

HOW CLIMATE CHANGE AFFECTS YOUR HEALTH: THE FACTS

DOCTORS FOR THE ENVIRONMENT AUSTRALIA





August 2021

Doctors for the Environment Australia acknowledges the Traditional Custodians of the lands on which this report has been produced. We recognise that First Nations peoples have cared for Country for millennia and seek to learn from Indigenous ways of knowing, being and doing. We acknowledge that sovereignty of this land was never ceded and pay our respects to First Nations Elders past and present, and to emerging leaders.

Doctors for the Environment Australia (DEA) is an independent, self-funded, non-governmental organisation of medical doctors and students in all Australian states and territories.

We work to address the public health impacts from damage to our natural environment such as climate change, which will increasingly undermine our health and our healthcare services if we fail to act.

We are supported by a distinguished Scientific Advisory Committee:

Prof Stephen Boyden AM, Prof Emeritus Chris Burrell AO, Prof Colin Butler, Prof Peter Doherty AC, Prof Michael Kidd AM, Prof David de Kretser AC, Prof Stephen Leeder AO, Prof Ian Lowe AO, Prof Robyn McDermott, Prof Lidia Morawska, Prof Peter Newman AO, Prof Emeritus Sir Gustav Nossal AC, Prof Hugh Possingham, Prof Lawrie Powell AC, Prof Fiona Stanley AC, Dr Rosemary Stanton OAM, Dr Norman Swan.

Suite 3 Ground Floor
60 Leicester Street, Carlton VIC 3053 0422 974 857
ABN 80 178 870 373
admin@dea.org.au
www.dea.org.au

How Climate Change Affects Your Health: The Facts

Climate change is a current and future threat to human health and well-being. The latest IPCC report confirms it is unequivocal that human influence has warmed the planet's atmosphere and oceans.¹ If governments and every level of society around the world can take effective action to reduce emissions over the next decade, we have the capacity to limit global warming to less than 2 degrees. This will not only reduce the risks to our health, but many climate change solutions will provide significant health benefits.

However, if we fail to reduce emissions, global warming will pose one of the greatest global threats of our time. The World Health Organisation has described climate change as the defining issue for public health in the 21st Century and warns that "The severity of impacts of climate change on health are increasingly clear and threatens to undermine the last 50 years of improvements in health."²

OVERVIEW

Climate change is driven by human activities such as the burning and mining of fossil fuels and deforestation, which produce greenhouse gases, predominantly carbon dioxide and methane. Greenhouse gases trap heat in the lower atmosphere, producing increases in air and sea temperatures. This leads to changes in rainfall patterns, increased frequency and severity of severe weather events, and sea level rise through expansion of water volume and melting of land-based ice.³ Increased carbon dioxide levels also increase ocean acidification. Globally, concentrations of all the major long-lived greenhouse gases in the atmosphere continue to increase, with global annual mean CO₂ concentrations reaching 410 ppm in 2019 and the CO₂ equivalent (CO₂-e) of all greenhouse gases reaching 508ppm. The level of CO₂ in the atmosphere currently is now over 417ppm - the highest levels on Earth in at least two million years.^{4,5}

Climate change affects health in many ways – directly through physical trauma, illness and mortality caused by extreme weather events such as floods, storms, bushfires and heatwaves, and indirectly through changing patterns of infectious diseases, changing patterns of air pollution, exposure to bushfire smoke and allergens, rising sea levels with coastal inundation, biodiversity loss, and threats to secure shelter, food, and water. A warming climate is clearly and inextricably linked to the disruption of environmental conditions that provide the very fundamentals for our physical and mental health - clean air, clean water, reliable sources of healthy and nutritious food, adequate shelter, and stable climatic conditions.

Climate change affects all populations, but also exacerbates existing inequities in Australian healthcare and society. The impacts of climate change will be more profound on those who are already experiencing disadvantage, marginalisation or disempowerment, including the poor, those with insecure work, people with disabilities, the elderly, and those with chronic health conditions. Race, ethnicity and migration status (refugees, asylum seekers, and people on temporary

visas) can increase vulnerability through language barriers and lack of access to services. Aboriginal and Torres Strait Islander Peoples are disproportionately affected by the impacts of climate change on their physical, mental, and spiritual health. Also vulnerable are people living in rural and remote communities or in areas of climate risk, people living in areas with weak health infrastructure, first responders and emergency service workers, and pregnant women and their babies. Children are amongst the most vulnerable to current health risks and will be exposed to climate change impacts for their entire lifetimes.

In 2019, major medical organisations in Australia including DEA, the AMA, most specialist Colleges and other medical organisations around the world declared a Climate Health Emergency,^{6,7} calling on governments for strong and effective action to reduce emissions and for recognition, preparation, and management of the critical public health challenges ahead.

Urgent action is needed to reduce emissions to keep global warming at less than 2°C. If we fail to do this, climate change tipping points will be reached at which limits on global warming will be exceedingly difficult or impossible to manage.^{8,9,10} A tipping point will occur when rising temperatures trigger a cascade of interrelated consequences with global repercussions. For example, the melting of Arctic permafrost will release large amounts of methane into the atmosphere, further accelerating global warming. In such a scenario, changes to the Earth's climate may become irreversible, and many residential and farming areas in the world, particularly in Australia, may become uninhabitable.

