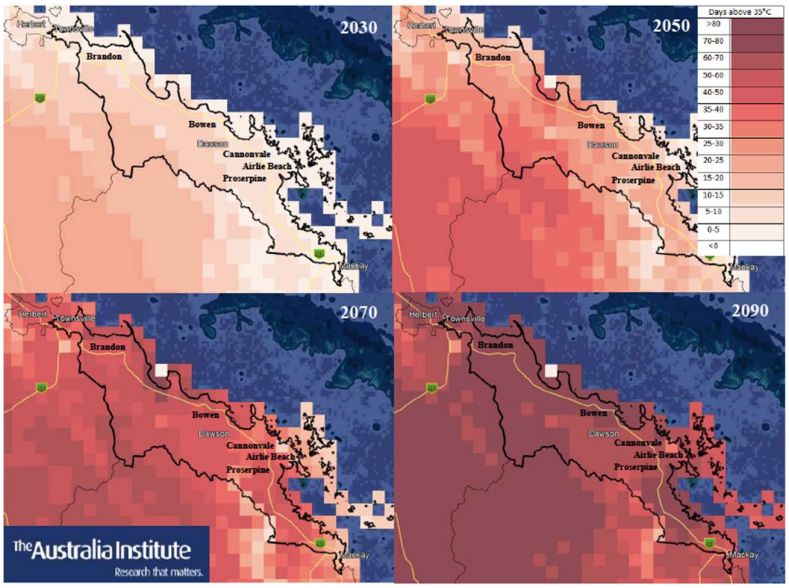

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Climate Assessment for the electorate of Dawson

The electorate of Dawson stands to be heavily impacted by climate change. Increasing natural disasters, drought and heatwaves will impact the community's health, infrastructure and vital industries, particularly agriculture, tourism and mining unless decisive action is taken to tackle climate change

Report

Mark Ogge

May 2019

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Summary

The electoral profile of Dawson describes the local industries as:

> Various small crops, prawn and fish farms, sugar growing and refining, beef cattle, coal mining related industries, abattoirs and tourism.[1]

All of these industries will suffer serious impacts from climate change unless decisive action is taken reduce emissions. The beef and sugar industries will suffer from extreme temperatures, floods, droughts and changes in rainfall and evaporation. The Great Barrier Reef and fisheries are under threat from rising ocean temperatures and ocean acidification, representing an existential risk to the tourism and fishing industries. Fires, like those experienced in November 2018 will become more frequent. Many mining and construction workers, farmers, and others required to undertake strenuous work outdoors will be put at risk by increasing heatwaves. Workforce productivity will fall.

Key findings

- Unless strong action is taken on climate change, by 2070, well within our children's lifetime, the electorate of Dawson is projected to experience:
    - Up to 25 percent increase in evaporation
    - Up to 50 percent reduction in rainfall
    - Up to 100 percent increase in heatwave days per year
    - Increasing fire risk
    - A 90-130 percent increase in the frequency of droughts and floods.

- These climate impacts would result in highly disruptive and costly impacts on the community and economy including:
    - Increased damage to property and infrastructure
    - Reduced agricultural yields
    - Reduced workforce productivity
    - Increasing heat related illnesses and deaths.

- Most of these impacts can be avoided if the globally agreed Paris climate target of 1.5 degrees is achieved.

[1] AEC (2019) Profile of the electoral division of Dawson (Qld), https://www.aec.gov.au/profiles/qld/dawson.htm

Table of Contents

Introduction

The electorate of Dawson consists of the Burdekin Shire Council, part of the Mackay Regional Council, part of the Townsville City Council, and part of the Whitsunday Regional Council.

This paper examines the projected impact of climate change in these regions on:

- Rainfall
- Evaporation
- Extreme temperature
- Heatwaves

This assessment draws on projections from the Queensland Government's *Future Climate Dashboard*.[2] The Dashboard has been developed by the Queensland Department of Environment and Sciences (DES), providing a comprehensive set of high resolution climate change projections for the state to assist the community and industries of Queensland to understand the changes and to support climate adaptation plans.

The assessment also draws on CSIRO/Bureau of Meteorology (BOM) *Climate Change in Australia* projections which were primarily developed to support the planning needs of Australia's natural resource management sector, and to provide information to assist climate adaptation processes. These projections use up to 40 global climate models and are the most comprehensive analysis of Australia's future climate ever undertaken.[3]

[2] Queensland Government (2018) Future Climate Dashboard, https://app.longpaddock.qld.gov.au/dashboard/#responseTab1

[3] CSIRO/BOM, Climate Change in Australia: Projections for Australia's NRM regions, https://www.climatechangeinaustralia.gov.au/en/

PROJECTED CHANGES TO DAWSON'S CLIMATE

Decreasing rainfall and increasing evaporation in Dawson

Water availability in the regions making up the Dawson electorate is dependent on a number of factors including rainfall, the rate of evaporation and the distribution of rainfall throughout the individual years and over extended periods.

