The Australia Institute
Research that matters.

HeatWatch

Extreme heat in Adelaide

Increasing extreme heat will have profound impacts on people, industries and ecosystems in Adelaide. CSIRO and Bureau of Meteorology projections estimate that the average number of days over 35 could increase by 180% without strong climate policies, from historical averages of 17–19 days per year up to 50–51 days per year by 2090.

Mark Ogge
Bill Browne
Travis Hughes

January 2019

ABOUT THE AUSTRALIA INSTITUTE

The Australia Institute is an independent public policy think tank based in Canberra. It is funded by donations from philanthropic trusts and individuals and commissioned research. We barrack for ideas, not political parties or candidates. Since its launch in 1994, the Institute has carried out highly influential research on a broad range of economic, social and environmental issues.

OUR PHILOSOPHY

As we begin the 21st century, new dilemmas confront our society and our planet. Unprecedented levels of consumption co-exist with extreme poverty. Through new technology we are more connected than we have ever been, yet civic engagement is declining. Environmental neglect continues despite heightened ecological awareness. A better balance is urgently needed.

The Australia Institute's directors, staff and supporters represent a broad range of views and priorities. What unites us is a belief that through a combination of research and creativity we can promote new solutions and ways of thinking.

OUR PURPOSE – 'RESEARCH THAT MATTERS'

The Institute publishes research that contributes to a more just, sustainable and peaceful society. Our goal is to gather, interpret and communicate evidence in order to both diagnose the problems we face and propose new solutions to tackle them.

The Institute is wholly independent and not affiliated with any other organisation. Donations to its Research Fund are tax deductible for the donor. Anyone wishing to donate can do so via the website at https://www.tai.org.au or by calling the Institute on 02 6130 0530. Our secure and user-friendly website allows donors to make either one-off or regular monthly donations and we encourage everyone who can to donate in this way as it assists our research in the most significant manner.

Level 1, Endeavour House, 1 Franklin St
Canberra, ACT 2601
Tel: (02) 61300530
Email: mail@tai.org.au
Website: www.tai.org.au

Summary

The projected rise in extremely hot days because of global warming presents a serious risk to the health and wellbeing of the Adelaide community. Adelaide already has the highest heatwave death rate of any major Australian city. Increases in extreme heat projected by the CSIRO as a result of global warming will escalate this vulnerability to dangerous levels unless greenhouse gas emissions are reduced.

Heatwaves can lead to serious illness and death. Heatwaves have caused more deaths in Australia since 1890 than cyclones, bushfires, floods, earthquakes and severe storms combined.[1]

At temperatures above 35 degrees, the human body's ability to cool itself reduces, making it a common benchmark temperature for occupational health and safety experts, academic and government researchers.

There has already been a clear increase in numbers of extreme heat days over recent decades. Since the 1970s, the number of days over 35 degrees has increased by a quarter at Adelaide Airport and by 40% in the Eastern Suburbs.

The number of days over 40 degrees at Adelaide Airport have tripled since the 1970s and extreme heat days in the Eastern Suburbs have more than doubled since the 1980s.

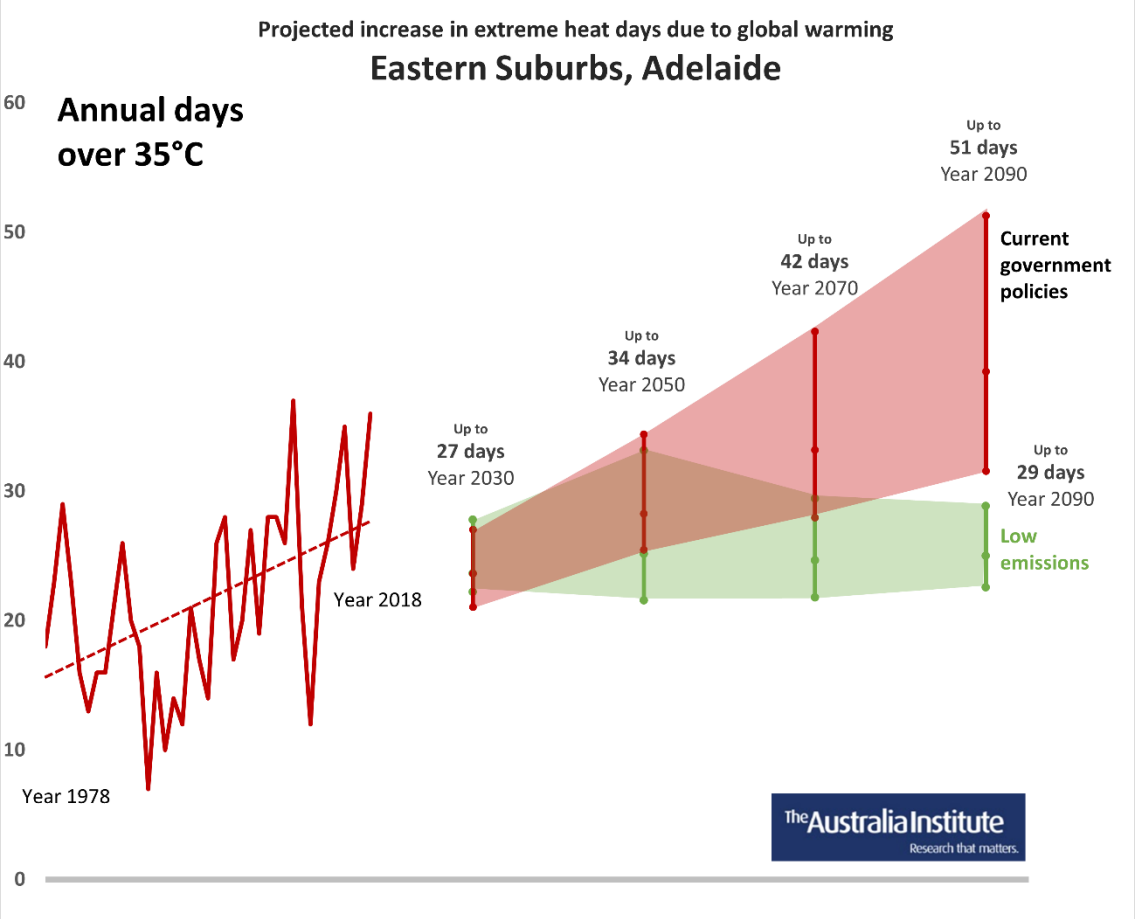
Of most concern, in the Eastern Suburbs days over 35 degrees could increase 180% to a projected 51 days by 2090, as shown in Figure 1 below.

The dramatic increase in extreme temperatures in recent year (also shown in Figure 1) suggests that current levels of extreme heat may already be exceeding levels projected for 2030. If so, the climate models may be too conservative in their projections.

The data also predicts large increases (600% or more) in days over 40 degrees, from Adelaide's historical average of 2.6 days over 40 degrees per year up to 19 days over 40 degrees per year by 2090. Without strong action on climate change, days over 40 degrees will become more frequent than days over 35 degrees have historically been.

[1] McMichael et al (2003) *Climate change and human health, risks and responses,* p 53, https://www.who.int/globalchange/publications/climchange.pdf

Figure 1: Forecast annual number of days over 35 degrees in Adelaide's Eastern Suburbs



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Extreme heat events present a risk to critical infrastructure including road, rail and electricity generation and have a major impact on productivity and economic activity.

Fortunately, if emissions are reduced the rises in extreme heat days will be far lower. As shown in Figure 1, with a decisive reduction in emissions the number of 35-degree days could be kept to a fraction of what would be expected under a business-as-usual scenario.

