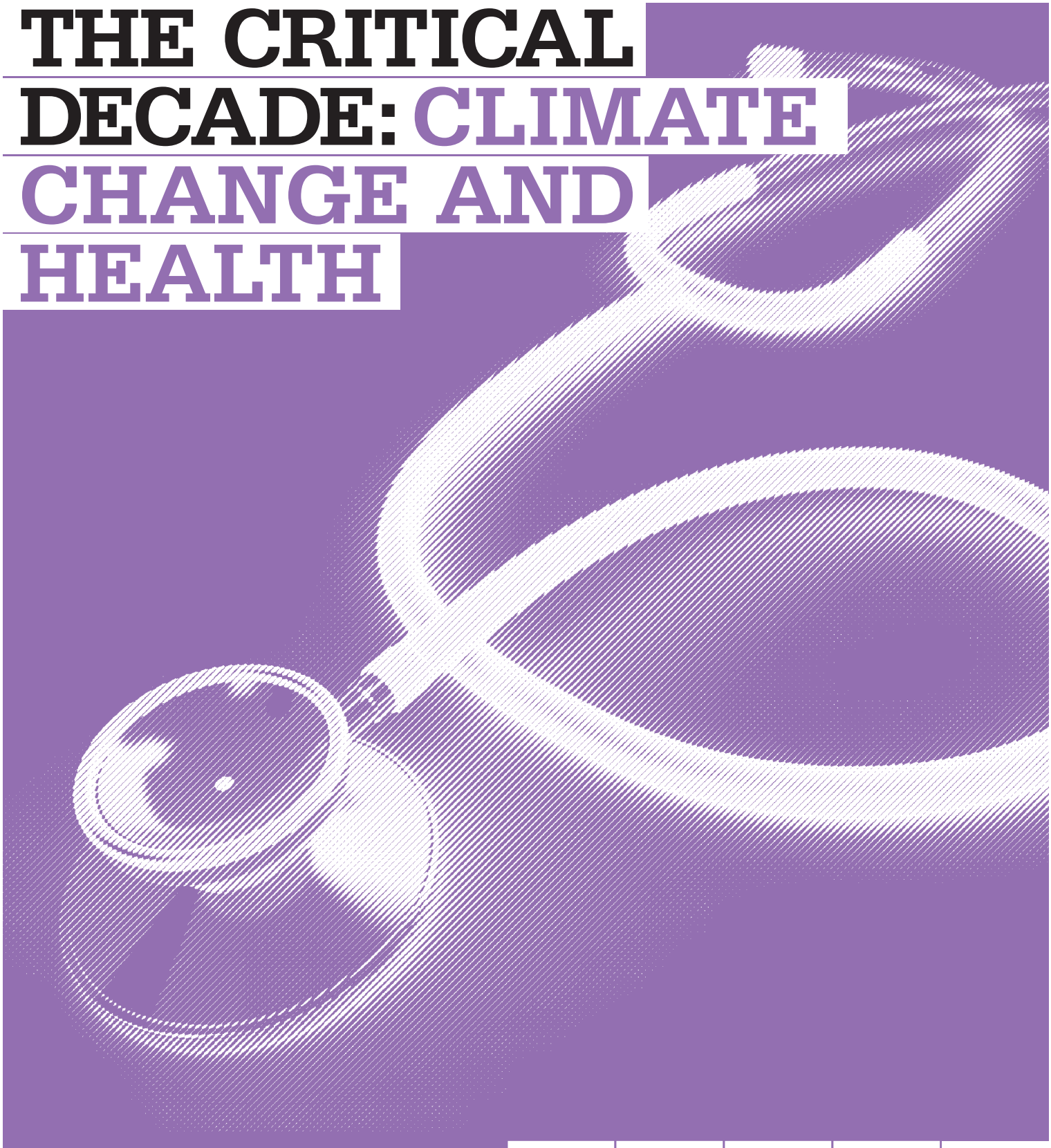
CLIMATE COMMISSION

THE CRITICAL DECADE: CLIMATE CHANGE AND HEALTH



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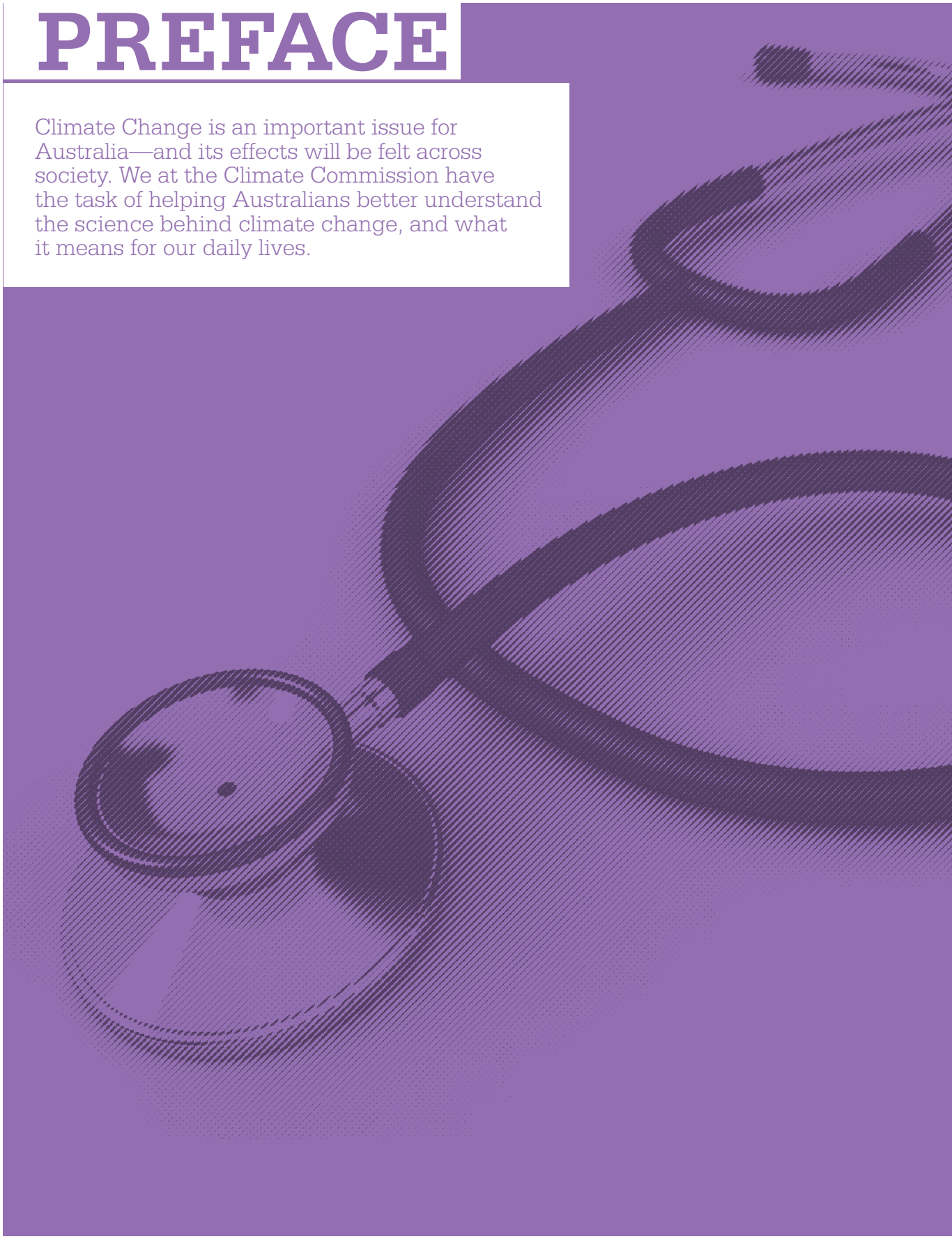
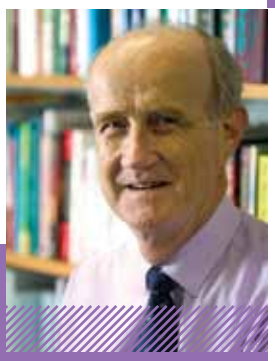
PREFACE

Climate Change is an important issue for Australia—and its effects will be felt across society. We at the Climate Commission have the task of helping Australians better understand the science behind climate change, and what it means for our daily lives.





The Climate Commission set out the clear scientific evidence that humans are the main cause of climate change in its 2011 report *The Critical Decade: Climate science, risks and responses*. In this special report, *The Critical Decade: Climate change and health*, we examine the effects that climate change has on human health and wellbeing. Our aim is to provide up-to-date information on the challenges to human health in a changing climate and how we can manage them. The information further reinforces the case that Australia, along with other countries, must take action to slow, and then stop, the process of human-induced climate change.

It is beyond reasonable doubt that climate change resulting from human activities—carbon dioxide released into the atmosphere from the burning of fossil fuels along with deforestation and other land uses—is triggering significant changes in the biological world. Research from Australia and around the world shows that recent climatic changes have resulted in shifting animal and plant distributions, and changes in the timing of many species' life cycles. Some animal populations are suffering from declining food supplies, and several species are already thought to have become extinct as a result of climatic stress.

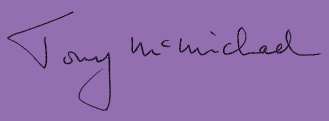
The human species is also increasingly exposed to climate change and we likewise face significant risks to our wellbeing, health and survival. Our technologies, knowledge and culture can provide some protection, but only up to a limit. Beyond that the risks to health will rise—this includes direct physical risks, for example from extreme weather events and heatwaves, and many other less-direct risks, for example from increases in some infectious diseases and reduced access to fresh water.

Evidence about these consequences is growing, although significant gaps in our knowledge of potential health risks remain. This information is critical for making the right decisions about climate change action, including the type and scale of actions we take to reduce our greenhouse gas emissions and limit climate change, and how we adapt to changes we cannot avoid.

The information contained in this report is based on scientific literature from Australia and around the world. A list of references is included at the back for those who would like further information about a particular subject.

We would like to thank our colleagues at the Climate Commission and on the Commission's Science Advisory Panel, as well as the many medical professionals we have consulted—in particular colleagues from the National Rural Health Alliance and the Cycling Promotion Fund, and Professor Tord Kjellstrom, Dr Paul Beggs, Dr Donna Green, Dr Lyndall Strazdins and Associate Professor Hilary Bambrick—for their advice and reviews of this report.

Lesley Hughes
Australian Climate Commission



Tony McMichael
Science Advisory Panel

01 INTRODUCTION

"CLIMATE CHANGE IS THE BIGGEST GLOBAL HEALTH THREAT OF THE 21ST CENTURY." (COSTELLO ET AL. 2009)

1.1 Health matters to Australians

Australia is a healthy nation and our health continues to improve, comparing well with other countries (AIHW, 2010a). Our life expectancy at birth continues to rise and is among the highest in the world—almost 84 years for women and 79 years for men (AIHW, 2010a). This good health provides a foundation for our way of life, our society and our economy.

AUSTRALIA IS A HEALTHY COUNTRY. BUT WE FACE A RANGE OF CHALLENGES, INCLUDING AN AGEING POPULATION AND HIGH RATES OF OBESITY AND ASTHMA.