Rainfall projections as a result of climate change are uncertain, ranging from a small increase in average annual rainfall, to a large decrease (up to 50 percent in some areas by 2070).

Evaporation is projected to increase substantially, up to in excess of 30 percent by 2070 in some areas.

Rainfall is also projected to be more concentrated into large flooding events, with floods and droughts expected to become more frequent.

Evaporation

Increasing evaporation can exacerbate drought[4] and reduce soil moisture,[5] reduce water levels in dams and reservoirs[6] and dry out vegetation increasing bushfire risk.[7]

Evaporation rates in the Dawson electorate are expected to increase substantially. Projections range from around 5 percent increase to over 25 percent by 2070. For instance, as shown in Figure 1 below the projections for Mackay range from 7 percent to 24 percent in 2070, with an average of all models being a rise of 17 percent.

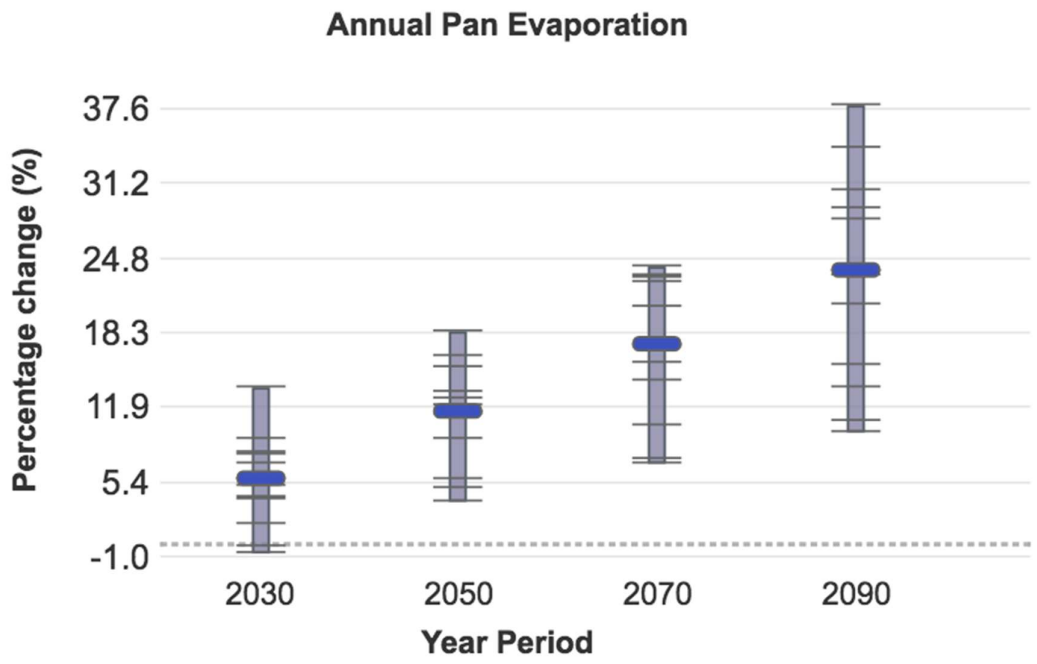
4 Hannan (2018), Record evaporation rates across eastern Australia exacerbate drought, https://www.smh.com.au/environment/weather/record-evaporation-rates-across-eastern-australia-exacerbate-drought-20180821-p4zys3.html

5 Steffen et al (2018) Deluge and drought: Australia's water security in a changing climate, https://www.climatecouncil.org.au/wp-content/uploads/2018/11/Climate-Council-Water-Security-Report.pdf

6 Helfer et al (2012) Impacts of climate change on temperature and evaporation from a large reservoir in Australia, https://www.sciencedirect.com/science/article/pii/S0022169412008827

7 Hughes et al (2018) Escalating Queensland Bushfire Threat: Interim Conclusions, https://www.climatecouncil.org.au/wp-content/uploads/2018/11/Queensland-Bushfires-and-Climate-Change_Interim-Conclusions.pdf

Figure 1: Projected change in annual pan evaporation in Mackay LGA



Source: QLD Government (2018) Future Climate Dashboard

Table 1 below shows the range of projected changes in rainfall for each of the local government areas within the Dawson electorate.

Table 1: Projected change in annual pan evaporation in local government areas in the Dawson electorate.