Australia makes a vastly disproportionate contribution to global warming. We are one of the lowest ranked countries in the world on climate action. As well as having one of the highest rates of domestic greenhouse gas emissions per person in the world, we have a staggering 44 tonnes per person of exported greenhouse gas emissions each, even greater than Saudi Arabia (35.5 tonnes per person) and around sixty times higher

than the US.[2] Even worse, there are plans for huge expansions in gas exports from the Northern Territory and Western Australia that could add a billion tonnes more of greenhouse gases to the atmosphere.[3]

A sharp reduction in Australia's domestic and exported emissions is essential to the global effort to prevent dangerous global warming and the associated increases in extreme heat that could have such a devasting impact on Adelaide and the country.

[2] Thwaites and Kestin (July 2018) *Australia ranked worst in world on climate action,* https://reneweconomy.com.au/australia-ranked-worst-world-climate-action-49472/

[3] Climate Analytics (2018) *Western Australia's gas gamble, Implications of exploiting Canning Basin and other unconventional gas resources for achieving climate targets,* https://climateanalytics.org/media/climateanalytics-report-westernaustraliasgasgamble-2018.pdf

Introduction

As the climate warms, the number of extremely hot days is increasing. The average number of days over 35 degrees in Adelaide (which we define further down) has increased considerably in recent years and is forecast to increase at an even higher rate without a strong action on climate change.

Adelaide is the most vulnerable major city in Australia to deaths from heatwaves. Between 2001-2015 Adelaide had more days exceeding a crucial temperature threshold above average temperatures than other major cities. As a result, it had a higher death rate than any other major city in Australia.[4]

Adelaide has experienced many heatwaves and extreme heat events over the last decade. In late January and early February 2009, Adelaide experienced a severe heatwave during which 58 heat related deaths were reported.[5] In January 2014, the Eastern Suburbs of Adelaide experienced five consecutive days over 40 degrees, followed by a similar heatwave in 2015 with six consecutive days over 35 degrees and with the hottest December night in over 100 years with a minimum of 31 degrees.[6]

A heatwave in early February 2017 resulted in the hottest February day on record for South Australia as a whole.[7]

There were three separate heatwaves in 2018, each with five or more days over 35 degrees,[8] and at the time of writing another severe six-day heatwave is forecast.[9]

[4] Londen (2018) *Measuring temperature-related mortality using endogenously determined thresholds,* https://link.springer.com/article/10.1007/s10584-018-2269-0

[5] Ibid, p 354

[6] ABC News (December 2015) *Adelaide swelters through hottest December night since 1897, as fourth day of heatwave expected,* https://www.abc.net.au/news/2015-12-07/night-above-30-degrees-adelaide-hottest-century/7005892

[7] BOM (April 2017) *Special Climate Statement 61—exceptional heat in southeast Australia in early 2017,* http://www.bom.gov.au/climate/current/statements/scs61.pdf

[8] BoM (n.d.) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml

[9] SBS News (January 2019) *SA set to sizzle through 6-day heat wave*

EXTREME HEAT

Extreme heat is dangerous for human health, for ecosystems and agriculture. At temperatures above 35 degrees, the human body's main cooling mechanism – sweating – is far less effective. Sweating exchanges heat from the body to the atmosphere, but this heat exchange process diminishes significantly beyond 35 degrees, so body temperature rises. This creates discomfort and a range of health impacts, from mild to severe, and can ultimately be fatal without intervention.[10]

Because of this, many regulators and researchers use 35 degrees as an important threshold for safety, work and climatic conditions. 35 degrees is seen as the "limit of high temperature tolerance" by the Occupational Health and Safety Representatives of the Victorian Trades Hall Council and many academic researchers note it as the point where substantial productivity is lost. The CSIRO and Bureau of Meteorology publish 35-degree threshold predictions.[11]

A future of such extreme heat days represents a serious threat to the wellbeing of people in Adelaide and to Australia's wider population. As well as an increase in heat-related deaths and illness, the rise in extreme heat increases irritability and psychological stress.[12] Hot weather affects patterns in domestic violence,[13] interrupts sleep patterns and reduces capacity and willingness to exercise. All carry broad ramifications, such as increased accident risk, sedentary life style-induced diabetes and cardio vascular disease.[14] Tracking and minimising the way climate change is affecting the number of hot days is of direct interest to the wellbeing of local communities, particularly in areas of high vulnerability to heatwaves like Adelaide.

---

[10] Hanna and Tait (2015) *Limitations to thermoregulation and acclimatisation challenges human adaptation to global warming,* Int J Environ Res Public Health, https://academic.oup.com/heapro/article/30/2/239/561863

[11] Victorian Trades Hall Council (2018) *Heat*, http://www.ohsrep.org.au/hazards/workplace-conditions/heat; Singh et al (2015) *Working in Australia's heat: health promotion concerns for health and productivity,* Health Promotion International, https://academic.oup.com/heapro/article/30/2/239/561863; CSIRO and BoM (2015) *Climate change in Australia: Projections for Australia's NRM Regions*, https://www.climatechangeinaustralia.gov.au/en/publications-library/technical-report/

[12] Queensland Health (2015) *Heatwave Response Plan* https://www.health.qld.gov.au/__data/assets/pdf_file/0032/628268/heatwave-response-plan.pdf

[13] Auliciems and Di Bartolo (1995) *Domestic violence in a subtropical environment: police calls and weather in Brisbane.* International Journal of Biometeorology 39 (1).

[14] Kjellstrom T et al (2009) *The Direct Impact of Climate Change on Regional Labor Productivity.* Archives of Environmental & Occupational Health 64 (4); World Health Organisation (2017) *Preventing noncommunicable diseases (NCDs) by reducing environmental risk factors*, http://apps.who.int/iris/bitstream/10665/258796/1/WHO-FWC-EPE-17.01-eng.pdf?ua=1

ADELAIDE

CSIRO and the Bureau of Meteorology (BoM) have produced temperature projections under several climate change scenarios for most of terrestrial Australia. The CSIRO–BoM data is a time series from the Australian Water Availability Project (AWAP) where the average temperature was compiled in roughly five kilometre by five kilometre spatial grids between 1981 and 2010.[15] This time series uses between five and eight models to predict days over 35 degrees, over 37 degrees and over 40 degrees in 2030, 2050, 2070 and 2090.[16] It also has a historical average for the years 1981–2010.

The report also employs the IPCC scenarios for global climate action: RCP 2.6 ("low emissions"), RCP 4.5 ("intermediate emissions") and RCP 8.5 ("high emissions/current government policies"). RCP 2.6 equates roughly to what is required to keep the world below 1.5 degrees warming, RCP 4.5 to what is required to keep the world below 2 degrees warming, and RCP 8.5 is the "business as usual" scenario where the world fails to act decisively on climate change. RCP 8.5 is the current trajectory due to the failure of most major polluting governments to implement necessary climate policies.

The Adelaide CBD crosses two squares of the spatial grid, which we have labelled as "Adelaide Western Suburbs" and "Adelaide Eastern Suburbs". Both squares begin in North Adelaide and end in Ashford (Western Suburbs) or Parkside (Eastern Suburbs). Between them, the squares cover a large portion – but not all – of the western and eastern suburbs.

The Adelaide Airport "square" includes Fulham Gardens, Flinders Park and the airport.

Separately, the Bureau of Meteorology has two long-standing measurement stations in Adelaide, which provide year-by-year historical measurements for our purposes: a Kent Town station and an Adelaide Airport station. The Kent Town station is in the Eastern Suburbs; the Adelaide Airport station is just south of Adelaide Airport. There is a measurement station in the Western Suburbs, West Terrace, but it only recently restarted operations.