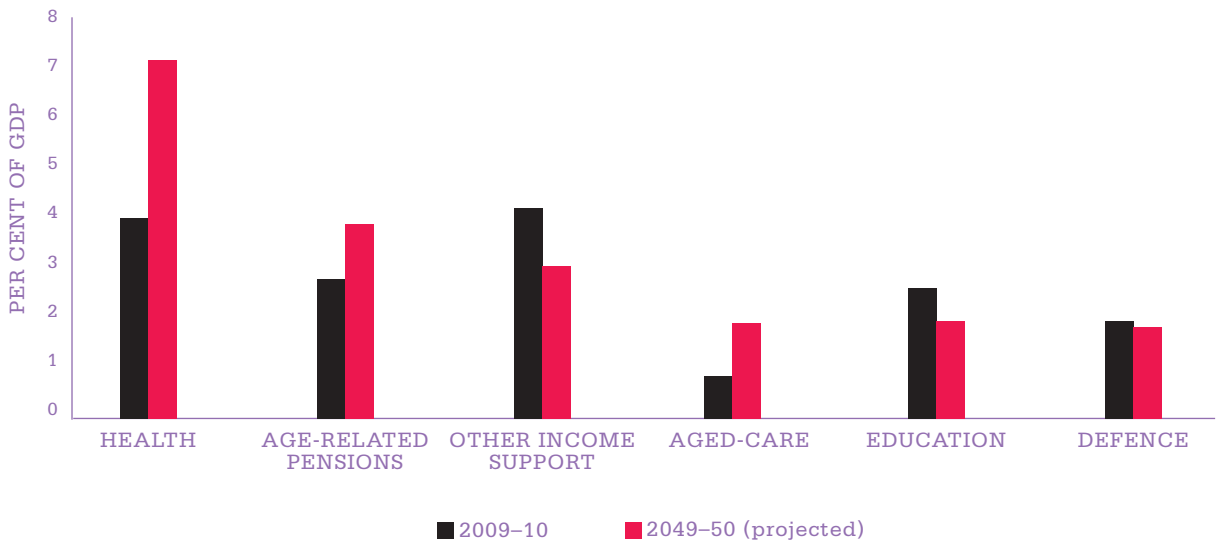
But our health isn't perfect. Cancer is Australia's leading health problem, followed by heart disease, disorders such as dementia and vision loss and mental disorders; Type 2 diabetes is rapidly on the rise and expected to become the leading health problem by 2023 (AIHW, 2010a). In addition, around one in 10 Australians suffer from asthma (Australian Centre for Asthma Monitoring, 2011).

Australia is also ageing. In recent decades, the proportion of the population aged 65 years and over has risen considerably, and about 800,000 Australians (3.7% of the total population) are now aged 80 years or over (AIHW, 2010a). Even if older people are healthier than in previous generations, the ageing trend means that, over time, there will be more illness in the population, placing extra demand on health services (AIHW, 2010a).

The collective investment in our health, as a percentage of gross domestic product (GDP), has increased steadily over the last decade. Federal Government spending is expected to continue to increase (see figure 1). In 2008–09 we spent over $5,000 per Australian, and governments funded almost 70% of Australia's health expenditure (AIHW, 2010b). This means that while not everyone needs health care, the costs are borne by all tax payers.

As the climate changes, many of those health burdens and costs are likely to rise.

Figure 1: Federal Government spending on health compared to other sectors, as a percentage of GDP.



Source: Modified from Commonwealth of Australia, 2010

1.2 Our health depends on our climate

The sustained good health of any population depends on reliable access to basic resources, such as food, water, shelter and energy. Climate is one of the main factors that influence these foundations.

OUR HEALTH IS DEPENDENT ON THE HEALTH OF THE ENVIRONMENT THAT SUPPORTS US. WE NEED CLEAN AIR, CLEAN WATER AND HEALTHY SOIL.

For example, the state of the climate affects almost every aspect of food production, from the plants and animals used, to the areas that are farmed, to the price of food in the supermarket. Droughts and floods can affect the availability and affordability of foods that make up a healthy diet. Without a healthy diet, humans are susceptible to a range of nutrition-related diseases like obesity, diabetes, heart attack and bowel cancer. Changes in temperature, rainfall and humidity can also affect the distribution and impact of food-borne infectious diseases, such as salmonella.

CLIMATE CHANGE POSES REAL AND SIGNIFICANT THREATS TO THE HEALTH OF AUSTRALIANS, NOW AND INTO THE FUTURE.

Australians are all too familiar with serious environmental impacts on health. We have experienced heatwaves leading to exhaustion and heart failure; bushfire smoke inducing asthma attacks; and post-traumatic stress from natural disasters such as droughts, floods and cyclones. In the worst cases, these events have led to deaths and cost billions of dollars in damages.

Climate change mitigation

Mitigation means a reduction in the release of greenhouse gases into the atmosphere—for example, through reducing our reliance on emissions-intensive sources of fuel and increasing the use of renewable electricity like wind or solar—or the removal of greenhouse gases from the atmosphere through the use of 'sinks' such as forests. The phrase 'unmitigated climate change' is often used to describe the impacts of climate change with no mitigation activity.

Climate change adaptation

Adaptation is action taken to adjust to the unavoidable consequences of climate change. This includes taking steps to reduce our vulnerability to potentially damaging impacts. For example, in the face of more frequent and intense bushfires, building regulations may need to change to improve fire resistance and even prevent new buildings in more fire-prone areas. Some adaptation occurs spontaneously, as when populations adjust physiologically over time (for example, decades) to living at higher temperatures.

1.3 Climate change affects our health in many ways

The effects of climate change—including rising temperatures, changes to rainfall patterns, sea-level rise and more intense weather events—have serious consequences for our health. As climate change continues, scientists anticipate that these health impacts will get worse.

The full range of risks to human health from climate change is mostly foreseeable from our existing knowledge about how natural variations in climate and weather, and the level of human-induced climate change already experienced, have affected rates of illness, disease and death.

Climate change affects our health in a number of ways, some of which are direct and others that flow on from other changes. Direct risks include:

- more frequent and intense heat waves resulting in more heart attacks, strokes, accidents, heat exhaustion and death;
- more frequent or intense extreme weather events—particularly storms, floods and cyclones— resulting in more injuries, deaths and post-traumatic stress; and
- more fires increasing the number of cases of smoke-induced asthma attacks, burns and death.

Risks of flow-on effects, although more complex and harder to predict in timing and extent, include:

- more exposure to some air pollutants and air-borne allergens, such as pollens and moulds, exacerbating respiratory illnesses, such as asthma, hay fever and longer-term heart and lung diseases;
- changed rainfall patterns—increases in rainfall in some regions and decreases in others—and hotter temperatures increasing the spread and activity of disease-transmitting mosquitoes and increasing the chances of food-borne infections;
- warming and drying in some regions leading to a higher prevalence of mental health problems and lower morale in rural communities;
- changed rainfall patterns and hotter temperatures leading to reduced supply and increased prices of some foods, resulting in reduced nutrition;
- changes, such as rising sea levels, hotter conditions and changed rainfall patterns, causing displacement of people from within and outside of Australia and community-wide negative effects on social and economic wellbeing; and
- increased pressure on health systems and emergency responses delaying effective delivery of health care.

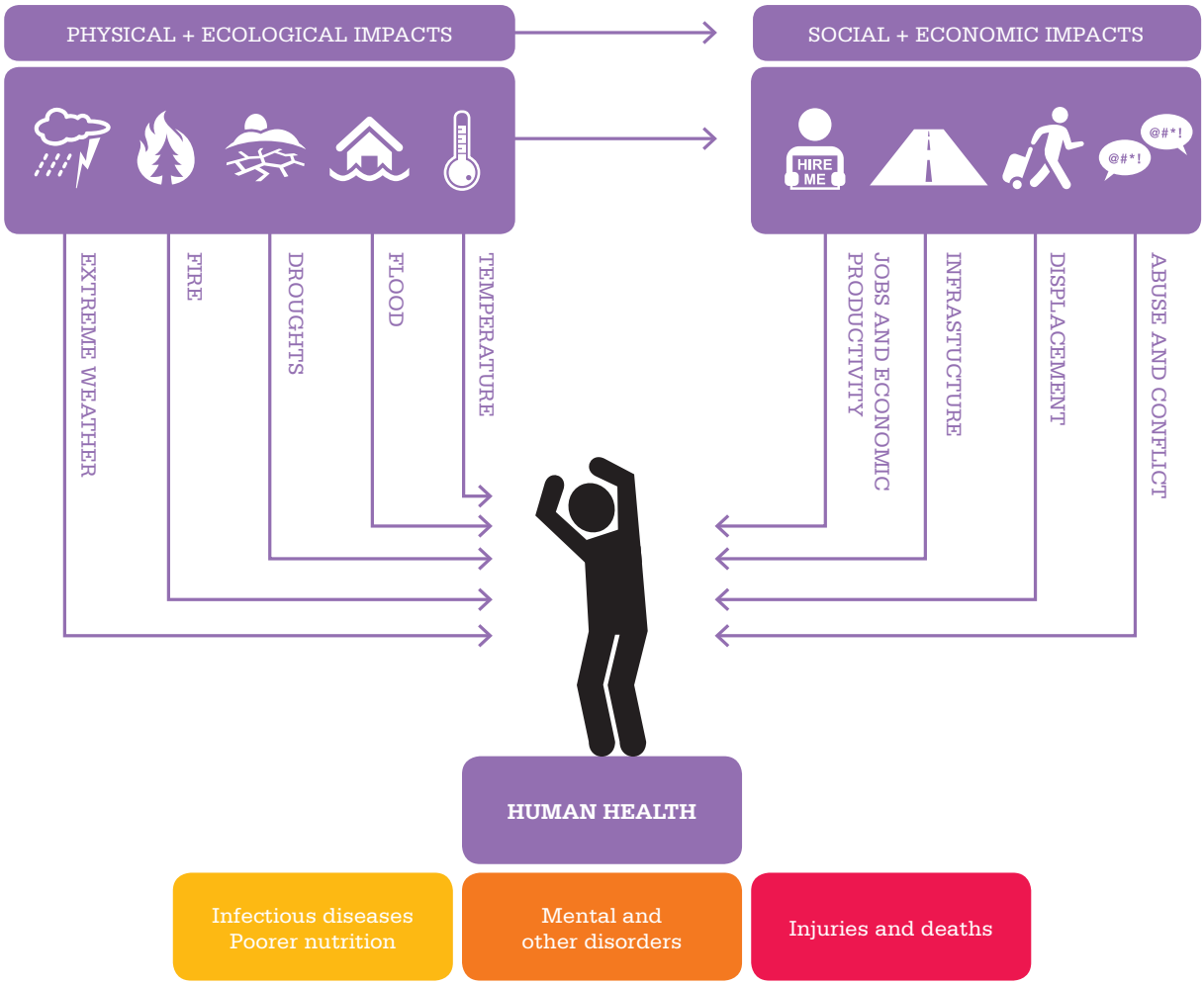
While climate change has potentially wide-ranging effects, many other non-climatic factors contribute to their severity. As above, this is evident from our existing experiences with how various systems and sectors respond to environmental change. For example, as noted in *The Critical Decade: Climate science, risks and responses*, the severity of the 2010–11 Queensland floods was exacerbated by several factors that were not related to climate. These included land cover change, the condition of catchments and the effectiveness of protective structures such as dams. The ultimate health outcomes were also influenced by the vulnerability of individuals and communities (see table 1) and the effectiveness of warnings and of emergency management actions.

Most health impacts of climate change are likely to be adverse, although some health benefits will occur in some regions—at least over the next few decades (McMichael and Lindgren, 2011). For example, if winters in some temperate countries become milder, then the usual seasonal excess of winter-time deaths from heart attacks and stroke should decrease. On balance, however, there is a much greater risk of harm to health and wellbeing than benefit from future climate change (IPCC, 2007, ch.8; Costello et al., 2009).