	2030	2050	2070	2090
Mackay	-1% decrease-14% increase	4-18% increase	7-24% increase	10-38% increase
Burdekin	-1% decrease - 17% increase	3-21% increase	6-28% increase	9-47% increase
Townsville	1-16% increase	3-21% increase	7-26% increase	10-44% increase
Whitsundays	1% decrease - 18% increase	4-21% increase	5-27% increase	9-42% increase

Source: QLD Government (2018) Future Climate Dashboard

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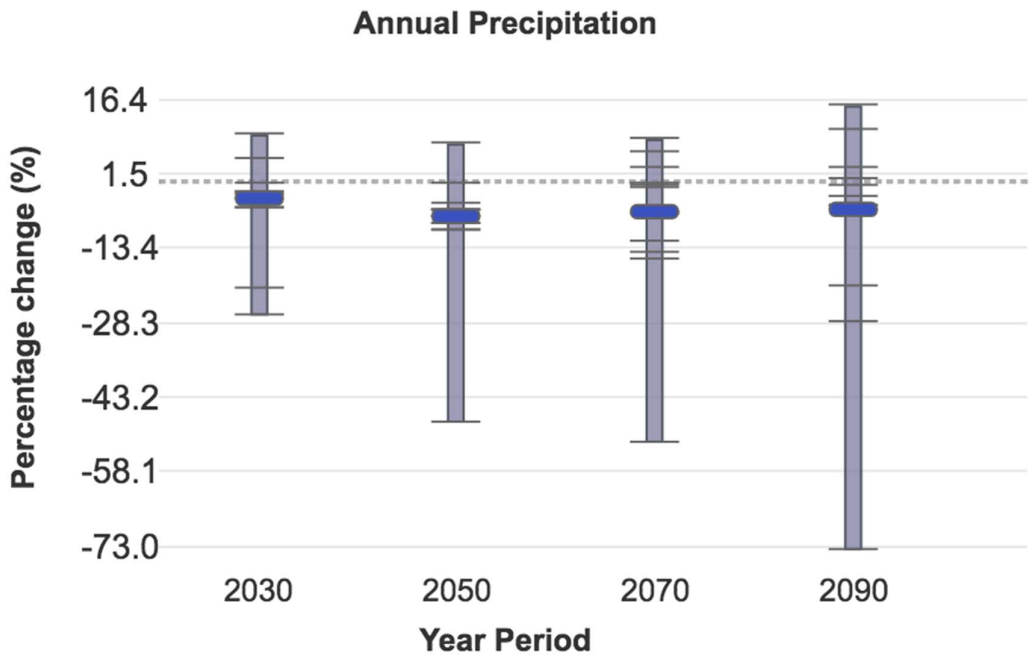
Rainfall

Rainfall projections for the Dawson electorate are uncertain. The average projections of all climate models are a relatively small fall in average rainfall (under 5 percent), however the overall range is from a small increase, to large decrease. For instance, as

shown in Figure 2 below the projections for Rockhampton range from a 10 percent increase in rainfall by 2070 to a 52 percent decrease.

Figure 2: Projected change in annual precipitation Mackay LGA.



Source: QLD Government (2018) Future Climate Dashboard

Table 2 below shows the range of projections for each of the local government regions in the Dawson electorate over the coming decades.

Table 2: : Projected change in annual precipitation of Local Government areas within the electorate of Dawson.

	2030	2050	2070	2090
Mackay	10% increase-27% decrease	8% increase-48% decrease	9% increase-52%decrease	16% increase-73% decrease
Burdekin	7% increase-29% decrease	7% increase-47% decrease	8% increase-51% decrease	23% increase-79% decrease
Livingston	10% increase-24% decrease	15% increase-44% decrease	14% increase-50% decrease	24% increase-72% decrease
Whitsundays	9% increase-29% decrease	8% increase-46% decrease	11% increase-51% decrease	10% increase-24% decrease

Source: QLD Government (2018) Future Climate Dashboard

Increasing drought and floods

The Australian Bureau of Meteorology (BOM) has found climate change has already increased the risk of major disruptions to Pacific weather (which includes eastern Australia), and that the risk will continue to rise as global warming increases. These major disruptions include drought and extreme rainfall.

The BOM modelling found there has already been a 30 percent increase in the frequency of rainfall disruptions which is projected to increase 90 percent in the early part of this century, and 130 percent increase as century progresses.[8]

Increasing extreme heat in Dawson

Climate change is increasing land and ocean temperatures. These increases can be measured as an increase in average temperatures over the year as a whole. Australia has warmed by just over 1 degree as a result of greenhouse gas emissions (from pre-industrial levels) and is projected to warm by up to over 5 degrees by the end of century if global emissions remain high.[9] The World Bank considers 4 degree "devastating" with "extremely severe risks for vital human support systems."[10]

QLD Government projections show an increase in the annual mean temperature for QLD as a whole of up to 5.5 degrees by 2090.[11] The projections for the regions within the electoral division of Dawson follow a similar trajectory, with slight variations between the regions. For example, the annual mean temperature is projected to rise by up to 4.3 degrees by 2090 in Mackay.

