Geelong, VIC

Chapter 5

Sustainable cities

Human settlements place pressure on the environment through the demand for water, energy, land and other resources, and through the production of wastes (including greenhouse gas emissions). Many of Australia's cities are also vulnerable to the potential impacts of a changing climate.

The principle of sustainable development was popularly defined by the 1987 Brundtland Report *Our Common Future* as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. In this regard, the concept of sustainability encompasses social and economic considerations as well as environmental aspects.

Fortunately, Australian cities can, in many ways, lead the nation towards a sustainable future. To date, opportunities for more sustainable outcomes in cities have, however, tended to focus on symptoms and not the underlying causes of unsustainable practices. Along with opportunities for improvement in specific sectors such as waste, water and energy, cities can influence sustainability through larger systems such as settlement patterns, including the location of employment areas in relation to residential areas, and the availability of public transport.

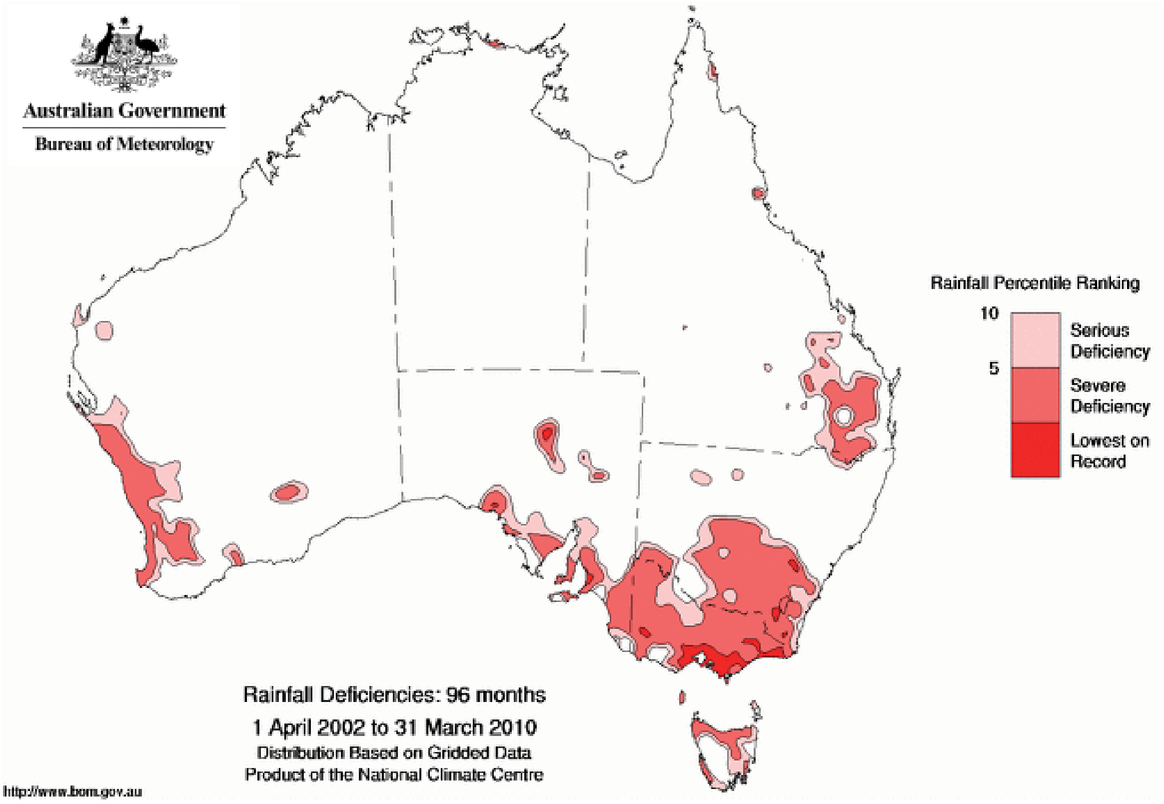
> *A sustainable human environment requires greater attention to urban design and a reduction in net consumption. In some areas of Australia where pressures are high, progress has been made in recognising the importance of urban form and infrastructure; the challenge is implementing this insight.*
>
> *Beeton, R (et al.) Australia State of Environment Report 2006, page 7*

5.1 Water

Australia's rainfall is characterised by extreme variability. Since 2002, severe rainfall deficiencies have been experienced in southern, eastern and south-western Australia, where the largest capital cities are located (Figure 20).

Urban water supplies are coming under increasing pressure from natural variability, changes in both temperature and rainfall, and population growth. During the financial year 2008–09 low rainfall and inflow to storages continued to adversely impact settlements on the eastern seaboard in Victoria and South Australia, with Melbourne and Adelaide reporting reductions in total water supplied due to low availability of water (National Water Commission 2010).