Table 1: Summary of risks and most vulnerable Australians.

Event	Examples of health effects	People most affected (see section 4)
Higher temperatures 	Higher incidence of allergies caused by pollen Higher incidence of mosquito-borne diseases Higher incidence of food- and water-borne diseases	Those with existing illnesses Those in hotter climates Children
Heatwaves 	Higher incidence of heat-related illnesses, such as exhaustion, heatstroke and acute renal failure Exacerbation of existing health conditions, such as predisposition to heart attack and kidney disease Higher incidence of mental and behavioural disorders More premature deaths	Those with existing illnesses City dwellers Low-income households Outdoor workers Older Australians Indigenous communities Tourists Obese and overweight people Children
Bushfires 	More injuries, burns and accidental death Higher incidence of respiratory illness, such as asthma attacks Higher incidence of mental health problems, including trauma and longer-term disruptions to social systems	Rural, urban-fringe and other fire-prone communities Indigenous communities Children Older Australians
Long-term drought / decreased rainfall 	Higher incidence of mental health problems, including suicidal behaviour, from loss of income and morale and disruptions to social systems Reduced access to fresh healthy food from reduced food yield Higher incidence of illness from contamination of water supplies and reduced hygiene due to water shortage	Rural communities and regional cities Indigenous communities Low-income households Children
Flood / increased rainfall 	More injuries, drowning and other accidental deaths Higher incidence of infectious disease, such as from contamination of food and water supplies Increased risk of respiratory illness from mould	Rural communities Children
Extreme weather events 	More injuries and death Higher incidence of mental health problems Exacerbation of existing illnesses from reduced access to health care Reduced access to fresh healthy food and clean water	Emergency workers Children Rural communities Older Australians Tourists Low-income households Coastal communities

Figure 2: Climate change affects our health and wellbeing in many ways, through both direct physical impacts and flow-on social and economic changes.



Source: modified from Capon and Hanna, 2009 and Berry et al., 2011a

02 CLIMATE CHANGE WILL AFFECT OUR BODIES

"AUSTRALIA'S EMERGENCY MANAGEMENT AUTHORITY ESTIMATES THAT IN THE LAST 100 YEARS HEATWAVES 'CAUSED MORE DEATHS THAN ANY OTHER NATURAL HAZARD (EXCEPT DISEASE), YET THEY REMAIN ONE OF THE LEAST STUDIED AND MOST-UNDERRATED PHENOMENA'." (SHERRATT, 2005).

2.1 Injuries, disease and death from heat extremes

There is no doubt that the world is warming. As climate change continues, hotter days and intense heatwaves are causing more heat-related health impacts. Hot days and heatwaves have a significant impact on our health—from lethargy to heatstroke and even death—and on our health systems.

Even small changes in our environment can have dramatic effects on the human body (see figure 3). Humans can only survive when core body temperature remains in a narrow range, around 37°C (Hanna et al., 2011). If the body produces or absorbs more heat (from physical activity or high air temperatures) than it can remove through sweating, core body temperature will rise.

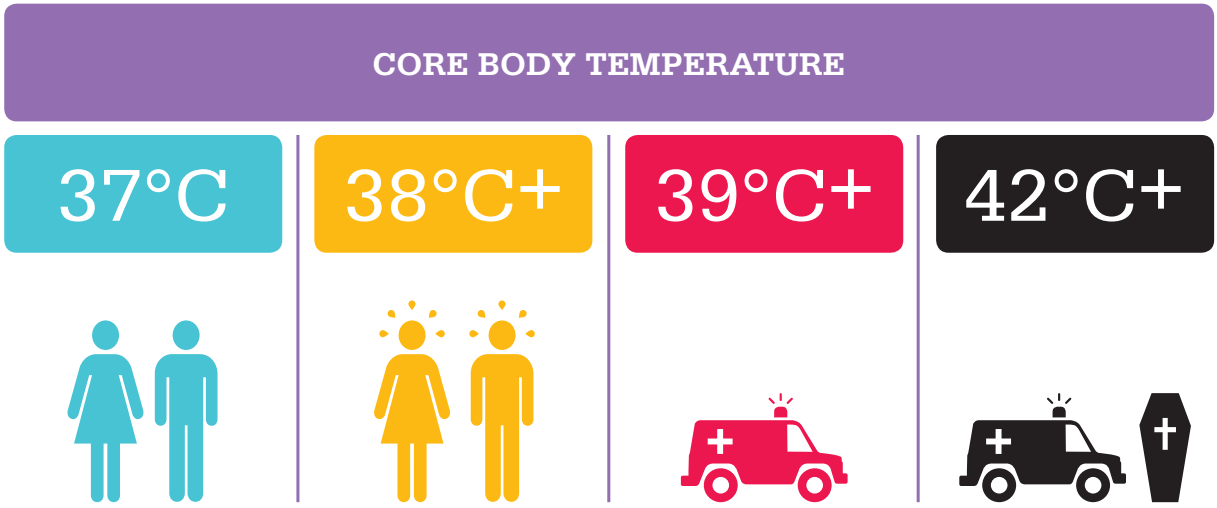
If core body temperature exceeds 38°C for several hours, the body can suffer heat exhaustion and reduced mental and physical capacity (Parsons, 2003; Berry et al., 2010). At core body temperatures above 39°C, more serious heat stroke and unconsciousness may occur (Kjellstrom et al., 2009). Serious heat stroke and even death occurs after a relatively short time if core body temperature goes above 42°C (Parsons, 2003).

There has been an increase in hot days and nights and a decrease in cold days and nights right across Australia. In the last five decades the number of record hot days in Australia has more than doubled (CSIRO and BOM, 2010).

HOT DAYS AND HEATWAVES PUT SUBSTANTIAL PRESSURE ON OUR BODIES, LEADING TO GREATER INCIDENCE OF LETHARGY, HEATSTROKE, AND HEAT-RELATED DEATHS.

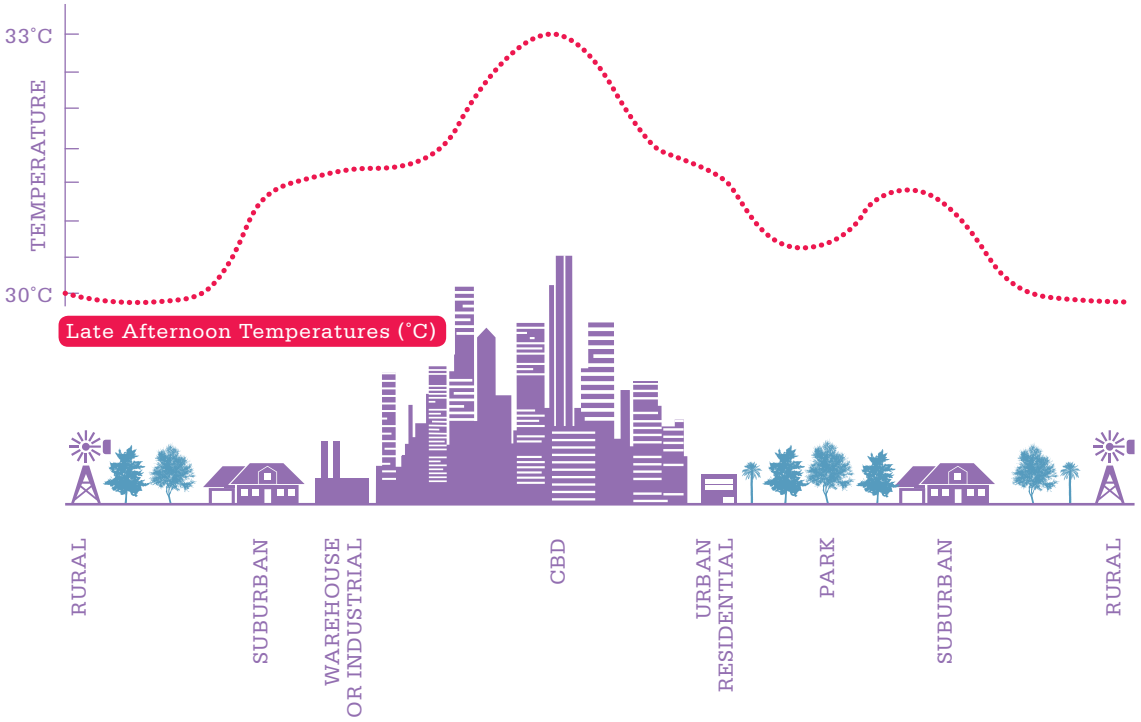
Recent heatwaves around Australia have caused increased hospital admissions for kidney disease, acute renal failure and heart-attacks, and increased deaths. During the severe heatwaves in south-eastern Australia in 2009, Melbourne sweltered through three consecutive days at or above 43°C in late January. There were 980 deaths during this period—374 more than the estimated 606 that would have occurred on average for that time of year, or an estimated increase of 62% (DHS, 2009). Most of the increase was among people aged 75 or older (DHS, 2009).

Figure 3: Temperature effects on the human body.



Source: Drawn from in-text references

Figure 4: The urban heat island effect. The average annual air temperature in cities (more than one million people) may be 1 to 3°C hotter than surrounding areas.



Source: Modified from US EPA, 2008 and NASA, 1999

During the Brisbane heatwave of 7–26 February 2004, the average temperature was 32°C and the maximum temperature ranged from 26° to 42°C. Overall deaths increased by 23% (excluding injury and suicide) compared with the same period in 2001–2003, when the temperature ranged from 22°C to 34°C (Tong et al., 2010).

"THE NUMBER OF HIGH TEMPERATURE EXTREMES IN AUSTRALIA HAS INCREASED SIGNIFICANTLY OVER THE PAST DECADE, WHILE THE NUMBER OF LOW TEMPERATURE EXTREMES HAS DECREASED."
—THE CRITICAL DECADE: CLIMATE SCIENCE, RISKS AND RESPONSES

These are examples of extreme heatwaves over short timeframes. It is a similar story over the longer term. For example, over the 13 summers from 1993 to 2006, the number of people requiring ambulance transport during heatwaves in Adelaide increased by 4% when compared with non-heatwave periods; a corresponding trend in increased total hospital admissions of 7% was observed during heatwaves over this period (Nitschke et al., 2007). A recent study estimated an approximate 80% probability that the unprecedented and extreme July 2010 heatwave in Moscow—which resulted in thousands of premature deaths—would not have occurred without climate warming (Rahmstorf and Coumou, 2011).

People with existing health disorders are more vulnerable to health impacts of hot days and heatwaves (see section 4). For example, in Adelaide, studies of the 2008 and 2009 heatwaves found that patients with kidney disease were particularly susceptible to extreme heat events: hospital admissions for kidney disease and acute renal failure rise during heatwaves compared with non-heatwave periods (Nitschke et al., 2007; Khalaj et al., 2010; Hansen et al., 2008b).

Hospital admissions for heart attack among people aged 15-65, particularly men, have also been shown to increase in Adelaide during heatwaves (Nitschke et al., 2007). In Melbourne, a study across 1999 to 2004 found that hospital admissions for heart attacks increased by about 10% on days when temperatures exceeded 30°C, and by almost 40% during heatwaves in which the three-day average temperature exceeded 27°C (Loughnan et al., 2010).

