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HeatWatch: Extreme Heat in Western Sydney

Research report

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Extreme heat is already disproportionately impacting Western Sydney. Days over 35°C could increase fivefold by 2090 without strong climate action. By then, places like Penrith could experience up to 58 days of extreme heat per year. This is not inevitable. Strong policies to reduce emissions and adapt to rising heat could ensure the safety of Western Sydney residents.

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HeatWatch:
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Acknowledgements

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Executive Summary

Western Sydney is among the most affected regions of Australia when it comes to extreme heat. Its inland position at the foothills of the Blue Mountains prevents the cooling impact of a coastal breeze and works to trap heat. Human influence compounds this through the removal of heat-reducing green spaces, replacing them with materials such as concrete and asphalt. As a result, some suburbs of Western Sydney are already experiencing temperatures between 8°C and 10.5°C hotter than Eastern Sydney.

Climate change will increase the frequency and severity of extreme heat days in the Western Sydney region. The Australia Institute selected 12 federal electorates in Western Sydney and analysed CSIRO and Bureau of Meteorology (BoM) climate scenarios for projected extreme heat in these areas.

Under a high emissions scenario, Western Sydney could experience up to 46 days of extreme heat (defined as over 35°C) annually by 2090. This is a fivefold increase from the historical average of just under nine days of extreme heat per annum. The impacts are not just limited to future generations of Western Sydney, as seen in Figure 1 with the number of days over 35°C doubling by 2030 and tripling by 2050.

However, if state and federal governments aligned with international efforts to curb rising emissions to follow a low emissions pathway, this could limit the number of extreme heat days to no more than 17 per year – significantly minimising the impacts on the residents of Western Sydney.

When the data is broken down by electorate, it is notable that under a high-emissions scenario, all Western Sydney federal electorates would see an increase of four to five times their current baseline by 2090.

Of the 12 federal electorates, Lindsay, containing Penrith, is projected to have the highest number of days over 35°C. Under a high-emissions scenario, Lindsay could experience temperatures of over 35°C for up to a month per year by 2050. By 2090, this is projected to double, with up to 58 days per year. Yet, if emissions are reduced, this could be limited to 22 days as shown in Figure 2.

FIGURE 1. ANNUAL DAYS OVER 35°C IN WESTERN SYDNEY

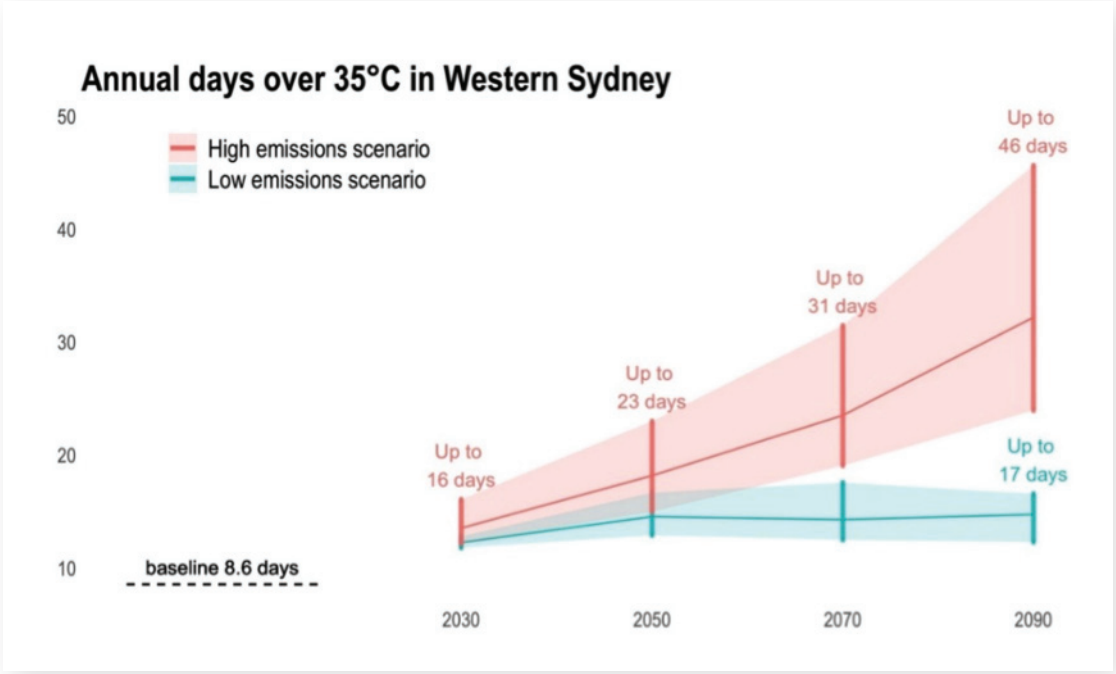
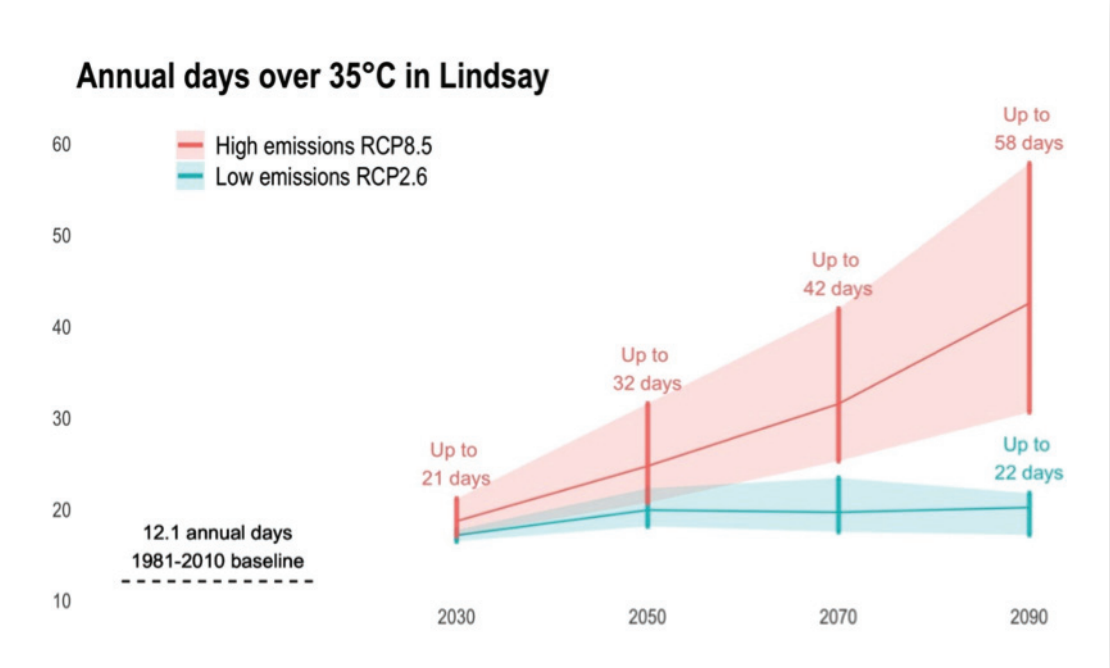


FIGURE 2. ANNUAL DAYS OVER 35°C IN LINDSAY



Alarmingly, annual figures for Lindsay are already outstripping these future projections. Data from the Penrith Lakes BoM weather station shows there were 44 days over 35°C recorded in both 2018 and 2019 – outstripping the projection for average days over 35°C in 2090 under a high emissions scenario (projected at an average of 42.5 days per year).

Extreme heat represents serious health risks for Western Sydney residents. 35°C is considered the threshold for what is acceptable, with higher temperatures significantly reducing the effectiveness of the body's ability to cool down. This can have direct impacts such as dehydration and heatstroke, as well as exacerbating pre-existing medical conditions.

When hot days are combined with hot nights, the body has no opportunity to cool down and recover. As a result, mortality rate from heat increases nearly 20% when the average temperature across a 24-hour period is above 30°C. Extreme heat has already been shown to kill more people in Australia than all other natural disasters combined.

Damage is not just limited to direct health impacts. Extreme heat often causes damage to critical infrastructure, including transport and electricity. As one of the fastest growing urban populations in Australia, Western Sydney is particularly vulnerable to these disruptions due to its reliance on an aging electricity grid and a transport system under stress. As such, power failures can be fatal.

At a broader level, the impacts of extreme heat can result in major disruptions to how Australians work. For the year 2013-14, the cost of lost productivity for Australia due to extreme heat was estimated at USD 6.2 billion (AUD 8.5 billion). This cost has likely increased, given the record-breaking temperatures in the years since. Looking to the future, New South Wales Treasury modelling estimates that up to 2.7 million working days are projected to be lost in the state every year from heatwaves by 2061.

Extreme heat is not just a concern for future generations, but an immediate problem for the people of Western Sydney that requires an immediate response.

Over nine out of ten (92.5%) of Western Sydney residents recently surveyed by Sweltering Cities agreed that politicians and political parties should have specific policies on dealing with heat. The 2022 federal election presents a timely opportunity for candidates to present policies on how to mitigate the cause of rising extreme heat days, namely climate change, and its impacts through adaptation.

Unfortunately, current policies of the Australian and NSW Governments are more likely to exacerbate rather than mitigate Western Sydney's extreme heat. Australia's national emissions reduction target of 26-28% by 2030 is broadly consistent with a high emissions scenario that could see extreme heat increasing fivefold in Penrith.

Coal is the single largest source of greenhouse gas emissions and contributor to climate change and NSW remains a major producer and exporter of coal, with plans to expand production.

Failing to mitigate climate change, both its causes and impacts, could lock Western Sydney into devastating increases in extreme heat that could transform the growing region into a dangerous place to live and work. This is not inevitable with an effective response.

Introduction

On the 4 January 2020, Penrith was the hottest place in the world, hitting 48.9°C.[1] This broke the record for the hottest day ever recorded in Greater Sydney. On a backdrop of the 2019-2020 Black Summer bushfires, the extreme heat combined with severe fire danger and poor air quality painted a stark picture of the localised realities of climate change.

As the climate warms, extreme heat is increasing in frequency and severity, and days like the 4 January 2020 could become more common.

To avoid dangerous climate change, countries have agreed under the Paris Agreement to limit global warming to well below 2°C, and to pursue efforts to remain below 1.5°C. However, even considering the most up to date emission reduction pledges from November 2021, the world is on track for between 1.9°C and 2.7°C warming at best.[2] Australia's own pledge to reduce emissions 26-28% by 2030 has not been updated in seven years; were all countries to follow a similar level of low ambition, it would result in global warming of around 4°C.[3]

Of all extreme weather events exacerbated by climate change, extreme heat is the most fatal. Heat kills more people in Australia than any other natural disaster, with around 2% of Australia's total deaths between 2006 and 2017 linked to heat.[4] If emissions are not reduced in line with the Paris Agreement, the increase in extreme heat days may mean places like Penrith become dangerous to live and work, particularly for people vulnerable to heat-related illnesses.

Western Sydney is one of the fastest growing urban areas in Australia, with a current population of 2.5 million projected to increase to 3.5 million within 15 years.[5] With the development of a new airport to connect Western Sydney directly with the world, the state and federal governments are investing in and banking on continued growth. However, this growth will be impacted if heat continues to increase.

Through analysis of Bureau of Meteorology (BoM) and CSIRO data, the Australia Institute examines various scenarios to determine how climate change will affect the number and intensity of extreme heat days in Penrith and other parts of Western Sydney. Understanding projected increases of extreme heat is critical to future planning across all areas of public policy, due to its potential impacts on health, infrastructure and ecosystems.

This analysis aims to serve as a useful resource in managing a hotter Western Sydney, which could be mitigated with stronger climate change policy.