EXTREME HEAT

Global temperatures have increased due to climate change. The mean surface temperature across Australia has increased by $1.44 \pm 0.24^\circ\text{C}$ since national records began in 1910. Australia's ten warmest years have occurred since 2005, and the summer of 2018-2019 was the hottest on record.¹¹ January 2019 was the warmest on record for Australia in terms of mean, maximum, and minimum temperatures.¹² Although this mean increase does not seem sufficiently large to have impacts, it reflects more severe temperature extremes.¹³

Heatwaves are predicted to become increasingly more frequent, more intense, and longer in duration as the earth's surface warms. The death toll from heatwaves in Australia has exceeded that for any other environmental disaster.¹⁴

Globally, 37% of warm season heat-related deaths can be attributed to climate change and increased mortality is evident in every continent.¹⁵

Heatwaves have been called 'silent killers', as deaths may not always be identified as heat-related if the death is due to worsening of an underlying health condition.¹⁶

Effects of extreme heat:

- Exposure to high temperatures, especially over days or weeks with high overnight temperatures, leads to higher rates of mortality and heat-related illnesses such as dehydration, heat exhaustion, heatstroke and worsening of existing health conditions, such as heart, lung, and kidney disease.^{17,18,100,101}
- There is evidence that exposure to extreme heat may adversely impact pregnant women and birth outcomes including increased pre-term birth rates, low birth weight babies, increased stillbirth rates and neonatal stress.¹⁹
- Extreme heat can increase atmospheric dust or other pollutants such as ozone, which can trigger asthma.²⁰ Smoke from bushfires is often associated with heatwaves and can exacerbate heart and lung disease.
- Heatwaves are detrimental to mental health with worsening symptoms, increased hospital admissions and mortalities attributed to mental health issues, and increased suicide rates recorded in hot weather.^{21,22}
- High temperatures pose an extra risk to the old and very young, those with mobility or mental health problems, those without access to cooler housing or air-conditioning, outdoor workers, sportspeople, and those working in essential and emergency services. Hospital admissions are increased during heatwaves and put extra pressure on healthcare and emergency services.²³
- Heat also poses an extra risk to Aboriginal and Torres Strait Islander Peoples, due to the high frequency of heat-sensitive chronic diseases (such as cardiac and renal conditions) in this population.
- Extreme heat can result in power blackouts due to excessive demand, further adding to heat stress for those reliant on air-conditioning, compromising refrigerated medications/vaccines, and can result in food spoilage with risks of food poisoning.

- Heat decreases productivity through a number of ways including a reduction in work performance, increased fatigue, and absenteeism, causing significant economic loss.²⁴



For further information, see [Doctors for the Environment Australia's factsheet on heatwaves](#).

BUSHFIRES

Australia's bushfires are being intensified by changing weather patterns, particularly droughts and heatwaves.^{25,26,27} The duration, scale, and intensity of Australia's 'Angry Summer' was unprecedented - the 'bushfire season' lasted for eight months from July 2019 to February 2020.

The health impacts of bushfires can be severe and long lasting. Direct impacts include burns, heat stress, injury, and death. Indirect health effects include significant short and long-term impacts on mental health, societal disruption and loss of basic services such as General Practitioner care, housing and provisions.²⁸ Bushfires can affect water quality, especially when followed by heavy rainfall which mobilises ash and other soluble nutrients from burnt and devegetated ground into water catchments and drinking water reservoirs. For example, after the 2003 Canberra fires, the ACT's drinking water was contaminated with sediment, iron and manganese necessitating the construction of a water filtration plant and causing disruptions in water supply.²⁹

The stress of experiencing a bushfire can affect people psychologically, socially, and economically. As well as risks to human life, property may be lost, pets and livestock killed, communities and livelihoods threatened, and home environments destroyed. These compounding impacts contribute to mental health disorders, including depression, anxiety, post-traumatic stress disorder (PTSD), domestic violence, alcohol and substance abuse, triggering of underlying mental health problems, suicide, strained community relationships and reduced productivity.^{30,31} Mental health problems have been observed in those affected by fires up to ten years after the event. Children and youths are particularly vulnerable to PTSD as well as behavioural and emotional disorders.^{32,33}

BUSHFIRE SMOKE

Bushfire smoke is a complex mix of particulate matter ($PM_{2.5}$ and PM_{10}) and gases including carbon monoxide, oxides of nitrogen and sulphur, benzene, formaldehyde and polycyclic aromatic hydrocarbons (PAHs), all of which are known to be detrimental to health.^{34,35,36,37} As

well as eye and severe airways irritation, smoke can aggravate existing lung conditions such as asthma. Fine particles ($PM_{2.5}$) within bushfire smoke can be absorbed via the lungs into the bloodstream and damage distant organs such as the heart and the brain.³⁸

Over the summer of 2019/2020, 80% of the Australian population was exposed to air pollution from bushfire smoke; with some exposures lasting for months, and with significant adverse health outcomes. One study has estimated that there were 417 excess deaths from bushfire smoke, with over 3000 hospital presentations for heart and lung conditions and over 1000 emergency presentations for asthma.³⁹ Several studies confirm that bushfire smoke is associated with worsening cardio-respiratory problems, increases in ambulance callouts, increased hospital admissions, and premature deaths.^{40,41} Maternal exposure to urban air pollutants including $PM_{2.5}$ during pregnancy has been linked to preterm births, decreased birth weight and other adverse outcomes. The composition of air pollution from bushfire smoke is different to urban air pollution and there is limited information about the effects of bushfire smoke on pregnant women, the foetus, and the newborn, though there is increasing evidence of its negative impacts.^{42,43}



For further information, see [Doctors for the Environment Australia's factsheet on bushfires](#).

