

# NO TIME FOR GAMES

CHILDREN'S  
HEALTH  
AND CLIMATE  
CHANGE

**Foreword**  
**Professor**  
**Fiona Stanley**

**Climate change poses a significant and growing threat to public health. However it's our children who, despite being the least responsible for causing it, unfairly bear the brunt of the impacts.**

*No Time For Games: Children's Health and Climate Change* collates scientific research on the child health effects of climate change, both in Australia and at a global level.

Doctors for the Environment Australia's timely report demonstrates extreme weather events and increasing temperatures are already causing childhood illness in households throughout Australia. Furthermore gastro-intestinal diseases, respiratory and heat related illnesses, and the physical and mental health impacts of floods, bushfires and droughts are all expected to rise.

This report makes it clear that Australia must be prepared to adapt our care of children to the threats our young people are experiencing as a result of climate change.

Our already stretched health services must immediately prepare for an inevitable increase in childhood sickness by training GPs and specialists, and educating the wider community, especially parents.

Crucially, federal and state governments must take immediate steps to curtail increasing temperatures by whatever means necessary. This includes contributing robust targets at the UN global climate change negotiations in Paris in 2015 which are aimed at setting strong emissions reduction targets to stall temperature rises.

Failure to act responsibly will have dire consequences for our children's wellbeing, and the impacts of inadequate action for their children verge on the apocalyptic and are too scary to contemplate.



*Professor Fiona Stanley, AC FAA  
FASSA is Patron and former Director  
of the Telethon Kids Institute,  
Distinguished Research Professor,  
The University of Western Australia,  
Vice Chancellor's Fellow,  
The University of Melbourne.  
She was named Australian of  
the Year in 2003.  
She is a member of Doctors for the  
Environment Australia's Scientific  
Advisory Committee.*

Conversely choosing now to limit further climate change offers a major opportunity to immediately improve the health of our children via reductions in air pollution and design of low carbon cities.

If we do nothing how will our generation, who had the chance to act but failed to do so, justify our inaction to future generations living on what will become an inhospitable planet?

As a parent, a grandmother and a public health professional with a long career in primary prevention, I strongly urge all Australians to get behind this report's bold recommendations. Together we can and must help tackle climate change for the sake of our children, while there is still time.

### **About Doctors for the Environment Australia**

*Doctors for the Environment Australia (DEA) is an independent, self-funded, non-government organisation of medical doctors in all Australian States and Territories. Our members work across all specialties in community, hospital and private practices and public health.*

*We work to prevent and address the diseases local, national and global-caused by damage to our natural environment. We are a public health voice in the sphere of environmental health with a primary focus on the health harms from pollution and climate change.*

## Key Findings

**Children are particularly vulnerable to the health impacts of climate change because their behaviour exposes them to increased risks, their bodies respond differently to harms, and they are dependent on others.**

- 1 Climate change has a direct impact on children's mental and physical health. This will increase as temperatures rise and more frequent and severe extreme weather events such as bushfires and floods occur.
- 2 Children are particularly vulnerable to the health impacts of climate change because their behaviour exposes them to increased risks, their bodies respond differently to harms, and they are dependent on others.
- 3 Research shows a link between excessive heat and childhood emergency department attendances for diseases such as asthma, fever, gastroenteritis, and electrolyte imbalances.
- 4 There is evidence that exposure to extreme heat during pregnancy is related to premature birth.
- 5 Climate change affects children's mental health. Mental and emotional distress documented for children and adolescents following weather disasters include post-traumatic stress disorder and higher rates of sleep disturbance, aggressive behaviour, sadness, and substance abuse.
- 6 Flooding can have comprehensive health effects on children. They include drowning and near-drowning, injury, hypothermia or electrocution. Dirty water that floods bring into homes, yards and playgrounds can also carry diarrhoeal disease, skin and soft-tissue infections and a flu-like illness called leptospirosis. In the damp conditions following floods, mould spores proliferate to aggravate allergies and asthma attacks in children.

## Key Findings

- 7 Diseases carried by mosquitoes, including dengue, Ross River virus, Barmah Forest virus and Murray Valley Encephalitis are of concern, with dengue the most relevant to children.
- 8 The current global increase in childhood asthma could be partly explained by increased exposure to allergens in the air driven by climate change.
- 9 Climate change will increasingly threaten the fundamental foundations of children's health - clean air, food, water and social and economic stability. Australia is not immune.
- 10 Activities that contribute to climate change also directly worsen child health. The continued use of coal, gas and oil causes significant harm to children mainly via air pollution.
- 11 It is very likely that there will be an increasing burden of disease in Australia requiring attention from general practitioners and hospitals due to injury or psychological trauma from extreme weather events, infections such as gastroenteritis and illness due to ozone and bushfire air pollution.
- 12 Our health system infrastructure or resources can themselves be directly affected by climate change, potentially limiting their ability to provide care. In the heatwave prior to the Black Saturday bushfires, 25 per cent of all hospitals had problems with their air conditioning or cooling systems.
- 13 To avoid widespread, severe and irreversible impacts associated with 4 degrees of global warming, urgent action must be taken to reduce greenhouse gas emissions. Global climate change negotiations in Paris this December offer a crucial opportunity for Australia to make a strong commitment to protect our children.

**Climate change will increasingly threaten the fundamental foundations of children's health - clean air, food, water and social and economic stability**

## Contents

Introduction	7
Children are more vulnerable to the health effects of climate change	9
Climate change: effects on children's health	11
Extreme weather events	14
Infectious diseases	21
Allergic diseases	24
Air pollution	25
Climate change threatens the foundations for children's health – clean food, water and social stability	27
Failing to act affects children's mental health	30
Climate change will put increasing pressure on children's healthcare services	31
Failing to act is a major intergenerational injustice	34
Solutions	35
References	39

## Introduction

### Climate change is now affecting the health of our children.

Science tells us climate change is already leading to increasing temperatures and more extreme weather events, and is affecting sea level rise, patterns of rainfall and ice cover, and the behaviour of ecosystems. Such changes have vast health impacts, and it is our children who are most vulnerable.

As doctors, we are therefore increasingly concerned about the health effects in Australian children of more frequent and severe droughts, floods, bushfires and heatwaves, which we are now witnessing, and climate change-related alterations in the spread of infectious diseases, air pollution and triggers to allergic diseases and asthma.

What worries doctors the most however is that climate change is threatening the underlying social, economic and environmental determinants of child health. Reduced availability of food, water and sanitation and disruption



to education and social stability are already occurring in developing countries. Australia is not immune to such effects in the future. We have a moral responsibility to assist the children of the world and a vested interest in maintaining geopolitical stability.

Globally climate change is already causing the deaths of 400,000 people

per annum (*DARA, 2012*) and 88 per cent of the burden of disease due to climate change falls on children under the age of five (*McMichael & Campbell-Ledrum D, 2004*); this latter figure takes into account the effect of expected future years of life lost lived in reasonable health, assuming a person in good health can live into their eighties. Research at the Australian level has been limited but we know enough to say our children are already being affected, and will be increasingly impacted in coming years.\*

The effects we are seeing today are at 0.85 degrees of average temperature warming. We are gravely concerned for

## Introduction

our children if the world continues emitting greenhouse gases to keep us on track towards 4-5 degrees of average warming this century - it is widely recognised by scientists this would risk a largely inhospitable planet. What is at stake is national responsibility for the future of our children. To allow such an atrocity to occur would constitute a major intergenerational health threat and unspeakable injustice.

Unfortunately our current commitment to action has become a victim of politics and vested interests in Australia. Doctors are dismayed at our country's bipartisan targets for reducing emissions by 5% by 2020 on 2000 levels and by moves to increase coal exports- these are both at odds with protecting our most precious asset – our children.

As doctors we make daily decisions on whether to start treatment based on available evidence. In the case of climate change we have more than enough information to act. We therefore must speak up on behalf of our children, who cannot take action themselves, yet whose health will be the most affected.

Global climate negotiations in Paris this December represent a major opportunity for Australia to amend its lagging efforts by committing to ambitious emissions reductions. Politicians need to realise that many measures to reduce emissions also have substantial immediate health benefits for children. Preparing our health services and infrastructure for inherent climate change from past and current emissions is also essential.

This report outlines the available evidence on existing and expected health effects of climate change on our children, and paediatric health services, both in Australia and globally. We make recommendations to the government on necessary actions to take to the UN climate change meeting in Paris and to implement in Australia to protect children's health.

No one is more important in our society than our children. The fact is climate change is now threatening their health and future in major ways. We implore the mums, dads and grandparents of Australia to join us in insisting that governments make the necessary changes.



## Children are more vulnerable to the health effects of climate change

Children are more vulnerable to many of the health effects of climate change because their behaviour exposes them to harm and because they have a different bodily response to these harms (*Bunyavanich, Landrigan, McMichael, & Epstein, 2003*).

Children are particularly vulnerable to a changing climate because:

- They drink, eat and breathe more for their body weight compared to adults, which increases their risk from hazards such as air pollution, water shortage and contamination, and malnutrition.
- They have difficulty coping with stresses from increasing average and extreme temperatures because of their immaturity of physiology and metabolism.
- Their immature and naive immune systems make them more vulnerable to many infections.
- Their rapid growth and development in utero and childhood means exposure to harmful situations such as maternal and/or childhood malnutrition, or exposure to air pollutants leading to chronic asthma, can have ongoing, severe and long-term effects into adult life.