[1] BoM (2021) *Annual Climate Summary for Greater Sydney*, http://www.bom.gov.au/climate/current/annual/nsw/sydney.shtml
[2] Meinshausen, Lewis, Nicholls, & Burdon (2021) *COP26 Briefing paper: Updated warming projections for NDCs, long-term targets and the methane pledge. Making sense of 1.8°C, 1.9°C and 2.7°C,* https://data.climateresource.com.au/ndc/20211109-ClimateResource-1-9C_to2-7C.pdf
[3] Climate Action Tracker (September 2021) *Australia,* https://climateactiontracker.org/countries/australia/
[4] Longden, Quilty, Haywood, Hunter and Gruen (2020) *Heat-related mortality: an urgent need to recognise and record* https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(20)30100-5/fulltext
[5] KPMG (2021) *Demography and destiny in Western Sydney,* https://www.lightsonpenrith.com.au/upload/lights-on-penrith/demography-and-destiny-in-western-sydney.pdf
[6] Park (2019) *Federal election 2019: The political battle for the mythical Western Sydney vote,* https://www.abc.net.au/news/2019-05-14/federal-election-2019-the-battle-for-western-sydney/11076762?nw=0&r=HtmlFragment
[7] Khan et al. (2021) *Spatiotemporal variation in urban overheating magnitude and its association with synoptic air-masses in a coastal city,* https://www.nature.com/articles/s41598-021-86089-2
[8] Rachwani (2021) *'Extremely dangerous': how much of the heat can western Sydney bear?* https://www.theguardian.com/australia-news/2021/mar/08/extremely-dangerous-how-much-of-the-heat-can-western-sydney-bear
[9] United States Environmental Protection Agency (2021) *Learn about heat islands,* https://www.epa.gov/heat-islands/learn-about-heat-islands
[10] Sweltering Cities (2021) *Sydney Summer 2020-21 Survey Report,* https://swelteringcities.files.wordpress.com/2021/04/sweltering-cities-sydney-community-survey-report-20-21.pdf

Western Sydney Extreme Heat Days

'Western Sydney' is large both in geographic reach and population. It is difficult to define, due to its diverse and sprawling nature.[6] For this report, the Australia Institute has implemented an electorate-based approach. This covers 12 federal electorates situated inland from the coastal and harbour areas all the way to the foothills of the Blue Mountains, outlined in Figure 3.

Temperatures in Western Sydney electorates are already far hotter than their coastal counterparts. During extreme heat events, the mean daily maximum temperature can be between 8°C and 10.5°C hotter in Western Sydney than in the CBD of Sydney.[7]

This is due both to natural geographical features as well as human influence. Western Sydney does not experience the cooling effect of the sea breeze, while the pan-like geomorphology of the region traps hot air.

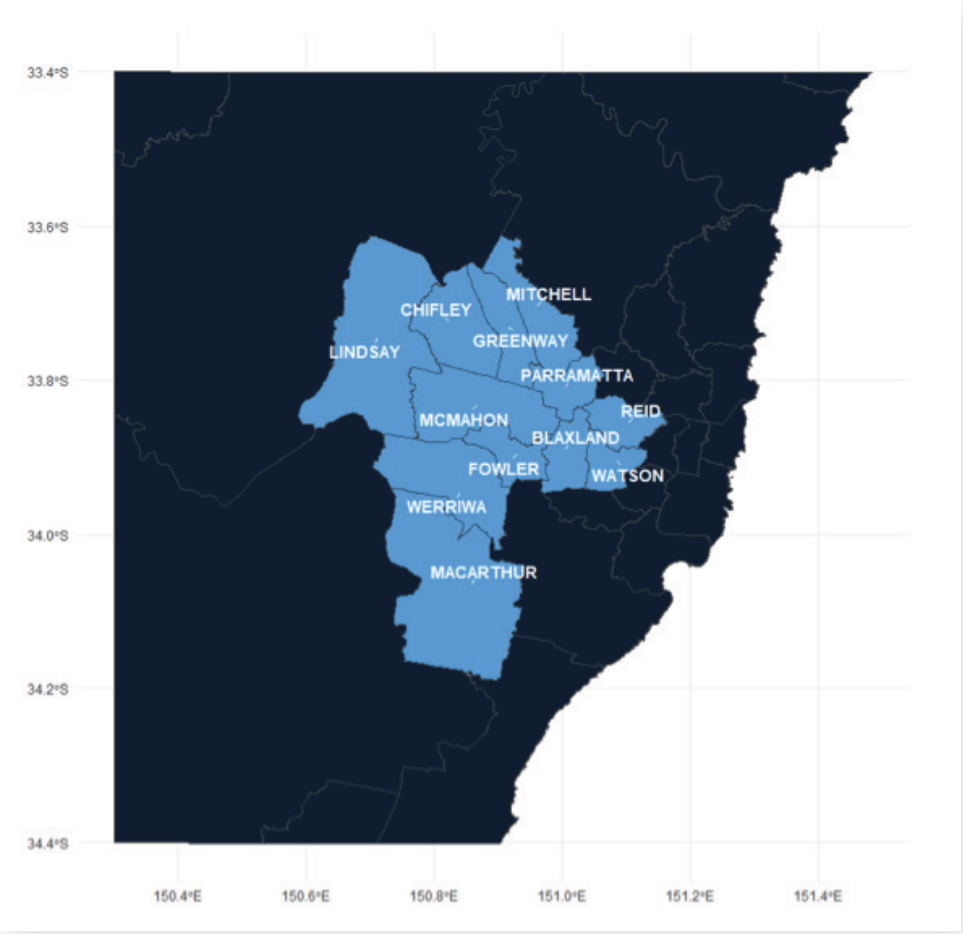
Human development in the area compounds this impact, absorbing the heat to create an urban heat island (UHI) effect. By removing features that naturally reduce heat, such as green spaces and waterways, and replacing them with asphalt and concrete, these surfaces absorb heat, which is then released throughout the night, increasing night-time temperatures and preventing suburbs from cooling down.[8]

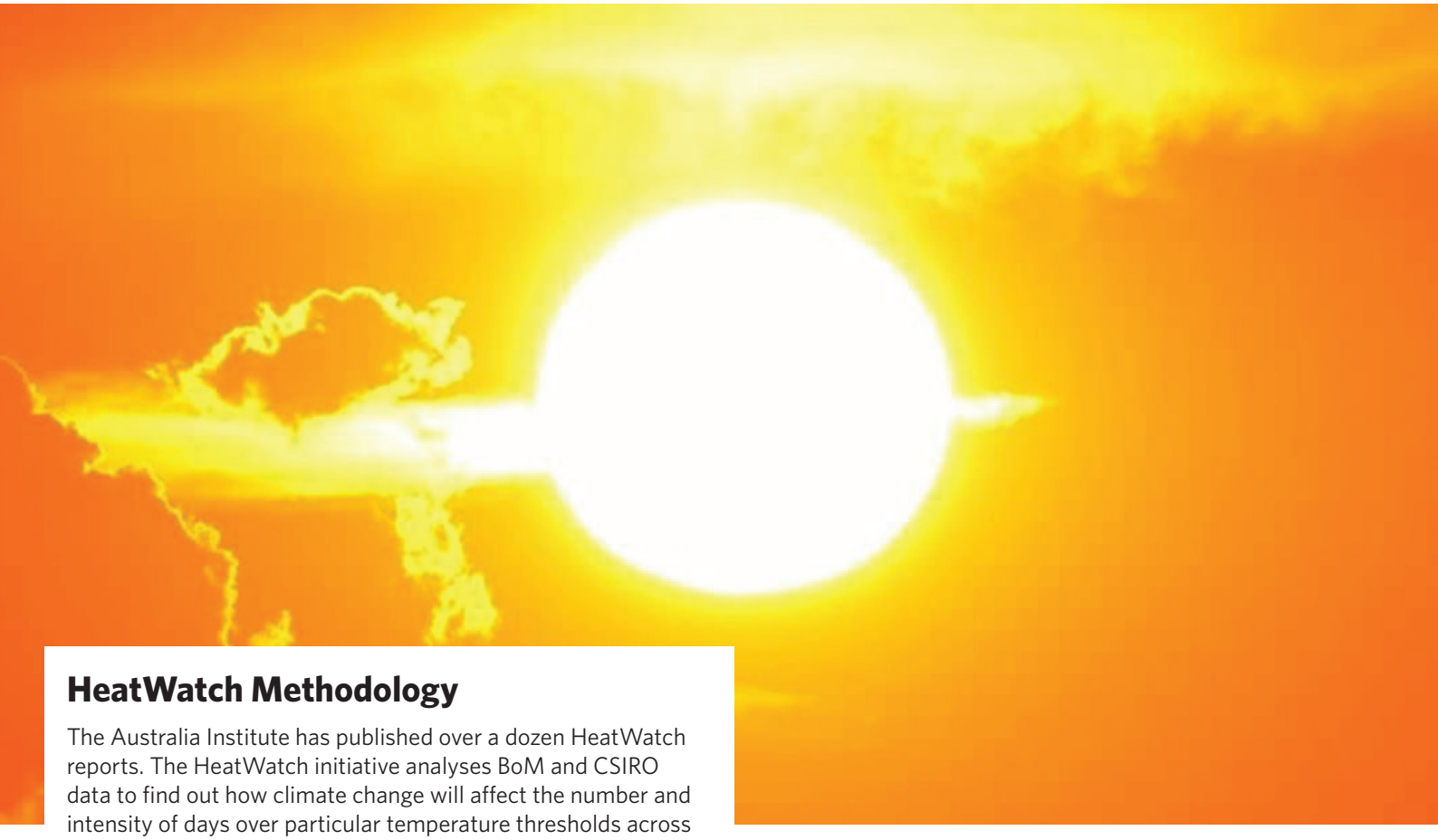
During the daytime, UHI causes exposed surfaces like roofs to heat to temperatures up to 15°C hotter than the air while rural areas remain closer to the atmospheric temperatures, creating an 'island' effect in cities. As a result, UHI can lead to temperature difference as high as 12°C between urban and rural areas.[9]

The result is increasingly hotter days, more often. As the report explains, Western Sydney is already experiencing extreme heat well above what is projected due to current climate change scenarios.

A community survey of almost 700 residents of Western Sydney undertaken in early 2021 by Sweltering Cities found that 92.5% of people surveyed believe politicians and political parties should have policies on heat.[10] By outlining future projections of extreme heat, this report similarly demonstrates the necessity for improved policies to address extreme heat in Western Sydney.

FIGURE 3. FEDERAL ELECTORATES OF WESTERN SYDNEY





HeatWatch Methodology

The Australia Institute has published over a dozen HeatWatch reports. The HeatWatch initiative analyses BoM and CSIRO data to find out how climate change will affect the number and intensity of days over particular temperature thresholds across Australia.

The projections are based on the output of several climate models, giving a range of projections represented by the shaded areas in the charts that follow. The models are selected for their performance in accurately projecting temperature increases to date.

This report employs the United Nations Framework Convention on Climate Change's (UNFCCC) representative concentration pathways (RCPs). The pathways represent different emissions scenarios, with RCP2.6 being a low emissions scenario aimed at limiting temperature rise to 1.5°C, and RCP8.5 being a high emissions scenario. Some studies suggest that RCP 8.5, which would see emissions rise until the end of the century, most accurately reflects cumulative CO_2 emissions trajectories based on current policies.[11] There are other intermediate scenarios, but this paper focuses on the two mentioned in order to highlight the difference between serious action and inaction.

By mapping potential increases in days of extreme heat (days over 35°C and 40°C) under different emissions scenarios, the Australia Institute highlights the danger that global warming poses to Western Sydney, and how strong policy could help limit this danger. For a more detailed explanation of the methodology, see Appendix I.

[11] Schwalm et al (2020) *RCP8.5 tracks cumulative CO2 emissions,* https://www.pnas.org/content/117/33/19656

Projected Increase In Days Over 35°C

Mapping potential increases in days exceeding extreme temperature thresholds is critical to understanding the threat of climate change, due to the impact extreme heat has on human health, as well as other social, environmental and economic outcomes.

At temperatures above 35°C, the body's ability to cool itself is significantly reduced. When these extreme temperatures are sustained over multiple days, the body is not given a chance to cool down and negative impacts compound. Above 35°C, the risk of heat stress for workers engaging in heavy manual labour is considered high.[12]

The threshold for extreme heat utilised by many scientists and government bodies is 35°C, with the CSIRO and BoM publishing 35°C threshold predictions which are used in this report. In this report, hot days are defined as days over 35°C.