However, while increasing average or mean temperatures can have serious impacts on human health and activities, extreme temperature events are the most dangerous to human health, agriculture and the natural environment.

The QLD Government provides projections for the number of extreme heat days over various thresholds. These maps in Table 3 below show the increasing frequency of extreme temperature days in the electorate of Dawson over the coming decades. The

[8] BOM (2017) Droughts and flooding rains already more likely as climate change plays havoc with Pacific weather, http://www.bom.gov.au/climate/updates/articles/a023.shtml

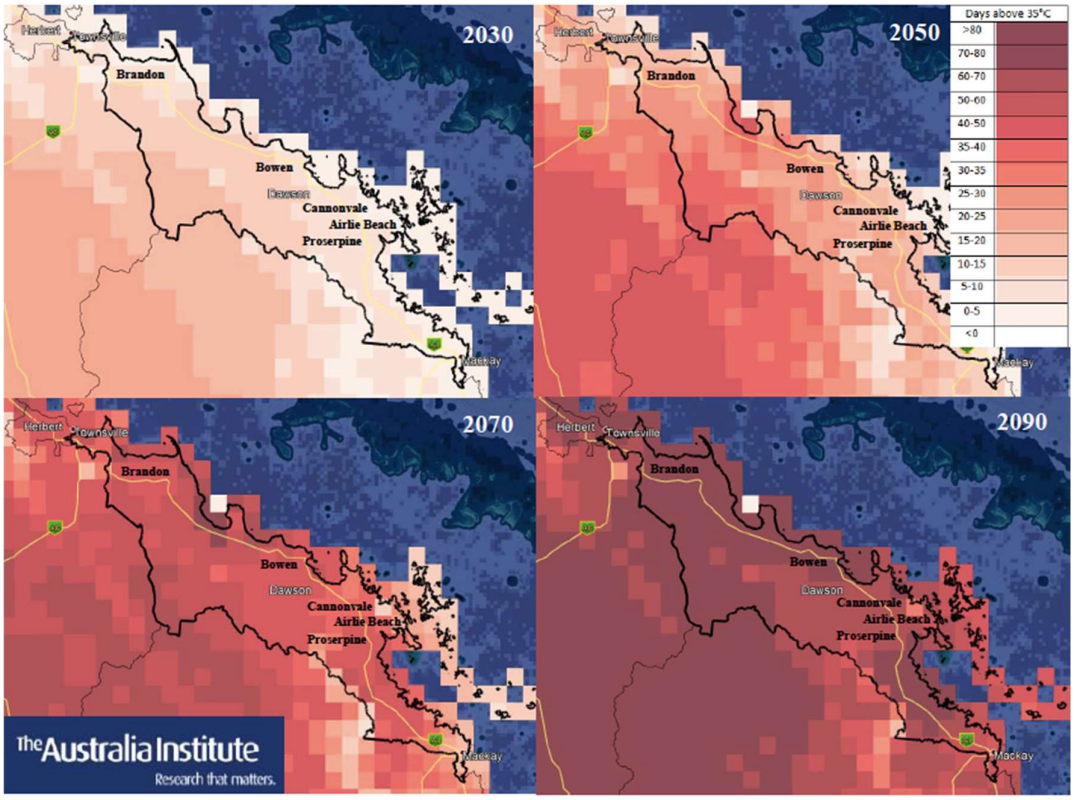
[9] BOM, CSIRO (2015) Australia's changing climate, https://www.climatechangeinaustralia.gov.au/media/ccia/2.1.6/cms_page_media/176/AUSTRALIAS_CHANGING_CLIMATE_1.pdf

[10] World Bank (2012) Turn down the heat: Why a 4 degrees Celsius warmer world must be avoided, https://openknowledge.worldbank.org/handle/10986/11860

[11] Queensland Government (1018) Future Climate Dashboard, Mean Temperature QLD, https://app.longpaddock.qld.gov.au/dashboard/#responseTab1

darker the shade of red, the greater the increase in the number of hot days per year in that location. These maps can be viewed in greater detail in the Appendix at the back of this report.

Table 3: Increases in number of days over 35 degrees in the electorate of Dawson.



Source: QLD Government (2018) Future Climate Dashboard

The CSIRO and BOM provide a separate set of projections, for the number of extreme heat days over various thresholds for particular locations. These projections are broadly consistent with the QLD Government projections but allow us to examine the projections for particular locations, and also enable comparison between a business-as-usual emissions scenario, and a scenario consistent with emissions reductions required to meet the 1.5 degree Paris target.