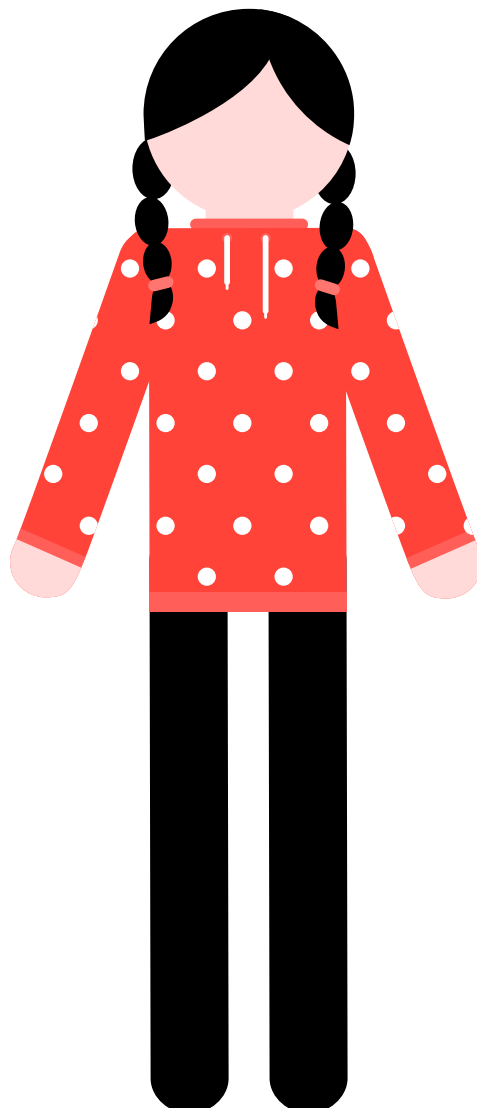
Psychological trauma exposure in childhood can lead to alterations in a developing brain's function and longer term cognitive and mental health impacts.

- Their behaviour is different and they lack many self-protection mechanisms: They more frequently put things in their mouths, increasing chances of infection. They tend to spend more time outdoors thereby exposing themselves to hazards such as dehydration and sunburn.
- They rely on primary care givers to protect and provide for them- and will suffer more if their responsible adult is impaired.

Children have a longer life expectancy, and are therefore more at risk from the effects of repeated or prolonged exposures. On a broader scale, early effects of climate change on a generation's physical or mental health could leave lasting consequences on human capital as children reach adult life, and eventually on subsequent generations (*Butler CD, 2014; Yoko, Goodman, & Parker, 2009*).

Climate change will widen existing equity gaps within society. Children who are at existing disadvantage are likely to suffer more from the effects of climate change, although no population is immune. One example is likely to be Aboriginal and Torres Strait Islander children in remote areas who already suffer lack of access to healthy foods or adequate infrastructure.

Why children are more vulnerable to the health effects of climate change



**Rapid development of brain and body**

---

**Higher respiratory rates**

---

**Dependence on caregivers**

---

**Larger body surface area**

---

**Higher metabolic rate**

---

**Different behaviour**

---

**Immature immune system**

---

**Lifelong exposure**

---

## Climate change: effects on children's health

**Nearly all physical, environmental and socioeconomic impacts of climate change may ultimately affect child health, through altering weather patterns, changes in water and air quality, food quantity and quality, ecosystem services, livelihoods, infrastructure and migration.**

Doctors (AAP, 2007) consider health effects of climate change as either:

- those occurring directly due to temperature changes, extreme weather events, changes in air pollution, allergy triggers or infectious diseases; or
- those occurring indirectly due to wider changes in underlying social, environmental and economic foundations of health.

Indirect health effects include those increasingly predicted to occur due to climate change-related water and food insecurity, disruption to social and economic stability, and migration.

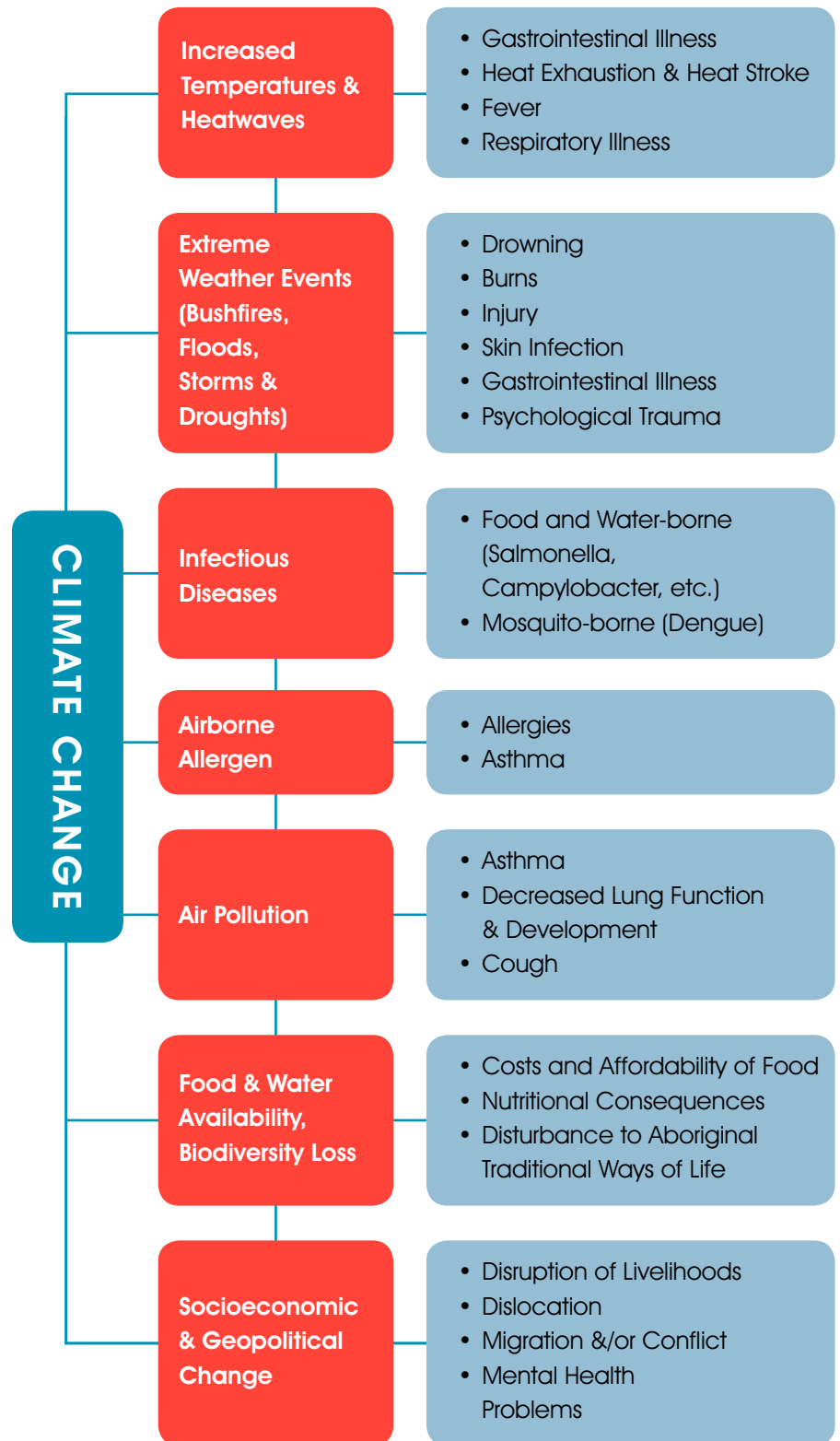
### **In Australia**

In Australia, we are already seeing the effects of increasing temperatures and heatwaves, bushfires, floods and droughts, including psychological disturbances. Gastrointestinal illness in children is of concern. Doctors worry about the expected effects of climate change on allergic diseases, air pollution and mosquito-borne infections. Indirect effects described above will become more prominent as climate change progresses.

# NO TIME FOR GAMES: CHILDREN'S HEALTH AND CLIMATE CHANGE

## Existing and expected health impacts of climate change on child health in Australia

Credit: Adapted from (Bunyavanich et al., 2003)



### **The global picture**

Evidence strongly suggests climate change is already contributing to the global burden of disease and premature deaths via both direct and indirect effects, for example in the Asia Pacific region where the Pacific Islands are suffering seawater inundation (*Mathiesen, 2015*).

In 2010 it was estimated that climate change caused the loss of 400,000 lives (DARA, 2012). Previous disease burden estimates by WHO calculated 88% of the years of life lost due to ill-health, disability or early death due to climate change fell on children predominantly in developing countries due to malaria, malnutrition, diarrhoea, and inland flooding fatalities (*McMichael & Campbell-Ledrum D, 2004*). This figure takes into account the effect of expected future years of life lost lived in reasonable health, assuming a person in good health can live into their eighties.\*

It cannot be overemphasised that climate change and poverty are strongly related and there is general agreement that international goals to alleviate poverty cannot be attained without reduction of climate change (*A. McMichael, Montgomery, & Costello, 2012*).

At a global scale, the importance of local environmental factors to child health is demonstrated by the WHO. They estimate that a third of the worldwide burden of disease for children is due to modifiable factors in air, water, soil and food (*Prüss-Üstün & Corvalán, 2006*)

### **The future**

Evidence indicates that climate change will increasingly exacerbate, or expand the geographical range of existing diseases through resultant environmental, social and economic changes. While we know that children are particularly vulnerable to the problems that will increasingly occur with a changing climate, little research has been done particularly in Australia to predict numbers that will be affected in the future, and therefore enable us to plan our health system accordingly. In general, negative health risks are expected to far outweigh any potential health benefits of climate change, such as reduced cold-related deaths, particularly in Australia (*Bambrick, Dear, Woodruff, Hanigan, & McMichael, 2008; McMichael, Montgomery, & Costello, 2012; McMichael et al., 2003*).

Science clearly tells us that based on our current greenhouse gas emissions trajectory we are currently on track for a 4-5 degree rise in average global temperature this century (*IPCC, 2013*). The latest Intergovernmental Panel on Climate Change report describes this scenario as risking 'severe, widespread and irreversible impacts'. It is clear that this situation risks environmental, economic and social instability, which would result in profound changes to our children and their children's lives, health and wellbeing. Urgently limiting our emissions could put us on a path to keep to less than 2 degrees of warming, increasing the likelihood of avoiding severe impacts.

The sections below summarise our existing knowledge on health impacts of climate change, with a particular focus on Australia and, where relevant, the global context.