In previous HeatWatch graphs, we have used data from the square south of Adelaide CBD for Adelaide. This captures the warming effect for a large portion of suburban

[15] CSIRO and Bureau of Meteorology (2015) *Climate Change in Australia Information for Australia's Natural Resource Management Regions: Technical Report*, CSIRO and Bureau of Meteorology.

[16] All eight models – ACCESS1.0, CESM1-CAM5, CNRM-CM5, GFDL-ESM2M, HadGEM2-CC, CanESM2, MIROC5 and NorESM1-M – are available for the RCP 4.5 and RCP 8.5 scenarios. Five models – CESM1-CAM5, CNRM-CM5, CanESM2, MIROC5 and NorESM1-M – are available for the RCP 2.6 scenario.

Adelaide, but for this report we are using the Adelaide CBD, in part because it includes the Kent Town monitoring station.

ABOUT HEATWATCH

The Australia Institute's HeatWatch initiative puts current Australian research about temperature increases due to global warming into context, using data from the Bureau of Meteorology and the CSIRO.

Global temperature increases of 1.5 or 2 degrees above pre-industrial levels will have dramatic impacts on human health, the ecosystem and the economy. The IPCC has found that human-induced warming reached 1 degree above pre-industrial levels in 2017.[17]

Current policy settings would see more extreme warming than 2 degrees above pre-industrial levels. However, temperatures fluctuate by much more than a few degrees every day, meaning that the compounding and extreme effects of temperature increases can be difficult to imagine.

HeatWatch uses extreme heat days (days over 35 degrees) along with other thresholds like 37 degrees and 40 degrees to highlight that the effects of global warming will include a dramatic increase in days where it is uncomfortable or dangerous to operate outside – affecting industries like construction, sport and other outdoor activities.

HeatWatch began with *Cooked with gas: Extreme heat in Darwin,* which highlighted that the Northern Territory's plans to exploit emission-intensive oil and gas reserves will contribute to global warming which could increase the number of days over 35 degrees in Darwin from the current rate of 22 per year to 275 per year in 2070.[18]

Other HeatWatch reports have covered extreme heat in Rockhampton, Gladstone, Roma, the Sunshine Coast, the Gold Coast and Western Sydney. Three Queensland reports were presented alongside Queensland Fire and Emergency Services workshops on extreme heat.

The Australia Institute will continue to focus on additional locations and welcomes interest in collaborating on local versions of the reports.

All HeatWatch reports are available on our website: http://www.tai.org.au/heatwatch

[17] IPCC (2018) *Global Warming of 1.5 °C,* p 1:4, https://www.ipcc.ch/report/sr15/

[18] Hanna and Ogge (2018) *Cooked with gas: Extreme heat in Darwin,* http://www.tai.org.au/content/cooked-gas-extreme-heat-darwin

Increasing hot days in Adelaide

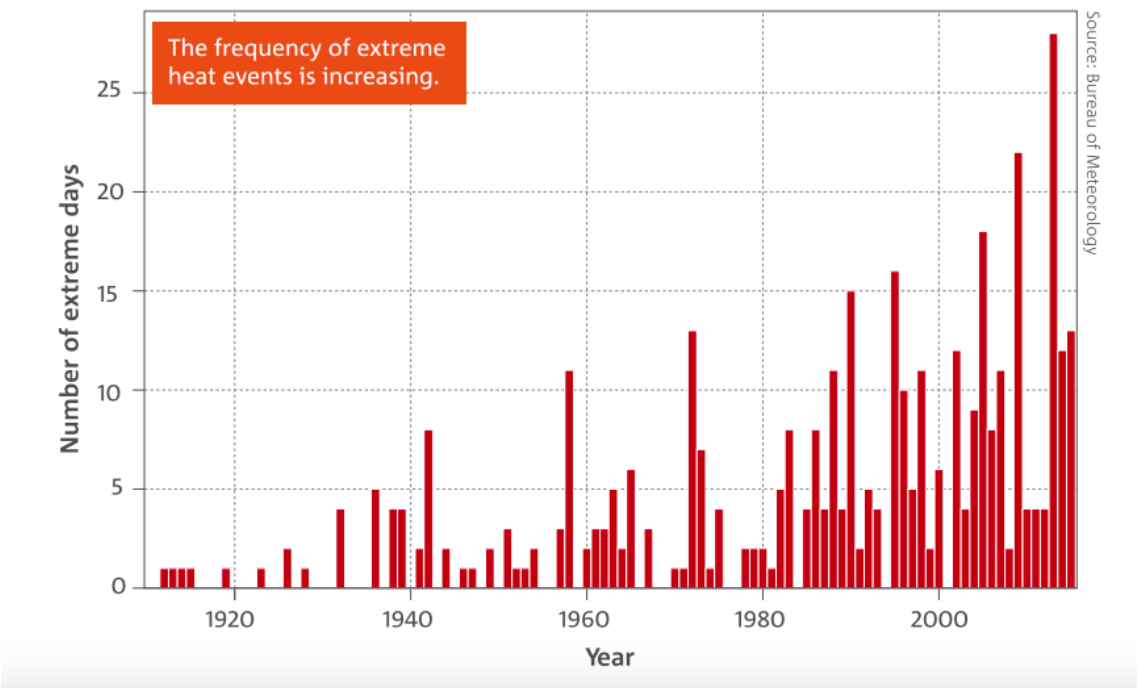
In Australia and globally there has been a clear trend of increasing temperatures and extreme heat events that are attributable to global warming.

The increase in extreme heat events across Australia as a whole is shown in Figure 2 below. This Bureau of Meteorology graph shows the annual number of days exceeding the 99th percentile of each month from 1910–2015.

The Bureau of Meteorology attributes this trend to global warming:

> As the global climate system has warmed, changes have occurred to both the frequency and severity of extreme weather. In Australia, the most obvious change has been an increase in the occurrence of record-breaking heat.[19]

Figure 2: Frequency of extreme heat days, Australia



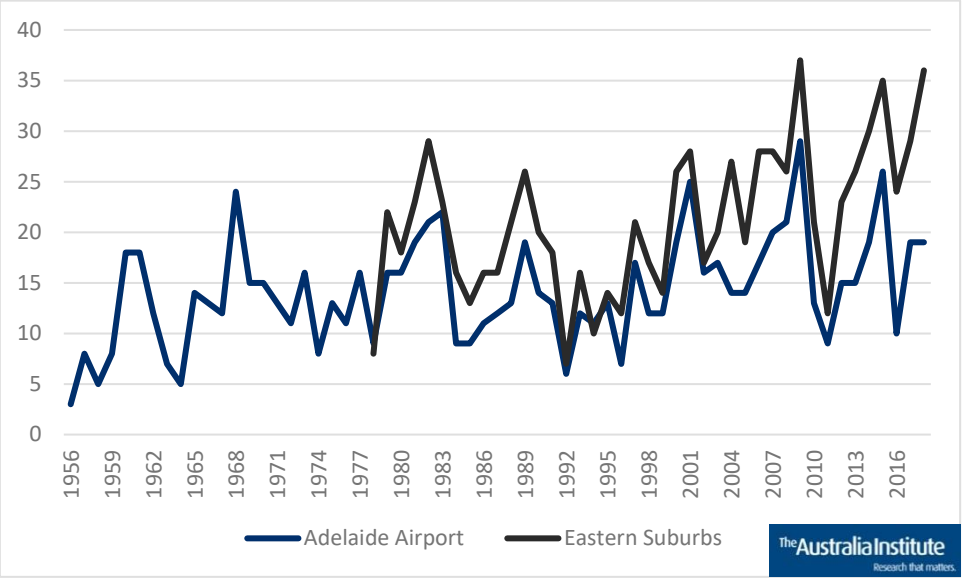
Source: BoM (2016) *State of the Climate*

[19] BoM (2016) *State of the Climate*, http://www.bom.gov.au/state-of-the-climate/State-of-the-Climate-2016.pdf

The Bureau of Meteorology has long-term temperature records for two sites in Adelaide: Adelaide Airport (since 1956) and Kent Town in the Eastern Suburbs (since 1978).