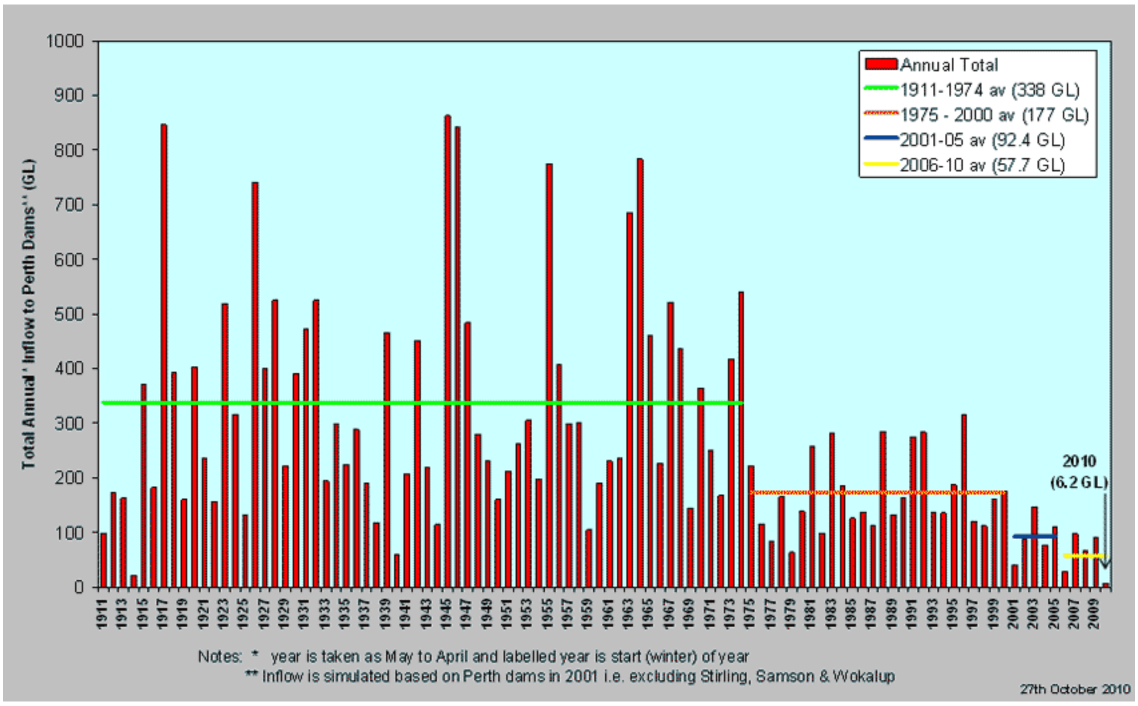
Figure 20 Rainfall deficiencies—April 2002 to March 2010



Source: Bureau of Meteorology (2010a)

There has also been a marked reduction in surface water available for storage in Perth; where the average annual inflow into Perth's dams experienced four-step change reductions from 338 gigalitres (GL) over the period 1911 to 1974 to an average of 57.7 GL between 2006 and 2010 (Figure 21).

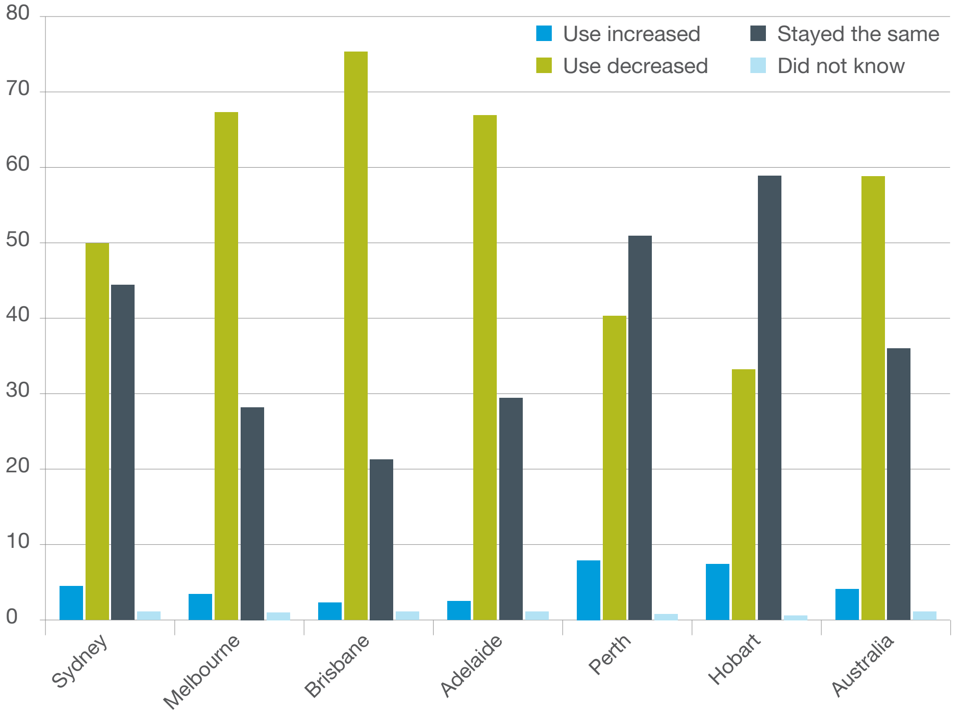
Figure 21 Western Australia inflows to dams 1911–2010



Source: Western Australia Water Corporation (2010)

In the longer term, the Bureau of Meteorology predicts that—under the influence of climate change—reductions in rainfall are likely to continue in the decades to come in the southeast and southwest of the continent (BoM 2010b). Recent pressures on potable water supplies, and associated conservation measures, have resulted in a dramatic change in water consumption in many of our cities, as illustrated in Figure 22.