Children and people who are elderly, work in heat-exposed jobs or have low incomes are all at greater risk from heat extremes (see section 4). In addition, most people live in cities and cities are going to be even hotter because of what is known as the "urban heat island effect" (see figure 4). This term describes how urban areas can generate and store more heat than nearby rural areas. The average annual air temperature of a city with a million people may be 1 to 3°C hotter than the surrounding areas (US EPA, 2008). In the evening, the difference can be as high as 12°C. The over-heating of urban environments can also pose various indirect risks to health via threats to infrastructure, including curtailed rail services (for example, buckled railway lines), over-extended emergency services, and failures of gridded electricity supply.

Projections

As climate change continues, Australians will experience even more days of extreme heat and related health impacts. Modelling of future climate change predicts that Australians will face extreme hot weather far more often (CSIRO, cited in Garnaut 2008; IPCC, 2011). If climate change continues on its current path, the number of days over 35°C each year will likely rise substantially in all major cities by the end of the century (see figure 5), including in Darwin where it could rise from 9 to 312 days—almost the whole year (CSIRO, cited in Garnaut, 2008).

Future heatwaves will also tend to be hotter and longer lasting (Keenan and Cleugh, 2011). The number of heat-related deaths in Australia is likely to rise accordingly.

However, projected changes in death rates are likely to vary widely between locations, reflecting the fact that fewer people will die from the effects of cold and more will die from the effects of heat (Bambrick et al., 2008).

Figure 5: Projected number of days over 35°C in Australian capital cities.

	2008	2030	2070	2100
MELBOURNE:	9	12	21	27
SYDNEY:	3.3	4.4	9	14
BRISBANE:	0.9	1.7	8	21
ADELAIDE:	17	22	34	44
PERTH:	27	35	56	72
CANBERRA:	5	8	21	32
DARWIN:	9	36	221	312
HOBART:	1.4	1.7	2.5	3.4

Source: Modified from CSIRO, cited in Garnaut, 2008.

Occupational health and heat extremes

The lives and livelihoods of many Australian workers are at risk from heat. Working outdoors exposed to the sun, or indoors without adequate ventilation, is particularly dangerous and can lead to serious heatstroke and even death (Kjellstrom et al., 2011). Physical exertion during hot weather becomes dangerous when the body is no longer able to remove the heat it produces (Kjellstrom et al., 2009). There can also be psychological impacts, such as confusion, aggression and other behavioural changes (Berry et al., 2010).

Workers at risk of extreme heat exposure include those who work outdoors, such as construction workers and builders, maintenance workers, those on outside mine sites, farmers and emergency and essential service providers (Hanna et al., 2011). The protective clothing often required in these industries can inhibit the cooling effect of sweating and may increase the risk of heat exposure.

While most workers will spontaneously pace themselves to avoid physical exhaustion, heat-related health risks will increase when work is "externally paced" by machine speed or where workers are paid based on output (Hanna et al., 2011). Workplaces where taking breaks is not encouraged, or is not socially acceptable, will put workers at particular risk.

Although people who live in hot climates, such as Australia, have developed a certain level of resilience to heat, there are upper limits to human thermal tolerance (Parsons, 2003). In a warming world these limits may be exceeded. Maloney and Forbes (2011) call days when sweat will be insufficient to regulate a person's temperature and when body temperature will increase by 2.5°C in less than 2 hours "dangerous days". On these days heat stroke is a real risk after only a few hours. They estimate that in Perth the number of dangerous days for acclimatised people doing physical labour (those who are used to the climate) will increase from 1 day per year to 21 days per year by 2070. For unacclimatised people (those unused to the climate) the number of days will increase from 17 days per year to 67 (Maloney and Forbes, 2011). An increase in the number of dangerously hot days could have significant economic impacts. For example at the Port of Melbourne, port workers are permitted to stop work when temperatures reach 38°C. During a heatwave, this slows down or halts loading/unloading processes at the port, significantly delaying vessels and delivery schedules as well as greatly increasing labour costs (Queensland University of Technology, 2010).

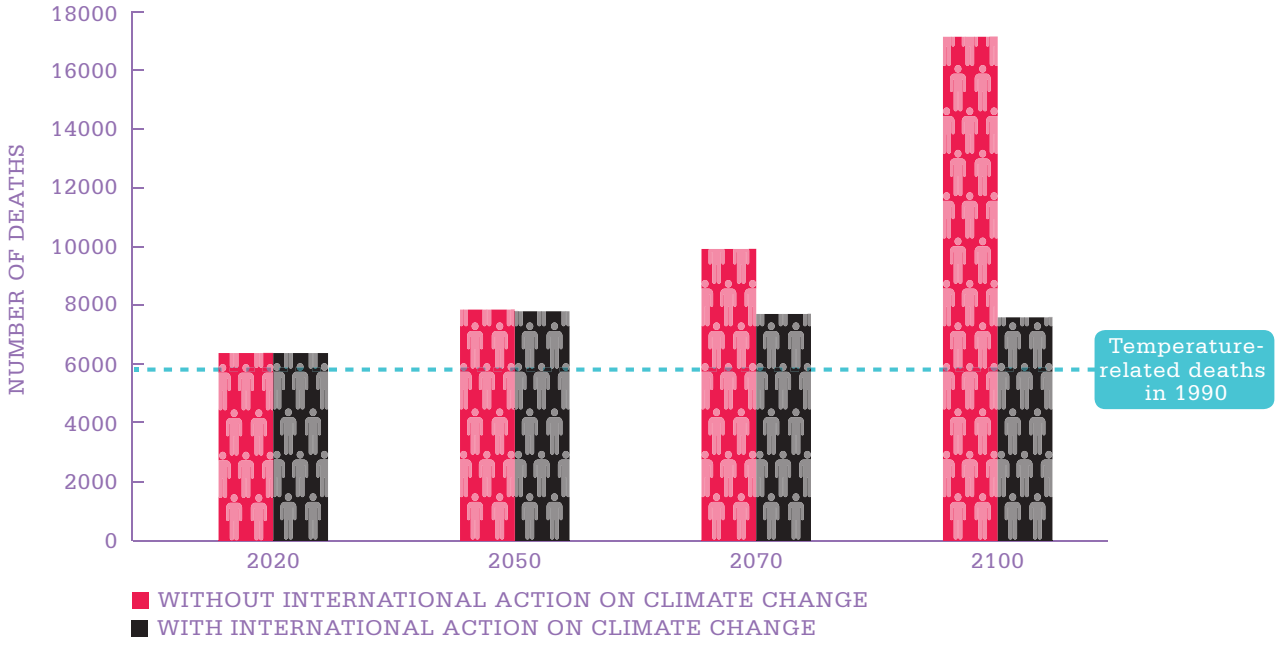
Under a worst-case scenario, unmitigated climate change may modestly reduce temperature-related deaths in Victoria, Tasmania, South Australia and NSW, due to reductions in the number of cold-related deaths; but, deaths could increase markedly in Queensland and the Northern Territory (with 10 times as many deaths by the end of the century compared with no climate change) and in Western Australia (twice as many deaths) (Bambrick et al., 2008).

At the national level, reductions in cold-related deaths are likely to be significantly outweighed by heat-related deaths by mid-century (McMichael et al., 2003; Bambrick et al., 2008). For example, under the scenario of unmitigated climate change mentioned above, the balance of national annual temperature-related deaths was estimated to increase from around 5,800 in 1990 to 6,400 in 2020, 7,900 in 2050 and 17,200 in 2100 (Bambrick et al., 2008). By comparison, with effective international climate change mitigation, these estimated numbers of temperature-related deaths would increase by considerably smaller amounts during this century (see figure 6).

AN INCREASE IN THE NUMBER OF DANGEROUSLY HOT DAYS COULD HAVE SIGNIFICANT ECONOMIC IMPACTS.

Although further research is needed to predict the full impacts, some health services are already preparing for the impacts of rising temperatures (see section 5).

Figure 6: Projected temperature-related deaths in Australia with and without action on climate change.



Source: Bambrick et al., 2008

2.2 Injuries, disease and death from other extreme weather events

There is evidence that climate change has already led to a change in the frequency, duration and intensity of extreme weather events (IPCC, 2011; Pall et al., 2011; Rahmstorf and Coumou, 2011; Trenberth, 2011), such as temperature extremes, storms and floods. These events have health, social and economic costs.

Natural disasters cause injuries, disease and death; they also cause social disruption and cost billions of dollars in damage. The December 2010 and January 2011 flooding in Queensland and tropical cyclones Anthony and Yasi demonstrate the catastrophic effects that extreme weather events can have on life, health and infrastructure. More than 78% of Queensland was declared a disaster zone and 35 people were killed by the floods; in total, about 2.5 million people were affected (QFCI, 2011).

MORE FREQUENT AND SEVERE EXTREME EVENTS WILL SERIOUSLY HARM OUR HEALTH.

The floods and cyclones caused major disruptions to Queensland health services and increased demand for them (Queensland Health, 2011). This included:

- Flooding and cyclones caused the cancellation of 1,396 booked elective surgeries as a result of both increased demand on hospitals and staff unavailability;
- More than 200 patients in areas affected by cyclones were transferred to Brisbane hospitals, leading to a 73% increase in 'long waits' for elective surgery;
- 501 clinical staff deployed by Queensland Health assisted 10,000 people affected by the floods and cyclones between 28 December 2010 and 18 February 2011;
- Over 17,000 tetanus/diphtheria vaccines were distributed to reduce the risk of disease; and
- Queensland Health's phone information service, "13 HEALTH", answered 54,881 calls from flood-affected areas.

The flooding also caused costly damage to existing health infrastructure. The Queensland and Federal governments are providing $18.1 million over two years to repair damage caused to health facilities (Queensland Health, 2011). To provide long-term mental health support following the floods and cyclones, $37.8 million is also being provided over 2011-13 to fund the Queensland Mental Health Natural Disaster Recovery Plan (Queensland Health, 2011).

Even as flood waters recede, health and wellbeing can be affected. Contact with contaminated floodwater and soil can cause diarrhoeal and other bacterial infections; stagnant waters provide a breeding ground for disease-carrying mosquitoes; and mould triggers allergies, asthma and respiratory infections (Harley et al., 2011).

Source: andesign101/ Shutterstock.com

It is difficult to directly attribute individual extreme events, such as the Queensland floods or cyclones, to climate change because these kinds of events occur as part of natural climate variability. However, recent changes in our climate, such as the warming of the surface of the ocean are creating conditions that are more favourable for generating extremes such as floods and intense cyclones.

Such extreme weather events affect some Australians more than others. Older people, children, low-income earners, rural communities, coastal communities and remote Indigenous communities are particularly at risk (see section 4).

Projections

The Critical Decade: Science, risks and responses noted that many of the impacts of climate change are due to extreme weather events. The most important of these are related to high temperatures, including heatwaves (discussed in section 2.2) and bushfires; heavy rainfall events; and storms, such as tropical cyclones and hailstorms. In Australia, the conditions that favour large and intense bushfires—extreme temperatures, high winds and low humidity—are likely to become more common in regions such as south-eastern Australia (CSIRO, 2007). Intense rainfall events are also likely to increase, particularly in northern Australia (CSIRO and BOM, 2010), which makes flooding more likely. A combination of higher sea levels and storm surges is also likely to cause greater inland flooding and erosion in some regions, including parts of the Victorian and Queensland coasts (CSIRO, 2007).

Although associating any individual extreme weather event with climate change is complex, recent research indicates that, in some regions, it is possible to identify the likelihood of whether climate change contributed to extreme events (Pall et al., 2011; Min et al., 2011). In the autumn of 2000, floods in the UK damaged nearly 10,000 properties, severely disrupted services and caused insured losses of around £1.3 billion (approximately $3.6 billion) (Pall et al., 2011). Researchers found that climate change contributed to an intensification of heavy rainfall events over large swathes of the northern hemisphere and substantially increased the risk of flood occurrence in England and Wales (Pall et al., 2011). The 2010 Moscow heatwave mentioned in section 2.1 is further evidence.