Figure 3 below shows the average number of days over 35 degrees in each year from 1956 onwards at Adelaide Airport and from 1978 onwards in the Eastern Suburbs of Adelaide.

Figure 3: Annual number of days over 35 degrees Adelaide, 1956–2018



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml

Figure 3 shows that the trend of days over 35 degrees in Adelaide has increased significantly over the last 70 years. Despite drought and heatwaves in the early 1980s and the Millennium Drought of the early 2000s, the past ten years have the highest number of hot days recorded.

There is a clear increase in numbers of extreme heat days over the recorded period as summarised in Table 1 below:

Table 1: Average days per year above 35 degrees, Adelaide

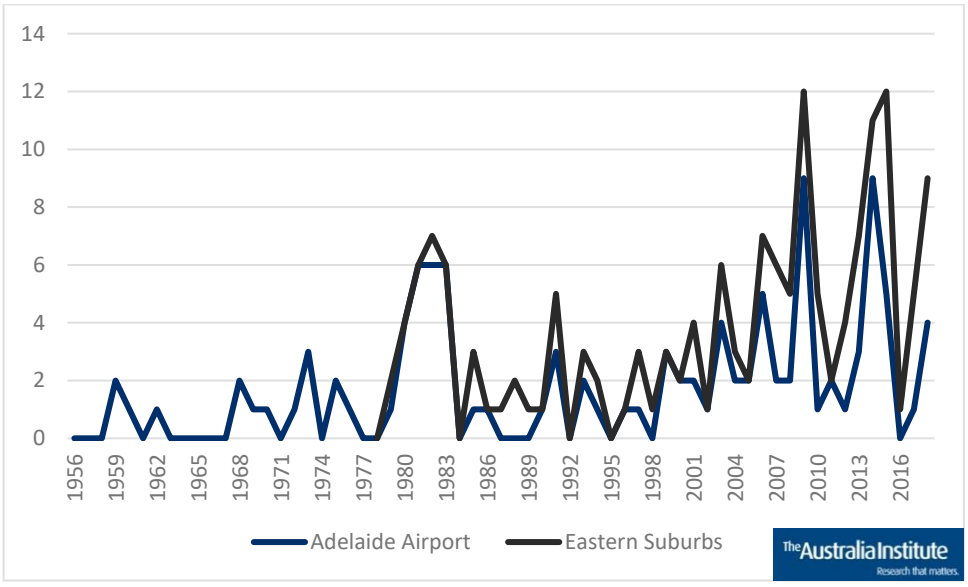
Decade	Adelaide Airport	Eastern Suburbs
1958–1967	11.2	
1968–1977	14.2	
1978–1987	14.4	18.4
1988–1997	12.5	16.5
1998–2007	16.6	22.4
2008–2017	17.6	26.3
Average	**14.4**	**20.9**

Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml

Since the 1970s, the number of days over 35 degrees has increased by a quarter at Adelaide Airport and by 40% in the Eastern Suburbs.

The number of days over 40 degrees has also risen steeply at both Adelaide Airport and the Eastern Suburbs.

Figure 4: Annual number of days over 40 degrees Adelaide, 1956–2018



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml

Table 2: Average days per year above 40 degrees, Adelaide

Decade	Adelaide Airport	Eastern Suburbs
1958–1967	0.4	
1968–1977	1.1	
1978–1987	2.5	3.0
1988–1997	0.9	1.8
1998–2007	2.3	3.5
2008–2017	3.3	6.4
Average	**1.8**	**3.8**

The Australia Institute
Research that matters.

Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml

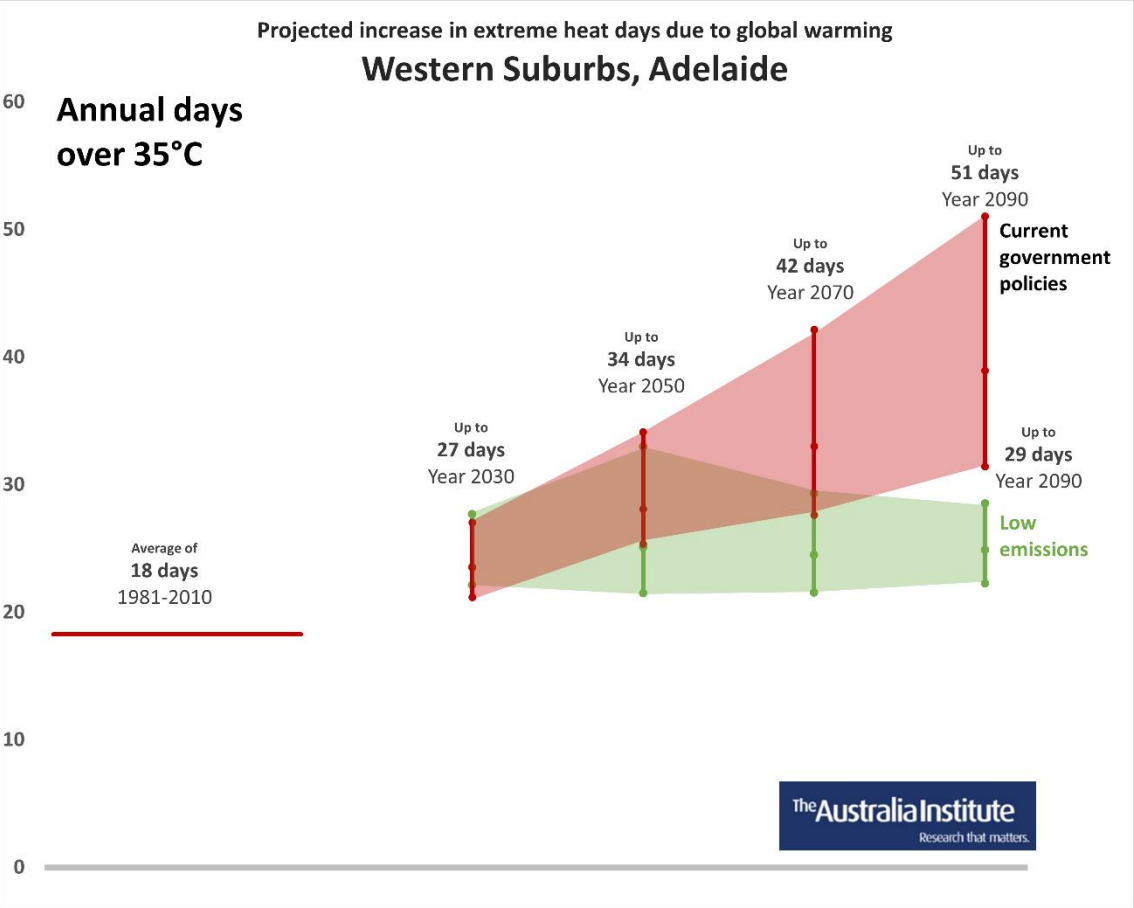
As shown in Table 2 above, days over 40 degrees at Adelaide Airport have tripled since the 1970s and extreme heat days in the Eastern Suburbs have more than doubled since the 1980s. More worrying still, the following decades are likely to exacerbate these challenges.