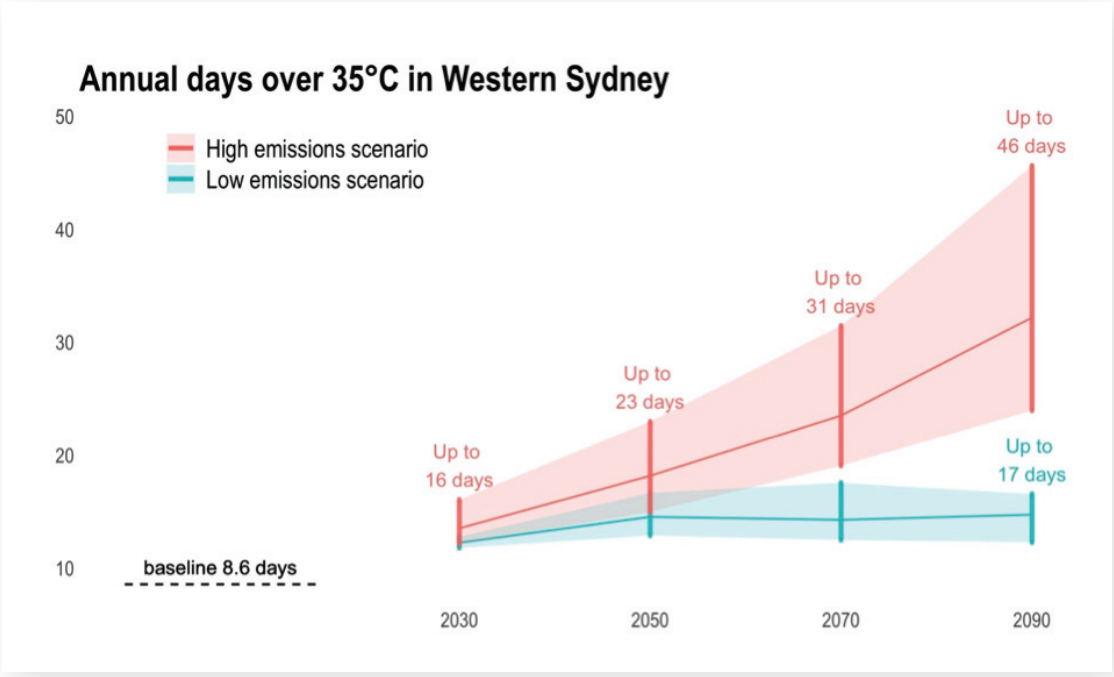
As shown in Figure 4, the number of days over 35°C in Western Sydney is expected to increase in coming decades. Under RCP8.5, a high emissions scenario (red), there could be an average of 32 days (and up to 46 days) annually over 35°C by 2090 across the 12 federal electorates analysed in Western Sydney. These projections are a four to fivefold increase from the baseline 1981-2010 average of 8.6 days.

Under RCP2.6, a low emissions scenario (blue), this could be limited to an average of 15 days (up to 17 days) over 35°C annually with strong global climate action.

TABLE 1: MEAN NUMBER OF PROJECTED ANNUAL DAYS OVER 35°C

	2030	2050	2070	2090
High Emissions (RCP8.5)	13.5 days	18.2 days	23.5 days	32.2 days
Low Emissions (RCP2.6)	12.3 days	14.6 days	14.3 days	14.7 days

FIGURE 4. ANNUAL DAYS OVER 35°C IN WESTERN SYDNEY



[12] Parsons, K. (2014) *Human thermal environments: The effects of hot, moderate, and cold environments on human health, comfort, and performance,* 3rd ed, Boca Raton: CRC Press, Taylor & Francis Group.

Projected Increase In Days Over 40°C

The report also looks at the number of days over 40°C, which could increase significantly in Western Sydney. As shown in Figure 5, under a high emissions scenario, Western Sydney could see up to 10 days annually over 40°C by 2090 — up from a historical baseline of just one day per annum.

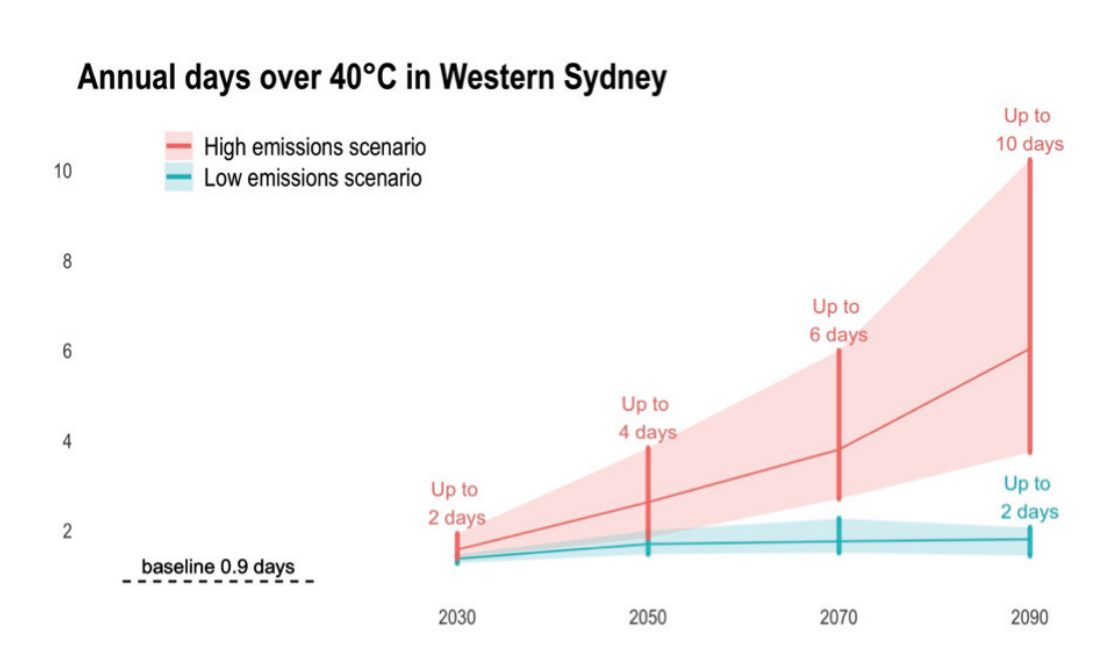
Not only does this analysis demonstrate a significantly higher number of days of extreme heat, but the CSIRO warns that these days could also be a lot hotter — by up to 4.8°C.[13] Given Penrith reached 48.9°C in January 2020, this could push temperatures well above 50°C.

Ultimately, how quick, and by how much these temperatures change depends on reductions of greenhouse emissions, while the wellbeing of Western Sydney residents depends on policies that equip them to withstand increasing heat.

TABLE 2: MEAN NUMBER OF PROJECTED ANNUAL DAYS OVER 40°C

	2030	2050	2070	2090
High Emissions (RCP8.5)	1.6 days	2.6 days	3.8 days	6.0 days
Low Emissions (RCP2.6)	1.4 days	1.7 days	1.8 days	1.8 days

FIGURE 5. ANNUAL DAYS OVER 40°C IN WESTERN SYDNEY



[13] CSIRO (2021) *How will climate extremes change Australia?* https://www.csiro.au/en/research/environmental-impacts/climate-change/climate-change-qa/how-will-climate-extremes-change-australia

Breakdown by Electorate

While the above data shows an aggregated increase in extreme heat days across all 12 federal electorates, when separated, it becomes evident that extreme heat is not spread evenly across the region.

The 1981-2010 baseline data shows that some electorates experience more hot days than others. Notably, Lindsay and Chifley already tend to experience more than 10 days above 35°C.

When projected into the future, all 12 federal electorates, regardless of baseline or location, would experience a four to fivefold increase on their baseline under a high emissions scenario (RCP8.5) by 2090.

The federal electorates that currently have the highest baseline are also those that would experience the largest increase in hot days. For instance, with a current baseline of 11 days over 35°C, under a high emissions scenario the Chifley electorate can expect an average increase of 27 more hot days (totalling 43 annually) on top of their current baseline, with a potential peak of up to 45 additional hot days (totalling 56 annually).

The federal electorates closer to the coast, such as Reid and Watson, have lower baselines of hot days and similarly can expect smaller increases in hot days. However, these increases are still significant. Under a high emissions scenario, Reid and Watson can expect to experience on average 17 more hot days, with a potential peak of up 28 more hot days in Reid and 27 more hot days in Watson. The full breakdown by electorate can be found in Appendix II.

FIGURE 6. BASELINE ANNUAL DAYS OVER 35°C, USING 1981-2010 DATA

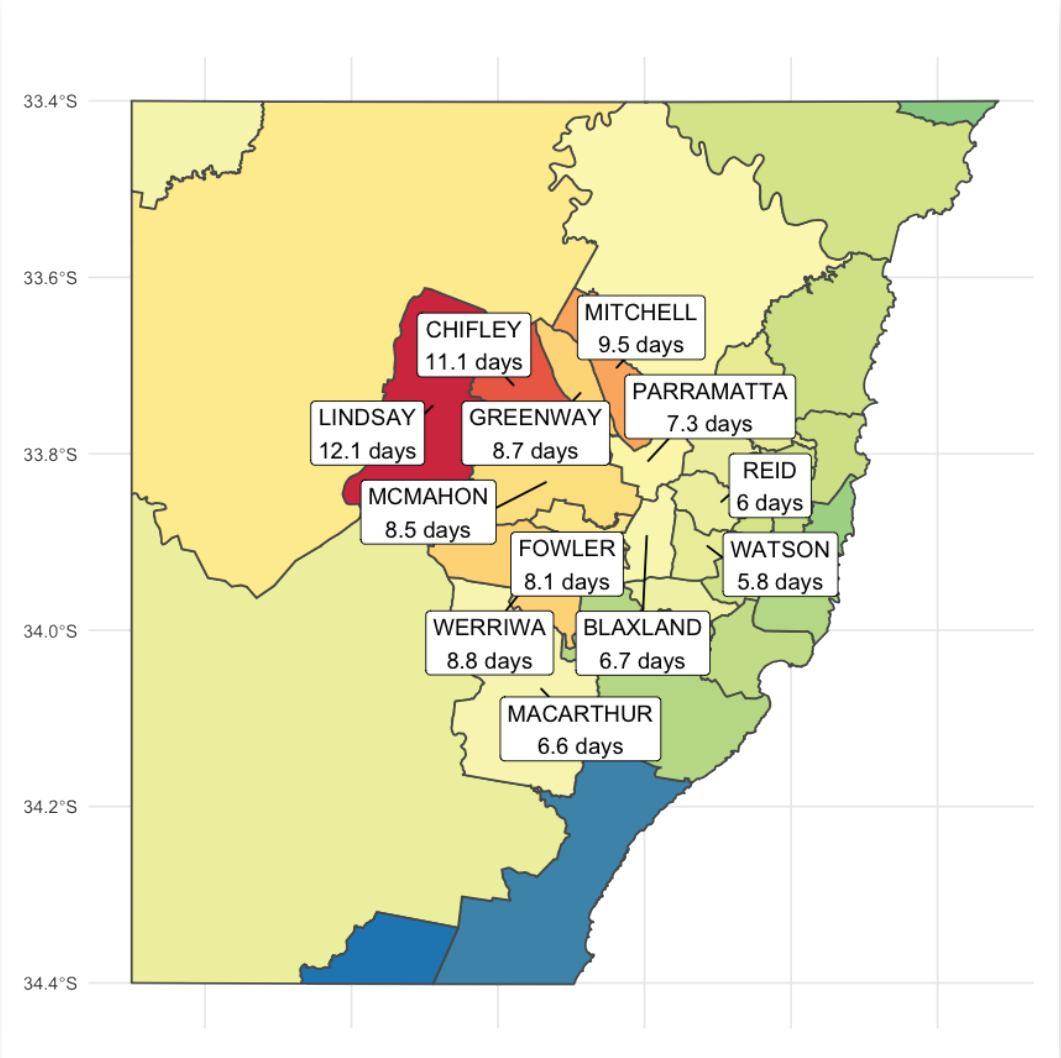
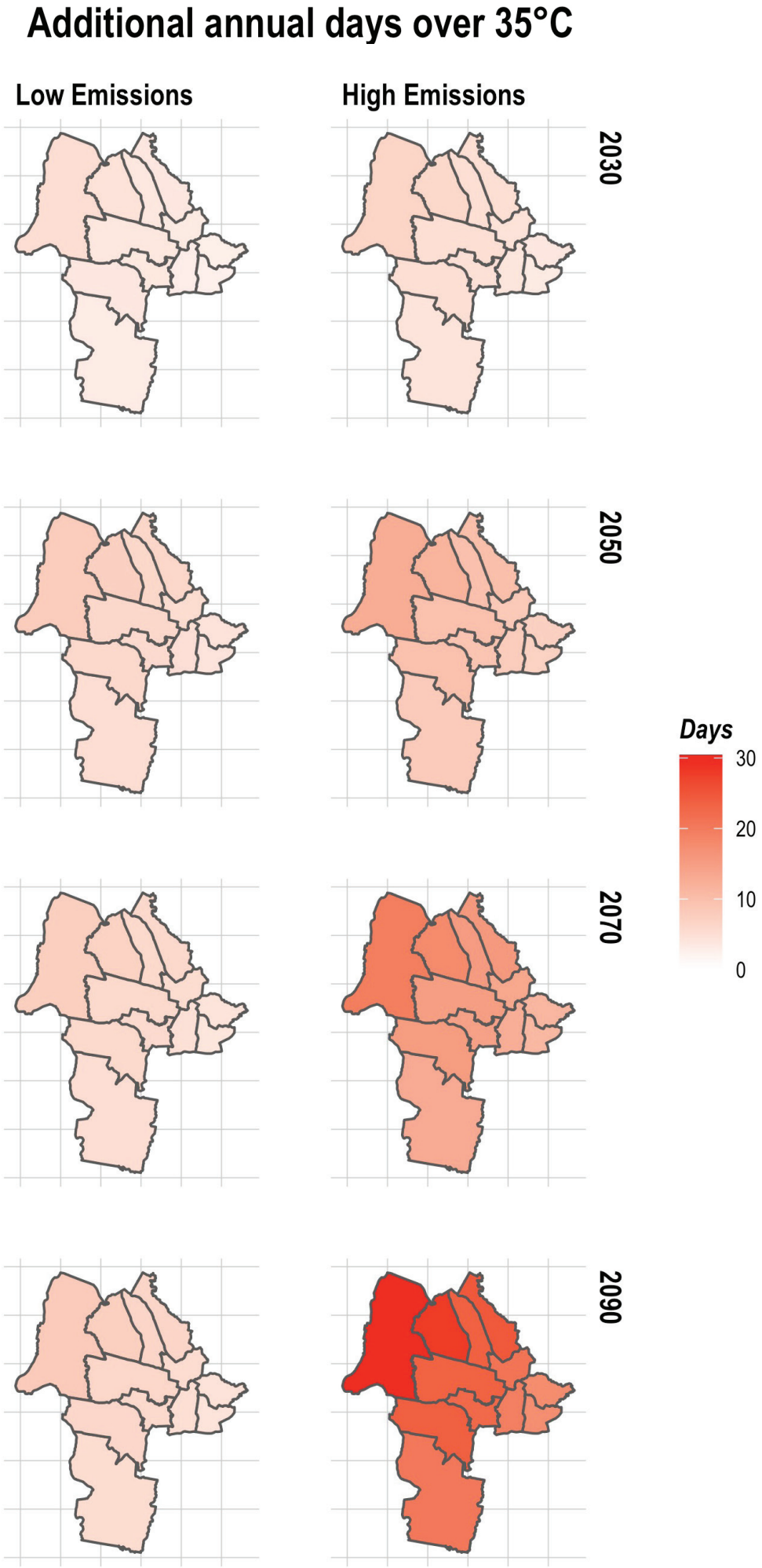


