Climate change is widely regarded as the biggest threat to health in the 21st century (Costello et al. 2009; WHO 2015), yet the way we deal with this threat is a significant opportunity to improve health both locally and globally (Watts et al. 2015). Climate change affects health in many ways: directly through extreme events such as heatwaves, floods, bushfires, and indirectly via worsening air quality, changes in the patterns of infectious diseases, threats to food and water supplies, and effects on mental health.

**EXTREME HEAT**

In the past 50 years, average temperatures across Australia have increased, and heatwaves have become longer, hotter and more frequent (CSIRO & BOM 2014). Throughout the 21st century even longer, hotter heatwaves are expected due to climate change (Reisinger et al. 2014).

Heatwaves have caused more deaths in Australia over the past 100 years than any other natural event (Steffen et al. 2014). Recent heatwaves around Australia have caused increased hospital admissions and deaths. Exposure to prolonged high temperatures leads to higher rates of heat-related illnesses, such as dehydration, heat exhaustion, heatstroke, and worsening of existing health conditions, such as heart and kidney disease, and potentially death (Climate Commission 2011). Heatwaves put significant extra strain on healthcare and emergency services (Toolo et al. 2014; Wang et al. 2012; Turner et al. 2013).

Children, the elderly, people living in cities and those with pre-existing medical problems are more at risk during heatwaves. High temperatures also pose a risk to outdoor workers and those working in enclosed indoor areas; at particularly high risk are farmers, construction workers, and those working in emergency and essential services (Singh et al. 2013). Heat stress decreases productivity and causes significant economic loss (Kerstin et al. 2015).

Power outages are more common during heatwaves, causing refrigeration and air-conditioning systems to fail. Food spoilage may occur, increasing the risk of gastrointestinal infections such as Salmonella. Many medicines and vaccines must be refrigerated, and their supply may be threatened during heatwave events. Heatwaves also exacerbate drought, lead to higher levels of urban ozone air pollution, and increase the risk of bushfires. Transport services can be impacted, affecting supply chains, businesses and communities.

**BUSHFIRES**

Increasing temperatures, more frequent, intense and prolonged heatwaves, and declining rainfall are increasing the risk of bushfires in Australia (Reisinger et al. 2014; CSIRO & BOM 2014). The frequency of extreme fire weather has increased since the 1970s, particularly in south-east Australia, and the duration of the bushfire season has increased (CSIRO & BOM 2014). The risk of bushfires is expected to continue to increase with climate change, particularly in southern and eastern parts of Australia (CSIRO & BOM 2014; Reisinger et al. 2014).

Bushfires pose numerous risks to health. Burns, injuries and death may result directly from bushfires, while dehydration and heat exhaustion are particular risks for fire fighters. Smoke inhalation can damage the lungs and airways. Smoke may also be carried hundreds or thousands of kilometres away from the bushfire zone, affecting the health of communities across vast areas. Bushfires damage and destroy homes, infrastructure and services, health care services may be severely affected, for example due to damage to hospitals and medical centres. In Victoria in 2009, the Black Saturday bushfires resulted in 173 deaths, and 414 people presented to public hospital emergency departments in the first 72 hours after the fires (Cameron et al. 2009). Long-term mental health impacts on survivors can be significant. Greenhouse gas emissions from fires also contribute to our total emissions (Department of Climate Change and Energy Efficiency).
A decline in rainfall across southern Australia has been observed in recent decades, associated with a reduction in river flows. In the southwest, average annual rainfall has declined by 17% since 1970, while a 15% decline in late autumn and early winter rainfall has been observed in the southeast since the mid-1990s (CSIRO & BOM 2014). With ongoing climate change, further reductions in average rainfall across southern Australia are expected, with an increase in the frequency and severity of droughts (CSIRO & BOM 2014). Effects on agriculture are likely to result in reduced food production due to declining crop yields and stock losses. Bushfire and extreme weather events (cyclones, flooding, heatwaves) and changing patterns of pests and diseases may also threaten and destroy food supply (Garnaut 2008).

Declining food production and resultant increasing prices threaten the availability of healthy food for Australian communities, meaning more people will be at risk of under-nutrition. In particular, healthy food may be less accessible for low income earners and those in regional and remote areas. In addition, Australia will likely be under pressure to increase food exports to other regions, particularly the Asia-Pacific, due to the negative effects of climate change on global food supply (Garnaut 2008).