SEVERE STORMS AND FLOODS

Increased atmospheric greenhouse gases and global warming is leading to increased ocean temperatures. Around Australia oceans have warmed by around 1°C since 1910, contributing to longer and more frequent marine heatwaves. Global mean sea levels have risen by about 25cm since 1880 and continue to rise at an accelerating rate.⁴⁴ Sea levels are rising around Australia, including more frequent extreme sea levels associated with storms surges, surface waves and high tides that increase the risk of inundation and damage to coastal infrastructure, residences, and communities.^{45,46,47,48} Warmer ocean surfaces cause more evaporation and warmer air carries more moisture. When cyclones and coastal storms form in these conditions they lead to heavy rainfall, high winds, severe storms, flooding, and coastal storm surges.^{49,50,51}

In the coming decades, Australia is projected to see fewer tropical cyclones, but a greater proportion are forecast to be of high intensity, with large variations from year to year. Consistent with trends globally, both the

frequency and ferocity of extreme weather events in Australia are predicted to increase.⁵²

Queensland's 2011 floods, in which there were 33 recorded deaths, were compounded by an unprecedented wet season,⁵³ and the record floods in Townsville in early 2019 followed 1200mm of rain over 10 days, the highest since records began in 1888.⁵⁴ Early in 2021, the central coast of NSW experienced severe storms and rainfall resulting in five deaths and record flooding of the Hawkesbury River catchment.^{55,56}

The direct health effects of severe storms and floods may include:

- Injury and death from drowning, falls, electrocution, being struck by debris and mudslides/landslides
- Hypothermia
- Acute and long-term mental health impacts
- Bites and injuries from displaced wild animals

Storms can cut off populations from essential services - safe water, power, food supplies, pharmaceutical and medical supplies, emergency services, and health care.^{57,58} For example, thousands remained without power or safe drinking water for weeks after the severe storms east of Melbourne in June 2021.⁵⁹

The indirect health effects may include:

- Increased mosquito borne diseases such as dengue and Ross River fever from changing patterns of mosquito distribution and numbers
- Gastrointestinal illnesses from contaminated supplies of food and lack of power/refrigeration
- Heavy rainfall and flooding can cause sewage overflow and can mobilise dissolved bacterial and toxic contaminants into floodwaters and drinking water supplies
- Skin and wound infections from abrasions or cuts in contact with dirty and contaminated water
- Other bacterial diseases such as leptospirosis and melioidosis that can be spread in floodwaters and contracted through abrasions and cuts
- Mould growth, promoted by damp conditions, which aggravates asthma and other allergic reactions
- Exposure to toxins in floodwaters such as chemicals and pesticides
- Power outages which can compromise the

functioning of water treatment plants and the provision of clean water to populations⁶⁰



For further information, see [Doctors for the Environment Australia's factsheet on severe storms and floods](#).

FOOD AND WATER SECURITY

Although Australia currently has an abundant food supply, and produces more food than it consumes, it is also considered to have one of the most vulnerable agricultural sectors globally because of the impacts of climate change.⁶¹ Greater variability in rainfall, rising temperatures, prolonged droughts, and a higher frequency and severity of extreme weather events are key threats to Australian food and water security in the decades ahead.

The IPCC has identified two major agricultural production areas – south-western Australia and the Murray Darling Basin - that will experience significant impacts from climate change.⁶² Reduced rainfall, the lack of a major river system and reliance on dams and bores in the south-west will affect agricultural yields.^{63,64} In south-eastern Australia, changing weather patterns have already increased variability of crop yields. Heat stress in livestock can reduce reproductive rates, weight gain and milk production.^{65,66} Severe droughts kill livestock and crops, increase soil erosion, increase bushfire risk, and damage the native flora and fauna of ecosystems. These changes in agricultural productivity pose significant risks to the nature, distribution, quality and affordability of our food supply in the decades ahead.

Having access to a reliable supply of clean safe water is a fundamental determinant of good health and an essential public health measure. But water security and quality are threatened by drought, high temperatures, heavy rainfall, and flooding. Critical urban water shortages during the Millennium Drought (2001-2010) were experienced in Brisbane, Sydney and Adelaide.⁶⁷ In rural areas, some towns also faced water shortages, with Murrumbidgee in NSW relying on water trucks for household supplies. Poor food and water security has particularly concerning implications for Aboriginal and Torres Strait Islander Peoples, many of whom already face significant structural barriers to adequate nutrition and clean water. Drought is a major psychological stressor and is associated with significant mental health issues for farmers, young people and others living in rural areas.⁶⁸



For further information, see [Doctors for the Environment Australia's factsheet on 'Healthy food, Healthy people, Healthy planet'](#).

INFECTIOUS DISEASES

Climate has a major influence on the behaviour, reproduction and geographical distribution of many of the organisms which cause infectious diseases and the insect vectors through which they spread. For example, warmer temperatures cause mosquitoes to feed more frequently and produce more offspring. Viruses also replicate faster within the mosquito, and all these factors together contribute to more mosquitoes capable of transmitting infection. Heavy rainfall can also increase mosquito abundance, while droughts can reduce mosquito predators and competitors, allowing mosquitoes to thrive.⁶⁹

Mosquito-borne diseases in Australia include Ross River virus, Barmah Forest virus, Murray-Valley encephalitis and dengue.^{70,71} Notifications of dengue virus infections in northern Australia have increased over the past 30 years, from typically a few hundred to over a thousand annually.⁷² Modelling suggests that changes in climatic conditions over coming decades, particularly increased temperatures, heavy rainfall events and drought, are likely to increase the burden of all of these diseases in endemic areas and lead to disease outbreaks in new areas.⁷³



For further information, see [Doctors for the Environment Australia's factsheet on zoonoses](#).