Western Suburbs, Adelaide

Under current government policies, in the Western Suburbs days over 35 degrees would go from a historical average of 18 days per year to a maximum of 27 days by 2030, 34 days by 2050, 42 days by 2070 and 51 days by 2090.

The Western Suburbs would benefit significantly from climate policies that would keep warming below 1.5 degrees, as represented by the RCP 2.6 scenario. Climate policies to keep warming below 1.5 degrees would reduce predicted days over 35 degrees to 28 days by 2030, increase to 33 days by 2050 and lower and stabilise at 29 days by 2070.

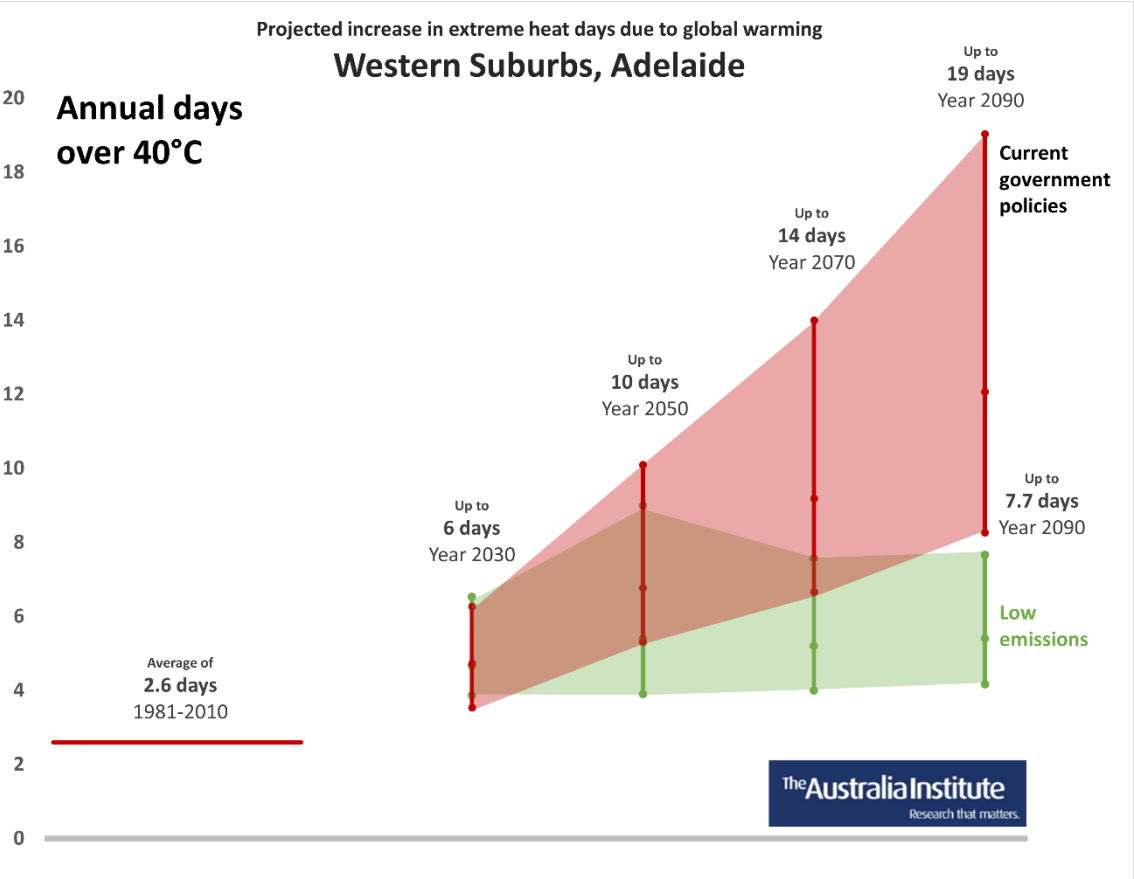
Figure 5: Forecast annual number of days over 35 degrees Western Suburbs



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

The Western Suburbs has historically experienced 2.6 days over 40 degrees per year. Without strong climate policies, this could increase to up to 14 days by 2070 and 19 days by 2090. With strong climate policies, the number of days over 40 degrees could be limited to 8 per year on average.

Figure 6: Forecast annual number of days over 40 degrees Western Suburbs



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Table 3: Western Suburbs days over 35 degrees

	1981-2010	2030	2050	2070	2090
Historical	18.3				
Low emissions		22.1-27.7	21.5-33.0	21.5-29.3	22.3-28.5
Intermediate emissions		21.5-25.0	23.2-28.7	24.8-31.5	24.8-32.7
Current policies		21.2-27.0	25.4-34.1	27.6-42.2	31.4-51.0

Source: CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Table 4: Western Suburbs days over 40 degrees

	1981-2010	2030	2050	2070	2090
Historical	2.6				
Low emissions		3.9-6.5	3.9-9.0	4.0-7.6	4.2-7.7
Intermediate emissions		3.5-5.9	4.4-7.2	5.2-8.5	5.0-9.1
Current policies		3.5-6.3	5.3-10.1	6.7-14.0	8.3-19.0

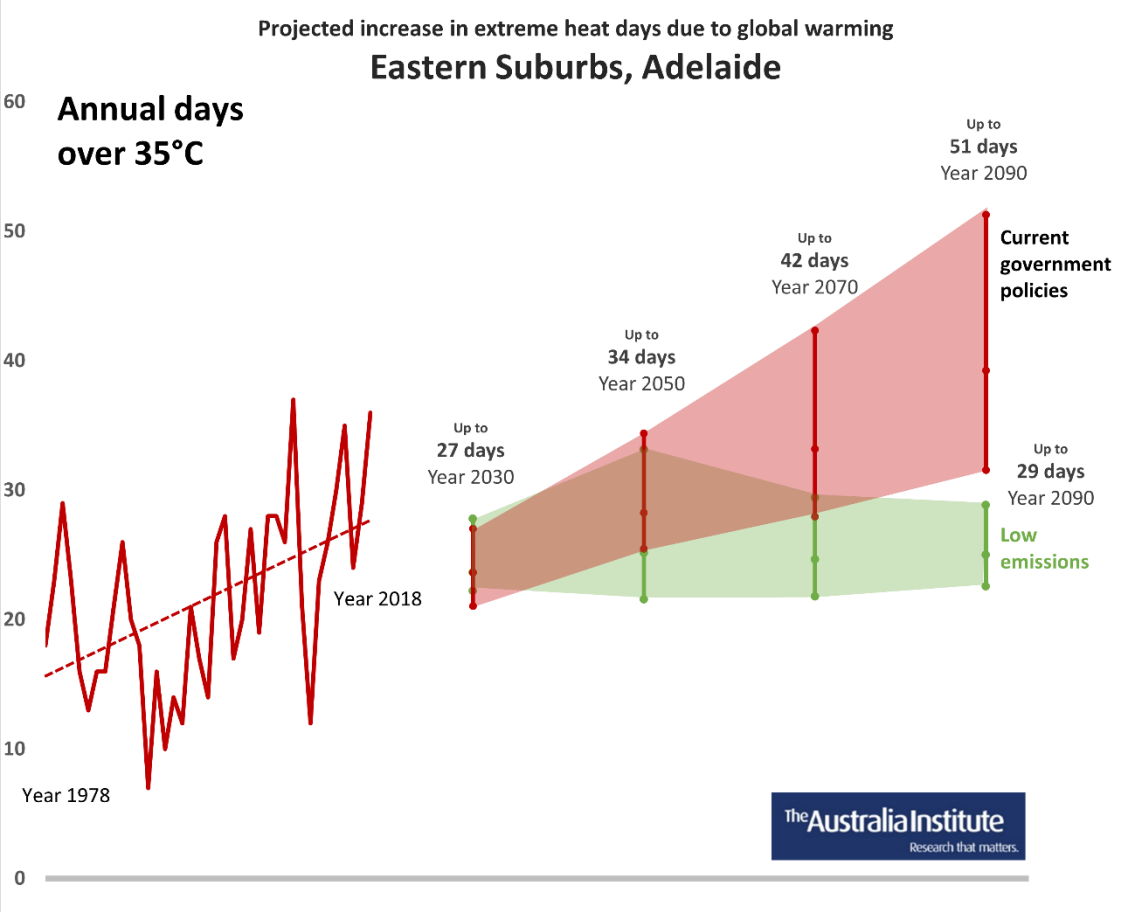
Source: CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Eastern Suburbs, Adelaide

Under current government policies, the Eastern Suburbs would see days over 35 degrees go from a historical average of 18 days per year to a maximum of 27 days by 2030, 34 days by 2050, 42 days by 2070 and 51 days by 2090.