Figure 22 Changes in personal water use in the 12 months to 2007–08

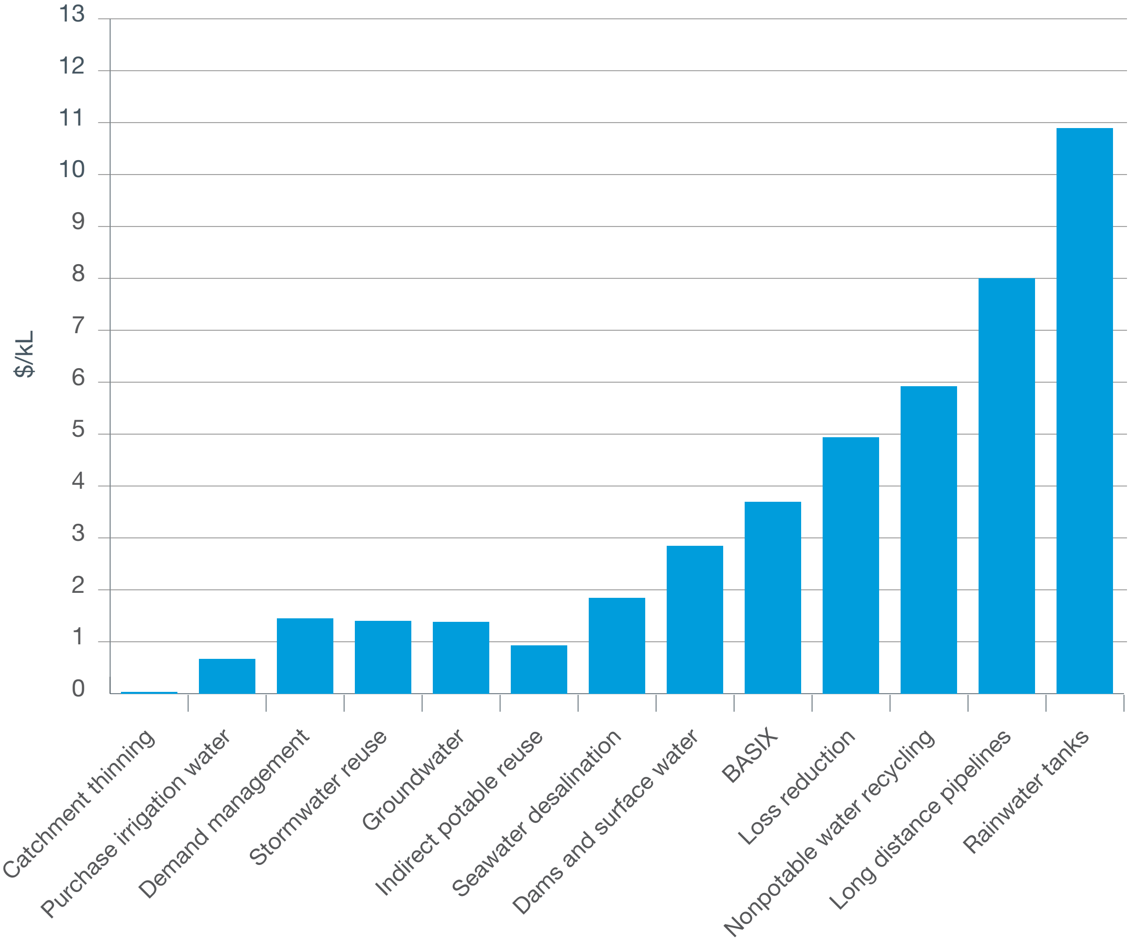


Source: ABS (2009b)

However, the consumption of water by households and industries in cities has to be considered in the context of other sectors in the economy. Irrigated agriculture, for instance, is by far the highest user of water in the nation (ABS 2006a).

Resolving issues of water security can be expensive if potential options are not considered (Figure 23). In response to population growth and long-term changing climatic conditions, the urban water industry has recently made unprecedented investment in infrastructure to provide our cities and towns with a more diversified and secure portfolio of water supply sources. Total reported capital expenditure by the water industry (mostly by major (100 000+ customers) and bulk utilities) increased from $4.5 billion in 2007–08 to $8.1 billion in 2008–09; representing an 80% increase (National Water Commission 2010). Investments include the development of new water sources that are less climate dependent (predominantly desalination and recycling), and other major projects (including pipelines).

Figure 23 Levelised costs of alternative water sources by selected cities



Source: Marsden Jacob Associates (2007)

Note: Marsden Jacob Analysis based on water supply plans for Sydney, Adelaide, Perth and Newcastle. The lower bound of indirect potable reuse estimate is based on Toowoomba. Comparable costings for Melbourne are not available and no costings are available for Queensland.

5.2 Energy

According to the International Energy Agency (2009) Australia is one of the highest consumers of energy per capita in the world, with aggregate energy consumption having steadily increased over the past three decades (Shultz 2009).

The trend of increasing energy use presents a major challenge for long-term sustainability. Most energy used in Australia is from non-renewable sources, including coal, petroleum products and natural gas. This poses at least two major threats: first, a threat to energy security from a heavy reliance on finite and depleting resources; and second, a broader climate change threat from a heavy reliance on sources that are major contributors to carbon emissions.

The National Energy Security Assessment (Department of Resources Energy and Tourism 2009) found Australia's level of energy security has decreased in the face of increasing energy prices, threats to international energy markets (such as global financial shocks and growing resources nationalism), and changes in supply and demand, particularly those relating to crude oil production.

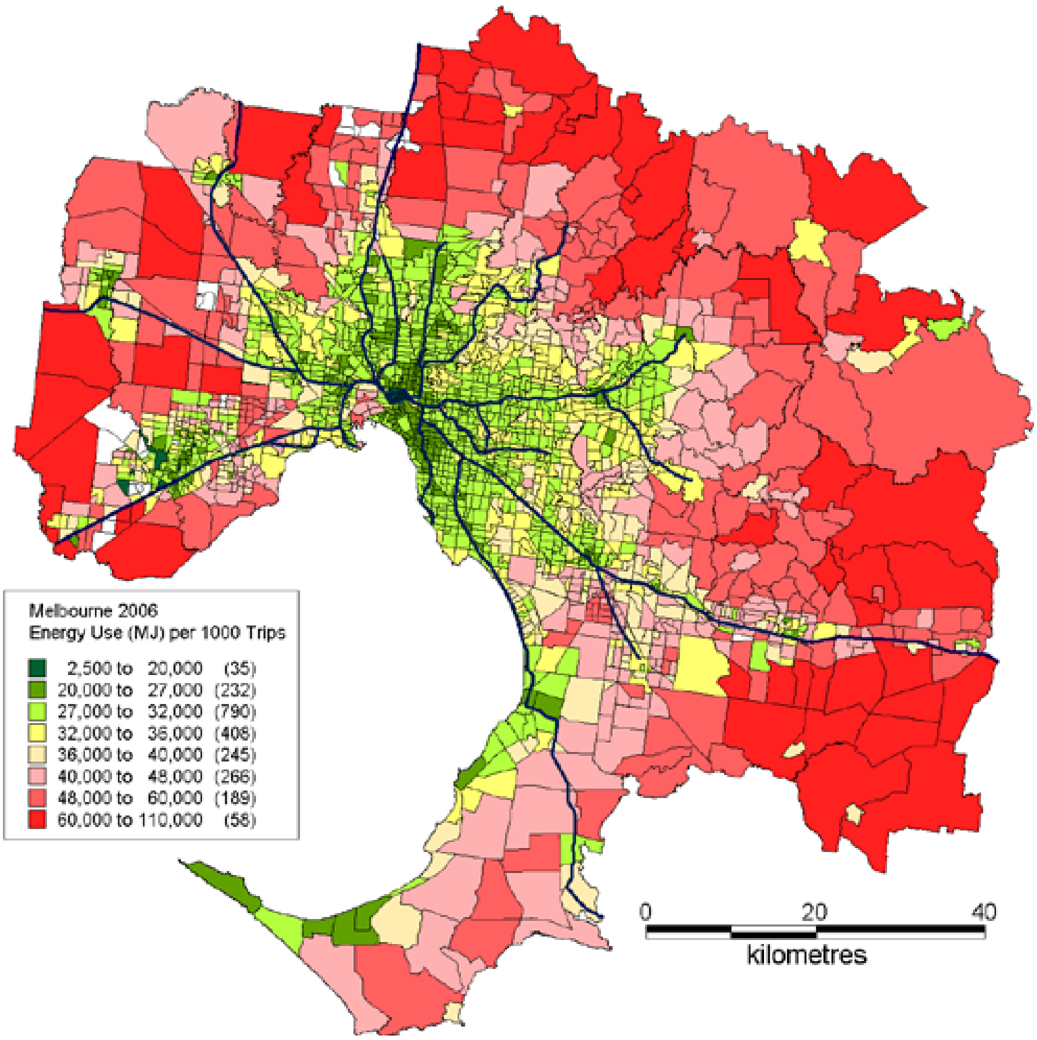
Australia's cities are significant end users of energy and because cities can harness economies of scale in achieving better efficiency and diversifying fuel types and sources, there are significant opportunities in cities to improving energy security and reducing the rate of climate change.