BIODIVERSITY

Biodiversity and the health of our ecosystems are declining faster than at any time in human history. Species extinction is already hundreds to thousands of times faster than the background rate of species loss that has been occurring naturally in the last tens of millions of years.⁷⁴

Healthy natural environments (ecosystems) rich in a variety of animal and plant species (biodiversity) provide us with oxygen, fresh water, and fertile soils on which human life depends. Natural ecosystems are complex and depend on abundant biodiversity as every species has a specific role in maintaining the health and resilience of its ecosystem. Human health is, in turn, inextricably linked with the natural world, and good human health depends on healthy ecosystems for clean air, a reliable source of healthy and nutritious food, clean and abundant water and a stable climate. Trees and vegetation provide the oxygen needed for life on earth – it takes about 30 mature trees to produce the amount of oxygen one human breathes every year.⁷⁵ Trees also absorb and help reduce atmospheric CO₂. Forests absorb and redistribute water, increase rainfall and improve water quality. Forests and native vegetation are

necessary for the survival of pollinators such as bees, which are important for the fertilisation of many food crops.

Biodiversity is also an irreplaceable resource for the discovery of medicines and biomedical advances. About half of all known drugs in current use consist of naturally occurring compounds or their derivatives.⁷⁶ They include vital drugs such as penicillin, opioids, digitalis, cancer treatments, anti-coagulants and antimalarials. Of the estimated 400,000 plant species on earth, only a fraction has been studied for pharmacological potential. Many species – both terrestrial and marine - threatened with extinction include plants and animals that may be a source of bioactive compounds for current and potential future medicines.⁷⁷

Climate change is one of the biggest factors contributing to biodiversity loss, although multiple other human-induced factors are exacerbating ecosystem decline. These include unsustainable agricultural practices, land and mangrove clearing for agriculture and development, population growth and spread, deforestation, mining, the introduction of predators and feral domestic animals, and use of pesticides and toxins.⁷⁸

Marine biodiversity and marine ecosystems are also being seriously threatened by over-exploitation of resources and by ocean warming and acidification resulting from climate change. Warming of the ocean has contributed to longer and more frequent marine heat waves which in recent years have impacted marine ecosystem health, marine habitats, and species. These impacts include depleting kelp forests and sea grasses, a poleward shift in some marine species, increased occurrence of disease within marine species,⁷⁹ mangrove destruction, and mass coral bleaching around Australia.

Ocean acidification in waters around Australia is estimated to have increased by 30% since 1880, causing changes in marine reproduction, organism growth and physiology, species composition and distribution, nutrient availability, and reduced calcification which threatens the survival of corals and shellfish. Loss of coral reefs and mangroves markedly reduce the breeding and feeding grounds of a vast range of marine life on which some populations depend for food.⁸⁰

Biodiversity loss is particularly detrimental to the health and wellbeing of Aboriginal and Torres Strait Islander Peoples, who have practiced sustainable custodianship of Australia's lands and waters for millennia, and depend on rich natural environments for traditional foods, medicines, and cultural connections.



For further information, see our [factsheet on why we need forests and native vegetation for our health, and how land-clearing harms our health](#).

AIR POLLUTION AND ALLERGIES

Climate change impacts local air quality by changing the meteorological variables that influence the spatial and temporal distribution of air pollutants. Depending on conditions, air quality may be made worse or improved by changing weather patterns.

Fine particle pollution and atmospheric warming have the potential to increase ground level ozone in urban regions, a significant respiratory irritant.^{81,82} Ozone is a gas formed when UV light reacts with oxides of nitrogen and volatile organic compounds, substances that are produced by vehicle exhausts and bushfires.⁸³ Droughts, bushfires and hazard reduction burning also affect air quality by increasing airborne particulate matter, respiratory irritants, and chemicals.⁸⁴ (See section on bushfire smoke above). There is evidence suggesting that airborne environmental pollutants may be partially responsible for the increase in allergic respiratory disease seen in industrialised countries over the past several decades.⁸⁵

Airborne allergens (aeroallergens) such as pollens and moulds can trigger asthma and hay fever. Changing weather patterns have increased the intensity of the pollen season and prolonged its duration in some places. Increases in CO₂ have been shown to increase total pollen levels, especially those plants that thrive at higher CO₂ levels such as ragweed.^{86,87,88} Climate change may also increase the number of thunderstorm events that increase the risk of asthma from pollen exposure (“thunderstorm asthma”). Such an event occurred in Melbourne in 2016, causing nine asthma-related deaths.⁸⁹

ECOLOGICAL ANXIETY AND GRIEF

‘Eco-anxiety’, ‘ecological grief’, ‘solastalgia’ and ‘climate change anxiety and grief’ all describe feelings about anticipated threats to, or actual losses of our natural world from the impacts of climate change. These feelings are being increasingly recognised as having significant psychological impact, especially in young people.⁹⁰ They can be associated with direct losses of ecosystems, but also as a response to real and anticipated changes in our way of life.⁹¹ Climate anxiety may include panic attacks, insomnia, despair and feelings of hopelessness and may compound other daily stressors leading to stress related problems such as substance abuse disorders, anxiety disorders and depression.

Although the phenomenon of climate anxiety and climate grief are still not fully understood, more research is emerging. It disproportionately affects some groups, for example, young people and women, and those who

rely closely on the land for livelihood and wellbeing (i.e., farmers and Aboriginal and Torres Strait Islander Peoples) are at the forefront of exposure to the climate crisis. Also those professionals working within climate science often experience burnout, anxiety, grief and depression with some choosing to leave the field.⁹² Approaches recommended to manage feelings about climate change include focussing on what you can do at a personal and local level, maintaining a healthy routine and seeking social support from others.