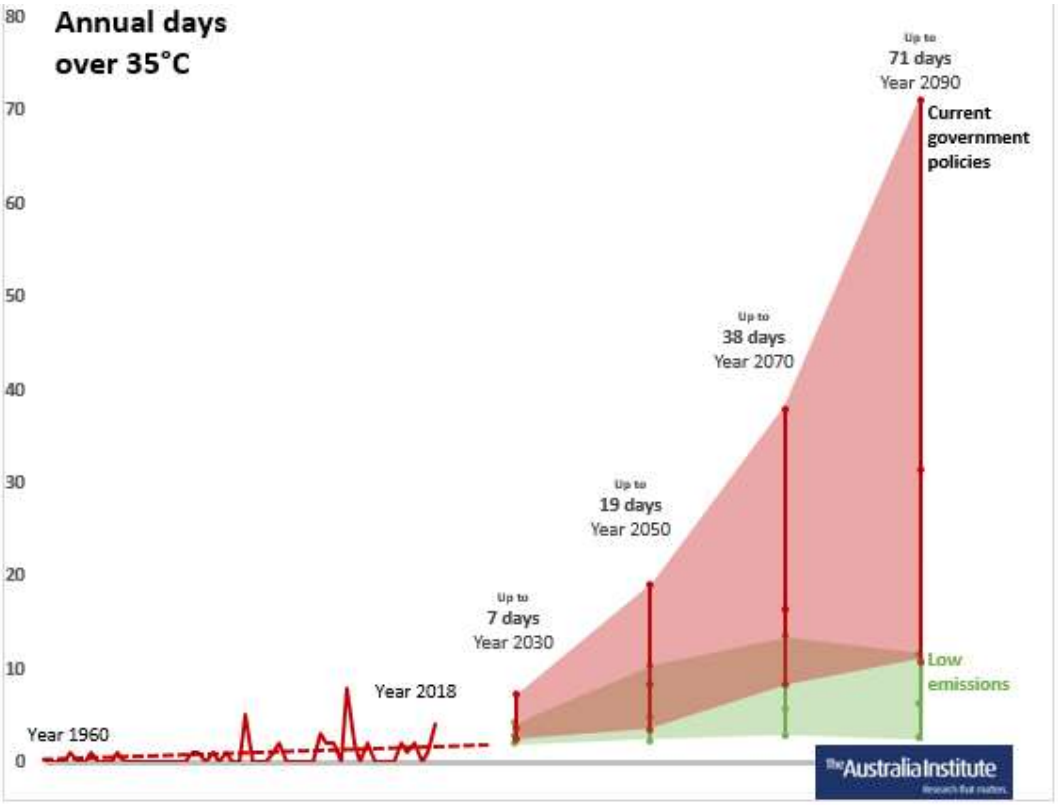
The three graphs under Figure 3 below shows the historic and projected increase in extreme heat days for Townsville. The red line shows actual recorded historic annual number of days over 35 degrees, with the dotted line showing the trend.

The red shaded area shows the range of projections from various climate models used by the CSIRO and BOM over coming decades if emissions continue to increase on current trajectories.

The green shaded areas show the range of projected days over 35 if the world achieves a reduction in greenhouse gas emissions consistent with the 1.5-degree target agreed to by Australia and almost all other nations under the Paris Agreement in 2015.

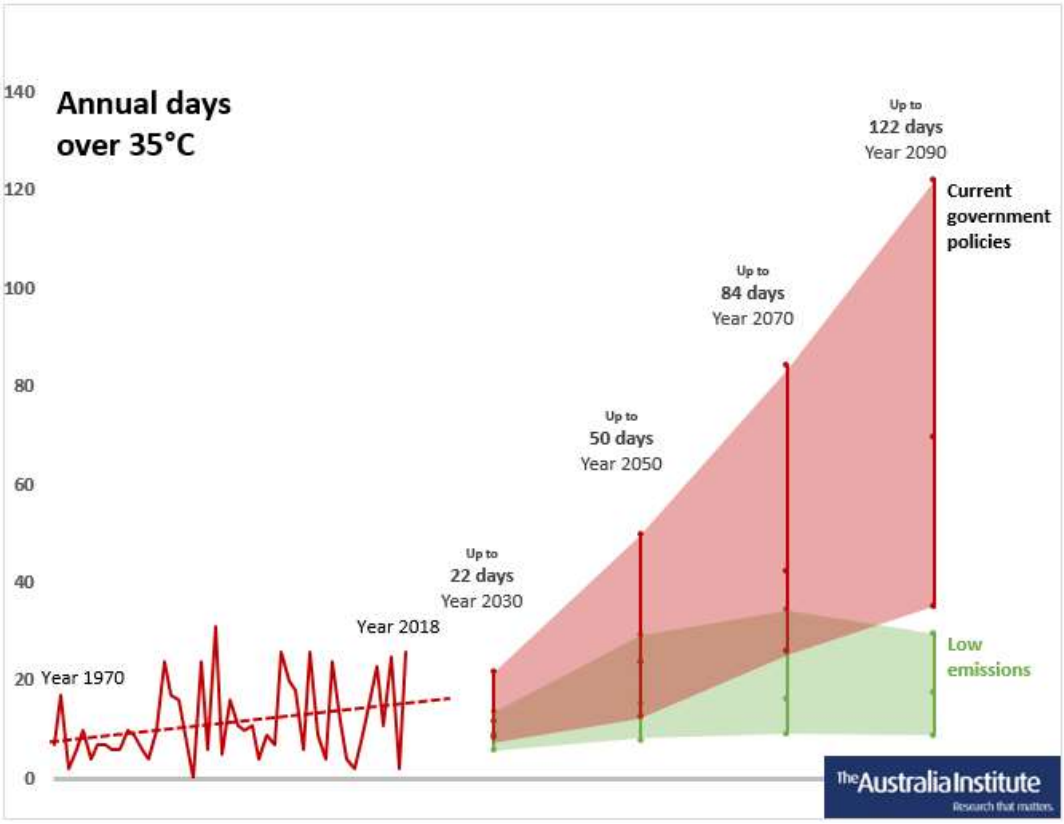
A reduction of emissions in line with the globally agreed target of 1.5 degrees avoids the vast majority of the projected increase in extreme temperatures, leading to a decline beginning around mid-century.