**Infectious Diseases**

Climate change is predicted to increase the risk of infectious disease transmission in Australia. For example, increasing temperatures and changing rainfall patterns are expected to change the patterns of mosquito-borne diseases, such as dengue fever and Ross River virus (Harley et al. 2011). Increasing temperatures may also increase the risk of food-borne infections such as bacterial gastroenteritis, due to increased growth of pathogens including Salmonella, Campylobacter and E. coli. Severe weather events associated with climate change can damage infrastructure essential for good health, including sewerage management and safe drinking water supply.

**Air Pollution**

Burning of coal for electricity generation releases dangerous air pollutants, in addition to climate change. Urban smog contains air pollutants such as ground-level ozone. Ozone levels increase on hot sunny days, with models predicting increases with climate change (IPCC 2013). Ozone irritates airways and aggravates conditions like asthma. For example, hospitalisations in Sydney due to ozone pollution are expected to double by 2050 due to climate change (Cope et al. 2008). Air quality is also adversely affected by bushfires, with smoke containing harmful particulate matter and carbon monoxide (Johnston 2009).

**Allergies**

Approximately 1 in 5 Australians has an allergic disease, (ASCIA 2013) and 1 in 10 suffer from asthma (AIHW 2011). Asthma and other allergic diseases have a major impact on physical health and quality of life, affecting work, school, social activities and psychological health. Common asthma triggers include plant pollens and fungal spores, with both influenced by climatic and meteorological factors. Warmer temperatures and increasing levels of carbon dioxide in the atmosphere can increase the production, potency and release of allergens such as pollens and spores, aggravating allergic diseases including asthma (Gauderman & Bambrika 2005; Blande et al. 2012). Changes to wind and rainfall patterns caused by climate change may also affect allergen production and distribution. Asthma is also aggravated by air pollutants such as nitrogen oxides, sulphur dioxide, ozone and particulate matter. Exposure to air pollutants may contribute to the development of asthma in children, and nitrogen dioxide exposure has been associated with increased childhood wheezing and asthma medication use (Gauderman et al. 2005).

**Mental Health**

Aside from its effects on physical health, climate change may adversely affect the mental health of many people in Australia. Extreme events such as cyclones, floods, droughts and bushfires cause psychological distress due to trauma, illness, loss of loved ones, destruction of property and disruption.
of communities. Displacement causes significant distress, as does the disruption of goods and services, and uncertainty regarding employment, education and the risk of further natural disasters. Depression, anxiety and post-traumatic stress disorders may occur as a result, with major long term effects on personal, family and community function.

Previous events have demonstrated the potential effects of climate change on mental health. Children surveyed six months after the 2003 Canberra bushfires, which destroyed 500 homes, showed much higher rates of behavioural and emotional problems compared to the baseline rate in Australia, with nearly half showing symptoms of post-traumatic stress disorder (McDermott et al. 2005). After Cyclone Yasi, the prescription of antidepressant drugs increased in affected areas, suggesting an increase in psychosocial distress in these affected communities (Usher et al. 2012). Long term events such as prolonged droughts also have a negative effect on mental health, particularly in farming communities. The more severe the drought, the worse the effects on mental health and wellbeing (Edwards et al. 2014).

VULNERABLE GROUPS
Some groups of people are more vulnerable to the effects of climate change on health.

Children are particularly vulnerable for numerous reasons. For example, they have immature immune systems, putting them at increased risk of infections, and are more susceptible to heat stress and dehydration. In addition, their rapid growth and development means harmful exposures in childhood may have severe long term effects.

Elderly people and those with pre-existing medical conditions are more prone to dehydration, heat stress and exacerbations of heart and lung disease, particularly when routine health services are disrupted by extreme events such as heatwaves and bushfires.

Pregnant women are at increased risk of heat stress during heatwaves due to the physiological demands of pregnancy, and hot weather during pregnancy increases the risk of babies being underweight at birth (Greenstone et al. 2013).

People living in rural and remote areas, and Aboriginal and Torres Strait Islander people are also at increased risk, in part due to their higher levels of underlying disease and limited access to health care services.