CLIMATE ACTION: HEALTH OPPORTUNITIES

There are numerous immediate and lasting health co-benefits to be gained by action to limit climate change. Reducing 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 disease, heart disease, stroke, and lung cancer.

A plant-based diet, with reduced consumption of red meat, fats and sugars can be good for our health and the environment.^{93,94} Sustainable agricultural practices, reduced meat production, buying locally grown food, buying less processed food, and reducing food waste will help lower greenhouse gas emissions, lower rates of deforestation and biodiversity loss, and help prevent overuse of water resources.

Reducing our reliance on private vehicles and increasing our use of public transport and ‘active transport’ – walking and cycling – both reduces traffic congestion and exhaust pollution and helps to reduce rates of obesity, diabetes, heart disease, and many musculoskeletal conditions.

The greening of urban areas decreases the heat-island effect, improves the quality of urban life, and improves health outcomes. For Aboriginal and Torres Strait Islander peoples, natural landscapes are integral to cultural and spiritual wellbeing. Spending time in nature is important for our physical and mental well-being. Time in forests and biodiverse landscapes can lower stress hormones, lower blood pressure, lift mood, and stimulate our immune systems.⁹⁵

HEALTHCARE SUSTAINABILITY

Currently the Australian healthcare contributes about 7% of Australia’s total emissions. We can lead by example by reducing this significant environmental cost by setting emissions reductions targets for this sector of 80% by 2030 and net zero emissions by 2040.

Doctors for the Environment Australia and the AMA have called for a National Sustainable Healthcare unit and the endorsement of Emission Reduction Targets for the healthcare sector.⁹⁶ In Doctors for the Environment Australia's report, [Net Zero Carbon Emissions](#), we outline the necessity and advantages for the Australian healthcare sector to reach net zero emissions by 2040 and provide recommendations to achieve this.⁹⁷ Doctors for the Environment Australia has also written a proposal for an Australian Healthcare Sustainability Unit.⁹⁸

Doctors for the Environment Australia has long advocated for decisive leadership in climate policy at all levels of government. Effective means to reduce emissions need to be developed and co-ordinated in

all the major sectors which contribute to greenhouse gas emissions in order to achieve the change that is required in the short time available. Of particular concern is the need for protection of children and future generations who will be disproportionately affected by the health impacts of worsening climate change over their lifetimes.⁹⁹ A child born today will live through a warming climate that will impact their health from infancy and adolescence to adulthood and old age. Doctors for the Environment Australia will continue to advocate for climate action policies that will limit global warming to improve current and future health outcomes for Australians.

FURTHER READING

The Lancet Countdown series

<https://www.lancetcountdown.org/2020-report/>

<https://www.mja.com.au/journal/2019/211/11/2019-report-mja-lancet-countdown-health-and-climate-change-turbulent-year-mixed>

Bureau of Meteorology

<http://www.bom.gov.au/state-of-the-climate/>

The Climate Council

<https://www.climatecouncil.org.au/>

<https://www.climatecouncil.org.au/resource/reports>

Doctors for the Environment Australia

<https://dea.org.au/our-work/climate-change/>

Sixth Assessment Report from the Intergovernmental Panel on Climate Change

<https://www.ipcc.ch/assessment-report/ar6/>

Hanna E, McIver L. Climate change: a brief overview of the science and health impacts for Australia Medical Journal of Australia. 208(7): 16 April 2018. https://www.mja.com.au/system/files/issues/208_07/10.5694mja17.00640.pdf

REFERENCES

1. <https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/>
2. WHO (2018) COP 24 special report: health and climate change. World Health Organisation <https://www.who.int/globalchange/publications/COP24-report-health-climate-change/en/>
3. Rising Waters NASA <https://www.nasa.gov/specials/sea-level-rise-2020>
4. Bureau of Meteorology. State of the Climate 2020 <http://www.bom.gov.au/state-of-the-climate/>
5. <https://www.bloomberg.com/graphics/carbon-clock/>
6. <https://ama.com.au/media/climate-change-health-emergency>
7. DEA – Doctors declare a health emergency <https://dea.org.au/climate-health-emergency-declaration/>
8. Steffen W, et al. Trajectories of the earth system in the Anthropocene. Proceedings of the National Academy of Sciences of the USA August 14, 2018. 115(33):8252-8259 <https://www.pnas.org/content/115/33/8252>
9. McSweeney R. Tipping Points. Feb 10 2020 <https://www.carbonbrief.org/explainer-nine-tipping-points-that-could-be-triggered-by-climate-change>
10. Pearce F. As climate change worsens, a cascade of tipping points looms. Dec 5 2019. Yale Environment 360. <https://e360.yale.edu/features/as-climate-changes-worsens-a-cascade-of-tipping-points-looms>