### Extreme weather events

#### Heat waves

Heat waves are an increasing health problem in Australia, responsible for over 1 100 annual deaths (*McMichael et al., 2003*). While 173 people died in the Black Saturday fires, many people don't know an estimated 374 excess deaths occurred in Victoria during the accompanying heat wave (*Victorian Department of Human Services, 2009*).

CSIRO predict the number of days over 35°C across the nation will increase significantly by the end of the century. Hot days will increase 2.5 times in Adelaide, triple in Melbourne and Hobart, quadruple in Sydney, be six times higher in Canberra and 20 times higher in Brisbane. In Perth, for more than two months out of a given year, the mercury will soar over 35°C, as it will for 10 months in Darwin (*CSIRO, 2008b*).

Children are particularly vulnerable to the effects of heat due to behaviours such as playing out-doors during a heat wave, failing to drink sufficiently, and being less able to control their local environment. They are also thought to be more vulnerable due to their smaller body mass to surface area ratio.

Excessive heat can lead to syncope, cramps, exhaustion or, in the worst case scenario, heat stroke. Heat stroke is a medical emergency with a death rate as high as 33%. Symptoms of heat illness can include pale skin, cramping, profuse sweating, nausea, fainting and dizziness, which can progress to confusion and lack of sweating.

Very young children, especially children under one year of

age, are particularly vulnerable to over-heating. Reports of infants dying when left in vehicles suggest a generally low awareness of the dangers of heat.

Research increasingly shows excessive heat also demonstrates a relationship with many other childhood diseases, particularly respiratory disease, electrolyte imbalance, fever and kidney impairment (*Xu et al., 2014*). Australian research from Brisbane and Westmead Children's Hospital in Sydney demonstrated an association between higher temperatures and increased rates of emergency department attendances for fever, gastroenteritis, asthma, hormone and metabolic diseases and nervous system diseases (*Lam, 2007; Xu et al., 2014*). Overseas, a study during a 2006 heatwave in California showed children aged 0-4 were six times more likely to present to an emergency department compared to a period without



a heatwave, and visits for electrolyte imbalances increased 19% (*Knowlton et al., 2009*).

Evidence also indicates that high temperatures can affect the number of cases of other infections such as hand, foot and mouth disease, which occurs particularly in children. In a Japanese study, the weekly number of hand, foot and mouth disease cases

increased by 11.2% for every 1 degree increase in average temperature (*Onozuka & Hashizume, 2011*).

There is evidence that exposure to extreme heat during pregnancy is related to premature birth. Research in Australia showed that women were up to twice as likely to have a preterm birth following exposure to a heat wave (*Wang, Williams, Guo, Pan, & Tong, 2013*) with another study suggesting the effect is greatest when high temperature occurs later in pregnancy (*Strand, Barnett, & Tong, 2012*). In US research, a 5.6 degree Celsius increase in weekly average temperature was associated with an 8.6% increase in preterm delivery (*Basu, Malig, & Ostro, 2010*).

## Kids and sport

Sport is embedded in Australian society and culture: children play in backyards, participate at school and almost two-thirds take part in organised sport outside the school setting (*Climate Institute, 2015*).

Many sporting events are conducted at high-risk times and locations for children, where overexposure to UV and heat illness can occur. Sunburn during adolescence increases the risk of skin cancer later in life; and heat illness can progress to heat stroke, which is life threatening.

There is an increasing awareness of the issues of higher temperatures amongst sporting groups but a recent report by the Climate Institute finds that most sporting groups are struggling to cope with the issue, especially at the local level. Some groups are beginning to make specific allowances for increased vulnerability in children; the South Australian Cricket Association puts in place extreme heat measures at temperatures of 37+, or 34+ for kids (*Cricket South Australia*).

Constricting sporting activity is a concern however as only one-third of children, and one in ten young people undertake the healthy lifestyle recommendations of 60 minutes of physical activity every day (*ABS, 2013*).



### News Release **Minister Leon Bignell**

Minister for Tourism  
Minister for Recreation and Sport

Friday 31 January, 2014

#### SA sport and rec clubs to action extreme heat policy

South Australian sport and recreation clubs are urged to put their hot weather policies into action over the coming days, with the State Emergency Service issuing an Extreme Heat Warning.

All sport and recreation organisations, associations and clubs have an obligation to implement these policies for the health and safety of their members, participants and officials (referees and umpires).

This warning comes with temperatures expected to top 40 degrees over the weekend, moving into the high 30s for most of next week.

Minister for Recreation and Sport Leon Bignell said prolonged exposure to extreme heat was unsafe for those training or playing sport, as well as those umpiring games.

"We are going to see some very hot days and nights over the coming week so it is very important that sporting and recreation clubs and groups put their hot weather plans into place now and make sure these plans are well-known to everyone involved," Mr Bignell said.



### Bushfires

Record-breaking heat and drought due to climate change is increasing the risk and severity of bushfires in many parts of Australia. Furthermore the fire season is lengthening, reducing the length of time available for hazard reduction burning (*Climate Council, 2014*). After the Black Saturday bushfires in Victoria in 2009 a new 'catastrophic' fire weather warning was created.

The 2014 IPCC report confirms with 95% certainty that climate change is expected to continue to increase the number of days with very high and extreme fire weather, particularly in southern Australia (IPCC, 2014c). One estimate of the potential increase in very high and extreme fire weather days is 4%–25% by 2020 and 15%–70% by 2050 (*Hennessy, 2007*).

Children are particularly vulnerable to death or injury in bushfires due to a reduced ability to control their surrounding environment and fundamental dependence on their carer. Their smaller size and strength can make them more susceptible to physical injury and a higher skin surface to body mass ratio and higher relative water requirement creates an increased vulnerability to extreme heat and burns.



In Australia, bushfires have accounted for more than 800 deaths, including in children, since 1850 (*Cameron et al., 2009; King et al., 2013*).

The devastating Black Saturday bushfires in Victoria in 2009 which ranked as one of the world's ten most deadly recorded bushfires, accounted for 173 deaths and 800 emergency

presentations to public hospitals. The 2009 Victorian Bushfires Royal Commission's documented accounts of the events surrounding the deaths of all those killed are horrible and shocking (*Teague, McLeod, & Pascoe, 2010*). A large proportion of the fatalities (44%) were in those vulnerable and least able to care for themselves, namely children under 12 years of age, those over 70 years old and those with either chronic or acute disabilities (*Handmer, O'Neil, & Killalea, 2010*). At the Melbourne Royal Children's Hospital, four patients presented with burns from bushfires. Two were admitted to the ICU, one of whom had burns to 80% of their body and tragically died (*Cameron et al., 2009*).

The smoke resulting from bushfires can also seriously harm children's health. This is discussed later.

## Victorian Black Saturday bushfires in 2009

In the town of Chintin, a mother of three took her children to a nearby dam when the fire started leaping up the walls of their house. "We went in up to our necks and put the blanket over our head, but sure enough the fire came up to the ... dam and blew right over," she said. "The children were hysterical. I tried to be positive, said it would be okay, you're going to grow old, you're not going to die while you're little, and we kept on talking positively - slow your breathing down, don't breath in too much smoke (ABC, 2009)"

## Floods

Most Australians would remember the flood levy imposed after the unprecedented floods in Queensland in 2011 necessitated an estimated \$10 billion in reconstruction costs (IBIS, 2011). 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).

It is estimated that worldwide 2.8 billion people were affected by floods between 1980 and 2009, with more than 500,000 deaths (Doocy, Daniels, Murray, & Kirsch, 2013).

There is 95% certainty that increased frequency and intensity of flood damage to infrastructure and settlements in Australia will occur in the future due to a changing climate (IPCC, 2014c).

Flooding events can have comprehensive health effects on children. The physical health effects include drowning and near-drowning, injury, electrocution or hypothermia experienced during the event or clean-up process or brought about by damage to infrastructure.

Children are particularly vulnerable in floods because they rely on others to care for them, they may lack swimming ability and their reduced size and strength makes them susceptible to injury or hypothermia.

## NO TIME FOR GAMES: CHILDREN'S HEALTH AND CLIMATE CHANGE

Dirty water or leaked sewerage that floods bring into homes, backyards, streets, parks and local playgrounds can also carry diseases. These include diarrhoeal disease, skin and soft-tissue infections and a flu-like illness called leptospirosis.

Stagnant water can also contribute to an increase in mosquito-borne disease, and in the damp conditions

following floods, mould spores proliferate to aggravate allergies and asthma attacks in children.

In poorer countries the effects of flooding can include profound lack of food and clean water and displacement of entire populations. The Pakistan floods of 2010 affected the homes of 12 million people, destroyed 2.2 million

hectares of crops and killed 450,000 head of livestock. United Kingdom aid charities provided one million people with food, 510,000+ with clean water, 290,000 with emergency shelter and 200,000 people were given mosquito nets to prevent malaria (*Disasters Emergency Committee, 2012*).



Kids playing in Rockhampton during 2013 Queensland flooding

The Queensland Health Department issued warnings following the 2011 floods to limit skin exposure to dirty water, avoid eating poorly refrigerated food or drinking contaminated water, keep cuts clean and avoid getting bitten by mosquitoes that could breed in stagnant water. Queensland Health's Public Health Physician pointed out diarrhoea and viral illnesses could occur if food and personal hygiene were ignored (*ABC, 2011*).

### Psychological impacts of extreme weather events

The World Health Organization reports that between a third and half of all people exposed to natural disasters or conflicts will develop mental distress such as post-traumatic stress disorder (PTSD), depression or anxiety (*WHO, 2001*).

Children's ongoing brain development, along with their dependence on care-givers, makes them more vulnerable to the emotional trauma and mental health effects of bushfires, floods and droughts. Their suffering tends to be much longer lasting and can be much worse than the direct physical effects (*Ahern, Kovats, Wilkinson, Few, & Matthies, 2005*).