FIGURE 7. ADDITIONAL DAYS OVER 35°C



Feeling the Heat: Lindsay

Scenario

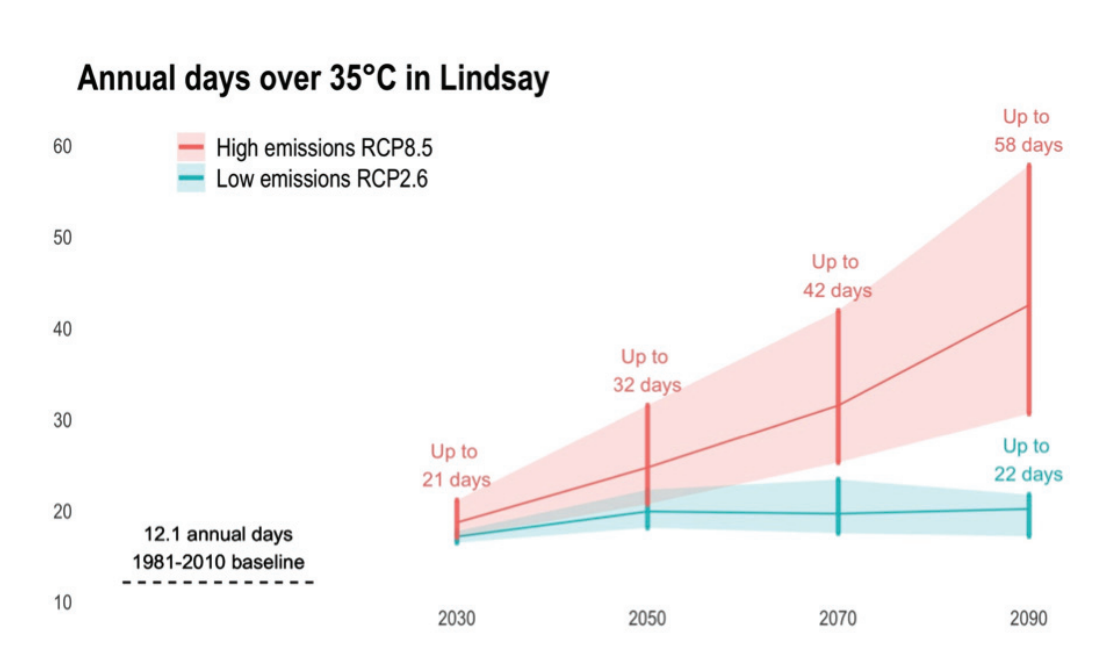
On the 4 January 2020, Penrith was the hottest place in the world, hitting 48.9°C.[14] The electorate of Lindsay, containing Penrith, regularly records the hottest summer temperatures of the Sydney basin.[15] Several suburbs in this electorate sit at the foot of the Blue Mountains, or in the lowest part of the basin, where hot air is easily trapped. In addition, it is one of the fastest growing parts of Sydney, with development reducing green space and further exacerbating heat. A Sweltering Cities community survey carried out in early 2021 showed that 86.7% of participants in Penrith think the way their local area is built increases heat (compared to 63% of people in South West Sydney).[16]

Looking to the future, Lindsay is projected to have the most extreme heat days of all 12 federal electorates analysed in Western Sydney. It is the only electorate projected to have an average of over 40 days a year of over 35°C heat by 2090, as shown in Table 3.

TABLE 3: MEAN NUMBER OF PROJECTED ANNUAL DAYS OVER 35°C IN LINDSAY

	2030	2050	2070	2090
High Emissions (RCP8.5)	18.7 days	24.7 days	31.5 days	42.5 days
Low Emissions (RCP2.6)	17.2 days	19.9 days	19.7 days	20.2 days

FIGURE 8. ANNUAL DAYS OVER 35°C IN LINDSAY



[14] AAP (2020) *Australian heatwave: Canberra and Penrith smash temperature records that stood for 80 years,* https://www.theguardian.com/australia-news/2020/jan/04/australian-weather-canberra-and-penrith-smash-temperature-records-that-stood-for-80-years

[15] Western Sydney University, Penrith City Council (2020) *Benchmarking summer heat across Penrith, New South Wales,* https://www.penrithcity.nsw.gov.au/images/penrith_city_council_benchmarking_summer_heat_across_penrith_web.pdf

[16] Sweltering Cities (2021) *Sweltering Cities Sydney Community Survey Report 2020-21,* https://swelteringcities.org/community-survey/ - note participants in the survey identified postcodes with Penrith and Campbelltown garnering the most response

In addition to the future projections, analysis of the current number of extreme heat days (over 35°C) in Penrith shows a worrying trend. Figure 9 displays the actual number of days over 35°C recorded at the Penrith Lakes BoM weather station since records began in September 1995 (dark blue bars). This is compared to the average number of days over 35°C expected by 2030 (grey horizontal line) and 2050 (light blue horizontal line) under a high emissions scenario. The trend line for the increase is also shown (dotted line).

The trend has already outstripped future projections, passing the average days of extreme heat for 2030 in 2004, and the 2050 projection in 2015.

It is even more alarming to note that the number of extreme heat days in the years 2018 and 2019, recorded at 44 each year, is already more than the average hot days projected for Penrith in 2090 (shown in Table 3). In short, Penrith is already experiencing extreme heat well beyond what is projected due to climate change.

Figure 10 shows the same for a threshold of 40°C, demonstrating that recorded days over 40°C in Penrith are already far outstripping future projections as a result of climate change.

FIGURE 9. PENRITH ACTUAL DAYS OVER 35°C COMPARED TO PROJECTIONS

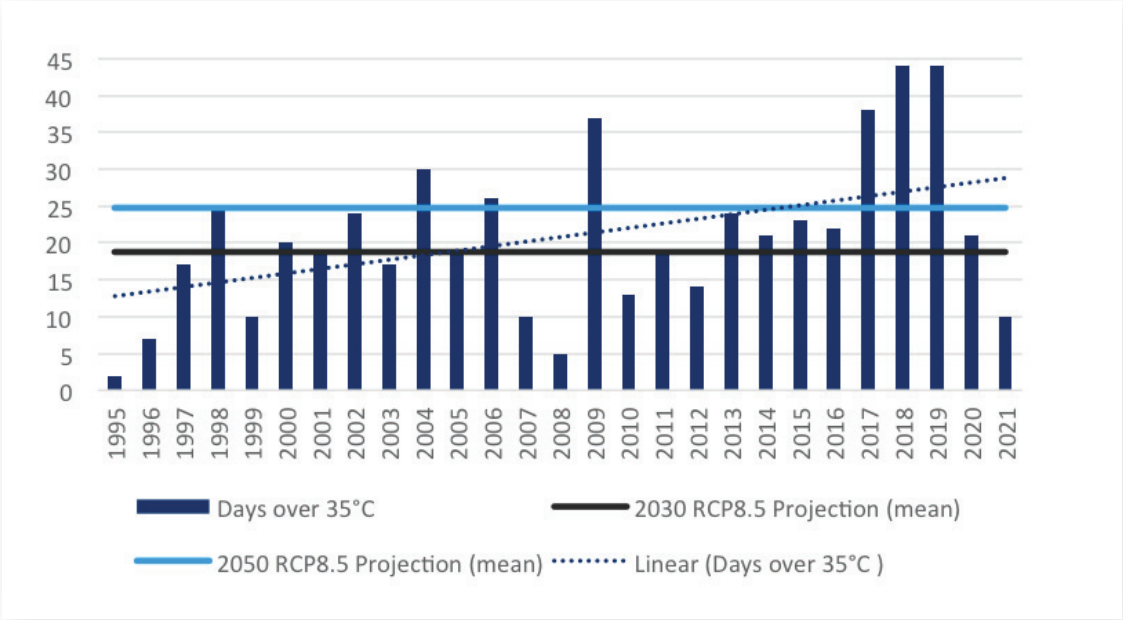
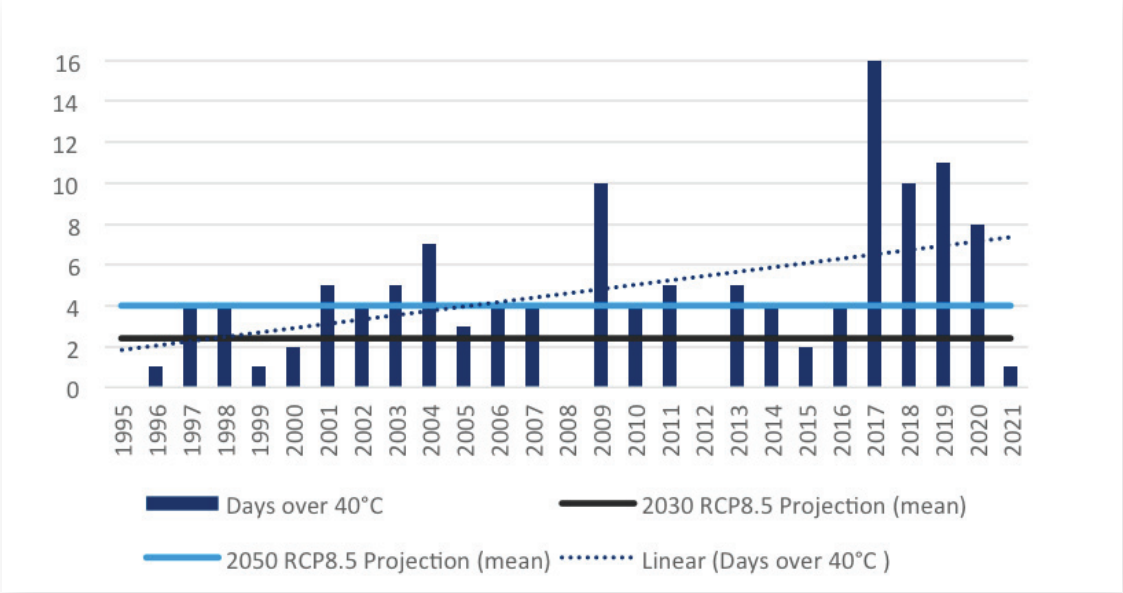


FIGURE 10. PENRITH ACTUAL DAYS OVER 40°C COMPARED TO PROJECTIONS



The Costs of Extreme Heat

Health Concerns

A future of increased extreme heat represents a serious threat to the wellbeing of Western Sydney residents and Australia's wider population. Extreme heat leads to an increase in heat-related illnesses such as dehydration and heat stroke, as well as deaths, with heat being Australia's biggest killer of any natural disaster.[17] Disturbingly, heat exposure has killed more Australians than all other natural hazards combined.[18]

Prolonged heat can also exacerbate pre-existing medical conditions such as heart or kidney disease and respiratory illnesses. Through both its impact on the human body at a cellular level, as well as its impact on air quality and disease transmission, it can lead to more heart attacks, strokes and increased risk of injury.[19]

The scale and nature of health impacts depend on timing, intensity and duration of an extreme heat event. When hot days are combined with hot nights, the body has no opportunity to cool down and recover. As a result, mortality rate from heat increases nearly 20% when the average temperature across a 24-hour period is above 30°C.[20] The synergistic effect of night humidity, increased temperatures and UHI in heatwaves has been estimated as doubling general mortality risk by the end of the century under RCP8.5.[21]

As well as an increase in heat related deaths and illness, the rise in extreme heat increases irritability and psychological stress.[22] Hot weather affects patterns in domestic violence,[23] interrupts sleep patterns and reduces capacity and willingness to exercise. All carry broad ramifications, such as increased accident risk, sedentary lifestyle-induced diabetes and cardiovascular disease.[24]

87.5% of Western Sydney residents surveyed by Sweltering Cities reported to have trouble sleeping in hot nights or during heat waves.[25] Meanwhile, 95% think that summers are going to become hotter. This is not just a feeling. Research by the Australia Institute found recent summers are generally a month longer in Australia, when compared to average temperatures that marked the start and end of summers in the 1950s and 1960s.[26]

In Sydney, a socio-economic divide coincides with a disparity in experiences of extreme heat. This means that extreme heat is, and will continue to, disproportionately affect those more vulnerable to its impacts for reasons such as age, health or income.