A particularly significant opportunity relates to the dependency on motor vehicles, which accounts for around 80% of transport use in Australian cities (ABS 2009c). Passenger motor vehicle use is estimated to be responsible for around 60% of petroleum-based energy consumed by the transport sector, with the remainder used for the distribution of goods and services (Sandu & Petchy 2009).

Alternative urban development forms can significantly influence transport energy use (Figure 23) and greenhouse gas emissions. Modelling of land-use scenarios for Melbourne undertaken by the Victorian Government (Whiteman et al. 2009), illustrate the long-term benefits of a compact inner city and a small number of larger polycentric outer cities in achieving urban sustainability outcomes. Better integrated land-use and infrastructure planning, that focuses on major transport hubs has the potential to reduce the overall travel task and, hence, energy demand and greenhouse gas emissions.

The benefits of urban inner-city redevelopment are also reinforced by a recent Australian study examining the costs of urban sprawl (Trubka et al. 2010a). This study illustrates the significant infrastructure and transportation cost savings that can be made by focusing investment on redevelopment rather than in outer fringe development. It suggests that 1000 inner-city dwellings can save approximately '$86 million up-front for infrastructure and $250 million for annualised transportation costs over 50 years' (Trubka et al. 2010a).

Figure 24 Transport energy trip efficiency—Melbourne (2006)



Source: Whiteman et al. (2009)

Note: Greenhouse gas emissions per 1000 trips has a similar footprint.

Residential and commercial buildings are responsible for approximately 20% of Australia's total energy consumption (Prime Minister's Task Group on Energy Efficiency, 2010). Residential energy use alone is growing at a rate of 2.2% per annum, attributed to population increase, greater ownership of appliances and information technology equipment, and increases in the average size of homes (Australian Bureau of Agriculture and Resource Economics 2009).

There is scope to improve the energy efficiency of the building sector through, for example, reforming building standards, retrofitting existing buildings, and regulating higher energy efficiency standards for appliances.

Australia also has access to a range of high-quality renewable energy resources. At present, this accounts for around 5% of total energy consumption but the Australian Government's new Renewable Energy Target will see this figure rise to 20% by 2020 (Office of the Renewable Energy Regulator 2010). This will be a significant contribution, both to securing energy and reducing the rate of climate change.

5.3 Waste

Australian cities are not only vast consumers of natural resources, they are also producers of waste.

The main solid waste streams include commercial and industrial waste, construction and demolition waste and solid municipal waste. Australians produce solid waste at a high rate relative to other OECD countries (Productivity Commission 2006). While national recycling rates have increased, both total volume and per person generation of waste have also increased.

For our cities to become more sustainable, the linear flow of resource inputs into cities and the production of waste needs to be disrupted. This can be achieved by closing material cycles by, for example, treating and reusing wastewater, recycling materials such as glass, plastics, paper and metals, composting organic waste, and using materials produced as waste by one industry process as an input into another (Newman and Jennings 2008).

Air pollution is also a form of waste. The National Environment Protection Measure for Ambient Air Quality (Air NEPM) sets national standards for the six key air pollutants to which most Australians are exposed: carbon monoxide, ozone, sulphur dioxide, nitrogen dioxide, lead and particles. The standards are legally binding on each level of government. State and Territory governments have passed complementary legislation and developed strategies aimed at sources of air pollution not covered in Air NEPM, targeting residential and industry sectors.

Whilst air quality standards are still exceeded on occasion in some cities, particularly with fine particles and ozone levels, Australian cities have low levels of air pollution when compared with cities of similar sizes overseas. However, air pollution from all sources remains a significant concern for urban communities.

The economic cost of premature mortality associated with motor vehicle pollution was estimated to amount up to $2.6 billion in 2005 and the economic cost of morbidity up to $1.2 billion (BTRE 2005). The combined economic cost of motor vehicle-related mortality and morbidity over the same period was estimated to be between $1.6 billion and $3.8 billion (BTRE 2005).

Australia's largest cities are increasingly prone to photochemical smog and particulates from internal combustion engines (cars, trucks and motorbikes), and industry. Motor vehicle transport is a major emitter of air pollutants in urban Australia.