Figure 3: Forecast annual number of days over 35 degrees in Mackay



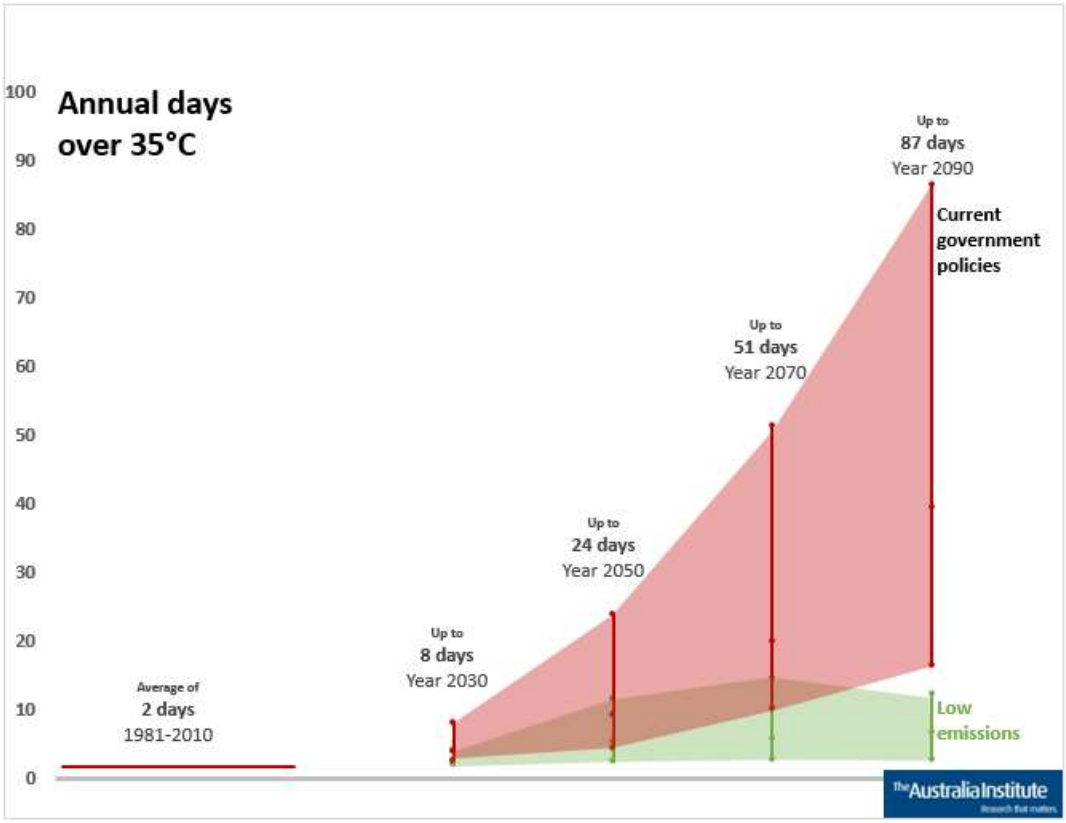
Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Figure 4: Forecast annual number of days over 35 degrees in Proserpine