Using census data around employment, income and service access, the ABS Socio-Economic Indexes for Areas maps advantage across Australia. Areas closer to the coast, in particular the local government areas of east and inner-north Sydney, consistently outrank Western Sydney in measures such as median income.[27] Yet it is residents in areas such as Penrith that are paying on average up to $100 per month more on their power bill compared to those living closer to the coast. Representing a higher proportion of income than in more advantaged areas, this works to compound Sydney's socio-economic disparity.[28] The Sweltering Cities survey showed that 55% of respondents in Western Sydney with air conditioning said sometimes they don't turn it on due to cost concerns.[29]

The disproportional exposure to extreme heat exacerbates inequality and a geographical divide in Sydney. This will only increase.

COVID-19

The COVID-19 pandemic has further exacerbated health concerns in times of extreme heat. Isolating or quarantining at home during extreme heat may increase risk of indoor overheating. Taking into consideration factors of access and affordability, those who cannot afford air-conditioning, for example, will be at higher risk.[30]

Hot days are known to increase crowds of people at community spaces such as shopping centres, due to the need for air-conditioning.[31] This is likely partially due to common advice from governments to seek out air-conditioned public spaces in times of extreme heat.[32] In the instance of a pandemic, however, the impact of gathering can lead to further spreading of COVID-19, compounding health impacts for those in the area.

Health facilities in Sydney are also under increasing strain due to rising COVID-19 infections — this is only predicted to rise.[33] Testing requirements can result in people waiting in extreme heat for hours, leading to increased risk of heat-related impacts as well as prolonged exposure to other contagious people.[34] In addition, hospitals resources are being directed towards addressing COVID-19, reducing the resources available to address heat stress.

For workers, the increased requirement to wear impermeable or semi-permeable personal protective equipment (PPE) exacerbates heat stress, especially if working outdoors or in spaces without adequate cooling.[35]

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[22] Queensland Health (2015) *Heatwave Response Plan* https://www.health.qld.gov.au/__data/assets/pdf_file/0032/628268/heatwave-response-plan.pdf
[23] Auliciems and Di Bartolo (1995) *Domestic Violence in a subtropical environment: police calls and weather in Brisbane.* International Journal of Biometeorology 39 (1).
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[28] Miletic (2017) *Why cooling homes in Sydney's West costs so much,* https://www.architectureanddesign.com.au/news/why-cooling-homes-in-sydney-s-west-costs-so-much-a#
[29] Sweltering Cities (2021) *Sweltering Cities Sydney Community Survey Report 2020-21,* https://swelteringcities.files.wordpress.com/2021/04/sweltering-cities-sydney-community-survey-report-20-21.pdf
[30] Victoria Department of Health (2021) *Heat health plan for Victoria,* https://www.health.vic.gov.au/publications/heat-health-plan-for-victoria
[31] Purtill (2021) *Heatwaves may mean Sydney is too hot for people to live in 'within decades',* https://www.abc.net.au/news/science/2021-01-24/heatwaves-sydney-uninhabitable-climate-change-urban-planning/12993580
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[33] Davey and Visontay (2021) *Covid update: Australia could have 200 000 cases a day by late January under 'worst-case' Doherty modelling*, https://www.theguardian.com/australia-news/2021/dec/21/covid-update-victoria-flags-reintroducing-common-sense-masks-after-act-mandates-them-indoors
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[35] UTS Climate Justice Research Centre (2021) *High heat and climate change at work,* https://unitedworkers.org.au/high-heat-at-work-report/

Economic Costs

In addition to health impacts, extreme heat impacts workplace productivity and can cause severe damage to critical infrastructure, facilities and services, including transport and electricity. These all come with significant costs to the economy.

For climate change more broadly, the costs for Australia experiencing dangerous climate change (RCP8.5) have been modelled by Deloitte Access Economics at $3.4 trillion by 2070, with 880,000 jobs lost.[36] For NSW, this scenario would result in a 4% drop in gross state product and 2% drop in employment by 2070 (note reductions are in reference to an economy with no damages).

Recent modelling undertaken by the NSW Treasury looks more specifically at extreme heat, estimating the costs associated with reduced workplace productivity.[37]

Identifying four vulnerable industries (agriculture, construction, manufacturing, and mining), they match ABS labour force data to temperature projections to project working days lost under different scenarios.

It shows that by 2061, between 700,000 and 2.7 million working days are projected to be lost every year from heatwaves, as shown in Table 5.

While this modelling does not measure health or infrastructure damage costs, nor productivity beyond these four industries considered, it provides a strong example of how to undertake definitive cost modelling of extreme heat in other areas. These may be harder to measure but have been noted by NSW Treasury as high priority areas for future research.

This modelling strongly supports past studies on the costs of extreme heat on workplace productivity. For the year 2013-2014, the cost of lost productivity due to extreme heat was estimated at USD 6.2 billion (currently AUD 8.5 billion).[38]

Other Australian studies focusing on heat stress, work and productivity have found a clear association between the rate of occupational injury claims and higher ambient temperatures. Heat exposure can increase the risk of workplace accidents through physical fatigue, the misuse of equipment and reduced mental capacity.

The delayed effects of heat stress beyond the workplace—for example, from a lack of sleep, or a more difficult journey into work—compound the impact of heat on work life longevity and job security.

Extreme heat can also impact critical infrastructure, having direct flow-on impacts for the economy. Coal and gas power stations regularly break down, and because of their size, breakdowns result in large amounts of electricity supply being lost suddenly and without warning. Heatwaves result in very high peak demand, and when these breakdowns occur during a heatwave, as they regularly do, blackouts can and do result.[39] During the 2009 heatwave in Melbourne, 500,000 people were left without power on a day that reached 44°C. There were 374 deaths recorded as a result, and the cost of the heatwave was estimated at $800 million.[40]

Similarly in New Orleans in the United States of America in September 2021, a huge power failure after Hurricane Ida left vulnerable residents in sweltering apartments for days. More New Orleans residents died from the heat than they did from the storm.[41]

With Western Sydney reliant on power for cooling in times of extreme heat, as well as having a transport system already under stress, the region is particularly vulnerable to infrastructure damage caused by heatwaves.

TABLE 4: WORKING DAYS LOST PER YEAR DUE TO HEATWAVES BY 2061

	Agriculture	Construction	Manufacturing	Mining
Low Warming (RCP2.6)	**100,000**	**520,000**	**100,000**	**4,000**
Reference Case (RCP4.5)	**200,000**	**1,030,000**	**190,000**	**8,000**
Higher Warming (RCP8.5)	**380,000**	**1,940,000**	**360,000**	**15,000**

Measured as the increase in days lost compared to current climatic conditions.
Source: NSW Treasury 2021

[36] Deloitte Access Economics (2020) *A New Choice: Australia's Climate for Growth* https://www2.deloitte.com/au/en/pages/economics/articles/new-choice-climate-growth.html
[37] NSW Treasury (2021), *An indicative assessment of four key areas of climate risk for the 2021 NSW Intergenerational Report,* https://www.treasury.nsw.gov.au/sites/default/files/2021-04/2021_igr_ttrp_-_an_indicative_assessment_of_four_key_areas_of_climate_risk_for_the_2021_nsw_intergenerational_report.pdf
[38] Zander, Botzen, Opperman, Kjellstrom and Garnett (2015) *Heat stress causes substantial labour productivity loss in Australia,* https://www.nature.com/articles/nclimate2623
[39] 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,* https://australiainstitute.org.au/wp-content/uploads/2020/12/P454-Cant-stand-the-heat-FINAL-2.31.pdf
[40] 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
[41] Bogel-Burroughs and Reckdahl (2021) *The Greatest Killer in New Orleans Wasn't the Hurricane. It Was the Heat,* https://www.nytimes.com/2021/09/15/us/new-orleans-hurricane-ida-heat.html

Future Generations

Climate change is often described as affecting "future generations", and the projections show that those living in 2090 and beyond, including today's young people, will be hit the hardest by extreme heat.

However, this is not a problem limited to future generations. It is already a lived experience, and without urgent policy changes to address both the causes and impacts of extreme heat, all generations will see further increases in extreme heat days in their lifetime.

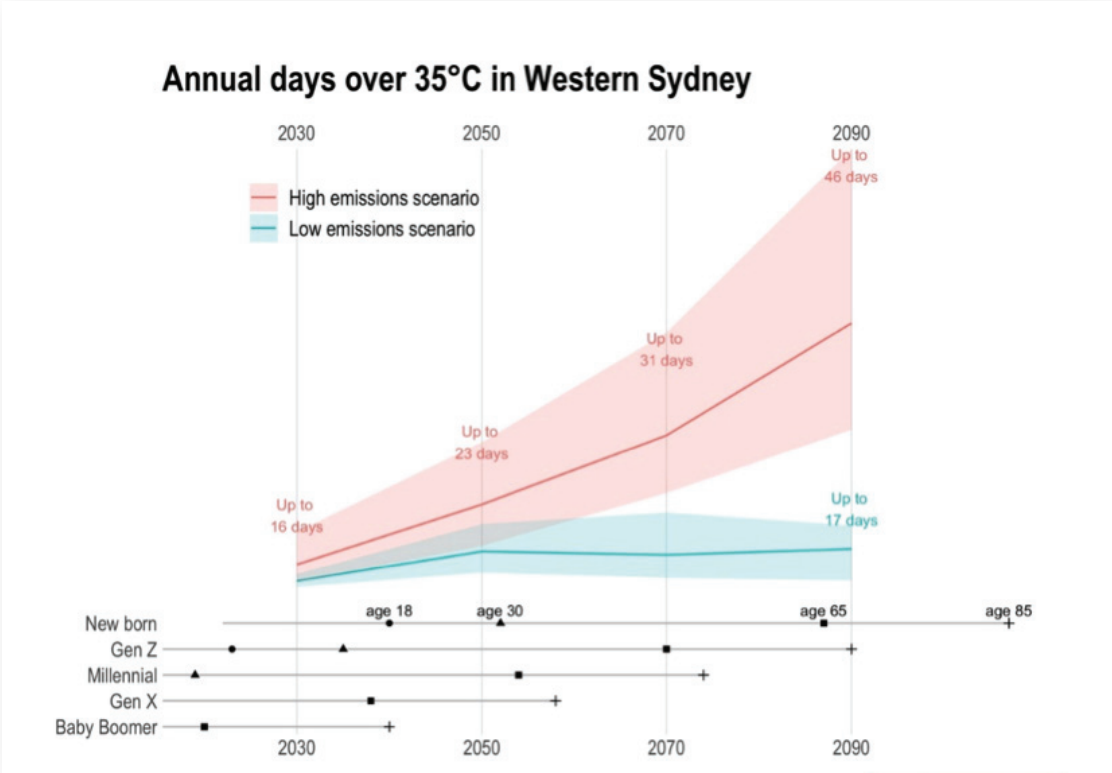
As shown in Figure 11, a member of Generation X, born in 1975 and living for 80 years, could see the number of extreme heat days in Western Sydney almost triple from 8.6 days per year to 23 days in their lifespan. A 14-year-old student, on the other hand, could see extreme heat days almost quadruple to 31 by the time they retire — and continue to climb to 46 days per year during their remaining years.

Depending on decisions made to limit global emissions in the next ten years, a newborn in 2022 will face drastically different levels of extreme heat when they reach retirement in 2090.