The Eastern Suburbs would benefit significantly from climate policies that would keep warming below 1.5 degrees, as represented by the RCP 2.6 scenario. Climate policies to keep warming below 1.5 degrees would reduce predicted days over 35 degrees to 28 days by 2030, increase to 33 days by 2050, and lower and stabilise at 29 days by 2070.

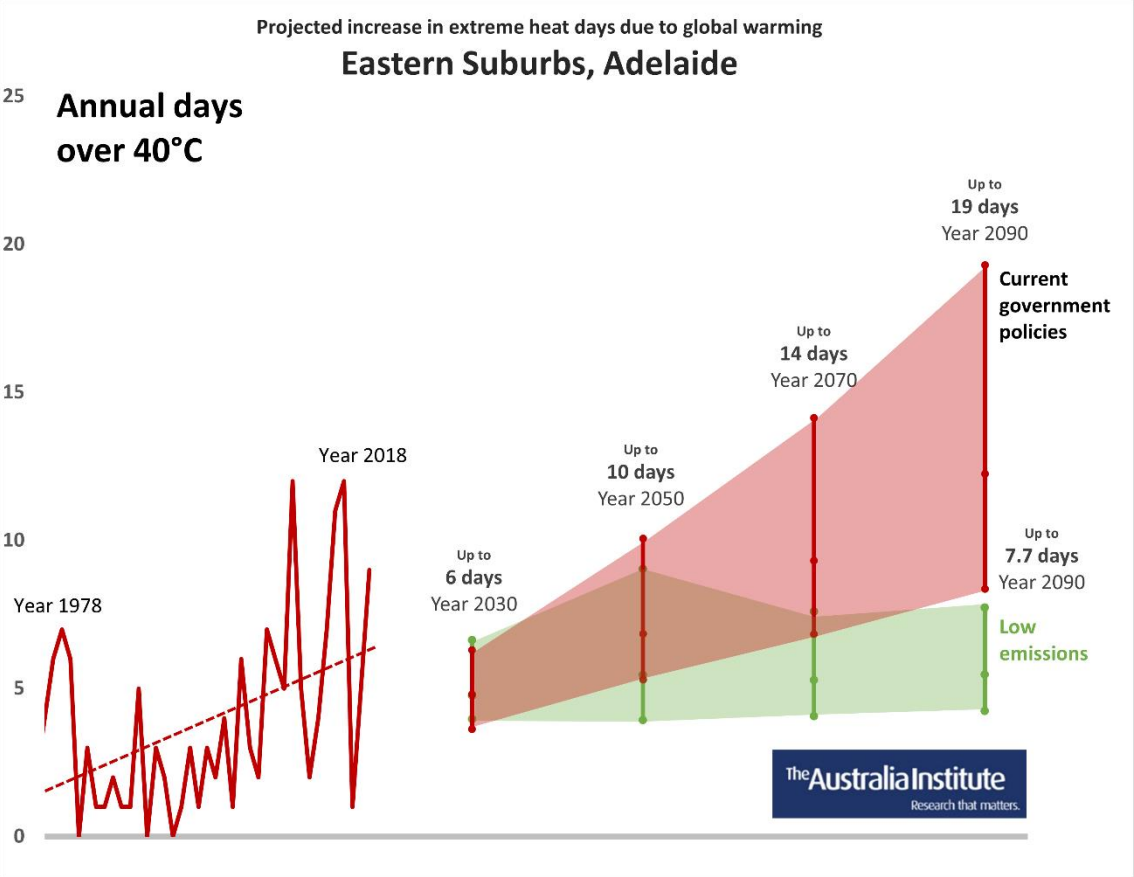
Figure 7: Forecast annual number of days over 35 degrees Eastern Suburbs



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

The Eastern Suburbs has historically experienced 2.6 days over 40 degrees per year. Without strong climate policies, this could increase to up to 14 days by 2070 and 19 days by 2090. With strong climate policies, the number of days over 40 degrees could be limited to 8 per year on average.

Figure 8: Forecast annual number of days over 40 degrees Eastern Suburbs



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Table 5: Eastern Suburbs days over 35 degrees

	1981-2010	2030	2050	2070	2090
Historical	18.4				
Low emissions		22.2-27.8	21.6-33.2	21.8-29.4	22.6-28.9
Intermediate emissions		21.7-25.3	23.5-29.0	25.0-31.7	25.1-32.9
Current policies		21.1-27.0	25.5-34.4	28.0-42.3	31.6-51.3

Source: CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Table 6: Eastern Suburbs days over 40 degrees

	1981-2010	2030	2050	2070	2090
Historical	2.6				
Low emissions		4.0-6.6	3.9-9.0	4.1-7.6	4.2-7.7
Intermediate emissions		3.6-5.9	4.5-7.3	5.2-8.6	5.0-9.2
Current policies		3.6-6.3	5.3-10.1	6.8-14.1	8.4-19.3

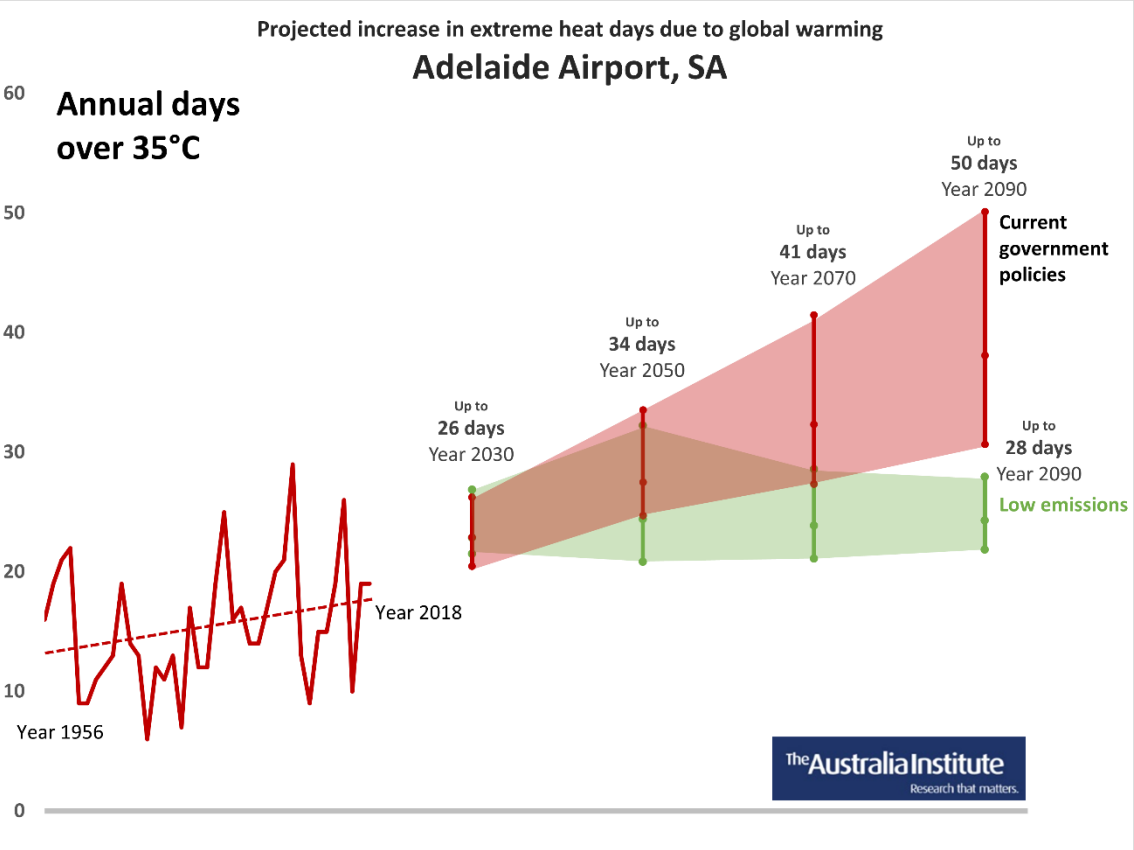
The Australia Institute
Research that matters.