Home and family belongings destroyed by the Kinglake bushfire 10 February 2009

Witnessing a traumatic event is the obvious trigger to many, but sudden changes in living routines, schooling, and social networks, and the ongoing social disruption, economic damage and population displacement caused by weather disasters can also impair a child's psychological and social development. In the worst

case, psychological distress can lead to marked alterations in brain function and longer term effects on cognition and mental health (*Pynoos, Steinberg, Ornitz, & Goenjian, 1997; Teicher et al., 2003*).

Mental and emotional distress documented for children and adolescents following weather disasters include post-traumatic stress disorder and higher rates of sleep disturbance, bed-wetting, aggressive behaviour and sadness. Exacerbations in depression, anxiety and stress have also been observed (*Abramson, Garfield, & Redlener, 2007; Ahern et al., 2005*).

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, Lee, Judd, & Gibbon, 2005*).

After Hurricane Andrew in south-eastern USA, it was found that children were 2-3 times more likely than adults to suffer symptoms of post-traumatic stress disorder and symptoms were longer lasting (*Shaw, Applegate, & Schorr, 1996*).

Further, research on children exposed to Hurricane Gustov three years after experiencing Hurricane Katrina suggests exposure to one natural disaster may amplify the psychological impacts of living through further events (Salloum, Carter, Burch, Garfinkel, & Overstreet, 2011).

Stress suffered by adults following a weather-related disaster can also have serious implications for children by impairing their abilities as care-givers, and by eroding the close and supportive relationships that are important to children's development.

In extreme circumstances neglect or physical, emotional or sexual abuse of children can result (*Rezaeian, 2013*). In a study from the US for example, rates of inflicted head injury to children under 2 years old increased five-fold after Hurricane Floyd (*Keenan, Marshall, Nocera, & Runyan, 2004*).

Slow-developing events such as prolonged droughts can contribute to chronic psychological distress and even suicides within families. This well recognised phenomenon in rural farming regions of Australia (*Kent & Alston, 2008*) adversely affects communities, family members and children and youth.

### Infectious diseases

Climate change may increase the spread or prevalence of some food-borne, water-borne or vector-borne infectious diseases which react to changes in temperature and moisture - again children can be particularly susceptible.

#### **Food- and water-borne disease**

Children are more liable to succumb to bacterial or viral food and water-borne infections because of their immature immune system, higher drinking rate, a propensity to place contaminated objects in their mouth and/or indiscriminate drinking of contaminated water. Once they have an infection, they can become dehydrated and malnourished more quickly in part due to a higher metabolic and breathing rate, and a higher requirement for water per unit of body weight.

Currently, diarrhoeal disease is the second leading cause of death in children under 5 years old globally, causing approximately 760,000 deaths per year, mainly in developing countries (*WHO, 2013*). Rises in temperature due to climate change are predicted to increase the incidence and severity of diarrhoeal disease so that each degree of rise in average temperature may lead to an increase of millions of cases worldwide (*Checkley et al., 2000*). Pre-existing malnutrition and the presence of other infections add to severity.

In Australia, recent research shows that hot days increase the number of young children attending hospital with gastroenteritis (*Lam, 2007*). In Peru, a study found for every 1 degree increase in temperature there was a 3-8% increase in hospital admissions for diarrhoeal disease (*Checkley et al., 2000*).

Under predicted increases in temperature due to climate change, food-borne bacterial gastroenteritis due to infections including Salmonella, Campylobacter and E.coli are expected to lead to between 205,000 and 335,000 cases annually in Australia in 2050 - many will be children (*Bambrick et al., 2008*).

Risk of infection is also increased by recent flooding, bushfires or heatwaves, which can variably result in loss of power generation, breakdown of water storage, sanitation and sewer systems, reduced refrigeration or inadequate means to thoroughly cook food. For example, over a 45 year period in the United States, 68% of water-borne illness outbreaks resulting from contaminated water sources were associated with preceding heavy rainfall (*Curriero, Patz, Rose, & Lele, 2001*).

### **Vector-borne disease**

A vector is an organism such as an insect that transmits a disease-causing microorganism from one host to another, usually through biting.



Rising temperatures, changing rainfall patterns, increased flooding and shifting climate regions may alter the distribution over time and space of vector-borne infectious diseases. In Australia, dengue, Ross River Virus and Barmah Forest Virus are of concern (*Bambrick et al., 2008*), with dengue the most relevant to children. Diseases susceptible to climate changes worldwide

include malaria, dengue fever and tick-borne diseases like Lyme disease and schistosomiasis (*IPCC, 2014a*). There is potential for new infectious diseases to emerge with a changing climate (*Bunyananich et al., 2003*).

Children can be more susceptible to mosquito and tick bites due to playing outside and close to the ground. Children, especially infants, are still in the process of physiological growth and are more immunologically sensitive to some infectious diseases. Additionally, if a disease spreads to a new geographical area, populations with no existing immunity can face an increased likelihood of infection.

**Dengue** The World Health Organization indicates that dengue fever is the fastest spreading vector-borne disease, now placing half of the world's population at risk and infecting around 390 million people worldwide each year (*WHO, 2015a*). The estimated population at risk in 2050 will be approximately five billion under a scenario of continued GDP growth and progression of climate change. The burden of disease and the majority of deaths caused by dengue are highest among children (Yoko et al., 2009).

Already, dengue is a significant problem for Australia - we have seen a number of larger outbreaks in recent years in the North of the country. In Queensland 2,069 locally-acquired dengue cases were recorded between 2000-2009 as a result of the virus being introduced by travellers returning from Asia (*Queensland Health, 2011b*).

Kearney et al. used biophysical models to predict that climate change will increase vector habitat suitability throughout much of Australia. Changes in water storage as a response to a drier climate may be an increasingly important pathway through which climate change affects mosquito breeding (*Kearney, Porter, Williams, Ritchie, & Hoffmann, 2009*).

Dengue can cause severe illness requiring admission to hospital, and can be life threatening particularly if contracted a second or third time. There is no vaccination or specific treatment. Unlike malaria where fast acting treatments for reducing the spread are generally effective, treatments to reduce the much longer period of dengue infection are not readily available. Dengue prevention and control solely depends on effective vector control measures.

**Malaria** Research suggests increased temperatures will spread the range of the vector mosquito to higher altitudes and latitudes. Moderately warmer temperatures can increase vector mosquito reproduction, development rate, survival and biting activity (*IPCC, 2014b; Shea, 2009*).

The disease currently causes 200 million cases and about half a million deaths across the world each year (*WHO, 2015b*). Beguin et al. model the population at risk of malaria due to a changing climate in 2050 will increase to 5.2 billion out of a predicted global population of 8.5 billion, assuming GDP per capita remains constant. If continued economic growth (presumed to align with social development) is factored in, this figure decreases to 1.95 billion, highlighting also the strong influence of economic development and good public health care on prevalence of the disease (*Béguin et al., 2011*).

The relevance of this situation to young children is compelling for they have more complications than adults and they suffer 85% of all deaths from malaria (*WHO, 2011*). Infection with malaria often leads to severe anaemia and can infect the brain and cause long-term disability. Malaria is not currently considered a threat to children in Australia for the foreseeable future under a changing climate (*A. McMichael et al., 2003*).

### Allergic diseases

Asthma is a major problem for Australian children with 1 in every 9 or 10 children suffering from the disease (*AIHW, 2011*). This high rate is reflected in our day-to-day lives - many of us know a child with asthma, and we recognise it can be a very serious problem in childhood. Children are also particularly susceptible to other allergic diseases such as hayfever and can go on to have life-long impairment from such conditions.



Over two million Australians have asthma, a relatively high prevalence compared to the rest of the world. In 2008 \$665 million was spent on treating asthma in Australia, equating to 0.9% of all direct health expenditure on diseases (*AIHW, 2015*).

The current global increase in childhood asthma could be partly explained by increased exposure to allergens in the air as a result of climate change (*Beggs & Bambrick, 2005*). There could also be an impact on other allergic diseases such as hay fever (*Beggs 2010 AR5*).



Warmer conditions, extension of the summer season and higher levels of atmospheric carbon dioxide generally favour the growth, production and release of allergens into the air such as fungal spores and plant pollen. Other climate changes such as higher winds and droughts may produce windborne dust and other atmospheric materials and transport these allergens to new regions.

Small geographical area studies have demonstrated that increasing concentrations of grass pollen lead to more frequent hospital visits due to asthma symptoms, with a time lag of 3 to 5 days (*Héguy et al., 2008*). Pollen levels have also been associated with hospital visits with hay fever symptoms (*Breton, Garneau, Fortier, Guay, & Louis, 2006*).

### Air pollution



Climate change is expected to increase air pollution from both ground level ozone and bushfire smoke. Equally, activities

that currently cause climate change (ie the burning of fossil fuels for transport or energy generation) also cause air pollution, making our children sick. Children are susceptible to air pollution due to their developing lungs, more time spent outdoors and higher underlying predisposition to asthma. This can lead to poor sleep, less ability to participate in active play, school absences,

medication use and more frequent visits to hospital or general practitioners (*EPA, 2009*).

**Ground level ozone** is a respiratory irritant and an important component of urban smog. It increases on hot sunny days, and therefore is expected to worsen in Australia as climate change progresses. It is predicted that hospitalisations due to ozone exposure in Sydney for example will increase by 40% by 2020 and 200% by 2050 (*CSIRO, 2008a*).

**Bushfire smoke** can seriously affect children, particularly infants, as it contains respiratory irritants, and inflammatory and cancer-causing chemicals. Smoke can be transported in the atmosphere for hundreds or thousands of kilometres exposing large populations to its impacts.

**Combustion of fossil fuels** Activities that contribute to climate change also directly worsen child health. The continued use of coal, gas and oil causes significant harm to children mainly via air pollution. This harm will continue or even increase unless there is a reduction in fossil fuel use and transition to renewable energies.

It is estimated that 1 500 premature deaths across all age groups, and approximately 1 250 emergency department presentations or hospital admissions for childhood asthma or respiratory illness occur every year in Australia in our four biggest cities alone, due to fossil-fuel generated particle air pollution (*Morgan, Broome, & Jalaludin, 2013*). Breathing in particulate (or small particle) air pollution is also associated with preterm births, low birth weight and infant mortality (*Kim, 2004*). Mercury from burning coal also ends up in the food chain and threatens the development of the brain and nervous system.