Addressing issues of urban air quality and pollution will require further improvements to emissions standards in motor vehicles and higher fuel quality, as well as encouraging a passenger shift to lower polluting forms of transport such as urban rail and active travel (walking, cycling and using public transport).

5.4 Climate change

> *Climate change is a diabolical policy problem. It is harder than any other issue of high importance that has come before our polity in living memory. Climate change presents a new kind of challenge. It is uncertain in its form and extent, rather than drawn in clear lines. It is insidious rather than (as yet) directly confrontational. It is long term rather than immediate, in both its impacts and its remedies.*
>
> *The Garnaut Climate Change Review 2008, page xviii*

5.4.1 Greenhouse gas emissions

Australia contributes approximately 1.5% of the total global greenhouse gas emissions, per capita emissions (including from land use, land-use change and forestry) in 2008 at 27.4 tonnes of carbon dioxide equivalent (CO2-e). This is the highest of all member countries of the OECD and more than four times higher than the world average (Department of Climate Change and Energy Efficiency (DCCEE 2010a).

Since 1990, national greenhouse gas emissions in Australia have also continued to grow with a net increase of approximately 5% (DCCEE 2010b). This has largely been contained by the land use, land-use change and forestry sector which has shown a strong decline of 79.8% between 1990 and 2008; largely as a result of reduced emissions from deforestation. If the land use, land-use change and forestry sector is excluded from the calculations, the figures for Australia's net growth in emissions jumps to more than 30%.

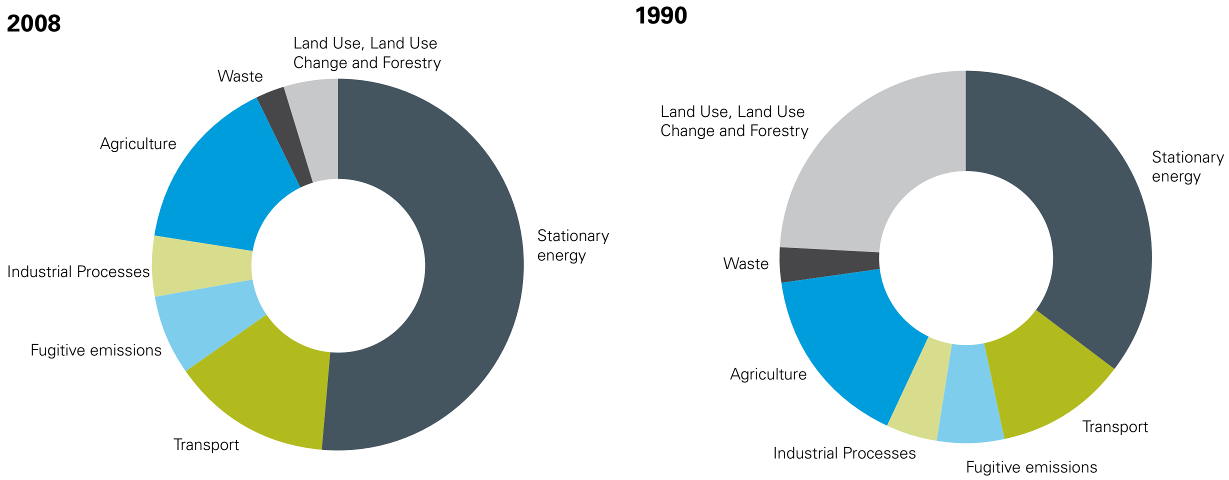
The Australian Government is working towards the introduction of a carbon price to lower emissions.

Within our cities, stationary energy and transport are the two key sectors representing the highest proportion of emissions, approximately 50% and 14% respectively in 2008 (Figure 25). Emissions in both sectors, but particularly stationary energy, have grown substantially since 1990 and, as such, provide the greatest opportunity for reducing greenhouse gas emissions.

Most Capital City Councils have adopted greenhouse gas emission reduction targets, and have been active in taking voluntary measures to mitigate climate change, including residential and commercial building energy efficiency retrofits, street lighting efficiencies, transport improvements, use and promotion of the generation of renewable energy, and encouragement of greater employment and residential densities. A focus on urban redevelopment, rather than outer fringe development, has been estimated to have the potential to save approximately 4.4 tonnes of greenhouse gas emissions per household (Trubka et al. 2010b).

However, much more still needs to be done within communities, business and governments at all levels to mitigate climate change impacts.

Figure 25 Change in Australia's CO_2-e emissions 1990–2008



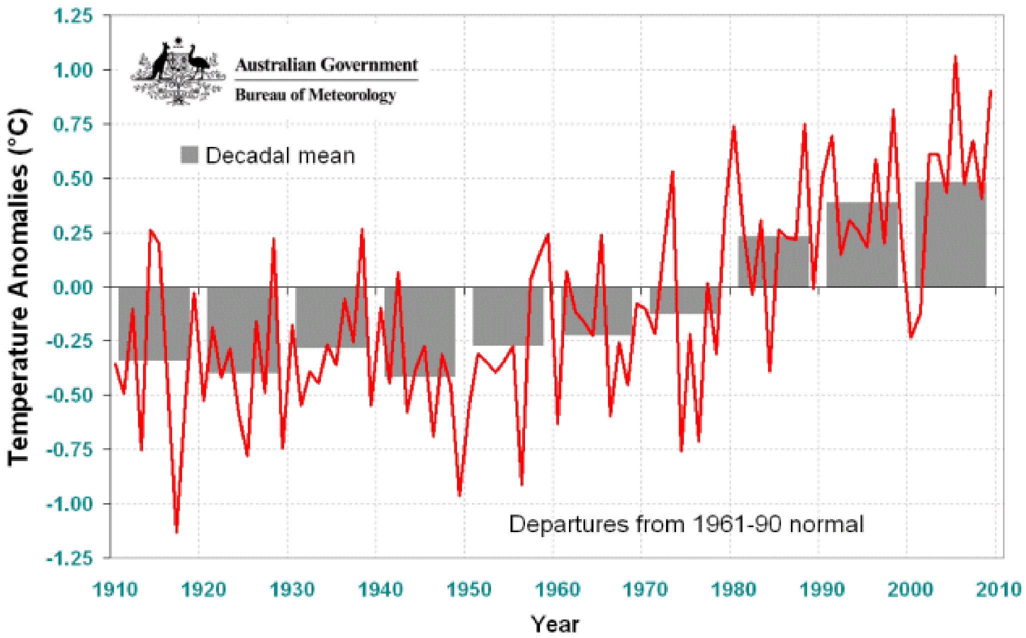
Source: DCCEE (2010b)

5.4.2 Changes in climatic conditions

Consistent with the trend of increasing greenhouse gas emissions, Australia's annual mean temperatures are also rising, as illustrated in Figure 26.