11. Bureau of Meteorology. State of the Climate 2020 <http://www.bom.gov.au/state-of-the-climate/>
12. The Climate Council. The Angriest Summer March 2019 <https://www.climatecouncil.org.au/resources/the-angriest-summer/>
13. Australian Government - Observed changes in our climate system. <http://www.environment.gov.au/climate-change/climate-science-data/climate-science/understanding-climate-change/indicators>
14. Cassella C. Science Alert May 2020. <https://www.sciencealert.com/official-death-records-are-terrible-at-showing-how-many-people-are-dying-from-the-climate-crisis>
15. Vicedo-Cabrera A et al. The burden of heat-related mortality attributable to recent human-induced climate change. *Nature Climate Change* 31 May 21 <https://www.nature.com/articles/s41558-021-01058-x>
16. Longden T, Quilty S, Haywood P, Hunter A, Gruen R. Heat related mortality: an urgent need to recognise and record. *Letter. The Lancet* Vol 4 May 2020. [https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196\(20\)30100-5/fulltext?ref=theprepping-com](https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(20)30100-5/fulltext?ref=theprepping-com)
17. Hunter A. Hot and bothered Jan 2020. <https://medicalschoo.anu.edu.au/news-events/news/hot-and-bothered-heat-affects-all-us-older-people-face-highest-health-risks>
18. DEA factsheet - Heatwaves https://www.dea.org.au/wp-content/uploads/2021/01/DEA-Fact-Sheet_HeatwavesWEB.pdf
19. Kuehn L, McCormick S. Heat Exposure and Maternal Health in the Face of Climate Change August 2017 *Int J Environ Res Public Health* 14(8):853 <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5580557/>
20. Meehl GA, et al. Future heat waves and surface ozone. May 2018. *Environmental Research Letters* 13(6): 064004 <http://dx.doi.org/10.1088/1748-9326/aabdc6>
21. Hansen A et al. The effect of heat waves on mental health in a temperate Australian city. *Environmental Health Perspectives*. 2008. 116(10) <https://ehp.niehs.nih.gov/doi/full/10.1289/ehp.11339>
22. Thompson R, Hornigold R, Page L, Waite T. Associations between high ambient temperatures and heat waves with mental health outcomes: a systematic review. *Public Health*. August 2018 Vol.161: 171-191 <https://www.sciencedirect.com/science/article/abs/pii/S0033350618302130?via%3Dihub>
23. Victorian Health. Heatwave January 2014 <https://www2.health.vic.gov.au/public-health/environmental-health/climate-weather-and-public-health/heatwaves-and-extreme-heat/heatwave-research>
24. Zander K et al. Heat Stress causes substantial labour productivity loss in Australia. *Nature Climate Change*. 2015 5:647-651 <https://www.nature.com/articles/nclimate2623>
25. World Weather Attribution. Jan 2020 <https://www.worldweatherattribution.org/bushfires-in-australia-2019-2020/>
26. Van Oldendorp G, Krikken F, Lewis S, Leach N. Attribution of the Australian bushfire risk to anthropogenic climate change. *Natural Hazards and Earth Systems Sciences*. 11 March 2020 https://www.researchgate.net/publication/339863197_Attribution_of_the_Australian_bushfire_risk_to_anthropogenic_climate_change
27. The Climate Council. Summer of Crisis report February 2020 <https://www.climatecouncil.org.au/resources/summer-of-crisis/>
28. DEA submission to the Bushfires Royal Commission 2019 <https://dea.org.au/submission-to-the-issues-paper-on-health-arrangements-in-natural-disasters-bushfires-royal-commission/>
29. The Climate Council. Deluge and Drought: Australia's water security in a changing climate. 2018 <https://www.climatecouncil.org.au/wp-content/uploads/2018/11/Climate-Council-Water-Security-Report.pdf>
30. DEA submission to the Bushfires Royal Commission, April 2020 <https://dea.org.au/royal-commission-into-national-disaster-arrangements-bushfires-royal-commission-april-2020/>
31. DEA submission to the Bushfires Royal Commission, June 2020 <https://dea.org.au/submission-to-the-issues-paper-on-health-arrangements-in-natural-disasters-bushfires-royal-commission/>
32. Centre for Disaster Management and Public Safety, University of Melbourne. Beyond Bushfires: Community Resilience and Recovery. January 2020. <https://unimelb.edu.au/cdmps/research/research-projects/beyond-bushfires>