WHAT CAN BE DONE?
The recent acceptance of the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) has emphasised the need for urgent and substantial reductions in greenhouse gas emissions to limit temperature increases to less than 2°C, whilst highlighting the inadequacy of current emissions reduction targets and the risks of unchecked climate change.

To reduce risks to human health, further climate change must be minimised. In particular, the burning of fossil fuels must be phased out; it is estimated that 80% of the world’s known fossil fuel reserves must be left in the ground, including vast known reserves in Australia, to limit global warming to 2°C (The Climate Institute 2013). Importantly, Australian coal-fired power stations are among the least carbon-efficient in the developed world, producing approximately 60% more carbon dioxide than those in the USA, and more than double that produced by power stations in Europe (Kennedy 2015). Furthermore, it is essential that we move to decarbonise our electricity sector, greenhouse gas emissions from Australia’s fossil fuel exports significantly exceed those from electricity generation in Australia. Presently these export emissions are not included in Australia’s greenhouse gas inventory. Australia could manage exported emissions through consideration of the impact of resulting climate change in the approval process for both the mining and exporting of coal and gas (Haverd et al. 2013).

Australia needs to reduce unnecessary consumption and continue urgently transitioning to renewable energy sources like solar and wind, instead of relying on coal, oil and gas. This switch is economically and technologically feasible, but there is a need for robust political commitment to halt new coal mine development, ensure the decommissioning of existing coal mines and support the transition to renewable energy (Watts et al. 2015). We also need stronger regulation of air quality in Australia, to better limit emissions of harmful particulate matter and gases. Protecting forests and other ecosystems is also essential to further reduce greenhouse gas emissions; deforestation accounts for a significant proportion of Australia’s greenhouse gas emissions (Australian Government Department of the Environment 2015), and rates of land clearing are increasing in many parts of the country, particularly in Queensland and New South Wales (The Wilderness Society 2015).

Individuals, communities and governments need to increase their use of active transport (cycling, walking and public transport) to reduce vehicular greenhouse gas emissions, and avoid unnecessary air travel. Dietary changes are also important; the agricultural sector is a major contributor to greenhouse gas emissions, and reducing our consumption of processed foods, red meat and dairy products will help to combat climate change (O’Mara 2011).

While mitigation of climate change by reducing greenhouse gas emissions is essential, we must also seek to adapt to changing climate conditions in anticipation of their likely effects on health. In particular, health systems and services must be adequately resourced and prepared to cope with the health effects of climate change. Potential effects on housing, essential services, community function and the economy must also be considered, to ensure that all members of society have the opportunity for good health and wellbeing (Selvey 2015; Watts et al. 2015).

HEALTH AND CLIMATE.WIN:WINS
Aside from reductions in greenhouse gas emissions, there are numerous immediate and lasting health ‘co-benefits’ to be gained by action to limit climate change. Reducing our use of fossil fuels (particularly coal) will help to improve air quality, through reductions in particulate matter and other air pollutants. This will help to reduce rates of lung cancer, other lung diseases, heart disease and stroke. Reducing our reliance on private vehicles, and increasing our use of ‘active transport’ (walking, cycling and public transport) can make urban spaces more attractive and help to reduce rates of obesity, diabetes, heart disease, some cancers, and many musculoskeletal conditions. Reduced consumption of red meat can also reduce heart disease and cancer risk, particularly bowel cancer (Smolińska & Paluszkiewicz 2010). Protecting forests and natural ecosystems helps reduce atmospheric carbon dioxide levels by sequestering carbon, improves air and water quality, supports biodiversity, and promotes mental health and well-being by supporting human connections with the environment. The greening of urban areas decreases the heat island effect, reducing the need for air conditioning and improving the quality of urban life. These benefits are not only important for public health, but also help to reduce demands on the health system.

MORE INFORMATION
For more information about climate change and health, visit:


• Climate Council https://www.climatecouncil.org.au/

• Intergovernmental Panel on Climate Change http://www.ipcc.ch/

REFERENCES


Gauderman, W.J. et al., 2005. Childhood asthma and exposure to traffic and nitrogen dioxide. Epidemiology, 16(6), pp.737-743.