Climate change is already projected to alter the frequency, intensity and/or geographical distribution of various extreme weather events in Australia, including extreme rainfall, cyclonic activity and bushfires. Of particular concern is the disproportionate effect that a small change in the mean temperature can have.

Figure 26 Annual and decadal mean temperature anomalies for Australia (compared with 1961–90 average)

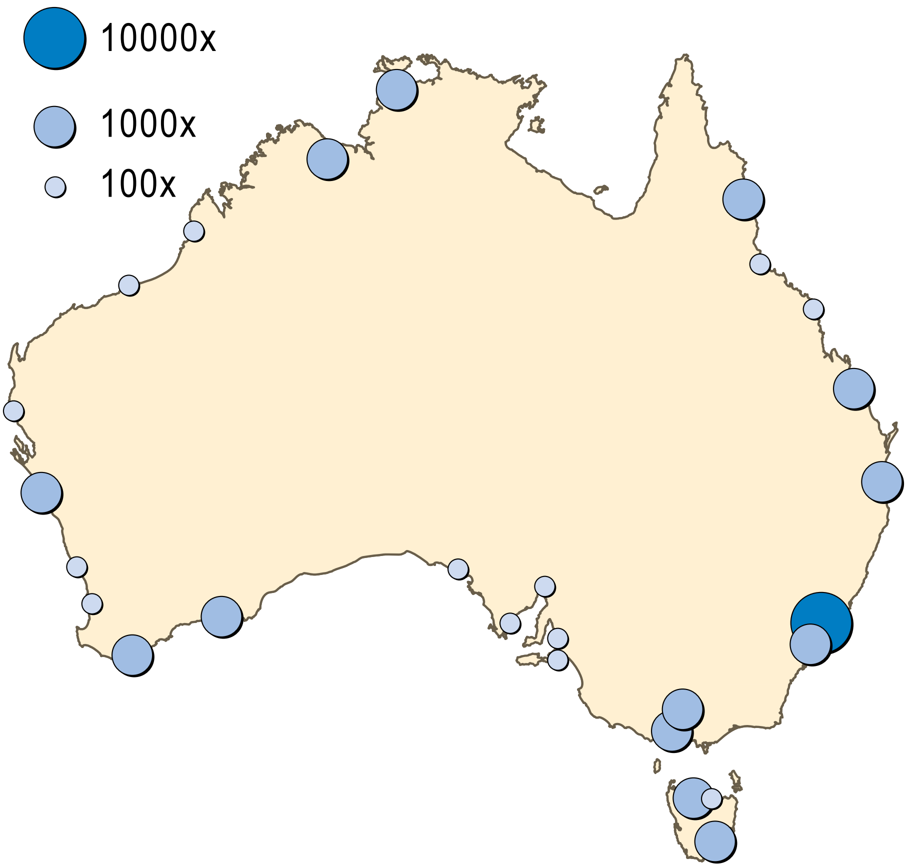


Source: Bureau of Meterology (2010c)

With 85% of the Australian population residing within 50 km of the Australian coastline (DCC 2009b) and with most of the nation's major cities also located in this zone, the natural and built environments and the communities they support are at particular risk of sea level rise, storm surge and, in some regions, cyclonic activity.

Figure 27 shows the estimated frequency of extreme sea level events occurring and identifies all major cities potentially affected. In the case of a 0.5 m sea level rise, events which occur once every few years are more likely to occur once every few days by 2100 (Antarctic Climate and Ecosystems Cooperative Research Centre (ACECRC) 2008). However, regional variation will mean that areas surrounding Sydney and Brisbane are more likely to experience larger increases in the frequency of extremes than Adelaide or Perth.

Figure 27 Estimated increases in the frequency of extreme sea level events under a sea level rise of 0.5m by 2100



Source: Antarctic Climate and Ecosystems Cooperative Research Centre (2008)

Given that global sea levels are projected to rise by as much as 1.1 metres by 2100 (DCC 2009b), the resulting inundation from these extreme events presents significant challenges for the planning and provision of infrastructure within Australian cities. Modelling undertaken for the DCCEE in preparing *'Climate Change Risks to Australia's Coast: A First Pass National Assessment'* (DCC 2009b) provides some illustration of this risk. The extent of inundation projected for the Gold Coast and Darwin, for example, will affect local communities, infrastructure assets and natural ecosystems.

Significant economic infrastructure located in low-lying areas is also vulnerable to inundation, as illustrated by modelling undertaken of some major Australian city airports. Such vulnerability is likely to result in disruption to airport operations and may have adverse consequences on local and regional economies as well as overall national productivity. Sustainable management of these key assets is fundamental for an effective climate change response.

Inland cites in Australia are also vulnerable to other specific risks from climate change. Modelling of the bushfire regime in the Australian Capital Territory (Cary 2002), for example, illustrates an increase in the size of the geographic region affected by bushfires and a reduction in the average interval between fires. This reflects scientific consensus that bushfire intensity will increase as average and extreme temperatures increase. There is already evidence of this shift, particularly in southern and eastern Australia.