More than half the world's population uses biomass or coal in low efficiency polluting household stoves. The required collection of firewood depletes forests, leading to desertification and reduced carbon sequestration.

It is estimated that particle air pollution, both indoor and outdoor, contributes to approximately 6.8 million premature deaths annually and more than 7% of the global burden of disease (*Lim et al., 2012*).

**Climate change  
threatens the  
foundations for  
children's health  
– clean food,  
water and  
social stability**

**The underlying foundations of children's health, clean water, adequate food and a stable society, will be threatened by climate change.**

Climate change is accelerating the loss of biodiversity and ecosystems on land and in the seas which have already been harmed by the expansion of humanity leading to deforestation, desertification, drought, food shortage and famine. This can result in a loss of shelter and livelihoods and potential conflict and geopolitical instability.

Australia is not immune to such effects, which are already occurring in the developed world. As the driest inhabited continent in the world, we are seeing water scarcity, drought and loss of biodiversity. The Great Barrier Reef has lost half of its coral in the last 27 years, in part due to climate change (AIMS, 2012).

**Food and water  
insecurity**

In Australia, the availability of water will become a major issue as the population increases in concert with climate change.

Across Southern Australia rainfall is expected to decline further over the coming decades. Agricultural production will decline without adaptation measures (IPCC, 2014c). This is likely to result in raised food prices, making healthy food less accessible for those on low incomes particularly those in



regional centres or remote communities. At the same time Australia will be under pressure to increase food exports to assuage world hunger.

On a global scale, access to clean drinking water is still unavailable to more than one billion people worldwide. As a result diarrhoeal disease and under-nutrition is the underlying cause of at least

3.5 million deaths each year, and of more than one third of deaths in children under five years of age (Black *et al.*, 2008). The IPCC states that "malnutrition linked to extreme climatic events may be one of the most important consequences of climate change" (IPCC, 2007).

Major food insecurity is already occurring in Africa particularly as a result of drought in the North, and extreme weather events can lead to prolonged hunger till relief is organised. Events in one country can affect many others. For example drought and bushfires across Russia in 2010 lead the country to ban wheat exports. Increasing demand for aid from neighboring countries affected by climate change is expected.

Average annual stream flow into Perth's dams has already decreased by nearly 80% since the mid-1970s (*WC, 2012*). Southeast Australia has experienced a 25% decline in average rainfall in April and May since the mid-1990s (*CSIRO and BoM, 2014*).

Up to 20% more droughts are predicted over most of Australia by 2030, and up to 80% more in south-western Australia by 2070 (*CSIRO, 2007*). The Murray Darling Basin river system supplies 70% of the water needed for the nation's irrigated crops and pastures; climate change is forecast to further reduce annual stream flow by 10-25% in 2050 and 16-48% by 2100 (*IPCC, 2007*).

### Socioeconomic and geopolitical instability

The effects of climate change imposed upon humanity will have their most serious effects on children. Around the world impacts from extreme weather events and infectious disease outbreaks are having huge economic costs which are driving budgets into deficit; consequently health and social services suffer. In the past decade, climate-related disasters have led to global economic losses of US\$2 trillion, with more than 250 million people affected by tropical cyclones- this is having an impact on the economic context in which children grow up (*UN Office for Disaster Risk Reduction, 2012; World Meteorological Organization, 2013*).

The OECD predictions for the world economy to 2060 are for growth to decline to around three-quarters its current rate, and for inequality to increase massively; climate change will accentuate this trend. The risk is that the economic effects of climate change begin to destroy capital, coastal land and agriculture in the first half of the century, shaving up to 1.5%

off world GDP and 5% in southeast Asia (*Braconier, Nicoletti, & Westmore, 2014*).

Climate change-related stresses are already leading to displacement of population within and between countries. Environmental deterioration partly resulting from climate change is predicted to become the biggest influence on population displacement this century, prompting an estimated 150 –200 million people to move by 2050 (*C. McMichael, Barnett, & McMichael, 2012*).

Such events, and the conflict that often accompanies them, can have extreme effects on the physical health of children. Save the Children UK estimates that millions of children worldwide will be killed, forced to flee their homes and placed at risk from hunger, disease and physical or sexual abuse due to disruption and displacement of families (*Save the Children, 2007*).

For children, major increases in mental health disorders can arise from disruption to family, home, schooling or civil or political conflict (*C. McMichael et al., 2012*). The psychological impact of climate induced change on communities with a strong spiritual and cultural attachment to land such as Australian Aborigines may be especially significant (*Green, 2006*).

**Failing to  
address climate  
change affects  
children's  
mental health**

**For many young people, the anticipation of climate change and the worry about their future is a major source of distress.**

Partridge states that a number of attitude polls have found high levels of concern for the environment among young Australians, including; nine out of ten respondents either 'concerned' or 'very concerned'; 76 per cent believing the government was not doing enough to protect the environment; and 91 per cent of 16–24-year-olds agreeing

that 'the threat to the environment is real and must be taken seriously' (Partridge, 2008).

Researchers have identified 'solastalgia' as the psychological distress people feel when the natural environment in which they live is changed for the worse (Albrecht, Sartore, & Connor L. et al, 2007).



People's concerns about the future of the world and humanity matter to social cohesion and capital. The erosion of faith in society shapes relationships to social institutions, especially governments. Positive images of the future allow individuals to identify with social goals and to channel their individual interests into a higher social purpose, providing a broader sense of meaning in life. Pessimism about the future on the other hand can reinforce the appeal of materialistic and individualistic values, which are also hostile to wellbeing (Strazdins & Skeat, 2011).

**Climate  
change will  
put increasing  
pressure on  
children's  
healthcare  
services**

**Currently there is much discussion in Australia on the future of our healthcare system. Climate change will result in added pressure to an already stretched health service, and if left unchecked, risks causing major reductions in the current level of service.**

Children need specialised medical care that recognises their differences in size, bodily systems and psychology. They also have an increased need for preventative care services, particularly pregnancy care, childhood immunisation and anticipatory guidance and support from parents. Pressure on accessible, affordable and appropriate health care services for children risks loss of the benefits gained through primary health care for lifelong health experience.

It is expected that there will be an increased burden of disease in Australia requiring attention from general practitioners and hospitals due to injury or psychological trauma from extreme weather events, infections such as gastroenteritis and illness due to ozone and bushfire air pollution. Economist Professor Ross Garnaut estimates that under a high greenhouse gas emissions scenario, climate change will lead to an estimated 335,000 new cases of bacterial gastroenteritis across all age groups in Australia by 2050, with over 92.3 million dollars in health and surveillance costs. Equally, models predict dengue could lead to health care costs of 22 million by 2100 if emissions are not reduced (*Bambrick et al., 2008*)

Consultations with health professionals relating to impacts from allergies, water and food scarcity, and social disruption, could also increase in the future, but estimates of the level of impact are difficult to predict or not available.

Those children particularly vulnerable are likely to require increased attention from health services. For example, Aboriginal people living in remote arid communities are likely to be at increased risk due to poor living conditions and access to services. An increase of 10% in the annual number of diarrhoeal admissions among Aboriginal children living in the central Australian region is predicted by 2050 (*McMichael et al., 2003*).

Our health system infrastructure or resources can themselves be directly affected by climate change, potentially limiting their ability to provide care. In the heatwave prior to the Black

Saturday bushfires, 25% of all hospitals had some type of issue with their air conditioning or cooling systems (*Lapsley, 2009*). The Queensland floods and cyclones in between December 2010 and February 2011 required 501 clinical staff to be deployed to assist 10,000 affected people. Over 17,000 tetanus/diphtheria vaccines were also distributed to reduce the risk of disease and Queensland Health information line answered 54,881 calls from flood-affected areas (*Queensland Health, 2011a*). Floods can also cause inundation or isolation of services, potentially affecting power supply, or access to medicines.

Such impacts can be very costly. The Queensland and federal governments provided \$18.1 million to repair damage to health facilities from the 2010/2011 floods, and \$37.8 million was marked to fund the Queensland Mental Health Natural Disaster Recovery Plan from 2011-2013 (*Queensland Health, 2011a*).

In the developing world, climate change is expected to worsen all top five causes of mortality in children under 5 years of age - acute respiratory illness (ARI), diarrhoea, malaria, malnutrition and neonatal deaths (*Kiang, Graham, & Farrant, 2013*). Demands on hospitals to treat such conditions will overload many resource-poor countries where healthcare sectors already struggle to provide the most basic healthcare.



## NO TIME FOR GAMES: CHILDREN'S HEALTH AND CLIMATE CHANGE

Floodwaters surrounding Wesley Hospital in Auchenflower, Brisbane, in January 2011 cut all vehicle access, including ambulances, to and from the hospital for nearly two days. Ambulance officers had to transfer emergency patients across the railway station overpass bridge on foot.

Linen, pharmacy and food supplies had to be carried or pushed over the bridge by staff.

Patients who could be discharged safely were advised to leave before the hospital became isolated, while all

elective, non-emergency services were cancelled for the remainder of the week. At one point, the electricity supply to the hospital was at risk of being cut, threatening to necessitate the evacuation of patients. (QFCI, 2012).



**Failure to act is  
a major inter-  
generational  
injustice**

**That the increasing health effects of climate change disproportionately affect children challenges the most fundamental call of humanity, to nurture its young.**

What is at stake is national responsibility for the future of our children. In our rich developed country, it would be impossible to find a more compelling example of intergenerational injustice than failure to act. It far outweighs any short-term financial 'intergenerational theft' relating to national debt in the current political cycle. We are incurring a debt which cannot be repaid.

In a world in which we increasingly recognise the interdependence of all peoples, what of our obligation to poorer nations? Industrialised countries are unequivocally historically responsible for the difficulties which will be felt by those already disadvantaged by climate change, and for the deaths and disease already being witnessed in the developed world, especially in children.

