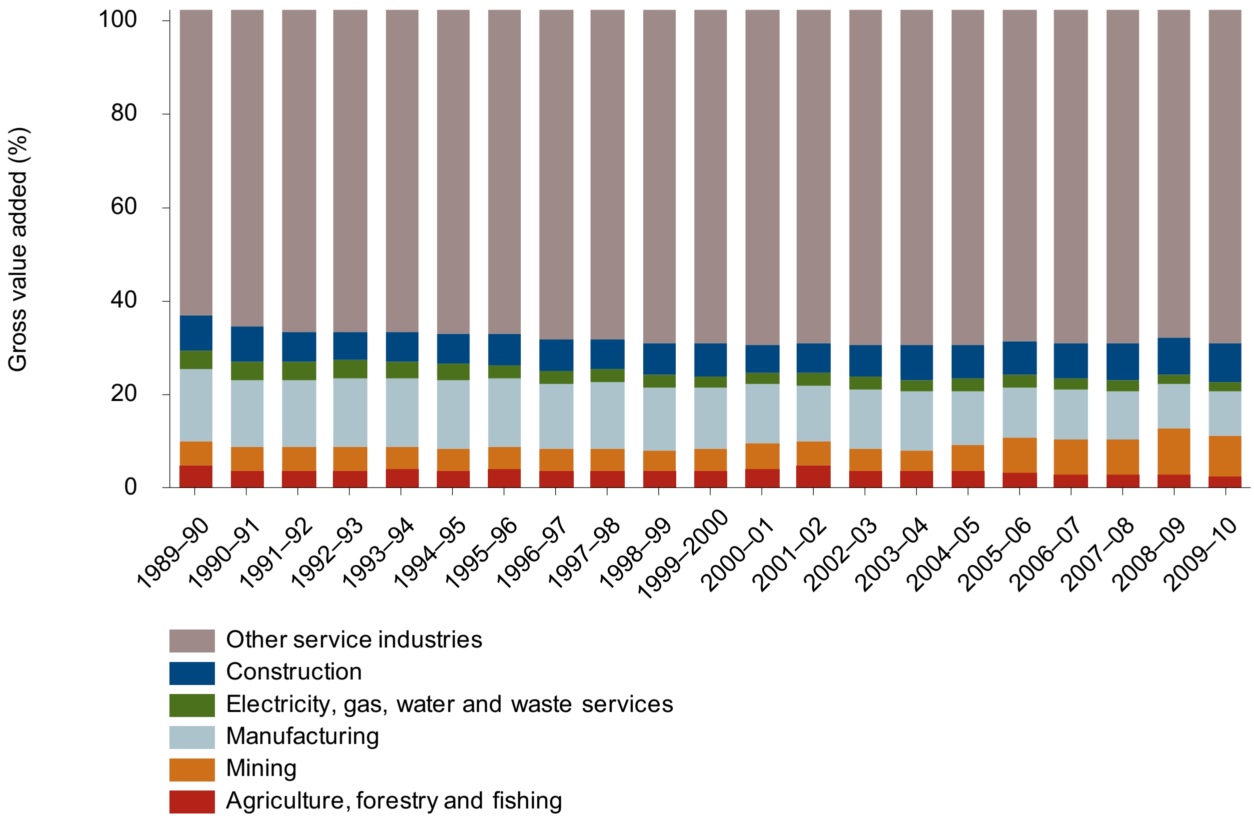
Just as an increasing population does not necessarily translate proportionately to increased environment impact, neither does a growing economy. However, there is strong historical evidence that this has been the case and thus will likely continue into the future. As the economy of Australia expands, it is likely that our consumption of resources and production of waste will also increase. In its 2008 report on Australia's environmental performance, the OECD recommended that Australia:[22]

> … make concerted efforts to decouple environmental pressures from economic growth, especially those pressures from the energy, transport and household sectors, including urban growth.

Historical trends can give insights into future trends in resource consumption and waste production, but do not consider significant changes in policy and the rate of technological innovation. Of course, in the real world, neither policies nor technology tend to be static, as demonstrated clearly in Box 2.1, which examines changes in the management of solid waste. From 1996 to 2009, government policy (strongly influenced by a growing community desire to recycle), together with improved technology, successfully diverted tens of millions of tonnes of solid waste from landfill into productive uses. This saved large quantities of valuable materials, and significant amounts of embodied energy and water.