2.3 Respiratory illness from air pollutants and air-borne allergens

Climate change is likely to lead to increases in certain types of air pollutants (Jacob and Winner, 2009; Ebi and McGregor; Spickett et al., 2011), as well as air-borne allergens like pollen and mould spores (IPCC, 2007, ch.8; Wolf et al., 2010). These have serious impacts on people who suffer from respiratory illnesses, such as asthma, hay fever and lung cancer, and from heart disease. Respiratory illnesses are already some of Australia's most common health problems, with around six million chronic sufferers (AIHW, 2005).

Most of the population is exposed to urban air pollutants and air-borne allergens; even small increases in these exposures can result in significant impacts on health and healthcare costs. Long-term exposure to urban air pollution accounts for 1.5% of all deaths in

Australia and short-term exposure accounts for a further 0.8% (Spickett et al., 2011). In 2009, asthma—which can be triggered by both pollutants and air-borne allergens—was identified as the underlying cause of 411 deaths (Australian Centre for Asthma Monitoring, 2011). In addition, about 15% of Australians suffer from hay fever (AIHW, 2005), which is commonly triggered by air-borne allergens.

The health cost of Sydney's air pollution alone is estimated to be between $1 billion and $8.4 billion each year (Spickett et al., 2011). In 2000-01, governments and health service providers around Australia spent $693 million on treating and managing asthma (AIHW, 2005).

Young children are likely to be disproportionately affected by increases in air pollutants and air-borne allergens because their bodies are still developing (Spickett et al., 2011). The elderly may have a higher risk of early death and of disease associated with heart and breathing problems, which is of particular significance given our ageing population (Spickett et al., 2011). People living on low incomes and Indigenous people have a higher risk of dying from asthma (Australian Centre for Asthma Monitoring, 2011).

Projections

Two main air pollutants—ozone that is closer to ground-level and particulates—as well as air-borne allergens are likely to increase with climate change.

Health effects on children

Children will be doubly hit by the adverse health impacts of climate change: children are generally more vulnerable because both their minds and their bodies are still developing. In addition, because they rely on adults for their daily needs, the health impacts experienced by their caregivers can flow on to affect children's wellbeing (Strazdins et al., 2011).

Key impacts for children include asthma and mental health. Asthma is already the most common chronic disease in Australian children and is more common in children than adults (ABS, 2006). A recent US report predicted that climate change could cause an average 7.3% increase from 1990 levels in ozone-related asthma visits to emergency departments by children in the New York City region by the 2020s (Sheffield et al., 2011).

The behaviour of children may also increase their vulnerability. For example, while playing unsupervised outside, children may not recognise the signs of heat stress in themselves or their playmates.

Exposure to stress and trauma, including from drought or extreme weather events, is of particular concern because the brains and emotional regulation systems of children are still developing. Following Cyclone Larry in March 2006, a study of school children in Northern Queensland found one in ten suffered from post-traumatic stress disorder, with symptoms including flashbacks, nightmares and a general state of distress (McDermott et al., 2010). Studies conducted after bushfires have shown that childhood stress and trauma has longer-term adverse effects on learning ability and mental health impacts (Pynoos et al., 2006). Children are also affected when parents and caregivers face increased stress or illness, such as the mental health disorders seen in rural communities during and after drought (Stain et al., 2011).

Ozone

Hotter temperatures will enhance ozone production in the lower (especially urban) atmosphere (Jacob and Winner, 2009; Spickett et al., 2011; Ebi and McGregor, 2008). Exposure to ozone can reduce lung function and increase respiratory problems, including aggravating asthma. It may also be associated with premature death—as it was in Brisbane's 2004 heatwave (Tong et al., 2010)—especially in people with heart and lung disease (Spickett et al., 2011). While 90% of ozone is concentrated many kilometres above us in the upper atmosphere (where it helpfully blocks harmful ultraviolet radiation from the sun), in the lower atmosphere it becomes a toxic component of ground-level smog (BOM, 2011).

CLIMATE CHANGE WILL REDUCE THE QUALITY OF OUR AIR WITH SERIOUS IMPLICATIONS FOR PEOPLE WHO SUFFER FROM RESPIRATORY ILLNESSES, SUCH AS ASTHMA, HAY FEVER AND LUNG CANCER, AND FROM HEART DISEASE.

Particulates

Climate change will lead to an increase in air-borne particulates. More exposure to air-borne particulates means that more people will become sick or die from respiratory and heart disease (Ebi and McGregor, 2008). For example, bushfire smoke has been associated with increased asthma symptoms, respiratory medication use and hospital admissions for asthma and other respiratory conditions (Beggs and Bennett, 2011). More frequent and intense bushfires are projected as a result of climate change (CSIRO, 2007) and so a corresponding increase in particulates, such as ash, is likely to exacerbate the severity of asthma (Jacob and Winner, 2009). Drought and severe dust storms have also been linked to increases in asthma severity and decreased lung function in major cities, including Adelaide, Brisbane, Melbourne and Sydney (Beggs and Bennett, 2011).

Air-borne allergens

Seasonal variations in allergic respiratory disease are well established in Australia. Triggers include outdoor aeroallergens such as pollens and fungal spores, and indoor aeroallergens, such as those from moulds, cockroaches, house dust mites and rodents (Bass et al., 2000).

There is good evidence that climate change is affecting the timing of allergenic pollen production (IPCC, 2007, ch.12). Studies, mostly from Europe, indicate that as temperatures have increased the pollen season has started earlier (IPCC, 2007, ch.12). One Dutch study found a strong correlation between temperature and the start of the pollen season (van Vliet et al., 2002). It found that an advance in the start of the season of between 3 and 22 days has already been observed between 1969 and 2001, with large differences in response between different plant species.

An earlier start to the pollen season will bring forward the start to the season for allergic respiratory diseases, like hay fever. The amount of pollen released into the atmosphere may also increase with hotter temperatures, contributing to an increase in the severity and occurrence of asthma and allergies (Wolf et al., 2010).

2.4 Infectious disease from mosquitoes, food and water

Climate change, through alterations in temperature, rainfall and humidity, is beginning to affect the occurrence of various infectious diseases around the world—some mosquito-borne, some water-borne and some food-borne.

In Australia, mosquito-borne infectious diseases such as dengue fever and Ross River virus are likely to extend their range and activity. Climate change may also increase the likelihood of newly-introduced

infectious diseases (McMichael et al, 2003). In other regions of the world, hotter and drier conditions may reduce the numbers and survival rates of mosquitoes, which could in turn reduce the risks of mosquito-borne diseases, like malaria (McMichael and Lindgren, 2011).

The geographic distribution of various infectious diseases—and some insects and other organisms that transmit them—have changed in recent decades in several countries, in association with regional changes in climate. Viewed together, these changes suggest that, worldwide, climate change is influencing the geographic range, the seasonality and the rates of occurrence of a number of infectious diseases. The reported changes include the extension of transmission zones for tick-borne Lyme disease in south-eastern Canada and Scotland, and for ticks that transmit viral encephalitis in Sweden (Cooney, 2011; Slack et al., 2011; Lindgren and Gustafson, 2001). Other evidence, while not certain, points to an influence of recent warming on the rising incidence of malaria at higher altitude in Kenya (Omumbo et al., 2011).

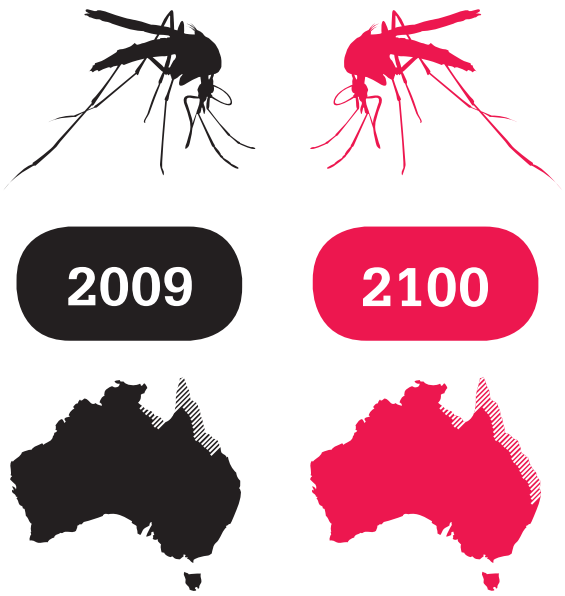
HOTTER TEMPERATURES AND CHANGES IN RAINFALL WILL INCREASE THE RISK THAT SOME DISEASES WILL SPREAD.

Hotter temperatures and changes to rainfall patterns due to climate change may also increase the distribution and impact of food- and water-borne viruses, parasites and bacteria that cause illnesses such as food poisoning. For example, the sanitation, hygiene and the safety of drinking water can be compromised by both lower rainfall (through concentration of bacteria) and floods (through contamination and mixing with sewage and runoff).

Dengue fever

Dengue fever is an infectious tropical disease that causes fever, headache, joint pain, skin rash and, in a few cases, haemorrhage and dangerously-low blood pressure. There is currently no vaccine, but precautions can be taken to prevent infection. The main carrier of the disease is the mosquito *Aedes aegypti*. The habitat, geographic range, and behaviour of this mosquito are very sensitive to temperature and, in particular, humidity and the presence of surface water (Kearney et al., 2009).

Figure 7: Projected spread of dengue fever by 2100.



Source: this diagram is indicative only and is drawn from the in-text references. Future habitat and potential spread of the Aedes aegypti mosquito will be determined not only by changes in climate but also by health, technology and population changes.

Dengue is currently confined to northern Queensland, where outbreaks occur almost annually (Ritchie, 2009; Russell, et al., 2009). In 2008-09, over 1,000 cases occurred in and around Cairns (Fitzsimmons et al., 2010). Outbreaks may increase because wetter conditions favour mosquito breeding and warmer temperatures speed up the maturation of viruses within the mosquitoes. These outbreaks may become more difficult to control and more geographically

widespread, and have broader public health consequences such as reducing the pool of available blood donors (Bambrick et al. 2009). There is evidence that the geographic range of the disease within Queensland may have expanded in recent years (Hu et al., 2011).

Projections

If no essective global action is taken to reduce greenhouse gas emissions, the geographic region suitable for dengue transmission may spread southwards, increasing the population at risk of exposure from 430,000 to between five and eight million Australians by the end of the century (Bambrick et al., 2008). If the climate becomes hotter and wetter dengue fever could spread south to northern New South Wales by 2100 (Bambrick et al., 2008).

In contrast, modelling based on scenarios that involve substantial reductions in greenhouse gas emissions indicate that far fewer people would be at risk—fewer than 1 million people by 2100 (Kearney, 2009; Bambrick et al., 2008).

While hotter temperatures from continued climate change will favour the spread of the mosquito in parts of Australia, the installation of large water tanks could potentially have an even greater effect on increasing future geographic distribution (Kearney, 2009; Beebe et al., 2009). There is a risk that in adapting to reduced water availability, some adverse flow-on impacts could be created.

Food- and water-borne disease

Increasing climate variability and temperature may boost the prevalence of bacteria, parasites and viruses; this in turn could increase the risk of food and water contamination.

Eating food or drinking water that is contaminated can cause symptoms of gastroenteritis or 'food poisoning'. These can range from minor to severe and include: diarrhoea, fever, vomiting, abdominal cramps and dehydration, which in some cases can lead to further health complications and even death.