***"The very great risks that a Four Degree World poses to human health in Australia and elsewhere, while somewhat unknowable in advance, surely provide a compelling reason for taking immediate and radical actions on behalf of long-term primary prevention and not just tinkering with electorally timid adaptive policies and actions. The two oncoming generations will live part of their lives in the late 21st century. Subsequent generations may find themselves in a radically self-rearranging natural world, increasingly unsuitable as a liveable habitat for humans."***

The late Professor Tony McMichael, who was one of the world's most eminent climate and health scientists.

Climate change threatens all the substantial economic, health and social gains we have made in addressing poverty in recent decades and risks returning one-third of the world's population back into extreme poverty by 2050 (*United Nations Development Programme, 2013*).

Our nation could and should do more than others to arrest the decline in global environment because we are one of the wealthiest countries, and we have a proud history of leading in other global issues such as tobacco control.

## Solutions

### **Prevention of climate change is essential and urgent, for there is no cure**

Protecting the health of our children unequivocally means doing our utmost to urgently prevent severe climate change.

World leaders have previously agreed to limit average warming to a 'safe threshold' of 2 degrees above preindustrial times, and there is increasing evidence a 1.5 degree rise is more advisable (*Hansen J et al., 2013*). However, to date, little action has supported this level of commitment and the current global emissions trajectory is leading us on a path to 4-5 degrees of warming unless we start reducing emissions this decade, risking 'tipping points' of runaway warming and consistent with global catastrophe for our next generations.

This is a threat needing priority attention.

Reduction in greenhouse gas emissions (mitigation) must be urgent and comprehensive. It requires intent, leadership and input and coordination from many Ministries of federal government; the Minister of Health because of the primacy of health consequences particularly for children; Ministers responsible for environment, energy, development, agriculture and regional development; and most importantly the Treasurer for the cost of mitigation will escalate the longer the delay.

In addition the states have a significant role in effecting federal measures and in adapting to changes already happening. They need to work to a federal plan for adaptation drawn up by experts and funded nationally.

The specific measures will result from a strong national agenda. Personal actions for reducing carbon use (like cutting down on automobile use) are important, but will not be in any way sufficient to address the problem. We need coordinated government action and leadership on this issue.

DEA advocates for the following actions:

**DEA advocates  
for the following  
actions:**

**1 Australia commit to strong targets  
and leadership in upcoming global climate  
negotiations in Paris**

Australia, as one of the world's most wealthy countries and as the country currently with the highest per capita greenhouse gas emissions, has a duty to offer leadership on its targets. Australia's current bipartisan agreement to a reduction of 5% on 2000 levels by 2020 is woefully inadequate to contribute fairly to reductions needed across the globe.

A low carbon transition is technically and financially possible and it is now a matter of political will and leadership. The Australian position at the UN global climate negotiations in Paris must be decided primarily by the science and not by those with vested interests in inaction.

At this meeting, which is just months away, the Australian domestic emissions reductions targets should be in line with those recommended by the Climate Change Authority:

**2025 target of 30% below 2000 levels**  
**2030 target of 40 - 60% below 2000 levels**

In addition to committing to domestic emissions reductions targets in Paris, Australia should also sign up to provide more support and finance to emerging economies to pursue low carbon development paths and assist them in adapting to climate impacts already occurring. The Government's current commitment of \$200 million towards the Green Climate Fund programme set up by the UN to undertake this process is commendable, however, it should not be taken from the falling international aid budget, and is not a fair contribution to the UN's target of \$100 billion annually by 2020.

**2 Keep fossil fuels in the ground and transition  
to renewable energy**

This needs a strong federal policy without impediment from the states.

Burning of fossil fuels (coal, oil and gas) is the major contributor to greenhouse gas emissions causing climate change. Most of the world's fossil fuel (coal, oil and gas) reserves must be left in the ground, unburned, to keep global temperature rise to no more than 2°C. This equates to 90% of Australian coal reserves.

Bipartisan plans for exploitation of Australia's Galilee Basin coal deposits are thus incompatible with effective action on climate change. The federal Government must commit to halting development of new coal resources and winding down existing coal mines.

At the same time more ambitious policies and measures, such as expansion of the Renewable Energy Target or carbon pricing, are urgently needed to assist the transition to renewable energies.

Governments must recognise that renewable energy becomes cost competitive or cheaper than fossil fuels if the health costs of harmful air pollution are included in the market price.

### **3 Realise the opportunities for a healthier future for our children**

Curtailment of fossil fuel burning in Australia will benefit all children immediately by reducing their exposure to air pollution. For example, President Obama recently launched his emissions reduction policy, the 'Clean Power Plan' from a hospital. The plan has public health and climate benefits worth an estimated \$55B to \$93B per year in 2030 (far outweighing implementation costs), and will avoid up to 6,600 premature deaths and 150,000 asthma attacks in children, 2,800 hospital admissions and up to 490,000 missed work or school days.

In addition, designing our cities to promote active transport and reduce use of motorised vehicles leading to lower greenhouse gas emissions can improve health through improvements in air quality, reduced traffic accidents, better social cohesion, and greater physical activity. Only one-third of children, and one in ten young people in Australia undertook the recommended 60 minutes of physical activity every day in 2011-12 (*ABS, 2013*).

### **4 Adaptation - Federal State partnership**

Australia is already suffering health and budgetary loss from extreme weather events and this will increase in coming years due to emissions already released into the atmosphere. The federal government needs to produce national plans for adaptation and the states need to enact them uniformly.

## 4 Adaptation - Federal State partnership contd

### Health and emergency services

These are largely federally funded services delivered by the states. With children's health a priority we need plans including:

- immunisation programs and infectious disease surveillance
- adequate water safety and sanitation infrastructure preparations for extreme weather
- heat wave and UV warnings
- early warning systems for bushfires/cyclones and air quality indices and advice
- identifying and protecting vulnerable individuals such as children via local health services or community organisations
- ensuring adequate emergency department and inpatient capacity and the establishment of post-disaster counselling and support for children
- education of health professionals, and the wider community

### Infrastructure and risk reduction

Protecting children's health also requires risk reduction in sectors other than health such as housing, agriculture, urban planning and transportation. Improvement in urban and regional planning design such as relocation away from areas at risk from natural disasters or sea-level rise, or better housing design to reduce heat impacts, are examples of reducing the risk of climate health impacts to children.



Reducing socioeconomic disadvantage in children and improving baseline health, food security and education are fundamentally the best form of climate change adaptation due to their role in making children and families more resilient and better prepared for the environmental risks brought by climate change.

## References

- AAP. (2007). *Global Climate Change and Children's Health Policy*. American Academy of Paediatrics Retrieved from <http://pediatrics.aappublications.org/content/120/5/1149.full#cite-as>.
- ABC. (2009). Victorian bushfires: Chintin mother shelters with children in neighbour's dam. <http://www.abc.net.au/news/2014-02-10/victoria-fires-chintin-mother-shelters-children-in-dam/5250208>
- ABC. (2011). Health concerns for QLD's flooded residents. <http://www.abc.net.au/local/stories/2011/01/05/3106862.htm>
- Abramson, D., Garfield, R., & Redlener, I. (2007). The recovery divide: Poverty and the widening gap among Mississippi children and families affected by Hurricane Katrina. Columbia University, New York: Mailman School of Public Health. Available from [http://www.ncdp.mailman.columbia.edu/files/recovery\\_divide.pdf](http://www.ncdp.mailman.columbia.edu/files/recovery_divide.pdf)
- ABS. (2013). Australian Health Survey 2011-2012. <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4364.0.55.004Main+Features12011-12?OpenDocument>
- Ahern, M., Kovats, R. S., Wilkinson, P., Few, R., & Matthies, F. (2005). Global Health Impacts of Floods: Epidemiologic Evidence. *Epidemiologic Reviews*, 27(1), 36-46. doi: 10.1093/epirev/mxi004
- AIHW. (2011). *Asthma in Australia 2011*. Canberra: Australian Government Department of Health.
- AIHW. (2015). *Asthma: About Asthma*. from <http://www.aihw.gov.au/asthma/>
- AIMS. (2012). *Media release: The Great Barrier Reef has lost half of its coral in the last 27 years* Australian Institute of Marine Science Retrieved from [http://www.aims.gov.au/docs/media/latest-releases/-/asset\\_publisher/8Kfw/content/2-october-2012-the-great-barrier-reef-has-lost-half-of-its-coral-in-the-last-27-years](http://www.aims.gov.au/docs/media/latest-releases/-/asset_publisher/8Kfw/content/2-october-2012-the-great-barrier-reef-has-lost-half-of-its-coral-in-the-last-27-years).
- Albrecht, G., Sartore, G. M., & Connor L. et al. (2007). Solastalgia: The distress caused by environmental change. *Australasian Psychiatry*, 15(1), S95-S98.
- Bambrick, H., Dear, K., Woodruff, R., Hanigan, I., & McMichael, A. (2008). Garnaut Climate Change Review: The impacts of climate change on three health outcomes: temperature-related mortality and hospitalisations, salmonellosis and other bacterial gastroenteritis, and population at risk from dengue. <http://www.garnautreview.org.au/CA25734E0016A131/pages/all-reports--resources-commissioned-reports.html>
- Basu, R., Malig, B., & Ostro, B. (2010). High ambient temperature and the risk of preterm delivery. *Am J Epidemiol*, 172(10), 1108-1117. doi: 10.1093/aje/kwq170
- Beggs, P. J., & Bambrick, H. J. (2005). Is the Global Rise of Asthma an Early Impact of Anthropogenic Climate Change? *Environmental Health Perspectives*, 113(8), 915-919. doi: 10.1289/ehp.7724
- Béguin, A., Hales, S., Rocklöv, J., Åström, C., Louis, V. R., & Sauerborn, R. (2011). The opposing effects of climate change and socio-economic development on the global distribution of malaria. *Global Environmental Change*, 21(4), 1209-1214. doi: <http://dx.doi.org/10.1016/j.gloenvcha.2011.06.001>
- Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M., . . . Rivera, J. (2008). Maternal and child undernutrition: global and regional exposures and health consequences. *The Lancet*, 371(9608), 243-260. doi: 10.1016/S0140-6736(07)61690-0
- Braconier, H., Nicoletti, G., & Westmore, B. (2004). *Policy Challenges for the Next 50 Years*, OECD Economic Policy Papers. (Vol. 9). Paris: OECD Publishing.
- Breton, M. C., Garneau, M., Fortier, I., Guay, F., & Louis, J. (2006). Relationship between climate, pollen concentrations of Ambrosia and medical consultations for allergic rhinitis in Montreal, 1994-2002. *Sci Total Environ*, 370(1), 39-50. doi: 10.1016/j.scitotenv.2006.05.022
- Bunyavanich, S., Landrigan, C. P., McMichael, A. J., & Epstein, P. R. (2003). The impact of climate change on child health. *Ambul Pediatr*, 3(1), 44-52.
- Butler CD, B. D., Mclver L, Page L. (2014). Mental Health, Cognition and the Challenge of Climate Change. In C. Butler (Ed.), *Climate Change and Global Health*. Oxfordshire.