Surfers Paradise after sunset, Queensland

Photo by Ilya Genkin



Source: Australian Bureau of Statistics, unpublished data

Figure 2.8 Australian industries 1990–2010 as a percentage contribution to gross value added

Although the slowdown in the rate of increase in recovery shown in Figure A (Box 2.1) is disappointing, it is important to note the significance of the gap between the 'total waste' line and the 'recovery' line. This represents a significant environmental and economic net benefit in terms of saved resources (including energy and water). Table 2.3 shows the GHG emissions avoided, and the amount of energy and water saved by recycling a tonne of various materials.

The connections among energy use, water use, GHG emissions and waste production are complex, changeable and sometimes overstated. For example, total energy use by water utilities in Sydney, Melbourne, Perth, Brisbane, Gold Coast and Adelaide in 2006–07 was 7.1 petajoules, meeting the water supply and treatment needs of 12.5 million people. This figure is approximately 0.2% of total urban energy use and less than 15% of the energy used for residential water heating; water supply and treatment are not strongly coupled to urban energy usage. Using a more energy-intensive future metropolitan scenario at 2030 (15.8 million people), with each person using 225 litres of residential water per day and a mix of supply sources (e.g. 40% desalination, 40% reuse and 20% new freshwater sources), would double the energy usage by water utilities compared with 2006–07 levels, but still only represent 0.3% of total urban energy use.[30]

As shown in Box 2.2, behavioural change can be a major factor influencing the nature of the linkage between population growth and the consumption of particular resources.

Box 2.1 Solid waste

Although the reliability of data on generation and management of solid waste in Australia is highly variable (making year-to-year and state-to-state comparisons difficult), there is general agreement between public and private sector observers that the long-term national trend of increasing solid waste generation is continuing.[23] Data from the Environment Protection and Heritage Council for 2008–09 indicate a national total of around 46.8 million tonnes.[29] Fortunately, over the past decade and a half, a significant proportion of the total waste stream has been diverted from landfill (around 52% in 2008–09). This has been achieved through the efforts by households, industry and governments to reuse, recycle and recover valuable materials from the waste stream.

Figure A shows how, after a period of rapid growth in the rate of diversion between 1996–97 and 1999–2000, while the rate of recovery has continued to increase, that increase has been matched by the increase in waste generated (which between 2002–03 and 2008–09 grew by 40%, compared with the population, which grew by 9.8%).[24-26]

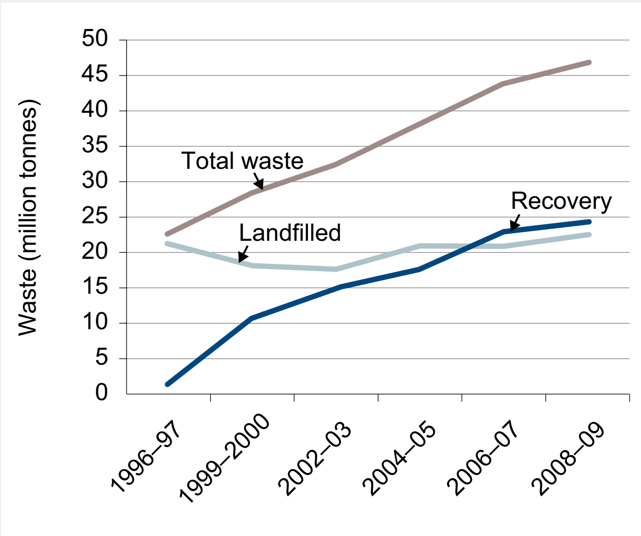


Figure A Waste generation, disposal and recovery in Australia, 1996–97 to 2008–09

Note: Waste and recycling data are generated in variable ways by a range of agencies, which means that there are wide disparities in the detail, geographic coverage, scale, timeframes and scope of the data. Within those limitations, effort has been made to ensure the accuracy of the information presented. Comprehensive data were not always available, and readers should exercise a degree of caution when using this information. Data methods and definitions have also changed between 2006–07 and 2008–09.