TABLE 5: AGE RANGES FOR GENERATION CATEGORIES IN 2022

Generation	Born	Ages
Generation Z	1997 - 2012	10-25
Millennials / Generation Y	1981 - 1996	26-41
Generation X	1965 - 1980	42-57
Baby Boomer	1946 - 1964	58-76

FIGURE 11. HOW GENERATIONS WILL EXPERIENCE CLIMATE CHANGE (WESTERN SYDNEY)



Pouring Fuel on the Fire

Many steps can be taken to adapt to and build resilience to intensifying heat. However, adaptation can only go so far. To limit the danger imposed on the residents of Western Sydney, governments in Australia and internationally must decisively reduce global emissions. As the projections show, emissions scenarios greatly impact the potential increase in days over 35°C.

Unfortunately, current policies of the Australian and NSW Governments are working to exacerbate rather than mitigate Western Sydney's extreme heat. Australia's current 2030 domestic emissions reduction target of 26-28% below 2005 levels is consistent with warming of 4°C if all other countries were to follow a similar level of ambition.[42] This would be broadly consistent with the worst-case high emissions (RCP8.5) scenario which the IPCC has said will lead to warming of 3.3-5.2°C warming by 2100.[43]

NSW is also a major coal producer and exporter. Coal when combusted is the largest single source of greenhouse gas emissions, and therefore contributor to climate change. The state produced 200 million tonnes (mt) of coal in 2020 which resulted in lifecycle emissions of around 540 mt CO_2, equivalent to the emissions of 75 coal power stations.[44] There are also plans for new coal mines in NSW that would have the capacity to produce a further 135 million tonnes of coal per annum (mtpa), which would result in a further approximately 350 mt CO_2 annually — equivalent to building almost 50 new coal power stations.[45]

The new coal mines planned for NSW would result in more than twice the emissions of the 43 coal power stations planned by China, which would emit around 150 million tonnes of CO_2 annually.[46]

[42] Climate Action Tracker (September 2021) *Australia,* https://climateactiontracker.org/countries/australia/
[43] IPCC (2021) AR6, Climate Change 2021, *The Physical Science Basis, Summary for Policy Makers, p.14,* https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf
[44] Assuming 7.2 mtpa CO2 per coal power station, which is the average emissions of Australian coal power stations at the time of writing.
[45] Ogge, Quicke and Campbell (November 2021) *Undermining Climate Action The Australian Way,* https://australiainstitute.org.au/wp-content/uploads/2021/11/P1163-Undermining-climate-action-the-Australian-way-WEB.pdf
[46] CREA, Global Energy Monitor (August 2021) *China's power & steel firms continue to invest in coal even as emissions surge cools down,* https://energyandcleanair.org/wp/wp-content/uploads/2021/08/China-Q2-briefing-coal-steel-CO2.pdf

Conclusion

Considering how different emissions scenarios would impact Western Sydney, the projections for extreme heat should be considered and integrated into planning for the region. While traditionally Sydney has not been built to withstand extreme heat as outlined in local government studies,[47] this is starting to change. Since 2019, all 33 Sydney councils have been funding a climate adaptation program that identifies heat as the number one threat to Sydney residents.[48]

In Western Sydney and the Blue Mountains, five local councils have developed a joint *Turn Down the Heat* strategy.[49] Consulting with various stakeholders across a range of sectors, this strategy aims to share best practices and develop priority areas with which to address the challenge of urban heat in their councils.

On a state government level, as part of broader environmental planning, the NSW government recently announced a move to ban dark roofs. Lighter coloured roofs reflect rather than absorb heat, with UNSW research showing that they could reduce temperatures inside the home by up to 10°C during a heatwave.[50]

At a federal level, climate policy to address both the causes and impacts of climate change leaves much to be desired.

The Federal Government continues to subsidise fossil fuels, approve new gas and coal projects and refuse to increase its 2030 climate target.[51] In addition, Australia has no National Adaptation Plan, despite this being a process recommended under the Paris Agreement, and adopted by the majority of countries.[52] On both mitigation and adaptation fronts, Australia can do much more to protect its citizens who are already experiencing the impacts of climate change such as extreme heat.

Extreme heat is an increasing concern to many residents of Western Sydney, who are eager for policy options to help cope with the ever-increasing heat.[53]

[47] WSP (2021) *Future proofing residential development to climate change,* https://www.waverley.nsw.gov.au/__data/assets/pdf_file/0006/181788/Future_Proofing_Residential_Development_to_Climate_Change_Final_Report_January_2021.pdf
[48] Purtill (2021) *Heatwaves may mean Sydney is too hot for people to live 'within decades'* https://www.abc.net.au/news/science/2021-01-24/heatwaves-sydney-uninhabitable-climate-change-urban-planning/12993580
[49] WRSOC (2018) *Turn Down the Heat,* https://wsroc.com.au/projects/project-turn-down-the-heat
[50] Davies and Visontay (2021) *Dark roofs to be banned in NSW, planning minister says,* https://www.theguardian.com/australia-news/2021/nov/17/dark-roofs-to-be-banned-in-nsw-planning-minister-says
[51] Verschuer (2021) *Government not on track for net zero by 2050,* https://australiainstitute.org.au/report/government-not-on-track-for-net-zero-by-2050/
[52] Nalau and Melville-Rea (2021) *Australia ranks last out of 54 nations on its strategy to cope with climate change,* https://theconversation.com/australia-ranks-last-out-of-54-nations-on-its-strategy-to-cope-with-climate-change-the-glasgow-summit-is-a-chance-to-protect-us-all-169627
[53] See Sweltering Cities (2021) Community Survey, page 17: https://swelteringcities.files.wordpress.com/2021/04/sweltering-cities-sydney-community-survey-report-20-21.pdf

Appendix I: HeatWatch Methodology

The Australia Institute's HeatWatch initiative analyses Bureau of Meteorology and CSIRO data to find how climate change will affect the number and intensity of extreme heat days across Australia.

The CSIRO–BoM data is a time series from the Australian Water Availability Project (AWAP) where the average temperature was compiled in five kilometre by five kilometre spatial grids between 1981 and 2010. This time series uses between five and eight models to predict days over 35°C and over 40°C in 2030, 2050, 2070 and 2090. Differences across space is based on a historical average for the years 1981–2010.

Our analyses use an average across all eight climate models selected by the CSIRO, and present the full range of their projected increases in days over the various temperature thresholds according to two different emissions scenarios. The trend line in these figures mark the mean average of the projections.

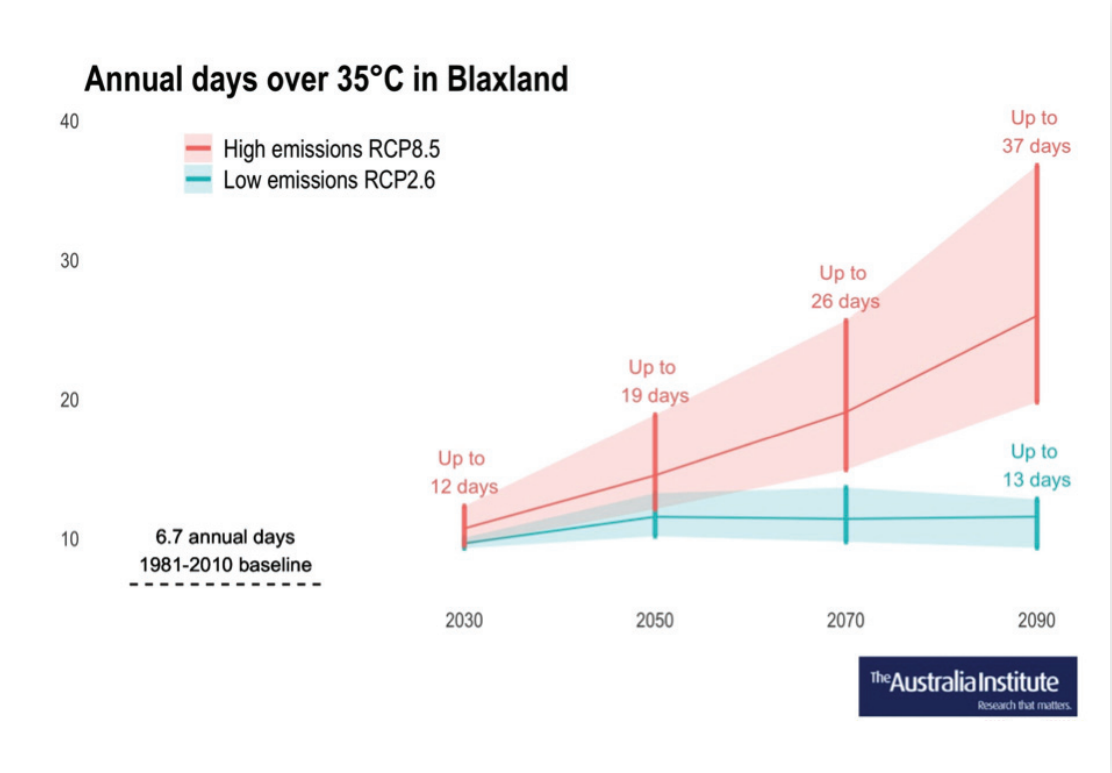
Our analyses look at areas within 12 selected electorates, aggregates these values to calculate the mean value, which is then shown as the value for each electorate under different projections.

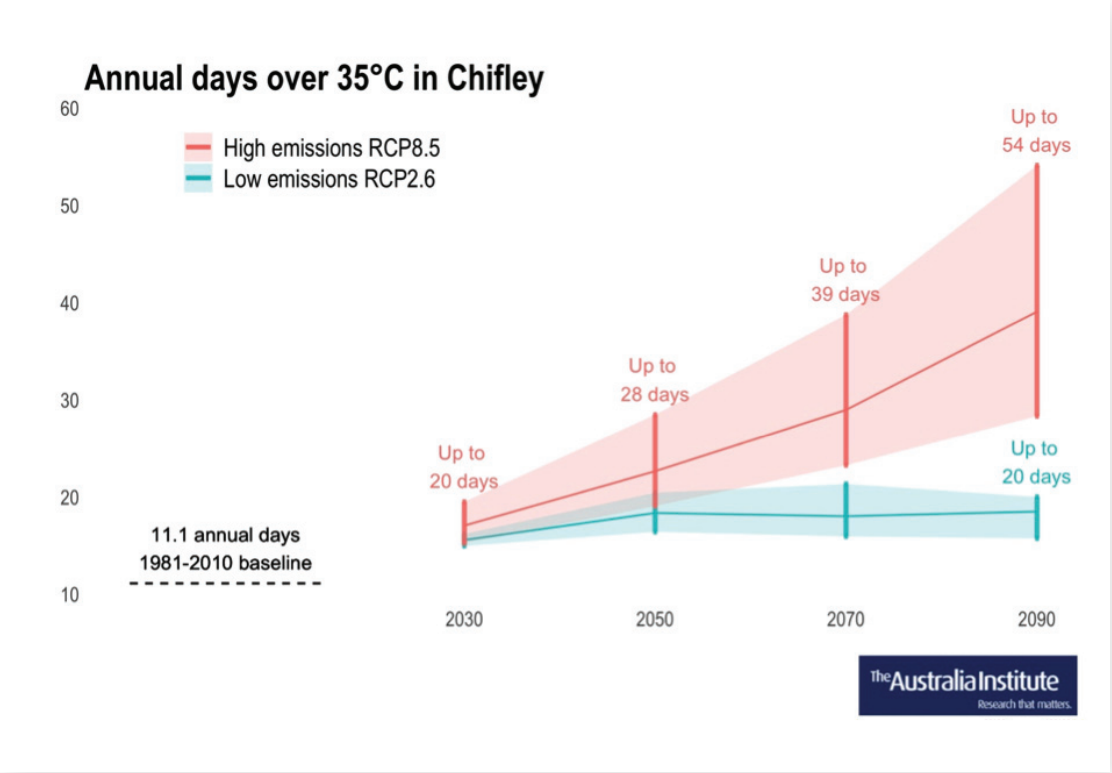
This report employs the representative concentration pathway (RCP) scenarios originating from IPCC's AR5 report, which are reflected in the BOM and CSIRO data. The pathways represent different emissions scenarios, with RCP2.6 being a low emissions scenario, and RCP8.5 a high emissions scenario. Some studies suggest that RCP 8.5, which would see emissions rise until the end of the century, most accurately reflects cumulative CO2 emissions trajectories based on current policies.[54]