## NO TIME FOR GAMES: CHILDREN'S HEALTH AND CLIMATE CHANGE

---

Cameron, P. A., Mitra, B., Fitzgerald, M., Scheinkestel, C. D., Stripp, A., Batey, C., . . . Cleland, H. (2009). Black Saturday: the immediate impact of the February 2009 bushfires in Victoria, Australia. *MJA*, 191 1 (1), 11-16.

Checkley, W., Epstein, L. D., Gilman, R. H., Figueroa, D., Cama, R. I., Patz, J. A., & Black, R. E. (2000). Effect of El Nino and ambient temperature on hospital admissions for diarrhoeal diseases in Peruvian children. *Lancet*, 355(9202), 442-450.

Climate Council. (2014). Be Prepared: Climate Change and the Victorian Bushfire Threat. <http://www.climatecouncil.org.au/uploads/1c34cb0cfad57bd333eb9e013c7fb6ef.pdf>

Climate Institute. (2015). Sport & Climate Change: How Much Heat Can Sport Handle. [http://www.climateinstitute.org.au/verve/\\_resources/Sport\\_and\\_climate.pdf](http://www.climateinstitute.org.au/verve/_resources/Sport_and_climate.pdf)

Cricket South Australia. SACA Heat Policy <http://www.cricketsa.com.au/library/SACA%20HEAT%20POLICY.pdf>

CSIRO. (2007). Climate change in Australia: Observed Changes and Projections. [http://ccia2007.climatechangeinaustralia.gov.au/documents/resources/Summary\\_brochure.pdf](http://ccia2007.climatechangeinaustralia.gov.au/documents/resources/Summary_brochure.pdf)

CSIRO. (2008a). A Methodology for Determining the Impact of Climate Change on Ozone Levels in an Urban Area Final Report. <http://www.environment.gov.au/system/files/resources/4c4d367c-1eed-418d-aa67-4c7854bd8645/files/climate-change.pdf>

CSIRO. (2008b). 'Projections of days over 35°C to 2100 for all capital cities under a no-mitigation case', data prepared for the Garnaut Climate Change Review Aspendale, Victoria.

CSIRO and BoM. (2014). *State of the Climate 2014* CSIRO and Bureau of Meteorology, Melbourne.

Curriero, F. C., Patz, J. A., Rose, J. B., & Lele, S. (2001). The association between extreme precipitation and waterborne disease outbreaks in the United States, 1948-1994. *Am J Public Health*, 91(8), 1194-1199.

DARA. (2012). Climate Vulnerability Monitor. A Guide to the Cold Calculus of a Hot Planet. Disasters Emergency Committee. (2012). Pakistan Floods Facts and Figures. from <http://www.dec.org.uk/pakistan-floods-facts-and-figures>

Doocy, S., Daniels, A., Murray, S., & Kirsch, T. D. (2013). The human impact of floods: a historical review of events 1980-2009 and systematic literature review. *PLoS Curr*, 5. doi: 10.1371/currents.dis.f4deb457904936b07c09dca98ee8171a

EPA. (2009). Climate change and children's health. US Environmental Protection Agency Retrieved from [http://www2.epa.gov/sites/production/files/2014-05/documents/ochp\\_climate\\_brochure.pdf](http://www2.epa.gov/sites/production/files/2014-05/documents/ochp_climate_brochure.pdf).

Government of South Australia. (2014). Media release: SA sport and rec clubs to action extreme heat policy. [http://www.premier.sa.gov.au/images/news\\_releases/14\\_01Jan/hotspot.pdf](http://www.premier.sa.gov.au/images/news_releases/14_01Jan/hotspot.pdf)

Green, D. (2006). Climate Change and Health: Impacts on Remote Indigenous Communities in Northern Australia. from CSIRO [http://www.cmar.csiro.au/e-print/open/greendf\\_2006.pdf](http://www.cmar.csiro.au/e-print/open/greendf_2006.pdf)

Handmer, J., O'Neil, S., & Killalea, D. (2010). Review of fatalities in the February 7 2009 bushfires. from Bushfire CRC, Centre for Risk and Community Safety RMIT University <http://www.royalcommission.vic.gov.au/Documents/Document-files/Exhibits/EXP-029-001-0001>

Hansen J, Kharecha P, Sato M, Masson-Delmotte V, Ackerman F, & Beerling DJ et al. (2013). Assessing "Dangerous Climate Change": Required Reduction of Carbon Emissions to Protect Young People, Future Generations and Nature. *PLoS ONE*, 8(12).

Héguy, L., Garneau, M., Goldberg, M. S., Raphoz, M., Guay, F., & Valois, M.-F. (2008). Associations between grass and weed pollen and emergency department visits for asthma among children in Montreal. *Environmental Research*, 106(2), 203-211. doi: <http://dx.doi.org/10.1016/j.envres.2007.10.005>

Hennessy, K. J. (2007). Fire weather. In *Climate change in Australia: technical report 2007*, Pearce KB, Holper PN, Hopkins M, Bouma WJ, Whetton PH, Hennessy KJ, Power SB (eds) (pp. 90-91). Aspendale, Victoria: CSIRO Marine and Atmospheric Research.



## NO TIME FOR GAMES: CHILDREN'S HEALTH AND CLIMATE CHANGE

---

- IBIS. (2011). Queensland floods: The economic impact. [https://www.nci.com.au/NCINet/Secure/Resources/Pdf/QLD\\_floods\\_special\\_report.pdf](https://www.nci.com.au/NCINet/Secure/Resources/Pdf/QLD_floods_special_report.pdf)
- IPCC. (2007). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* . Cambridge.
- IPCC. (2013). *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.* . Cambridge and New York: Cambridge University Press.
- IPCC. (2014a). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* Geneva, Switzerland.
- IPCC. (2014b). *Climate Change 2014: Impacts, adaptation, and vulnerability. Working Group II Contribution to the IPCC 5th Assessment Report. Chapter 11: Human Health: Impacts, Adaptation, and Co-Benefits.* . Cambridge and New York.
- IPCC. (2014c). *Climate Change 2014: Impacts, adaptation, and vulnerability. Working Group II Contribution to the IPCC 5th Assessment Report. Chapter 25: Australasia.* . Cambridge and New York.
- Kearney, M., Porter, W. P., Williams, C., Ritchie, S., & Hoffmann, A. A. (2009). Integrating biophysical models and evolutionary theory to predict climatic impacts on species' ranges: the dengue mosquito *Aedes aegypti* in Australia. *Functional Ecology*, 23(3), 528-538. doi: 10.1111/j.1365-2435.2008.01538.x
- Keenan, H. T., Marshall, S. W., Nocera, M. A., & Runyan, D. K. (2004). Increased incidence of inflicted traumatic brain injury in children after a natural disaster. *Am J Prev Med*, 26(3), 189-193. doi: 10.1016/j.amepre.2003.10.023
- Kent, J., & Alston, M. (2008). The big dry: the link between rural masculinities and poor health outcomes for farming men. *Journal of Sociology*, 44(2)133-147).
- Kiang, K., Graham, S., & Farrant, B. (2013). Climate change, child health and the role of the paediatric profession in under-resourced settings *Tropical Medicine and International Health*, 18(9), 1053-1056.
- Kim, J. (2004). *Ambient Air Pollution: Health Hazards to Children* AMERICAN ACADEMY OF PEDIATRICS Retrieved from <http://pediatrics.aappublications.org/content/114/6/1699.full>.
- King, D., Ginger, J., Williams, S., Cottrell, A., Gurtner, Y., Leitch, C., . . . Jackson, L. (2013). Planning, building and insuring: Adaptation of built environment to climate change induced increased intensity of natural hazards. . Gold Coast: National Climate Change Adaptation Research Facility.
- Knowlton, K., Rotkin-Ellman, M., King, G., Margolis, H. G., Smith, D., Solomon, G., . . . English, P. (2009). The 2006 California Heat Wave: Impacts on Hospitalizations and Emergency Department Visits. *Environmental Health Perspectives*, 117(1), 61-67. doi: 10.1289/ehp.11594
- Lam, L. T. (2007). The association between climatic factors and childhood illnesses presented to hospital emergency among young children. *Int J Environ Health Res*, 17(1), 1-8. doi: 10.1080/09603120601124264
- Lapsley, C. (2009). 2009 Victorian Emergencies: January Heatwave and Black Saturday Bushfires. Emergency Management, Department of Human Services.
- Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., . . . Ezzati, M. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*, 380(9859), 2224-2260. doi: 10.1016/S0140-6736(12)61766-8
- Mathiesen, K. (2015). Losing paradise: the people displaced by atomic bombs, and now climate change. Retrieved from <http://www.theguardian.com/environment/2015/mar/09/losing-paradise-the-people-displaced-by-atomic-bombs-and-now-climate-change>
- McDermott, B. M., Lee, E. M., Judd, M., & Gibbon, P. (2005). Posttraumatic stress disorder and general psychopathology in children and adolescents following a wildfire disaster. *Can J Psychiatry*, 50(3), 137-143.