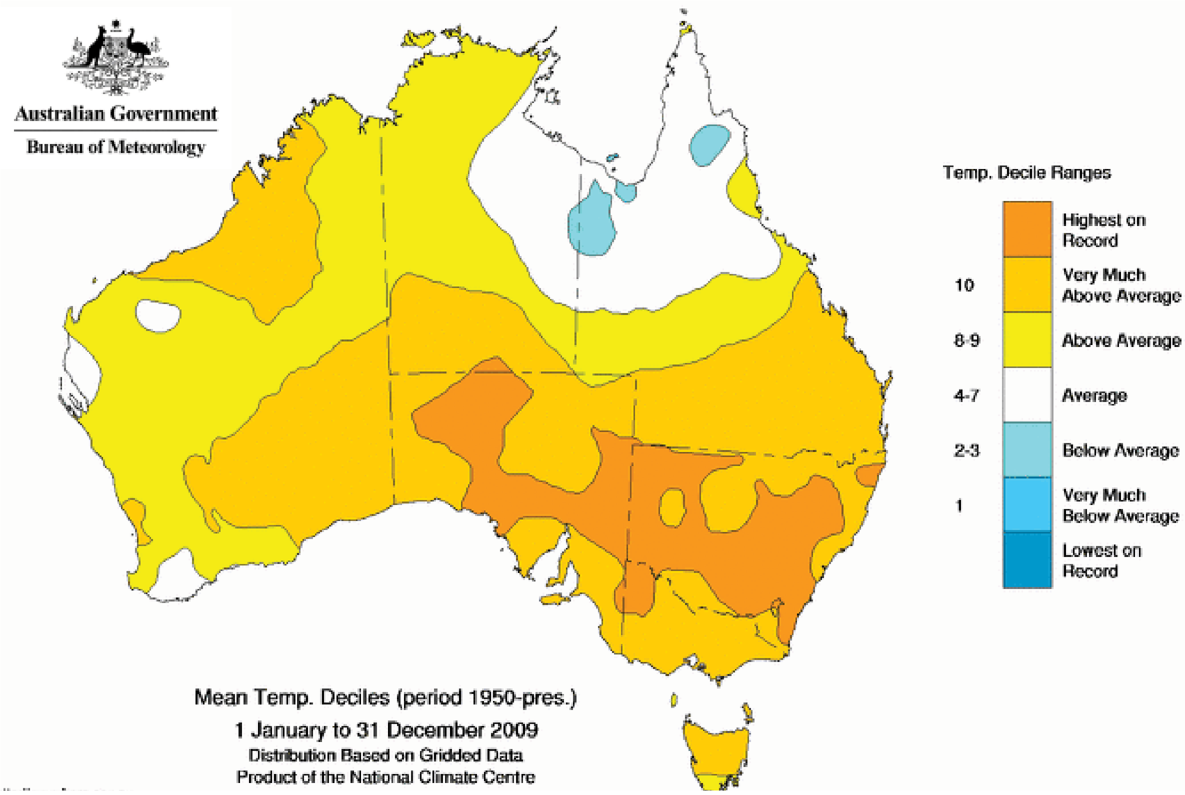
It is not, however, the single definable impact that is of greatest concern. Typically, regions within our major cities will be affected by cumulative or varying impacts across the landscape. For example, while inner-city areas may be more vulnerable to extreme rainfall and runoff as a result of a higher proportion of impervious surfaces; for outer areas, bushfire risk is typically of greater concern.

A vulnerability study undertaken by the Sydney Coastal Councils Group (Preston et al. 2008) is a good illustration of this and also of the need for decision makers in jurisdictions to be aware of the complexities and interconnected issues associated with planning for climate change. Although overall vulnerability provides a useful illustration for decision makers, individual jurisdictions will often be faced with competing priorities when dealing with climate change impacts. According to the Sydney Coastal Councils Group study, Rockdale, Botany Bay and North Sydney, for example, all have vulnerabilities associated with extreme heat, extreme rain and ecosystems that need to be balanced and sustainably managed.

Whilst it is not yet possible to attribute particular individual events to climate change, a number of recent events highlight the consequences of failing to prepare for changing climate—consequences that are likely to become more common. In early 2009, for example, Victoria experienced a record breaking heatwave and devastating bushfires, as Melbourne recorded a new temperature maximum of 46.4°C and other records were set across the State (Bureau of Meteorology 2010c). Transport infrastructure was placed under significant pressure from buckling railway tracks due to extreme heat and the security of Victoria's power supply was jeopardised. Millions of residents experienced power failures due to the combined impacts of bushfires and the shutdown of the Basslink Interconnector, after its design parameters for temperature were exceeded.

Human health impacts were also reported, with an additional 374 heat-stress related deaths occurring (primarily within the age group 75 years and over) over what was expected based on previous year estimates (Victorian Government DHS 2009). Increased heat stress resulting from extreme temperatures places considerable pressure on health and medical systems (Figure 28). An ageing population and increasing urbanisation will likely exacerbate this problem.

Figure 28 Mean temperatures for 2009 compared against historical temperature records



Source: Bureau of Meteorology 2010c

Infrastructure is also vulnerable to climate change, with projections indicating significant economic implications due to potentially reduced output and consumption of resources and services. Economic modelling for the Garnaut Climate Change Review (2008) suggests that climate change impacts on infrastructure could reduce Australia's gross national product by 1.23% by 2050 and by 2.42% by 2100, the highest potential economic impact of any impact area (Garnaut 2008b).

Impacts on infrastructure are likely to be associated with structural damage particularly through increased loadings from a climate impact (for example, increased wind gusts resulting from intense cyclonic activity, storm surge or increased temperatures) or material degradation. Concrete degradation, for example, is likely to be exacerbated by rising CO_2 levels, air temperatures and other factors. One study projects an increase in the likelihood and extent of corrosion damage of 720% under the worse case emissions scenario and the probability of complete failure being 18% (Peng and Stewart 2008). These issues will present ongoing challenges for asset management and maintenance processes.