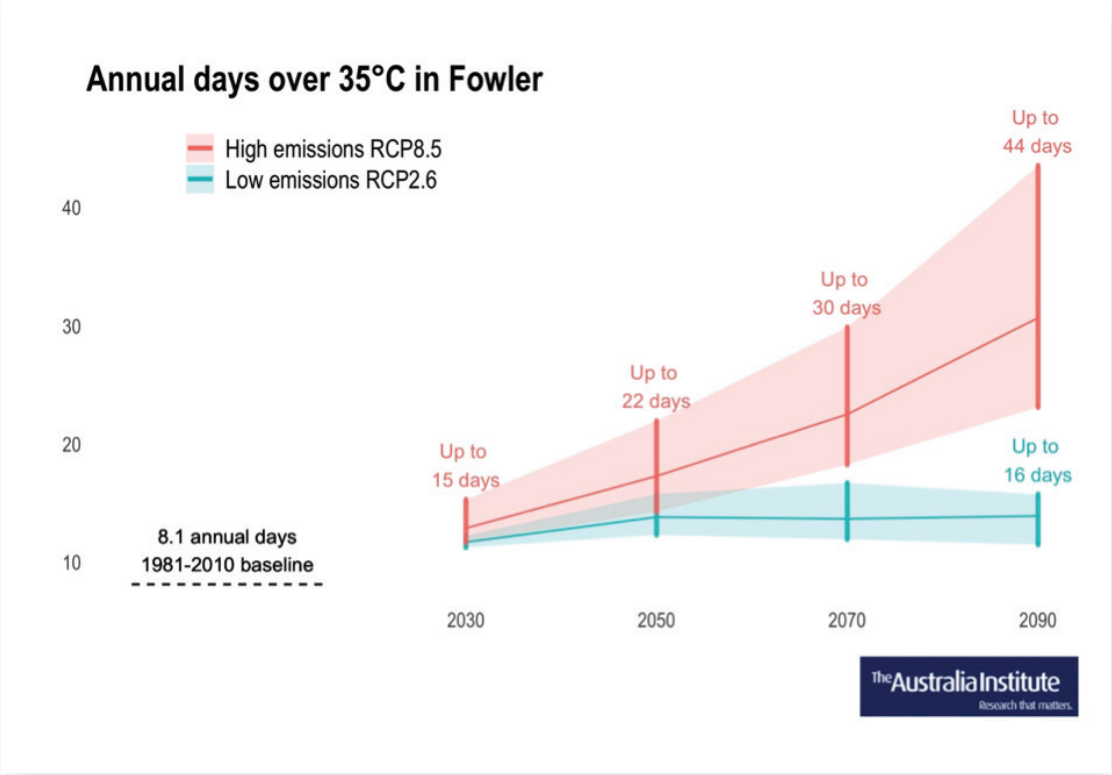
By mapping potential increases in days of extreme heat (days over 35°C) under different emissions scenarios, we highlight the effects that global warming could have on Western Sydney.

[54] https://www.pnas.org/content/117/33/19656

Appendix II: Hot Days by Electorate






Annual days over 35°C in Fowler
High emissions RCP8.5
Low emissions RCP2.6
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1981-2010 baseline
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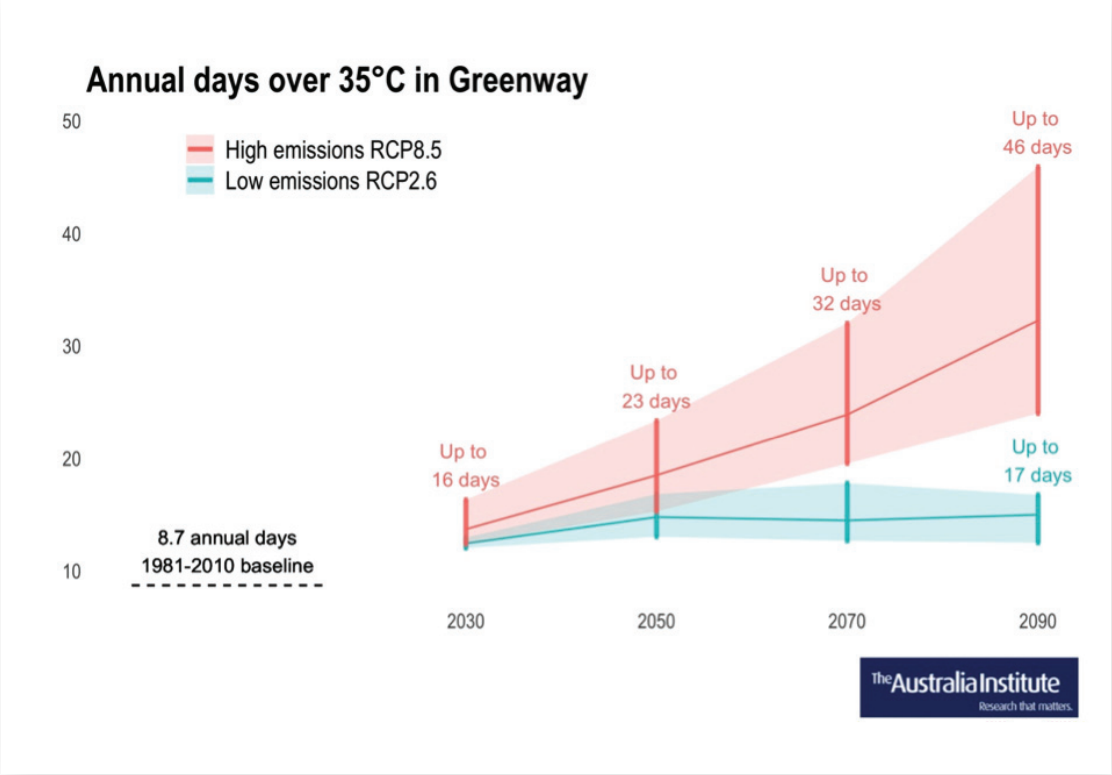
The Australia Institute
Research that matters.


Annual days over 35°C in Greenway
High emissions RCP8.5
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8.7 annual days
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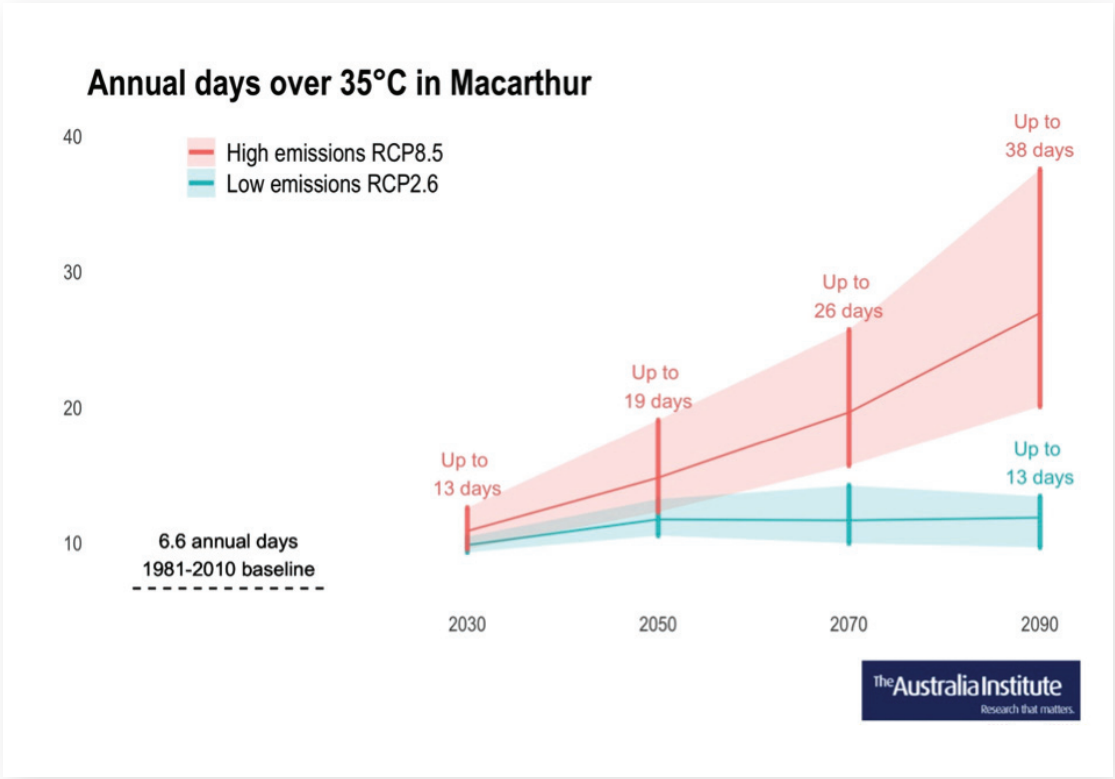
Research that matters.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High emissions RCP8.5
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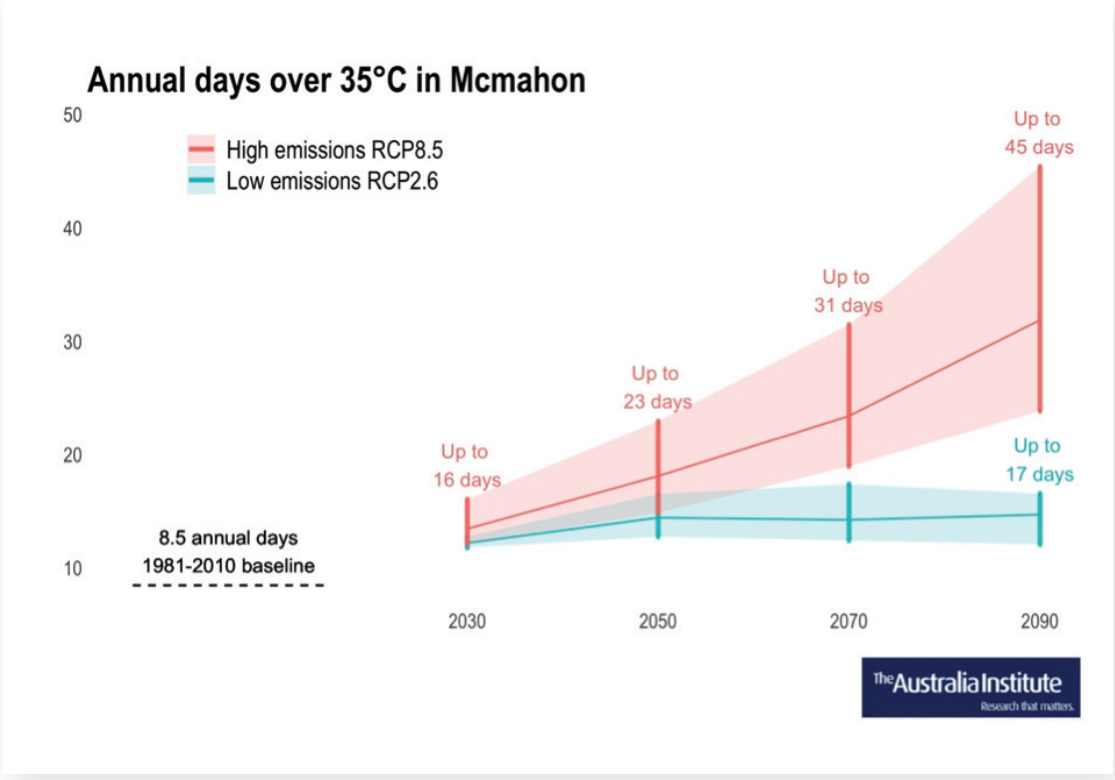
Research that matters.