Sources: 1996–97 and 2002–03 data, Australian Bureau of Statistics;[27] 1999–2000 and 2004–05 data, WCS Market Intelligence & WME Media;[28] 2006–07 data, Environmental Protection and Heritage Council;[29] 2008–09 data, Australian Government Department of Sustainability, Environment, Water, Population and Communities[26]

Table 2.3 Net benefit of recycling one tonne of waste material[a]

Materials	Global warming tonnes (CO_2 equivalent)	Energy gigajoules (low heating value)	Water (kilolitres)
Aluminium	15.85	171.10	181.77
Concrete	0.02	0.28	1.28
Cardboard/paper recycling	0.06	9.32	25.41
Food and garden organics	0.25	0.18	0.44
Glass	0.56	6.07	2.30
Mixed plastics	1.53	58.24	−11.37

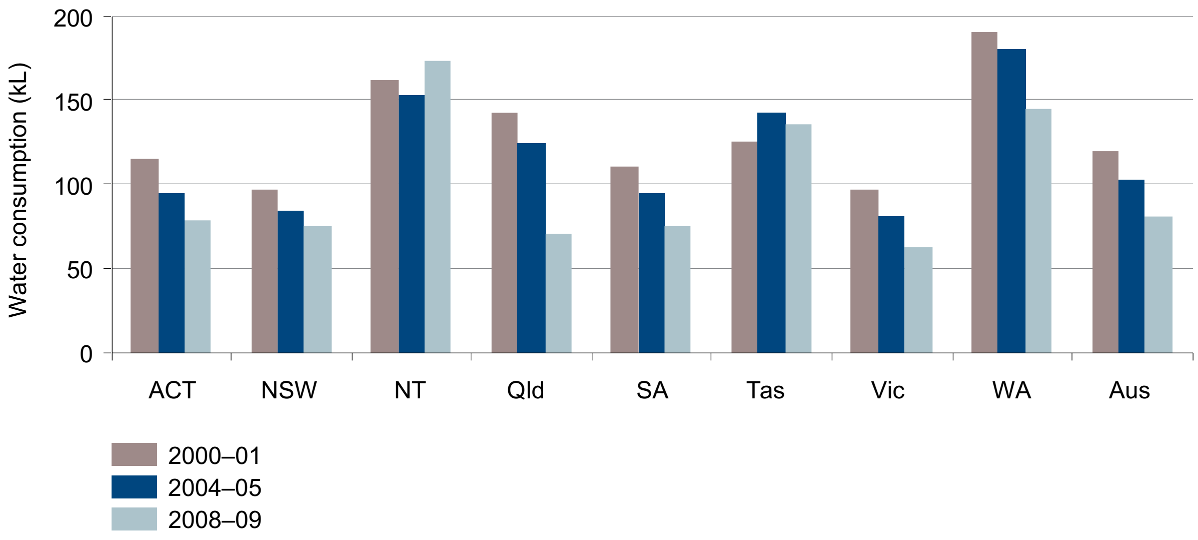
CO_2 = carbon dioxide

a Positive values are benefits, negative values are impacts

Source: Environmental Protection and Heritage Council[29]

Box 2.2 Household water consumption

In the face of widespread drought, and in response to increasing water supply charges and effective public education campaigns, household water consumption declined significantly in most states and territories from 2000–01 to 2008–09. There is little doubt that domestic water supply authorities will be watching closely to see whether the reductions in per capita consumption shown in Figure A are maintained following the widespread heavy rains in 2010 and early 2011, which restored many previously depleted water storages.



ACT = Australian Capital Territory; Aus = Australia; kL = kilolitre; NSW = New South Wales; NT = Northern Territory; Qld = Queensland; SA = South Australia; Tas = Tasmania; Vic = Victoria; WA = Western Australia

Sources: 2000–01 and 2004–06 data, Australian Bureau of Statistics;[31] 2008–09 data, Australian Bureau of Statistics[32]

Figure A Per capita household water consumption, 2000–01 to 2008–09

It is worth noting that the 2010 IGR makes reference to the important negative implications of unmitigated climate change to our future economy. It includes information from *The Garnaut Climate Change Review*, which conservatively estimated that unmitigated climate change would leave the Australian GDP in 2100 approximately 8% lower than it would be in the absence of climate change, with even greater impacts on consumption and real wages. This finding was more recently substantiated.[33] Unmitigated climate change involves additional significant risks and nonmarket costs not captured by such estimates.[34] The IGR concluded that:

> … to best manage these risks to Australia's future productivity growth, Australia needs to contribute to an effective global response to climate change.

Summary

The major drivers of changes to the Australian environment—climate change, population growth and economic growth—are historically related to environmental impact. Without significant policy and technological change (in some cases requiring global adoption), we can expect these relationships to continue into the future.

This chapter has examined the future direction and magnitude of these three crucial drivers. There is significant uncertainty in any and all of these predictions, partly due to uncertainties in the underlying science and projections, and partly due to the options available to Australians to minimise the negative environmental impacts of a growing nation and a high standard of living. In the latter, there is significant room for hope.

Gold mine, Cobar, New South Wales
Photo by Ilya Genkin

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