33. Australian Government - Royal Commission into Natural Disaster Arrangements. October 2020 <https://naturaldisaster.royalcommission.gov.au/>
34. United States Environmental Protection Agency. Wood Smoke and Your Health <https://www.epa.gov/burnwise/wood-smoke-and-your-health>
35. US Agency for Toxic Substances: Sulfur dioxide. Dec 1998 <https://www.atsdr.cdc.gov/toxprofiles/tp116.pdf>
36. Latza U, Gerdes S, Baur X. Effects of N2O on human health: a systematic review. May 2009 *Int. J of Hygiene and Environmental Health*. 212(3):271-287 <https://www.sciencedirect.com/science/article/abs/pii/S1438463908000539>
37. WHO Health effects of particulate matter. 2013 https://www.euro.who.int/_data/assets/pdf_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf
38. Pope C, Dockery D. Health effects of fine particulate air pollution. *J Air and Waste Management Assn*. 56:709-742 2006 <https://toxicology.usu.edu/endnote/PM-HealthEffects-Pope2006.pdf>
39. Johnston F et al. Unprecedented smoke-related health burden associated with the 2019-20 bushfires in eastern Australia. March 2020 *Medical Journal of Australia* 213(6):282-283 <https://onlinelibrary.wiley.com/doi/full/10.5694/mja2.50545>
40. DEA factsheet – Bushfires Dec 2017 <https://www.dea.org.au/bushfires-and-health-in-a-changing-environment-fact-sheet/>
41. Vardoulakis S, Jalaludin B, Morgan G, Hanigan I, Johnston F. Bushfire smoke: urgent need for a national health protection strategy. Feb 2020 *Medical Journal of Australia*. 212(8):349-353 <https://www.mja.com.au/journal/2020/212/8/bushfire-smoke-urgent-need-national-health-protection-strategy>
42. Abdo M, et al. Impact of wildfire smoke on adverse pregnancy outcomes in Colorado 2007-2015. *Int J. Environ. Research Public Health*. 2019. 16(19):3720. <https://www.mdpi.com/1660-4601/16/19/3720>
43. Jalaludin B, Johnston F, Vardoulakis S, Morgan G. Reflections on the catastrophic 2019-2020 Australian bushfires. *The Innovation*. 2020 [https://www.cell.com/the-innovation/pdf/S2666-6758\(20\)30010-2.pdf](https://www.cell.com/the-innovation/pdf/S2666-6758(20)30010-2.pdf)
44. Rising Waters NASA <https://www.nasa.gov/specials/sea-level-rise-2020/>
45. Australian Bureau of Meteorology. State of the Climate 2020 <http://www.bom.gov.au/state-of-the-climate/>
46. The Climate Council. Tropical Cyclones and climate change fact sheet 2020 <https://www.climatecouncil.org.au/resources/fact-sheet-tropical-cyclones-and-climate-change/>
47. CSIRO Sea Level, Waves and Coastal Extremes. <https://research.csiro.au/slrwavescoast/extremes/causes-extreme-sea-levels/>
48. <https://www.abc.net.au/news/2021-04-19/torres-strait-islanders-climate-change-impacts-uninhabitable/100069596>
49. Guerreiro SB, et al. Detection of continental-scale intensification of hourly rainfall extremes. *Nature Climate Change* 2018 8:803-807 <https://www.nature.com/articles/s41558-018-0245-3>
50. Bureau of Meteorology 2017 About tropical cyclones. <http://www.bom.gov.au/cyclone/about/>
51. Climate Science Special Report NCA4 <https://science2017.globalchange.gov/chapter/9/>
52. The Climate Council. The Angriest Summer 2019 <https://www.climatecouncil.org.au/wp-content/uploads/2019/03/Climate-council-angriest-summer-report.pdf>
53. Honert R, McAneney J. The 2011 Brisbane floods. *Water* 2011 3:1149-1173. <https://research-management.mq.edu.au/ws/portals/files/portal/16832889/mq-19234-Publisher+version+%28open+access%29.pdf>
54. City of Townsville report 2019. <https://www.townsville.qld.gov.au/community-support/community-safety/disaster-management/2019-weather-event>
55. National Public Radio March 14 2021 <https://www.npr.org/2021/03/24/980708784/40-000-evacuated-at-least-2-dead-in-massive-australian-floods>
56. The European Space Agency Satellite map record floods in Australia. 24 March 2021 https://www.esa.int/ESA_Multimedia/Images/2021/03/Satellites_map_record_floods_in_Australia
57. The Climate Council. Hitting Home 2021 <https://www.climatecouncil.org.au/wp-content/uploads/2021/01/hitting-home-report-V7-210122.pdf>