Annual days over 35°C in Mcmahon
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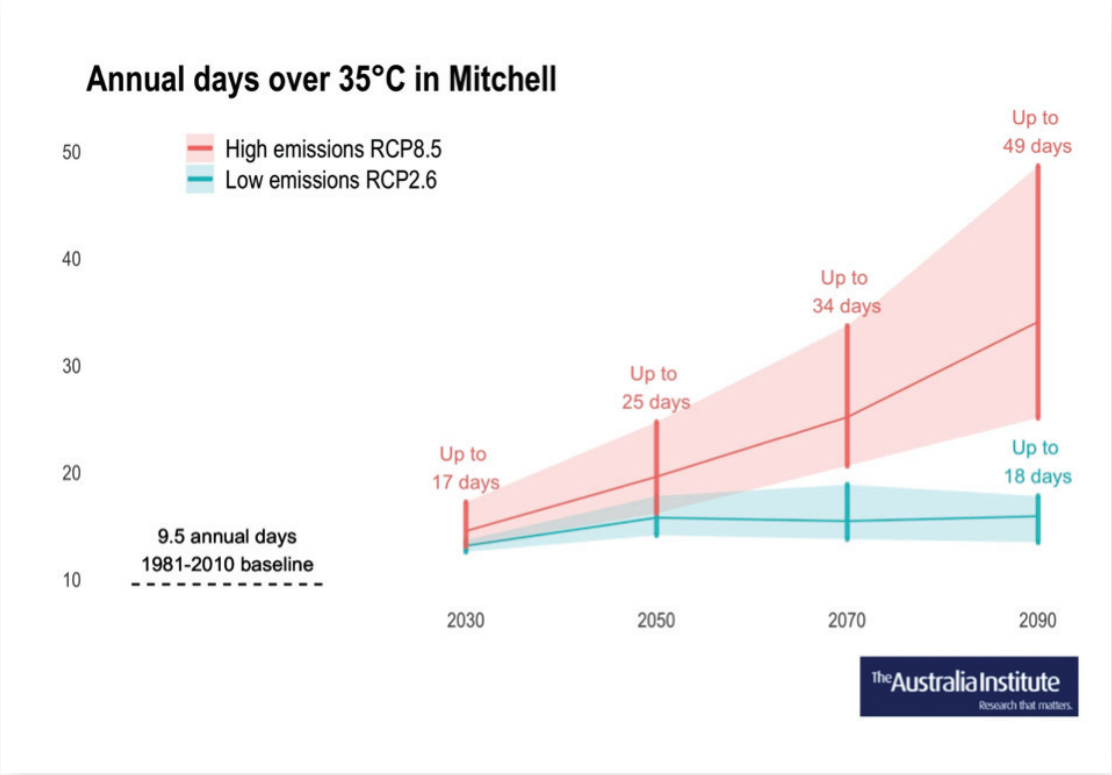
Research that matters.


Annual days over 35°C in Mitchell
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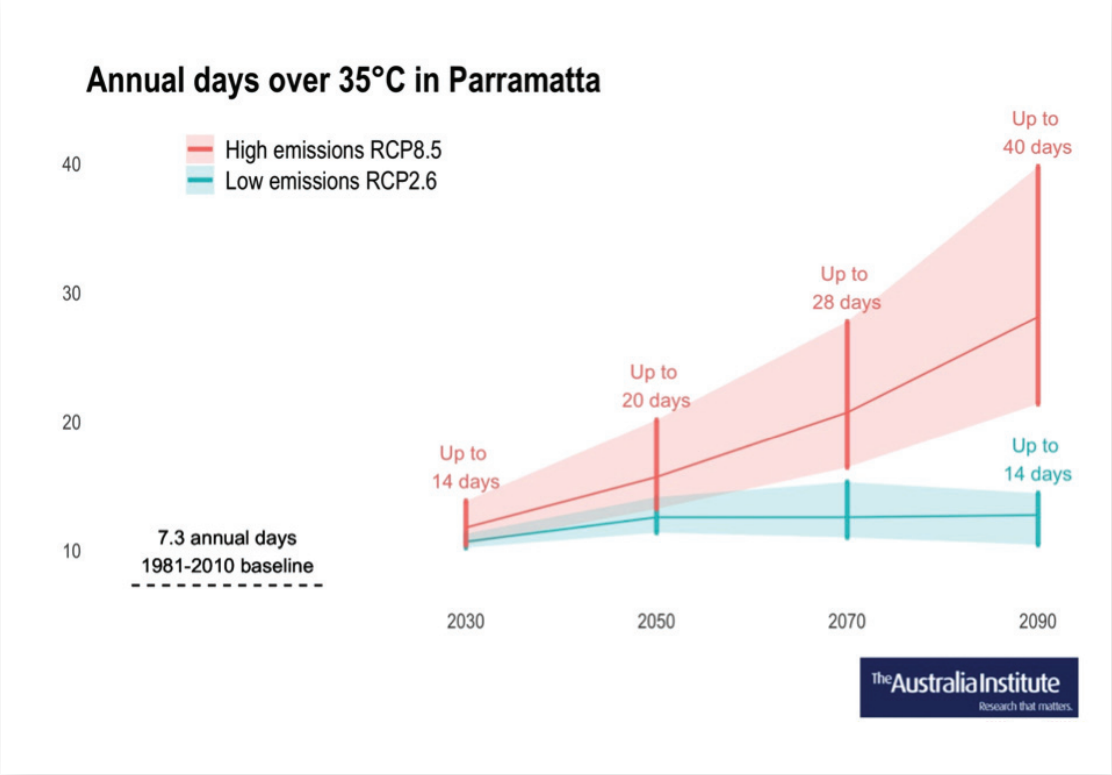
Annual days over 35°C in Parramatta
High emissions RCP8.5
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7.3 annual days
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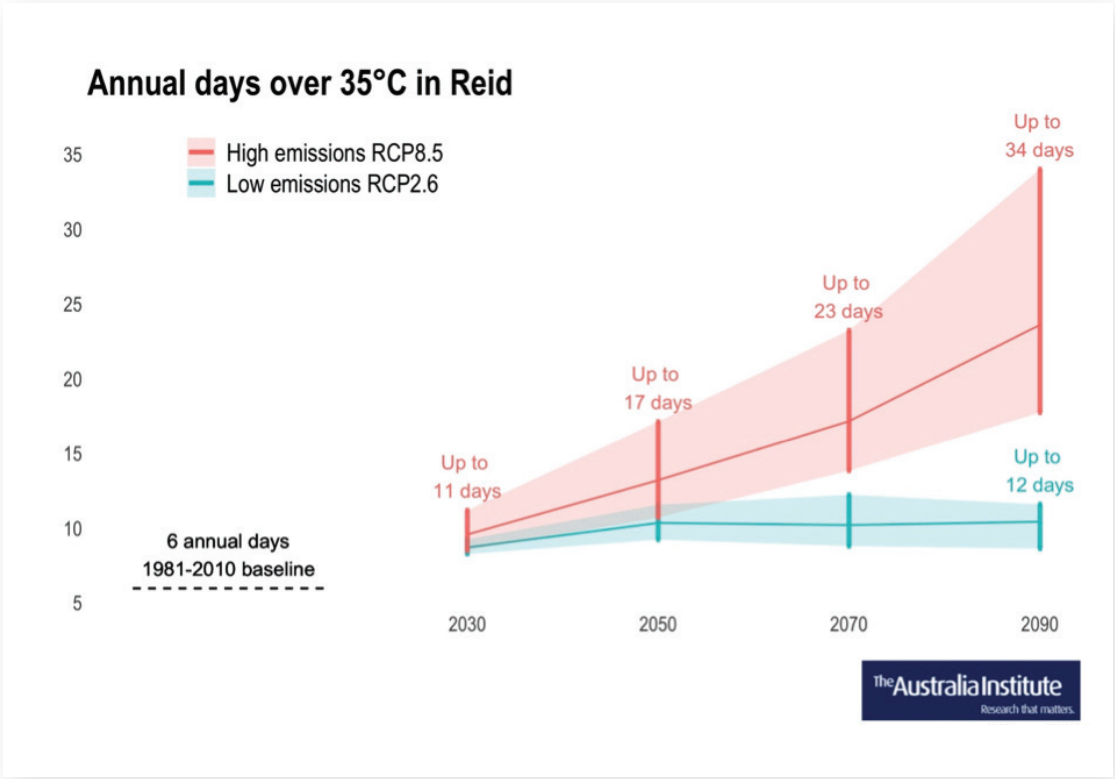
Annual days over 35°C in Reid
High emissions RCP8.5
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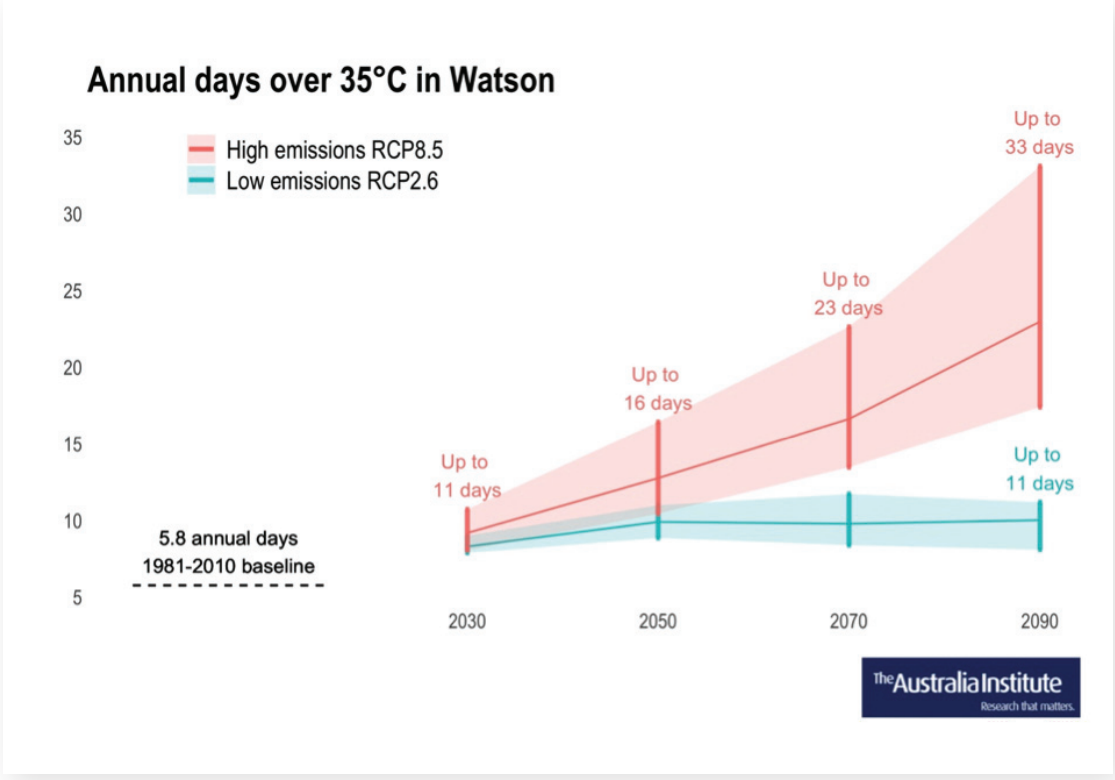
Research that matters.


Annual days over 35°C in Watson
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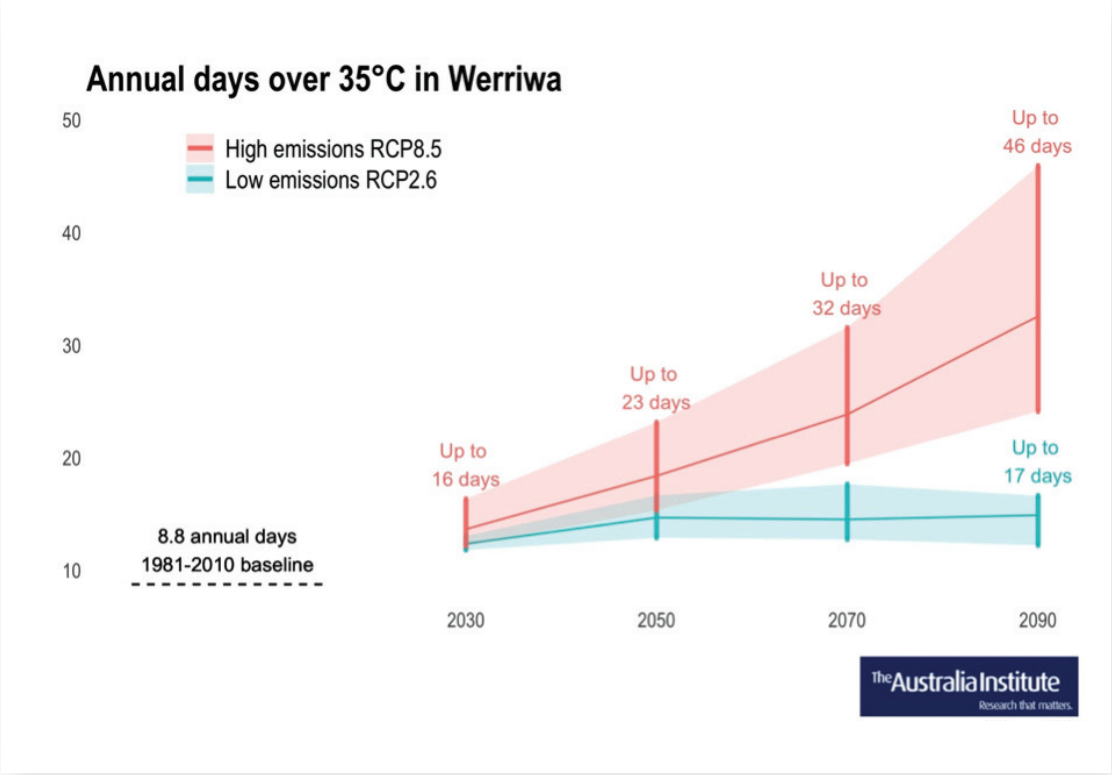
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Research that matters.

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