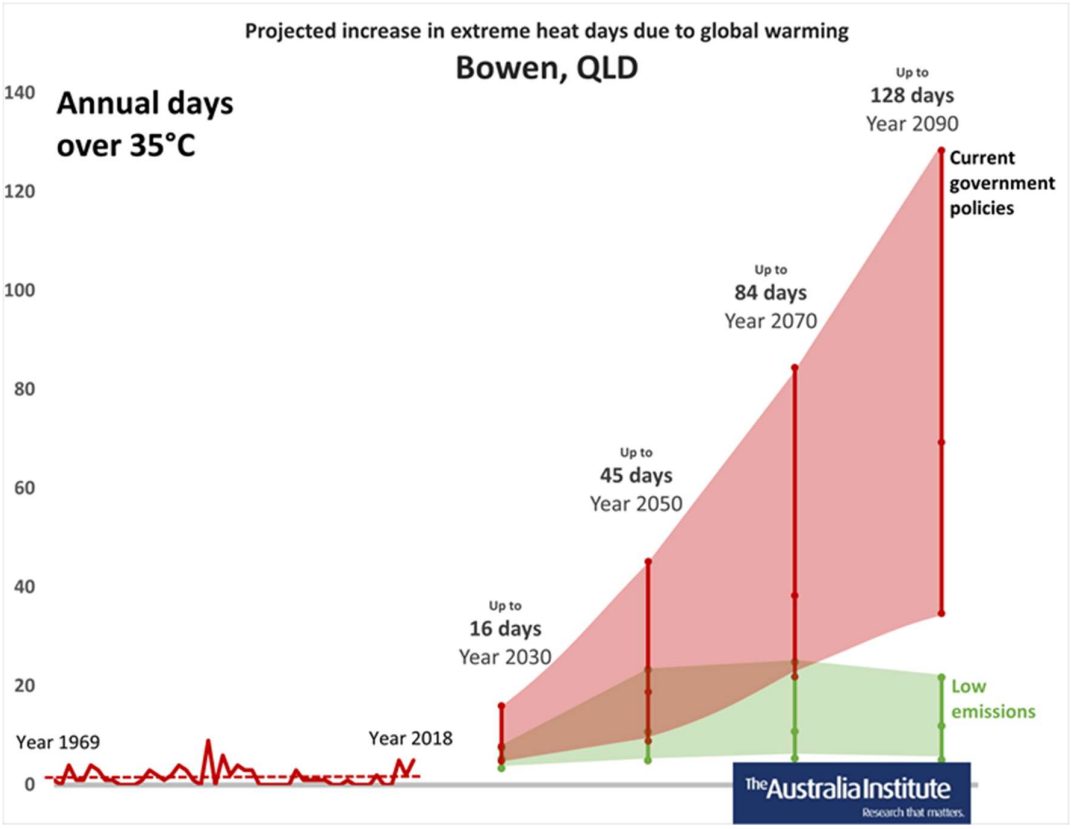
Source: Bureau of Meteorology (2019) *Climate data online,* http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2018) *Climate projections,* provided on request

Figure 5: Forecast annual number of days over 35 degrees Cannonvale/Airlie Beach



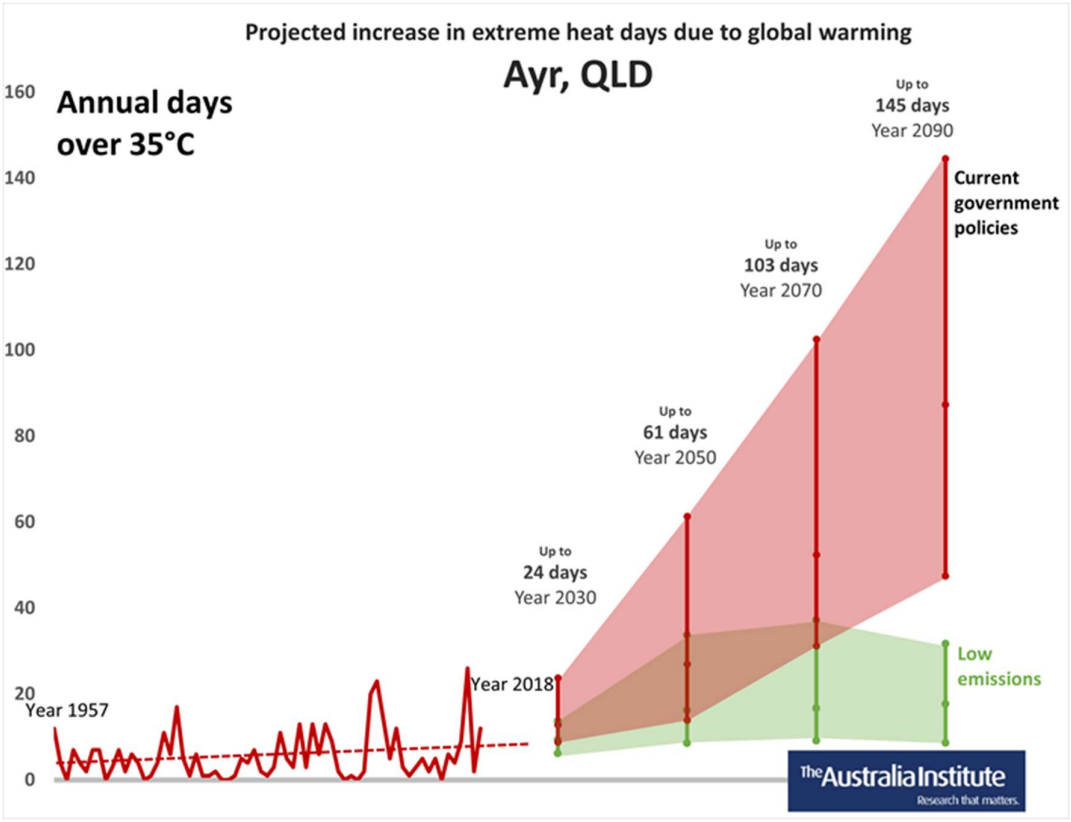
Source: Bureau of Meteorology (2019) Climate data online, http://www.bom.gov.au/climate/data/index.shtml; CSIRO and Bureau of Meteorology (2018) Climate projections, provided on request