## NO TIME FOR GAMES: CHILDREN'S HEALTH AND CLIMATE CHANGE

---

McMichael, A., & Campbell-Ledrum D, e. a. (2004). *Climate Change*. In: Ezzati M, et al. (editors) *Comparative Quantification of Health Risks: Global and Regional Burden of Disease Due to Selected Major Risk Factors*.

McMichael, A., Montgomery, H., & Costello, A. (2012). *Health risks, present and future, from global climate change* (Vol. 344).

McMichael, A., Woodruff, R., Whetton, P., Hennessy, K., Nicholls, N., Hales, S., . . . Kjellstrom, T. (2003). *Human Health and Climate Change in Oceania: A Risk Assessment 2002*. Canberra: Commonwealth of Australia.

McMichael, C., Barnett, J., & McMichael, A. J. (2012). An Ill Wind? Climate Change, Migration, and Health. *Environmental Health Perspectives*, 120(5), 646-654. doi: 10.1289/ehp.1104375

Morgan, G., Broome, R., & Jalaludin, B. (2013). Summary for Policy Makers of the Health Risk Assessment on Air Pollution in Australia. Prepared for National Environment Protection Council. <http://www.environment.gov.au/system/files/pages/dfe7ed5d-1eaf-4ff2-bfe7-dbb7ebaf21a9/files/summary-policy-makers-hra-air-pollution-australia.pdf>

Onozuka, D., & Hashizume, M. (2011). The influence of temperature and humidity on the incidence of hand, foot, and mouth disease in Japan. *Science of The Total Environment*, 410-411(0), 119-125. doi: <http://dx.doi.org/10.1016/j.scitotenv.2011.09.055>

Partridge, E. (2008). 'From ambivalence to activism: young people's environmental views and actions'. *Youth Studies Australia*, 27(2), 18-25.

Prüss-Üstün, A., & Corvalán, C. F. (2006). Preventing disease through health environments: Towards an estimate of the environmental burden of disease France: World Health Organization.

Pynoos, R. S., Steinberg, A. M., Ornitz, E. M., & Goenjian, A. K. (1997). Issues in the Developmental Neurobiology of Traumatic Stress. *Annals of the New York Academy of Sciences*, 821(1), 176-193. doi: 10.1111/j.1749-6632.1997.tb48278.x

QFCI. (2011). Queensland Flood Commission of Inquiry: Interim Report. from <http://www.floodcommission.qld.gov.au/publications/interim-report/>

QFCI. (2012). Queensland Flood Commission of Inquiry: Final Report: Chapter 7 Development and flood considerations. Brisbane.

Queensland Health. (2011a). Annual Report 2010-2011. <https://publications.qld.gov.au/storage/f/2014-06-10T04%3A57%3A48.920Z/part-1.pdf>

Queensland Health. (2011b). Queensland Dengue Management Plan 2010-2015.  
Rezaeian, M. (2013). The association between natural disasters and violence: A systematic review of the literature and a call for more epidemiological studies. *Journal of Research in Medical Sciences : The Official Journal of Isfahan University of Medical Sciences*, 18(12), 1103-1107.

Salloum, A., Carter, P., Burch, B., Garfinkel, A., & Overstreet, S. (2011). Impact of exposure to community violence, Hurricane Katrina, and Hurricane Gustav on posttraumatic stress and depressive symptoms among school age children. *Anxiety Stress Coping*, 24(1), 27-42. doi: 10.1080/10615801003703193

Save the Children. (2007). *Legacy of disasters: The impact of climate change on children*. London.

Shaw, J. A., Applegate, B., & Schorr, C. (1996). Twenty-One—Month Follow-up Study of School-Age Children Exposed to Hurricane Andrew. *Journal of the American Academy of Child & Adolescent Psychiatry*, 35(3), 359-364. doi: <http://dx.doi.org/10.1097/00004583-199603000-00018>

Shea, K. (2009). *Global Climate Change and Child Health: WHO Training Package for the Health Sector*. <http://www.who.int/ceh/capacity/climatechange.pdf>

Strand, L. B., Barnett, A. G., & Tong, S. (2012). Maternal exposure to ambient temperature and the risks of preterm birth and stillbirth in Brisbane, Australia. *Am J Epidemiol*, 175(2), 99-107. doi: 10.1093/aje/kwr404

Strazdins, L., & Skeat, H. (2011). *Weathering the future: Climate change, children and young people, and decision making: A report to the Australian Research Alliance for Children and Youth*.

## NO TIME FOR GAMES: CHILDREN'S HEALTH AND CLIMATE CHANGE

---

- Teague, B., McLeod, R., & Pascoe, S. (2010). 2009 Victorian Bushfires Royal Commission: Final Report. Victoria.
- Teicher, M. H., Andersen, S. L., Polcari, A., Anderson, C. M., Navalta, C. P., & Kim, D. M. (2003). The neurobiological consequences of early stress and childhood maltreatment. *Neurosci Biobehav Rev*, 27(1-2), 33-44.
- UN Office for Disaster Risk Reduction. (2012). Media Release: UNISDR Counts the Cost of 20 YEARS of Inaction on Climate Change and Risk Reduction. [http://www.unisdr.org/files/27162\\_2012no21.pdf](http://www.unisdr.org/files/27162_2012no21.pdf)
- United Nations Development Programme. (2013). Human Development Report 2013: The Rise of the South, Human Progress in a Diverse World. Canada.
- Victorian Department of Human Services. (2009). January 2009 Heatwave in Victoria: an Assessment of Health Impacts. Melbourne: .
- Wang, J., Williams, G., Guo, Y., Pan, X., & Tong, S. (2013). Maternal exposure to heatwave and preterm birth in Brisbane, Australia. *BJOG*, 120(13), 1631-1641. doi: 10.1111/1471-0528.12397
- WC. (2012). Yearly stream flow for major surface water sources. Water Corporation Western Australia Retrieved from [http://www.watercorporation.com.au/d/dams\\_streamflow.cfm](http://www.watercorporation.com.au/d/dams_streamflow.cfm).
- WHO. (2001). The World Health Report 2001 Mental Health: New Understanding, New Hope (pp. 43). Geneva, Switzerland.
- WHO. (2011). World Malaria Report 2011. Geneva: World Health Organization.
- WHO. (2013). Diarrhoeal disease: World Health Organization Fact Sheet 330. from <http://www.who.int/mediacentre/factsheets/fs330/en/>
- WHO. (2015a). Dengue and Severe Dengue: World Health Organization Fact Sheet 117. from <http://www.who.int/mediacentre/factsheets/fs117/en/>
- WHO. (2015b). Malaria: World Health Organization Fact Sheet 94. from <http://www.who.int/mediacentre/factsheets/fs094/en/>
- World Meteorological Organization. (2013). Media Release: The Global Climate 2001-2010: A Decade of Extremes. [https://www.wmo.int/pages/mediacentre/press\\_releases/pr\\_976\\_en.html](https://www.wmo.int/pages/mediacentre/press_releases/pr_976_en.html)
- Xu, Z., Hu, W., Su, H., Turner, L. R., Ye, X., Wang, J., & Tong, S. (2014). Extreme temperatures and paediatric emergency department admissions. *J Epidemiol Community Health*, 68(4), 304-311. doi: 10.1136/jech-2013-202725
- Xu, Z., Sheffield, P., Su, H., Wang, X., Bi, Y., & Tong, S. (2014). The impact of heat waves on children's health: a systematic review. *International Journal of Biometeorology*, 58(2), 239-247. doi: 10.1007/s00484-013-0655-x
- Yoko, A., Goodman, D., & Parker, D. (2009). Global Climate Change and Child Health: A review of pathways, impacts and measures to improve the evidence base. . Florence: UNICEF Innocenti Research Centre.

**Image credits:**

- Page 7 Doctor and young child- source Fotolia  
Page 15 Child with thermometer- source Fotolia  
Page 17 Bushfire- source Fotolia  
Page 19 "Kids playing in Rockhampton during 2013  
Queensland flooding" source Australian  
Broadcasting Corporation Library Sales  
Page 20 "Home and family belongings destroyed by the  
Kingslake bushfires 10 February 2009" source CFA  
Strategic Communications/Keith Pakenham  
Page 22 Mosquito- source Fotolia  
Page 24 Child with mask- source Fotolia  
Page 25 Powerlines and emitting towers- source Fotolia  
Page 27 Cracked earth- source Fotolia  
Page 30 Child hugging knees- source Fotolia  
Page 33 Image courtesy Dr David King  
Page 38 Children running- source Fotolia

**Authors**

Dr Sallie Forrest MBBS(Hons) MScPH(Dist) of (LSHTM)  
Policy and Advocacy Officer,  
Doctors for the Environment Australia

Emeritus Professor David Shearman AM MBChB PhD FRACP  
Honorary Secretary,  
Doctors for the Environment Australia

---

**Publication date**

May 2015

\*This paragraph was amended in November 2015  
to improve clarity

Report printed on 100% recycled paper

---

**Acknowledgements:**

Doctors for the Environment Australia gratefully acknowledges  
the assistance of Professor Fiona Stanley, Professor Linda  
Selvey, Professor Charles Watson, Dr Karen Kiang and  
members of DEA's Management Committee.

---

**Copyright**

You must acknowledge DEA appropriately and you must  
not distribute content that you have modified. Except where  
otherwise noted, content in this report is licensed under a  
Creative Commons Attribution, No Derivatives 4.0  
International License.

---

**Contact:**

67 Payneham Road College Park SA 5069  
M 0422 974857  
E [admin@dea.org.au](mailto:admin@dea.org.au)  
W [www.dea.org.au](http://www.dea.org.au)

---

Follow us on Facebook and Twitter @DocsEnvAus



Report design: [mightyworld.com.au](http://mightyworld.com.au)

---