Food

Hotter temperatures can lead to higher incidence of food-borne disease. This is because many infectious agents, such as *Salmonella* bacteria, are sensitive to temperature and multiply more readily as the temperature rises. Data from Australia's capital cities over the 11-years from 1991 to 2001 show clearly that the rate of notification of cases of food-borne diseases rises with average weekly or monthly temperature (D'Souza et al., 2004). This is the main reason why food spoilage and food-poisoning occurs more often in summer than winter.

Many infectious agents (especially bacteria, viruses, and single-cell organisms) contaminate food. In sufficiently high doses they cause gastroenteritis. The most common agents responsible for food-borne gastroenteritis are *E. coli*, *norovirus*, *Campylobacter* and *Salmonella* (DHA, 2005). Gastroenteritis is one of Australia's most common infectious diseases, and accounts for a high proportion of illness and lost work-days.

Extreme events can also make it harder to maintain food hygiene, water quality and sanitation practices. For example, extended power cuts can lead to outbreaks of gastrointestinal infections because food cannot be chilled in refrigerators and hot water is not available for washing.

Food-borne illnesses impose a significant cost. Every year, Australians suffer about 5.4 million cases of gastroenteritis from contaminated food, resulting in an estimated 1.2 million doctor visits, 300,000 antibiotic prescriptions and 2.1 million days of lost work (DHA, 2005). More seriously, these infections result in about 15,000 hospital admissions for gastroenteritis, almost one-fifth of which are for follow-on illnesses (such as reactive arthritis and irritable bowel syndrome). About 120 people die in Australia each year due to food-borne illness (DHA, 2005).

Young children and adult carers report the highest rates of gastroenteritis (DHA, 2005).

Food yields, affordability, nutrition and health

Our sources of plant and animal foods, whether farmed or wild, are attuned to average local climatic conditions—temperature, rainfall, soil moisture, and biodiversity (including pollinating species). Changes in climatic and environmental conditions can greatly reduce food yields. So too can extreme weather events—the severe heatwave in Western Europe in 2003 reduced grain yields in much of France by 25%, and the extreme and prolonged heatwave in south-west Russia in 2010 reduced the wheat harvest by around one-third (Barriopedro et al., 2011; Battisti and Naylor, 2009). Floods in Southeast Asia and in Pakistan have destroyed large areas of rice crops over the past two years, and recent cyclones in Queensland have caused considerable damage to banana plantations—with a subsequent tripling of the retail market price of bananas.

In much of the world, the loss of harvests and livestock poses one of the greatest threats to human health from climate change (Lobell and Field; 2007; Nelson et al., 2009). In particular, poor rural populations reliant on subsistence farming are at risk, and the growth, development (physical and intellectual) and survival of children in particular are threatened by food shortages. Further, chronic under-nutrition weakens the body, including the immune system, and increases susceptibility to some infectious diseases (Lloyd et al., 2011). In the Pacific region, rising sea level is already impairing the productivity of some low-lying coastal crops, including coconut palms (FAO, 2008).

Australia produces and exports much food. Yet we also import around 40% of our total national food consumption. For richer countries, trading can provide a buffer against the food stresses of climatic changes.

More than 40% of Australia's gross value of agricultural production is from the Murray- Darling Basin (ABS, 2007). While scientists foresee the possibility of some gains in Australian farm yields in the early phase of climate change, yields are projected to decline as temperatures continue to rise and rainfall patterns shift (Howden et al., 2009). The experience of the recent prolonged drought, particularly in south-eastern Australia, has underscored the reality of the risk to food yields, livelihoods, community morale and health (Hogan et al., 2011; Berry et al., 2011) if the drying trend continues.

Australian farming is likely to undergo a range of adaptive changes, to offset the risks from climate change. Some of those changes may be major ('transformative') changes—of the kind that will be needed to respond to the anticipated future downturns in local food yields (Howden et al., 2009). However, as climate change evolves in Australia, it is likely to lead to downturns in local food yields, reduced food quality and increased food prices. That, in turn, will impinge most on lower-income families and on remote communities where food choices are often limited, resulting in dietary insufficiencies, nutritional imbalances and health impairments (especially in young children) (Friel, 2010).

Water

Water-borne diseases are influenced by water temperature and the frequency and intensity of rain. Diseases such as cryptosporidiosis have complex relationships with climate, and may be affected by heavy rainfall or flooding (Britton et al., 2010).

For example, flooding can cause sewage or farm run-off to enter drinking-water supplies, leading to outbreaks of cryptosporidiosis and giardiasis (Karanis et al., 2007). During the Queensland floods in December 2010 and January 2011, a number of council water supplies were contaminated by infectious organisms. As a result some councils provided residents with bottled water (QFCI, 2011).

OUTBREAKS OF FOOD- AND WATER-BORNE INFECTIONS WILL INCREASE AS EXTREME WEATHER EVENTS BECOME MORE INTENSE AND AS TEMPERATURES RISE.

Droughts may also increase concentrations of some pathogens in water that have the potential to overwhelm disinfection and purification processes in water treatment plants. Many rural Australians are familiar with the severe hazards associated with blooms of toxic blue-green algae, or cyanobacteria, in dams and waterways during droughts. Such water is unfit for drinking and can cause liver damage, stomach upsets and disorders of the nervous system in humans (MDBA, 2008). It is also hazardous to livestock. Contact with high concentrations of blue-green algae can also cause skin and eye irritations (MDBA 2008).

Projections

Bacteria that cause gastroenteritis are projected to increase as a result of climate change (Kovats et al., 2004; Hall et al., 2002; Britton et al., 2010; Harley et al., 2011). A 2008 study estimated that between 205,000 and 335,000 new cases of bacterial gastroenteritis could occur each year by 2050, and between 239,000 and 870,000 cases by 2100 (Bambrick et al., 2008). An increase of 205,000 cases per year by 2050 could result in $56.5 million in health and surveillance costs and 570,000 lost work days; for 335,000 new cases, this could rise to $92.3 million in health and surveillance costs and 1.6 million lost work days (Bambrick et al., 2008). In contrast, certain viral causes of diarrhoea, especially rotavirus, are more commonly reported in winter and may therefore become less frequent in the future as average temperatures rise (D'Souza et al., 2008, Harley et al., 2011).

Flooding events may become more intense and/or more frequent, and may influence both food- and water-borne diseases. As discussed in *The Critical Decade: Climate science, risks and responses*, water availability is likely to decline in south-west Western Australia and in south-east Australia, although there is considerable uncertainty about the magnitude and seasonality of the change. Disease outbreaks are difficult to predict because they depend on many factors, including the type of causal event and the preparedness of our health services to respond.

03 CLIMATE CHANGE WILL AFFECT OUR MINDS

IT IS CLEAR THAT EXTREME WEATHER EVENTS CAN CAUSE MENTAL HEALTH PROBLEMS AND SOCIAL DISLOCATION.

3.1 Stress and mental illness from drought, extreme weather events and heat extremes

Mental health is already a significant concern in Australia, affecting individuals, families and communities. It also costs taxpayers over $5 billion annually (AIHW, 2010c), and is often influenced by changes in our environment.

A decade of recent experience with drought and reduced farm yields in the south-east and south-west of Australia underscores the risks to community morale, livelihoods, and health. For example, the results of one study in New South Wales found that a decrease in annual rainfall by about 300mm would lead to increase in the suicide rate by about 8% of the long-term average suicide rate (Nicholls et al., 2006).

Rising temperatures are also linked to a decline in mental health. Hospital admissions for mental and behavioural disorders in both rural and urban areas rise once ambient temperatures go above about 27°C. In metropolitan South Australia, admissions for mental, behavioural and cognitive disorders have been found to increase by around 7% during heatwaves (Hansen et al., 2008a; Nitschke et al., 2007). Deaths attributed to mental and behavioural disorders increased slightly during heat waves in the 65 to 74-year age group (Nitschke et al., 2007).

Extreme weather events—including floods, hailstorms, heatwaves, bushfires and dust storms—can have traumatic impacts on people and communities. Particularly in rural areas, coping with long-term droughts and associated community decline can also be a recurring and long-term burden. Extreme weather events, especially when they happen in close succession, also place heavy demands on Australia's emergency and health workers. For example, health and emergency workers may be required to work longer hours, be redeployed or experience high rates of personal loss, confusion and grief (Hope, 2010).

There are many ways in which climate change is likely to affect our psychological perspectives and mental health. Extremes of heat, through dehydration and disorientation, affect mood, judgment and behaviour—and can predispose people to accidents and injuries. Further, a warmer body temperature may impede the effectiveness of medication for people already suffering from mental health disorders. The anticipation of climate change, anxieties about what it signifies, and how it threatens future prospects (livelihoods, safety, family experiences) loom as sources of stress for some, including young people concerned about the future. Worldwide, including within Australia, farming communities that experience downturns or disruptions in production due to changes in climate and environment, are widely expected to experience stress and, for many, depression.

On the other hand, for some, climate change, and the signal it presents in relation to the need for some major changes in how we produce, consume and live, offers the positive opportunities to think anew about our priorities as a community.

Climate change effects on rural health

Harsh droughts, torrential rains and fire have always formed part of Australia's environment. As climate change progresses, these extreme events are projected to become more severe. The greater reliance of rural, regional and remote communities on the environment makes them especially vulnerable. More frequent and extreme bushfires, droughts and floods will increasingly affect physical wellbeing, mental health and incomes (NRHA, 2009).

Climate change may compound the difficulties and inequities that already face many rural and remote communities (Berry et al., 2011a). For example, many communities already find it hard to recruit dedicated health care and social service professionals. One report found that while major cities have 205 general practitioners per 100,000 people, inner-regional areas have only 128 and very remote areas as few as 61 (BITRE, 2008). Climate change may increase the demand for social support and mental health services, and, at the same time, make these services harder to sustain.

While rural communities have proved resilient over time in the face of disaster and drought, recent experiences in relation to the prolonged drought of the past decade have shown that climate variability contributes to mental health vulnerability (Berry et al., 2011b). The experience of drought and associated loss of income, changes to social roles and changes to the environment are associated with anxiety, stress and, tragically, suicidal thoughts and acts (McMichael, 2011; Clarke, 2010).

Community resilience and preparedness for extreme weather events can be built through strategies such as education about mental health and weather, building social networks and increased activity by health service providers (McMichael, 2011). Ensuring adequate levels of existing health care will help to build the resilience of Australia's rural communities as environmental conditions move beyond previous experience.

3.2 Societal stress and longer-term change

Climate change will both cause and exacerbate disruptions to environmental, social and economic systems. This is likely to place immense strain on societies and individuals. Climate change will affect where we choose to live and how we live, work and play. It will affect long-held relationships with place and environment.

One likely disruption from climate change is to where and how we produce food—and to food yields and quality. Climate affects almost every aspect of food production: the plants and animals used, average production and production variability, product quality, which areas are farmed, what soil types are preferred, the management systems and technologies used, input costs, product prices and natural resource management (PMSEIC, 2010).