Source: CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Adelaide Airport

Adelaide Airport's historical average (1981–2010) is 17 days over 35 degrees per year. Over the last 10 years, BoM observations at Adelaide Airport have ranged between nine and 29 extreme heat days per year.

Figure 9: Days over 35 degrees per year at Adelaide Airport



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

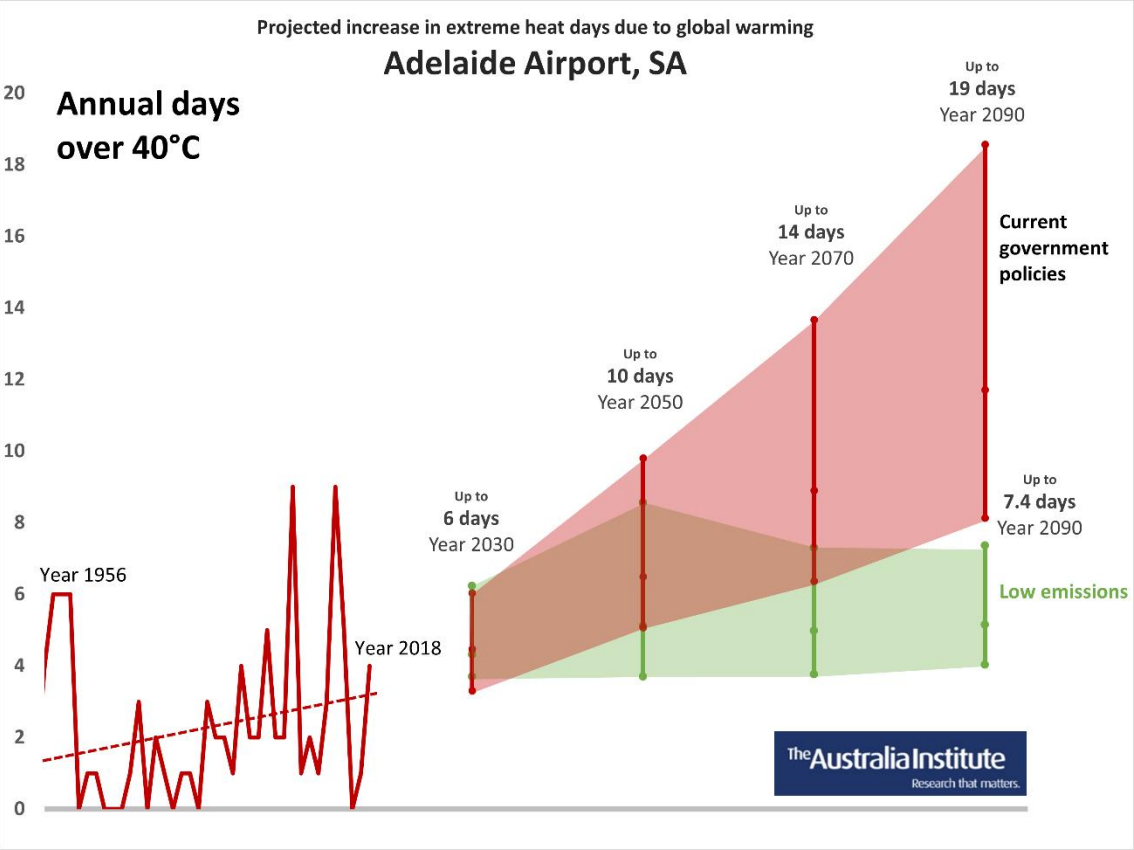
Under current government policies, Adelaide Airport's average number of days over 35 degrees would go from a historical average of 17 days per year to a maximum of 26 days by 2030, 34 days by 2050, 41 days by 2070 and 50 days by 2090.

People living and businesses located around and in Adelaide Airport will benefit significantly from climate policies that would keep warming below 1.5 degrees, as represented by the RCP 2.6 scenario. Climate policies to keep warming below 1.5

degrees would reduce predicted days over 35 degrees to 27 days by 2030, increase to 32 days by 2050, lower to 29 days by 2070 and 28 days by 2090.

Adelaide Airport will also see annual days over 40 degrees increase from the historical average of 2.5 to up to 19 by 2090. This is more than a seven times increase.

Figure 10: Forecast annual number of days over 40 degrees Adelaide Airport



Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Table 7: Adelaide Airport days over 35 degrees

	1981-2010	2030	2050	2070	2090
Historical	17.5				
Low emissions		21.5-26.9	20.8-32.2	21.1-28.6	21.9-27.9
Intermediate emissions		21.0-24.6	22.5-28.0	24.3-30.6	24.1-31.8
Current policies		20.5-26.2	24.7-33.5	27.3-41.5	30.7-50.1

Source: CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Table 8: Adelaide Airport days over 40 degrees

	1981-2010	2030	2050	2070	2090
Historical	2.5				
Low emissions		3.7-6.2	3.7-8.6	3.8-7.3	4.0-7.4
Intermediate emissions		3.3-5.5	4.2-6.6	4.9-8.3	4.6-8.8
Current policies		3.3-6.0	5.1-9.8	6.4-13.7	8.1-18.6

Source: CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Health and productivity impacts of extreme heat

The impact of extreme heat on human health, particularly over extended periods, is severe. Although people living in hot areas do acclimatise to help cope with extreme temperatures, there are limits.[20] A large increase in days over 35 degrees will push past those limits.

The health impacts of increasing extreme heat can include both direct heat illnesses such as heat exhaustion and indirect illnesses such as heart failure and even death.

WorkSafe Queensland lists a range of illnesses arising directly from extreme temperatures from mild cramps, rashes, and dehydration to severe injuries such as heat stroke, exhaustion and even death if treatment is delayed.[21] As climate change worsens this can be expected to put people that are more vulnerable at increasingly greater risk.

The groups most vulnerable to heat impacts include the elderly, the very young, and those with pre-existing health conditions. Illnesses such as angina, kidney disease, and diabetes are at higher risk of being triggered or exacerbated when people are unable to maintain a safe body temperature.[22]

People suffering from mental disorders are also vulnerable. This vulnerability to extreme heat can result from altered behavioral responses to high temperatures or the impact of medications.