For these reasons, asset and emergency management are also fundamental considerations that should be embedded in urban planning practices. The planning systems should seek to reduce the exposure of communities to climate change impacts and adopt technologies to reduce long-term asset management costs.

The impact of climate change on residential and commercial buildings is described by Garnaut (2008a) as being medium to high risk. A study of residential buildings in south-east Queensland undertaken by the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Climate Adaptation National Research Flagship, highlights the importance of improving planning and building regulation to take account of climate impacts.

Estimates produced indicate that a tightening of planning regulations today could reduce the cost of damage of a 1 in 100 year storm surge event in 2070 from $3.9 billion in net present value terms to $1.5 billion (Table 4). Additional reductions in damage costs could be expected if tighter planning regulations were also combined with stronger action to retrofit properties.

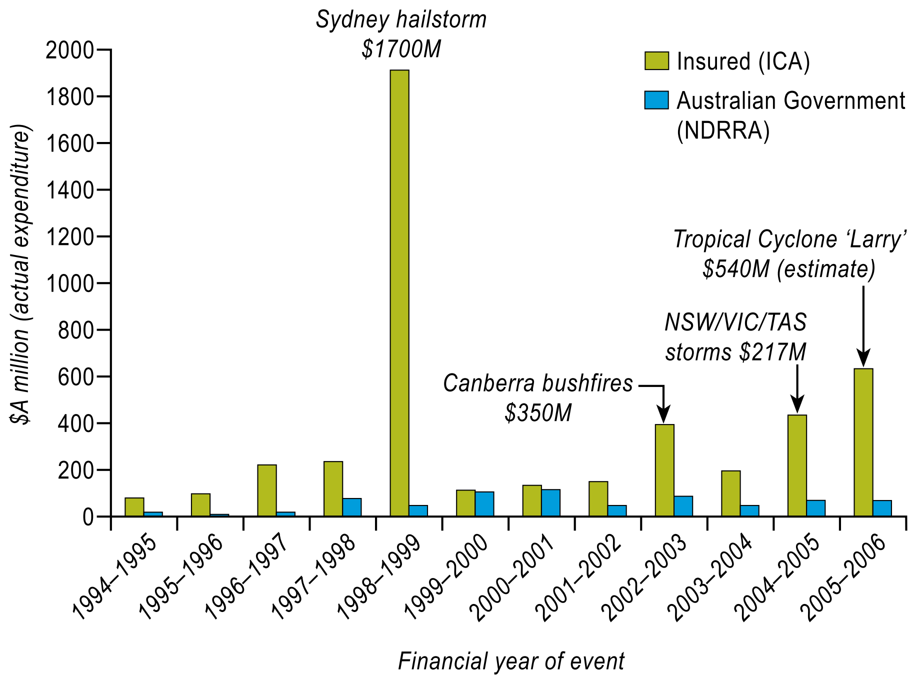
Table 4 Adapting to storm surge in south-east Queensland—estimated costs and benefits for a 1:100 year storm tide event in 2070

Adaptation option	Population at risk 2070	Residential buildings at risk 2070	Total cost of impact 2070
Business as usual (no changes to planning/ building regulations and assuming same rate of growth)	772 296	121 367	≈$3.9 billion
Planning regulations tightened to prevent further at risk development (no changes to building regulations)	273 000	47 900	≈$1.5 billion
Planning regulations tightened and measures to adapt existing housing stock (to maintain existing level of risk)	226 500	35 200	≈$1.1 billion

Source: Wang et al. (2010)

As illustrated in Figure 29 the cost of past natural disasters represents significant risks to the Australian economy. Anticipation of increased property damage as a result of climate change is expected to be reflected in higher insurance premiums and maintenance costs for both private and public property.

Figure 29 Costs of natural disasters in Australia 1994 TO 2006



Source: Middelmann, M. H. (Editor) (2007) *Natural Hazards in Australia: Identifying Risk Analysis Requirements*. Geoscience Australia, Canberra.

The insurance industry has a crucial role to play in adaptation and mitigation. A key tool available to insurers is the use of differentiated premium pricing to encourage actions which reduce risk. Accurate pricing of risk is fundamental to creating the right market signals and will make a significant contribution in discouraging 'risky' development and promoting more resilient construction.

Insurers have wide experience in employing such practices in household fire, burglary and auto insurance. As an example, pay-as-you-drive insurance products provide discounts of up to 50% for policyholders who drive less than the average driver. By offering financial incentives to the general community based on car usage, this type of insurance positively reinforces less resource-intensive behaviour and delivers positive outcomes against a number of other objectives important within our major urban areas, including reduced road congestion and greenhouse gas emissions.

Early planning and cost-effective mitigation and adaptation responses have the potential to deliver productivity benefits, reduce vulnerability and lessen the economic, social and environment cost burden on future generations.

5.5 Land consumption and conversion

Some of Australia's most productive and environmentally significant land is on the urban fringe of our major cities. These areas are often used for activities such as poultry farming, aquaculture and agriculture (including grazing) as well as for vineyards, turf farms and hydroponics—they provide many essential goods for our cities and regions. Ecologically significant land within these 'peri-urban' areas also provides valuable habitat for plant and animal species and recreational opportunities for the general population.

However, Australia's peri-urban areas often face competing pressures and decision makers are required to balance competing priorities as residential or other forms of land use encroach on valuable arable land. Whilst urban development may be seen as a more valuable higher-order land use, the economic implications of such urbanisation are significant. Historically, peri-urban areas have contributed to the total value of the national agricultural industry by an estimated 25%, despite comprising less than 3% of Australia's agricultural land. (Houston 2005).

Inland Australia faces significant constraints in providing quality arable land in the absence of the productive areas surrounding our metropolitan regions due to water availability and poor accessibility to regional and local markets.

Food security is a key concern in this regard. Although Australia has often faced weather variability and sometimes harsh conditions for food production, the country continues to maintain a reliable food supply for its cities and regions. With the projected impacts of climate change, however, and the growth of our urban regions consuming more agricultural land, food production practices and availability may be adversely affected.