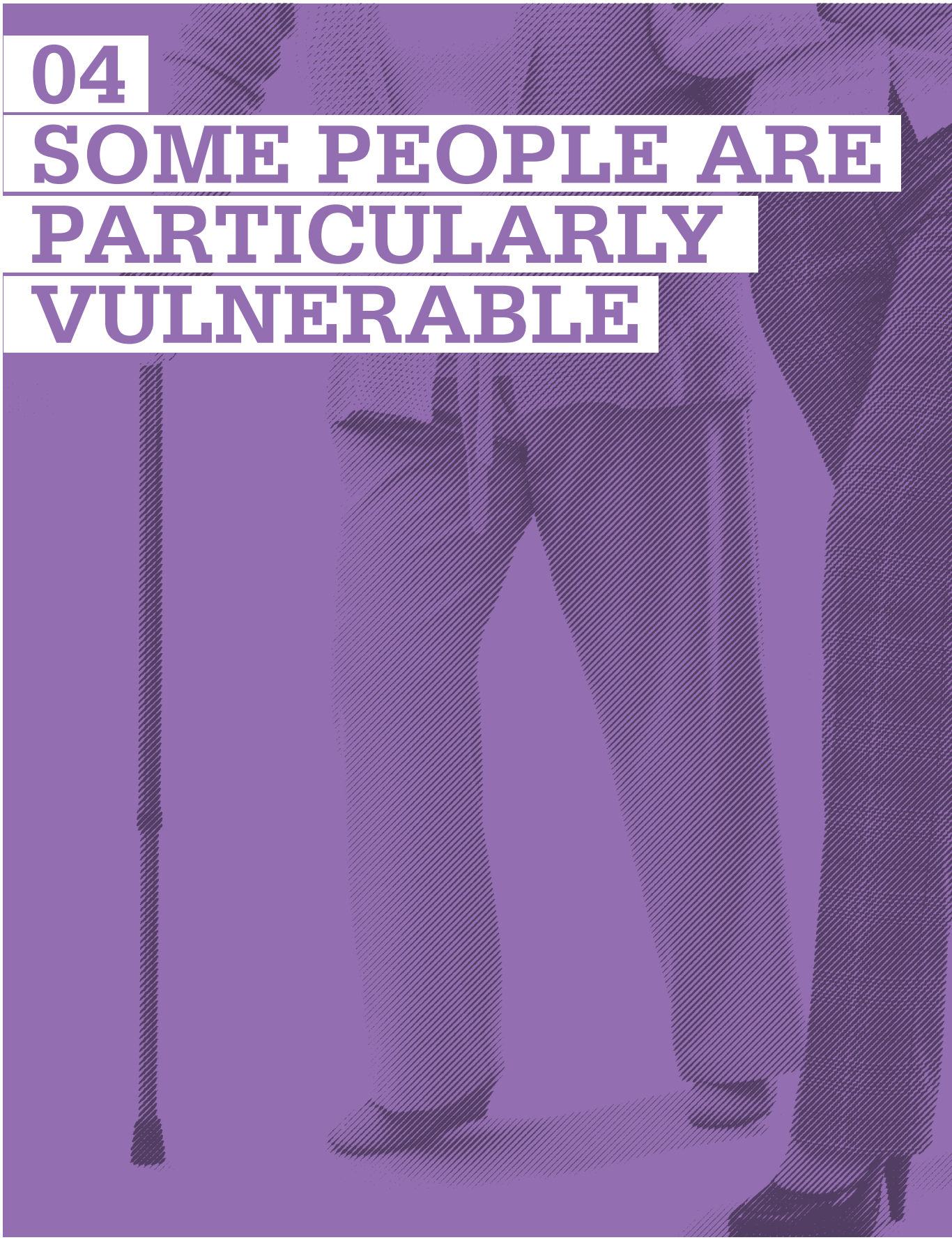
CHANGES TO ENVIRONMENTAL AND SOCIAL SYSTEMS CAN PLACE IMMENSE STRAIN ON BROADER SOCIETY, AS WELL AS INDIVIDUALS.

Climate change will affect the types of crops we grow and the regions in which we grow them. For example, if rainfall continues to decline at the dry margins in southern Australia, the viability of cropping in this region will be further reduced (IPCC, 2007, ch.11). Horticultural crops that require winter chill, such as stone fruits, may be negatively affected by hotter conditions (IPCC, 2007, ch.11). Irrigated agricultural production in the Murray-Darling Basin could decline by up to 92% by 2100 if climate change brings a long-term drying trend to that region (Garnaut, 2008). Many crops may be less nutritious, because protein content of plant tissues may decline as they respond to higher amounts of carbon dioxide in the air (Howden et al., 2003).

Climate change is also likely to cause social disruption and displacement of some communities or groups, both within Australia and in neighbouring regions. Climatic and environmental changes may threaten people's livelihoods and expose them to natural hazards, and a traditional response is to move location, or 'migrate' (Foresight, 2011; McMichael et al., 2010). As a nation, Australia recognises the close affinity between its unique landscapes and those who live on the land. If Australians are faced with relocation and the loss of a sense of place, mental and emotional pressures from other sources may be increased—particularly for Indigenous people (Green et al., 2009).

Displacement will occur both within and between countries. In 2009, 17 million people around the world were displaced by natural hazards, and 42 million in 2010 (Foresight, 2011). Those located in coastal areas, including residents of the Torres Strait Islands, are particularly at risk from rising sea levels.

04 SOME PEOPLE ARE PARTICULARLY VULNERABLE



4.1 Australians most likely at risk

The health impacts of climate change will vary from region to region and among people of different ages and states of health and wealth. The Australians most likely to be at risk are largely those already most vulnerable in our society—the very young, the aged, people with existing medical problems, and those in remote Indigenous communities (Bennett et al., 2011). The risks will also be significant for many rural communities, outdoor workers and tourists.

THE MORE VULNERABLE MEMBERS OF THE COMMUNITY—THE ELDERLY, THE YOUNG, THOSE WITH CHRONIC ILLNESS, THOSE IN LOWER SOCIO-ECONOMIC GROUPS AND INDIGENOUS COMMUNITIES—ARE ESPECIALLY AT RISK.

Vulnerability is influenced by exposure (such as where you live and work), sensitivity (your state of health), and by capacity to respond (your resources). Lower-income groups will generally be more vulnerable because they often have fewer community and personal resources. Some remote Indigenous communities—already exposed to climatic and environmental extremes, water shortages and impaired hygiene—may experience increases in diarrhoeal diseases, some changes in local and traditional food supplies, and exposure to shifts in several types of mosquito-borne diseases (Green et al., 2009).

Children and the elderly will be the most physically vulnerable to a changing climate. As discussed, children under 15 years—almost 20% of Australia's population (ABS, 2010)—have less capacity to cope with adverse weather and air pollutants because their bodies are still growing. Older people are also particularly vulnerable due to their reduced physical or mental abilities and increased isolation.

Source: © Royal Flying Doctor Service of Australia

Table 2: Australian populations likely to be especially vulnerable to the health impacts of climate change.

Populations vulnerable to the health impacts of climate change	Factors that may increase their vulnerability
Remote Indigenous communities 	› Isolation and remoteness › Poor access to healthcare services and poor existing health › Poor living conditions (especially sanitation and hygiene), as well as inadequate shelter from climate extremes due to homelessness and poor quality housing › Disruption of traditional connections to land and country through loss of cultural practices and history
People with low incomes 	› Poor access to healthcare services and poor existing health › Limited social support networks › Limited financial resources to respond to food price rises › Less access to public health information and warnings › Limited ability to take action in response to public health advice and warnings
Elderly 	› Physical and social isolation, limited support networks › Diminished physical and mental abilities (especially ability to regulate body temperature, and existing acute and chronic disease) › Less able to care for themselves during adverse weather › Prescription medication use can mask early symptoms of heat stress and exacerbate effects › Less able to take appropriate action in response to public health warnings
Children 	› Immature physical responses, and reduced capacity to cope with adverse weather and air pollutants › Behaviours that can lead to increased exposure to adverse weather, for example, spending a lot of time outdoors playing, not recognising signs of thirst and exhaustion › Increased rest requirements (compared to adults) – lack of sleep during hot nights may be particularly harmful › Experiencing extreme events can lead to increased mental health and post-traumatic stress issues in later life

Physical workers (especially outdoor workers) 	› Physically demanding activities during hot weather become dangerous to health – in particular, outdoors or in poorly ventilated indoor environments › Reduced productivity under increasingly difficult and dangerous conditions › Lack of rest periods, and lack of cool resting places, during working hours, and/or working longer hours to make up for lost productivity during hot periods › Multiple extreme weather events, especially those in close succession, may contribute to mental health issues among emergency responders, medical staff
Those with existing medical conditions 	› Poor existing health › Decreased physiological function and response to stressors › Responses may be further complicated by prescription medication use, for example, diminished thirst signals can heighten risk of dehydration
Rural communities 	› Poorer access to healthcare services, and poorer infrastructure for health-promoting activity (shade, sporting clubs) › Close dependence on environment for livelihood and lifestyle › Higher proportion of occupations with a direct relationship with climate and higher proportion of businesses in regional cities and towns directly or indirectly dependent on a supportive climate
Tourists (including domestic tourists) 	› Lack of familiarity with Australian climate and how to cope (for example, sun protection, higher fluid intake) › Lack of familiarity with public health warnings › Language barrier preventing understanding of how to respond appropriately to warnings (for example, daily reports of UV index, pollen count) › Lack of familiarity with local resources and procedures at times of need (for example, emergency evacuation routes, bushfire safety)

Source: Modified from Bennett et al., 2011

05 URGENT ACTION CAN PROTECT OUR HEALTH

THE CLIMATE HAS BEEN CHANGING FOR A NUMBER OF DECADES AND WE MUST PREPARE FOR SOME OF THE EXPECTED CONSEQUENCES FOR HUMAN HEALTH. WE STILL HAVE TIME TO PREVENT THE WORST IMPACTS—THIS IS THE CRITICAL DECADE FOR ACTION.

5. Urgent action can protect our health

Health effects of climate change are already being felt in Australia and are likely to grow worse as time goes on (see figure 8). Effects will be wide-ranging and will be felt in many different ways. Everyone is likely to be affected in one way or another. The importance of good health for our way of life, society and economy means we need to prepare for unavoidable health risks from climate change and prevent further, more serious consequences.

WE MUST BOTH MITIGATE AND ADAPT. IT IS PRUDENT FOR AUSTRALIA TO PREPARE AND PLAN FOR THOSE CHANGES WE CAN NO LONGER PREVENT.

We need to act now. Decisions we make from now to 2020 will determine the severity of climate change health risks that our children and grandchildren will experience. The longer we wait, the more serious the consequences.

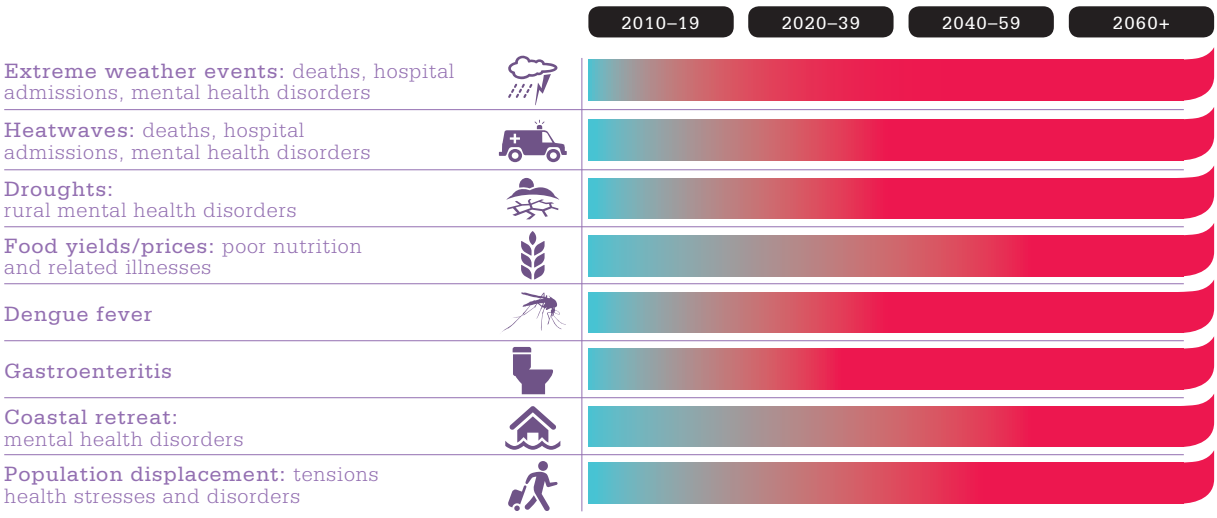
5.1 Strengthening the foundations of Australia's good health

Planning for change

We can minimise the risks to health from climate change that are already unavoidable by strengthening the foundations of our good health. One benefit of knowing what we can expect—for example, hotter temperatures—is that we can plan for the changes we need.