As stated earlier, irritability and psychological stress also increase in heat. When hot days are combined with hot nights, heat load and stress carry over and the body has no opportunity to cool down and recover. Studies show that there is an association between the mortality of not just stroke patients but also the general population and high night temperatures.[23] The 'synergistic effect' of night humidity, increased temperatures, and urban heat island effects in heatwaves has been estimated in some studies to double general mortality risk by the end of

[20] Hanna and Tait (2015) *Limitations to thermoregulation and acclimatisation challenges human adaptation to global warming,* Int J Environ Res Public Health 12.
[21] WorkSafe Queensland (n.d.) *Health effects,* https://www.worksafe.qld.gov.au/injury-prevention-safety/hazardous-exposures/heat-stress/health-effects
[22] Hanna et al (2016) *The silent killer: Climate Change and the Health Impacts of Extreme Heat,* The Climate Council, https://research-management.mq.edu.au/ws/portalfiles/portal/72578140/72578105.pdf
[23] Murage et al (2017) *Effect of night-time temperatures on cause and age-specific mortality in London,* Environmental Epidemiology 1; Roye (2017) *The effects of hot nights on mortality in Barcelona, Spain,* International Journal of Biometeorology 61.

the century under RCP 8.5.[24] Often underrated, major heatwaves have been dubbed the 'silent killer', causing more deaths in the last century in Australia than all natural diasters put together.[25]

Extreme heat nights also cause increased insomnia and lack of rest. This is exacerbated by the higher relative humidity overnight. As sleep is vital for healthy human functioning, a deficit means more susceptibility to disease, obesity, chronic illness and harm to our psychological and cognitive functioning.[26]

Productivity decreases significantly under these stresses as people are affected with the consequences of extreme heat. Workplace safety and the ability to work declines. This can also be displayed in economic terms as costs rise to account for the lack of labour productivity and changes needed in workplaces.[27]

Like most parts of Australia, a significant proportion of the local workforce is exposed to the heat. Construction and manufacturing are both significant employers in South Australia and are particularly exposed to extreme heat events. Most industries will also be impacted by extreme heat to various degrees.

The cost of lost productivity because of extreme heat in Australia has been estimated at almost $7 billon in 2013-14 alone.[28]

[24] Zhao et al (2018) *Interactions between urban heat islands and heat waves,* Environmental Research Letters 13.

[25] Hanna et al (2016) *The silent killer: Climate Change and the Health Impacts of Extreme Heat,* The Climate Council

[26] Obradovich et al (2017) *Nighttime temperature and human sleep loss in a changing climate,* Science Advances 3.

[27] Climate Council (2014) *Heatwaves: Hotter, Longer, More Often,* https://www.climatecouncil.org.au/uploads/9901f6614a2cac7b2b888f55b4dff9cc.pdf

[28] Zander, Opperman and Garnet (2015) *Extreme heat poses a billion-dollar threat to Australia's economy,* https://theconversation.com/extreme-heat-poses-a-billion-dollar-threat-to-australias-economy-41153

Impacts on infrastructure

Extreme heat can cause failures to critical infrastructure, particularly transport and electricity supply. Coal and gas power stations in particular are highly vulnerable to extreme heat, experiencing both reduced output and an increased level of breakdowns. This is exacerbated by high electricity demand as a result increased use of air-conditioning during extreme heat conditions. During the February 2017 heatwave in South Australia, 17% of gas generation (438 MW) failed to deliver during the peak demand period on the heatwave day (8th of February),[29] leading to widespread blackouts.[30]

In a highly urbanised environment like Adelaide, air-conditioning can be critical to people's wellbeing during extreme heat. Electricity blackouts during heatwaves lead to the loss of air-conditioning when it is most essential. During the 2009 Heatwave in Melbourne on the evening of the 30th of January, 500,000 people were left without power on a day that reached 44 degrees. There were 374 deaths recorded as a result of this heatwave overall. The estimated economic cost of the heatwave was $800 million.[31]

An efficient transport system is fundamental to the functioning of all large cities. Transport is also vulnerable to extreme heat. Roads can melt[32] and rail can buckle.[33] Some public transport does not have air-conditioning, or the air-conditioning can break down, causing great distress to commuters.[34]

[29] Ogge and Aulby (2017) *Can't stand the heat; The energy security risk of Australia's reliance on coal and gas generators in an era of increasing heatwaves*, http://www.tai.org.au/sites/defualt/files/P454%20Can%27t%20stand%20the%20heat%20FINAL%202.31.pdf

[30] Harvey and Shepherd (February 2017) *Rolling blackouts ordered as Adelaide swelters in heatwave,* https://www.news.com.au/national/south-australia/rolling-blackouts-ordered-as-adelaide-swelters-in-heatwave/news-story/13394f19db1ee94a59f4036fccdc1ba7

[31] NCCARF (2010) *Impacts and adaptation responses of infrastructure communities to heatwaves,* https://www.nccarf.edu.au/business/sites/www.nccarf.edu.au.business/files/attached_files_publications/Pub%2013_10%20Southern%20Cities%20Heatwaves%20-%20Complete%20Findings.pdf

[32] Cheer (January 2018) *Traffic delays after 10 kilometres of Victoria's Hume Freeway melts,* https://www.sbs.com.au/news/traffic-delays-after-10-kilometres-of-victoria-s-hume-freeway-melts

[33] Lauder (2009) *Melbourne railway buckles under heat,* http://www.abc.net.au/worldtoday/content/2008/s2477350.htm

[34] Robertson (January 2017) *Eastern Australia swelters under heatwave as hottest January on record looms,* https://www.theguardian.com/australia-news/2017/jan/18/eastern-australia-swelters-under-heatwave-as-hottest-january-on-record-looms

Conclusion

An increase in days of temperature over 35 degrees will have severe impacts on human health, including increased rates of heat-related deaths.

Adelaide is already experiencing a large increase in extreme heat events, affecting people's ability to work and enjoy the outdoors, to play and watch sport. As Adelaide is already disproportionately affected by the heat, including having the highest heatwave death rate of any major city in Australia, strong emissions reduction policies are essential.

Climate change will not affect everyone equally. People living and working in the western suburbs of Adelaide are already enduring more extreme temperature events than those in the eastern suburbs and are projected to experience even greater increases in the future.

Fortunately, none of this this inevitable. The CSIRO projections clearly show that if emissions are reduced in line with the Paris target of limiting global temperature increases to below 1.5 degrees, the increase in extreme temperature days will be a small fraction of the increase projected for our current emissions trajectory.

Australia makes a vastly disproportionate contribution to global warming. We are one of the lowest ranked countries in the world on climate action. As well as having one of the highest rates of domestic greenhouse gas emissions per person in the world, we have a staggering 44 tonnes per person of exported greenhouse gas emissions each, even greater then Saudi Arabia (35.5 tonnes per person) and around sixty times higher than the US.[35] Even worse, there are plans for huge expansions in gas exports from the Northern Territory and Western Australia that could add a billion tonnes more of greenhouse gases to the atmosphere.[36]

Stopping any further expansion of Australia's coal and gas exports, phasing out existing exports and reducing emissions produced at home are all essential to the global effort required to prevent increases in extreme heat that will have such a devastating effect on Adelaide and Australia as a whole.

[35] Thwaites and Kestin (July 2018) *Australia ranked worst in world on climate action,* https://reneweconomy.com.au/australia-ranked-worst-world-climate-action-49472/

[36] Climate Analytics (2018) *Western Australia's gas gamble, Implications of exploiting Canning Basin and other unconventional gas resources for achieving climate targets,* https://climateanalytics.org/media/climateanalytics-report-westernaustraliasgasgamble-2018.pdf