58. McCall B. Public health aspects of the Queensland floods Dec 2010-Jan 2011. Pathology 2012 Vol 44(1): S45-S46 <https://www.sciencedirect.com/science/article/abs/pii/S0031302516327064>
59. <https://www.sbs.com.au/news/thousands-in-victoria-to-be-without-power-in-the-middle-of-winter-for-three-more-weeks-after-wild-storms>
60. The Climate Council. Water Security in a changing climate. 2018. <https://www.climatecouncil.org.au/resources/water-security-report/>
61. The Climate Council. How climate change is affecting Australian food. 2015. <https://www.climatecouncil.org.au/resources/hard-to-swallow-how-climate-change-is-affecting-australian-food/>
62. IPCC Fifth Assessment Report 2014. Summary for Policy Makers pp 13-16 <https://www.ipcc.ch/report/ar5/syr/>
63. Collet J. Future Directions. Climate change and Australian food security. June 2014. <https://www.futuredirections.org.au/publication/climate-change-and-australian-food-security/>
64. Bureau of Meteorology. State of the Climate 2020 <http://www.bom.gov.au/state-of-the-climate/>
65. Collet J. Future Directions. Climate change and Australian food security. June 2014. <https://www.futuredirections.org.au/publication/climate-change-and-australian-food-security/>
66. The Climate Council. Feeding a hungry nation: climate change, food, and farming in Australia. 2015 <https://www.climatecouncil.org.au/resources/foodsecurityreport2015/>
67. The Climate Council. Deluge and Drought: Australia's water security in a changing climate. 2018 <https://www.climatecouncil.org.au/wp-content/uploads/2018/11/Climate-Council-Water-Security-Report.pdf>
68. Kelly B, Stain H. Drought and its effect on mental health. Australian Family Physician. Vol 36(12) 2007 <https://www.racgp.org.au/afpbackissues/2007/200712/200712Sartore.pdf>
69. <https://dea.org.au/zoonoses-joining-the-dots-between-people-animals-and-the-natural-world/>
70. Beggs P et al. The 2019 report of the MJA-Lancet Countdown on health and climate change. MJA 2019. 211(11):490-491 <https://www.mja.com.au/journal/2019/211/11/2019-report-mja-lancet-countdown-health-and-climate-change-turbulent-year-mixed>
71. Tomerini D, Dale P, Snipe N. Does mosquito control have an effect on mosquito borne disease? Jnl Am Mosq Control Assoc. 2011 March 27(1):39-44 <https://pubmed.ncbi.nlm.nih.gov/21476446/>
72. Australian government. Natural environment and health. 23 July 2020. <https://www.aihw.gov.au/reports/australias-health/natural-environment-and-health>
73. <https://dea.org.au/zoonoses-joining-the-dots-between-people-animals-and-the-natural-world/>
74. Ceballos G, Ehrlich P, Raven P. Vertebrates on the brink as indicators of biological annihilation and the sixth mass extinction. Proceedings of the National Academy of Sciences of the USA. June 16 2020. 117(24):13596-13602. <https://www.pnas.org/content/117/24/13596>
75. Nowak DJ, Hoehn R, Crane DE. Oxygen production by urban trees in the United States. Arboriculture & Urban Forestry 2007; 33(3): 220-226. <https://www.covingtonwa.gov/ISA%20-%20Oxygen%20Production%20by%20Urban%20Trees%20in%20the%20United%20States.pdf>
76. Dar R et al. Natural product medicines: a literature update.2017 The Jnl of Phytopharmacology. 69(6): 340-342 http://www.phytopharmajournal.com/Vol6_Issue6_06.pdf
77. UNEP, Convention on Biological Diversity, WHO Connecting global priorities: biodiversity and human health 2015 Page 11. <https://www.cbd.int/health/doc/Summary-SOK-Final.pdf>
78. DEA Biodiversity Policy November 2019 <https://dea.org.au/biodiversity-policy/>
79. <https://theconversation.com/is-global-warming-causing-marine-diseases-to-spread-55751>
80. Bureau of Meteorology State of the Climate 2020. Oceans. <http://www.bom.gov.au/state-of-the-climate/oceans.shtml>
81. US Global Change Research Program Climate and Health Assessment: Air Quality Impacts. <https://health2016.globalchange.gov/air-quality-impacts>
82. US EPA. Air quality and climate change research. <https://www.epa.gov/air-research/air-quality-and-climate-change-research>
83. DEA Expert Position Statement on Health-based standards for Australian regulated thresholds of NO2, SO2 and ozone. 2019 <https://www.dea.org.au/wp-content/uploads/2021/01/Expert-Position-Statement-PDF-7.pdf>
84. Dean A, Green D. Climate change, air pollution and health in Australia. Nov 2017. <https://www.grandchallenges.unsw.edu.au/sites/default/files/2019-01/climate%20change%20C%20air%20pollution%20and%20health%20in%20australia.pdf>
85. D'Amato G, Cecchi L, D'Amato M, Liccardi G. Urban air pollution and climate change as environmental risk factors or respiratory allergy: and update. J Investig Allergol Clin Immunology. 2010 20(2):95-102 <https://pubmed.ncbi.nlm.nih.gov/20461963/>
86. Ray C, Ming X. Climate change and human health: a review of allergies, autoimmunity and the microbiome. Int. J. Environ. Res. Public Health 2020 17(13):4814 <https://www.mdpi.com/1660-4601/17/13/4814>
87. D'Amato G, Cecchi L. Effects of Climate change on environmental factors in respiratory allergic diseases. August 2008. Clin Exp Allergy 38(8):1264-74 <https://pubmed.ncbi.nlm.nih.gov/18537982/>
88. Beggs P, Walczyk N. Impacts of climate change on plant food allergens: a previously unrecognised threat to human health. Air Quality, Atmosphere and Health. 1, 119-123 (2008) <https://link.springer.com/article/10.1007/s11869-008-0013-z>
89. Thien F et al. The Melbourne epidemic thunderstorm asthma event 2016. The Lancet Planetary Health 2(6) June 2018. PP e255-e263 <https://www.sciencedirect.com/science/article/pii/S2542519618301207>
90. Wu J, Snell G, Samji H. Climate anxiety in young people: a call to action. The Lancet Planetary Health Vol4(10); E435-436 2020 [https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196\(20\)30223-0/fulltext](https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(20)30223-0/fulltext)
91. Cunsolo, A., Harper, S. L., Minor, K., Hayes, K., Williams, K. G., & Howard, C. (2020). Ecological grief and anxiety: the start of a healthy response to climate change? The Lancet Planetary Health, 4(7), e261-e263. [https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196\(20\)30144-3/fulltext](https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(20)30144-3/fulltext)
92. Clayton S. Mental health risk and resilience amongst climate scientists. Nature Climate Change. 8, 260-261 (2018) <https://www.nature.com/articles/s41558-018-0123-z>
93. DEA factsheet https://dea.org.au/wp-content/uploads/2020/12/DEA11231-Food-Agriculture-Fact-Sheet_web-final.pdf
94. Willet W, Rockstrom J, Loken B, Springmann M. Food in the Anthropocene: The EAT-Lancet Commission on healthy diets from sustainable food systems. The Lancet Vol 393(10170): p447-92. https://www.researchgate.net/publication/330443133_Food_in_the_Anthropocene_the_EAT-Lancet_Commission_on_healthy_diets_from_sustainable_food_systems
95. Kotera Y, Richardson M, Sheffield D. Effects of forest bathing and nature therapy on mental health: a systematic review and meta-analysis. July 2020. International J of Mental Health and Addiction. <https://link.springer.com/article/10.1007/s11469-020-00363-4>
96. <https://www.ama.com.au/media/joint-statement-medical-professionals-call-emissions-reduction-health-care>
97. https://www.dea.org.au/wp-content/uploads/2020/12/DEA-Net-Zero-report_v11.pdf
98. <https://www.dea.org.au/wp-content/uploads/2021/01/DEA-HSU-Proposal-Final-.pdf>
99. No Times for Games. Summary Report Update 2018. Doctors for the Environment Australia [http://www.acsep.org.au/content/Document/NTFG%20Summary%20and%20Update%202018%2011-18%20Final%20\(002\).pdf](http://www.acsep.org.au/content/Document/NTFG%20Summary%20and%20Update%202018%2011-18%20Final%20(002).pdf)
100. World Health Organisation <https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health>
101. Peng B, et al. The effects of extreme heat on human mortality and morbidity in Australia: implications for public health. Asia-Pacific Jnl of Public Health 23(2): 27S-36S. 2011 <https://pubmed.ncbi.nlm.nih.gov/21247972/>