We need to secure water quality, food safety and housing; improve disease surveillance, early warning systems and health promotion; and improve access to medical services (Bennett et al., 2011). Reducing chronic disease within the population will also reduce some of the adverse health impacts of climate change, by lowering vulnerability (for example, lowering the risk of heart attacks during heatwaves). Such actions should be taken anyway, in the interest of improved public health. An opportunity therefore exists to build planning for the health effects of climate change into broader service and infrastructure planning.

Figure 8: Possible timeline of some future adverse health impacts in Australia from climate change.



Source: McMichael, 2011 (unpublished).

Planning needs to take account of the diversity within our population, including age, income, location, ethnicity, and occupation. The ageing trend in our population is particularly important.

EVEN WHERE THERE IS UNCERTAINTY ABOUT THE SIZE, DIRECTION OR TIMING OF SOME CHANGES—SUCH AS RAINFALL—IMPROVING OUR HEALTH IS STILL AN IMPORTANT GOAL.

Comprehensive planning is also needed for essential services. For example, effective planning should ensure that the public hospital system can cope with higher demand during heatwaves and that emergency services are sufficiently prepared and equipped to respond to more frequent and severe natural disasters.

In planning for climate change effects on health, we must recognise that a 'silver bullet' solution does not exist; instead, a range of options is needed. For example, an expected increase in heatwaves and heat-related deaths means multiple adaptation options are needed. These may include developing early warning systems to reach all citizens, improved preparation of health and emergency services, encouraging behavioural changes to reduce exposure to heat, and better home design (Wang and McAllister, 2011). Improved housing and suburb designs should also protect residents from extreme events like flooding and bushfire (Bambrick et al., 2011).

Taking action

We need to change the ways we live and work to adapt to climate change. Individuals, organisations and health professionals are already taking important action to adapt to a changing environment. For example, some workers at container terminals in the Port of Melbourne have a union-negotiated 'heat agreement', entitling them to a 15-minute break every hour if the temperature exceeds 35°C (Queensland University of Technology, 2010). Above 38°C, outdoor workers can stop working altogether until the temperature cools.

Emergency services are also on the front foot. For example, in the first 72 hours after the 7 February 2009 Black Saturday bushfires, 390 people presented to hospital emergency departments and 24 to the specialised referral centres for burns at The Alfred Hospital and the Royal Children's Hospital (Cameron et al., 2009). In anticipation of high admissions to the burns ward in The Alfred Hospital, patients stable enough to be moved were transferred out of the ward, extra beds were opened and surgical staff were put on standby.

TAKING ACTION TO PROTECT OUR HEALTH WILL HAVE COSTS, BUT THE COST OF INACTION WILL BE FAR GREATER

While Victorian hospitals coped well during this emergency, an even greater level of preparedness may be needed if we experience more frequent bushfires in future. For example, increased frequency of events may lead to more people needing treatment for severe burns. Such patients need considerable surgical resources devoted to them, particularly in the first 72 hours (Cameron et al., 2009).

THE MEDICAL PROFESSION HAS AN IMPORTANT ROLE TO PLAY IN COMMUNICATING THE HEALTH EFFECTS OF CLIMATE CHANGE. MANY AUSTRALIANS ARE UNAWARE OF THE REAL CONSEQUENCES FOR THEIR HEALTH AND THE HEALTH OF THEIR FAMILIES AND COMMUNITIES.

As Australians, we are lucky that we already have good health and that our health services are quick to respond to perceived and actual risks. These are the foundations on which we can build to better protect our health and that of future generations.

Health professionals in particular have an important role in ensuring that communities are prepared for a changing climate and the associated increase in the range of health concerns. They can help the community anticipate and plan for the expected and the unexpected.

Australia's Greenest Hospital

The new Royal Children's Hospital in Melbourne is expected to be Australia's greenest hospital. Measures include greater energy efficiency, an on-site gas tri-generation power plant, solar panels and a biomass fuel boiler. The Hospital expects to reduce greenhouse gas emissions by 45% compared to a conventional hospital (Department of Health, 2006). A 20% reduction in water use has been achieved through water treatment, water efficiency measures and rainwater collection.

Source: Victorian Government Department of Health 2011

The important role of health professionals

Public health professionals have an important responsibility for explaining public health challenges and ensuring that health services are equipped for those threats. For example, health professionals have been instrumental in raising awareness and advocating appropriate solutions to key public health concerns, like smoking.

Why does climate change matter to health professionals?

Climate change is a threat to our health

Over a number of years prominent individuals and organisations within the health profession have consistently highlighted that climate change is a serious threat to human health and wellbeing. Despite these efforts, many health professionals and much of the Australian community are yet to fully appreciate the health implications of a changing climate.

Communities with a deeper understanding of the health implications of climate change are better equipped to participate in decisions about addressing climate change and preparing themselves for changes that cannot now be avoided.

Health professionals have a special role as trusted communicators

An initial survey found that health professionals are among those trusted to provide truthful information about climate change (Leviston and Walker, 2011). Therefore, it is important that doctors have access to reliable, accurate information to provide useful information to their patients.

HEALTH PROFESSIONALS ARE A TRUSTED VOICE ON CLIMATE CHANGE IN AUSTRALIA

What should health professionals do about climate change?

Communicate

As trusted members of the community, public health professionals and health organisations have many opportunities to help the public and decision makers better understand the implications of climate change, including the risks to human health and Australia's health infrastructure.

Health professionals can also emphasise the personal relevance of climate change to individuals and society by focusing on health impacts and emphasising the immediate health benefits to individual and global health of effective climate change action.

Health professionals and health organisations can also work with other organisations to communicate the implications of climate change and the actions that can be taken. A coordinated approach will enhance the strength and clarity of messages.

Lead by example

Leadership by trusted health professionals, like doctors and nurses, and institutions, like hospitals and GP clinics, can have a significant ripple effect in the community. For example, health professionals and services that proactively prepare for future extreme weather events will also help build more resilient communities.

Source: © Royal Flying Doctor Service of Australia

5.2 Reducing the threat to our health

The most important and urgent strategy to protect our health and way of life is to reduce the emissions that cause climate change. The risks of future climate change to our health are serious, and grow rapidly with each degree of temperature rise.

PREPARING FOR CLIMATE CHANGE IMPACTS IS ONLY POSSIBLE UP TO A POINT. IF AUSTRALIA AND THE REST OF THE WORLD FAIL TO REDUCE EMISSIONS SUFFICIENTLY, WE RUN THE RISK OF CLIMATE CHANGE IMPACTS SO SEVERE THAT WE WILL BE UNABLE TO ADAPT.

Most scientists agree that the potentially catastrophic impacts of climate change can be avoided if we keep the global temperature rise to no more than 2°C above pre-industrial levels.

However, as set out in *The Critical Decade: Science, risks and responses*, humanity cannot emit more than 1 trillion tonnes of carbon dioxide equivalent between 2000 and 2050 if we are to have a 75% chance of limiting temperature rise to 2°C or less. In the first nine years of this period, humanity emitted 305 gigatonnes, or over 30% of the budget in less than 20% of the time period.

The decade between now and 2020 is critical if we are to remain within the 2°C guardrail.

An equally compelling reason to reduce greenhouse gas emissions is that the actions we take can have immediate health benefits now. Reducing emissions—by making our energy sources cleaner; our cars, houses and appliances more efficient; our cities friendlier to trains, buses, bikes and walking; and producing and eating healthier food—will help Australians live safer, healthier lives (Friel et al., 2009; Haines et al., 2009; Woodcock et al., 2009).

For example:

- Cleaner energy sources and more efficient use of energy will lead to healthier air (Haines et al., 2009).
- Improving the design of our cities and towns so that it is easier and safer to get around on foot, by bike and by public transport will reduce transport emissions and help people become more physically active (Woodcock et al., 2009; Bauman et al., 2008).
- Studies into the climate benefits of changing diet have found that a global transition to consuming less meat could substantially reduce emissions of methane and nitrous oxide—both of which are greenhouse gases—and create benefits for human health, such as heart disease and Type 2 diabetes. (McMichael et al., 2007; Stehfest et al., 2009).

MINIMISING THESE RISKS REQUIRES RAPID, DEEP AND ONGOING REDUCTIONS TO GLOBAL GREENHOUSE GAS EMISSIONS. WE MUST BEGIN NOW IF WE ARE TO DECARBONISE OUR ECONOMY AND MOVE TO CLEAN ENERGY SOURCES BY 2050—*THE CRITICAL DECADE: CLIMATE SCIENCE, RISKS AND RESPONSES*

Health benefits of reducing greenhouse gas emissions: the case of active travel

Improving the design of cities and towns to make it easier to get around on foot and bike has the potential for substantial benefits to our health, economy and greenhouse gas emissions. Physical inactivity causes over 13,000 deaths each year in Australia (Begg et al., 2007), and increases the risk of heart disease, Type 2 diabetes, breast and bowel cancer, depression and anxiety (Bauman et al., 2008). In 2007-08, three in five adults and one in four children were either overweight or obese (AIHW, 2010a). Increasing activity levels can prevent or limit these health disorders and thus save lives, and is an important part of combating obesity (WHO, 2004). For example, increasing by only 5% the number of Australians who do 30 minutes of moderate activity each day, could save 600 lives a year (Stephenson and Bauman, 2000). A Scandinavian study found that the death rate in workers who cycled to work was 28% lower than for others (Anderson et al., 2000).

Cycling and walking, in place of driving cars, can also help improve social connectedness and mental health. Walking can improve mental health and wellbeing, by having a positive impact on self-esteem, physical self-worth, stress and mood (Sinnett et al., 2011). One study found that Australians who walked for recreation as little as about 10 minutes a day were 72% more likely to report better physical health and 33% more likely to report better mental health, than those who walked less (Sugiyama et al., 2008). The Bus Association Victoria found that commuters in Victoria who caught the bus to work did about 41 minutes of incidental activity a day while those who commuted by car did only did eight minutes.

Current cycling levels are estimated to save the Australian health system $22.72 million annually (Bauman et al., 2008). A New Zealand study found that a 5% increase in short bicycle trips (less than 7 km) could have annual net health savings of NZ $200 million (Woodward and Lindsay, 2010). Promoting cycling and walking in place of driving cars can also help reduce greenhouse gas emissions. Transport generates 13% of Australia's emissions, and is one of the largest sources of increasing emissions in Australia (DCCEE, 2010). Passenger cars make up about half of transport emissions (DCCEE, 2010) and several studies have suggested that active transport can reduce reliance on private car-use and significantly reduce emissions (Giles-Corti et al., 2010).

Source: Neale Cousland/ Shutterstock.com

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