Figure 6: Forecast annual number of days over 35 degrees Bowen



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

Figure 7: Forecast annual number of days over 35 degrees Ayr



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

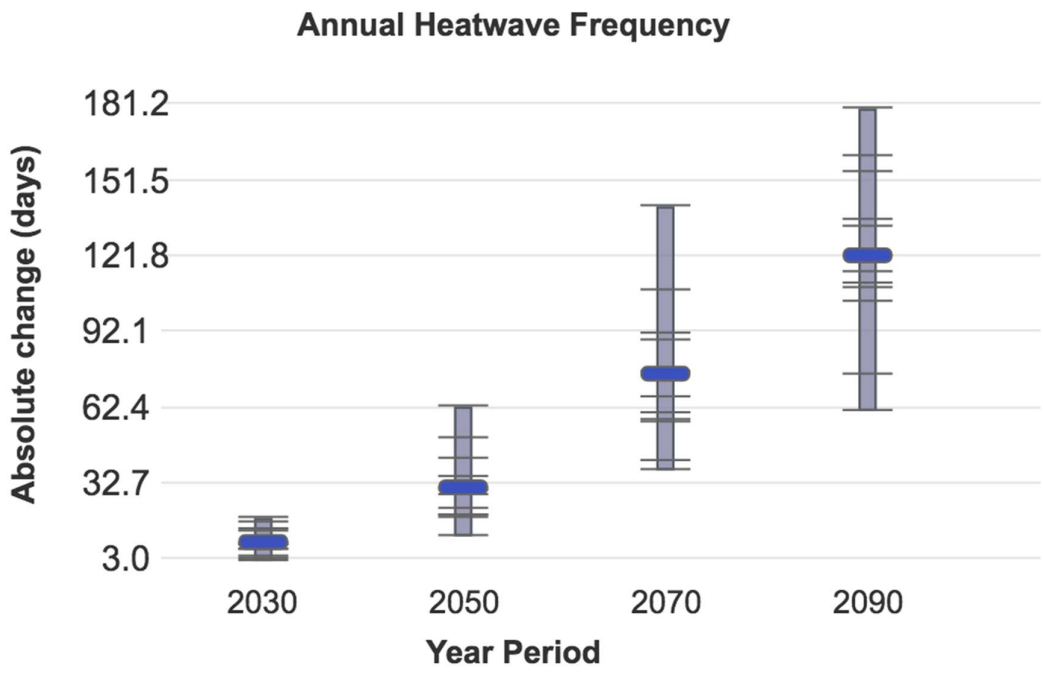
Increasing Heatwaves in Dawson

Heatwaves occur when there are three consecutive days of extreme temperature. Heatwaves have more serious consequences than hot days on their own, as people (and animals) have less opportunity to recover from extreme temperatures. Heatwaves are a serious health risk and have killed more people in Australia than all other natural disasters combined.[12]

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

Heatwaves in Dawson are projected to become more frequent, hotter and longer. In the Burdekin region for example, as shown in Figure 8 below, the annual number of heatwave days is projected to increase by up to almost 180 percent by 2070.[13]

Figure 8: Projected increase in annual heatwave days Mackay LGA.



Source: QLD Government (2018) Future Climate Dashboard

Figure 9 below shows the range of the projected in heatwave days per year in each of the local government areas in Dawson.

Figure 9: Projected increase in annual heatwave days of Local Government Areas within the electorate of Dawson.

	2030	2050	2070	2090
Mackay	3-25%	17-71%	55-138%	85-170%
Burdekin	3-20%	12-63%	38-141%	61-180%
Livingston	3-18%	14-57%	38-120%	60-158%
Whitsundays	3-19%	13-61%	35-132%	64-170%

Source: QLD Government (2018) Future Climate Dashboard

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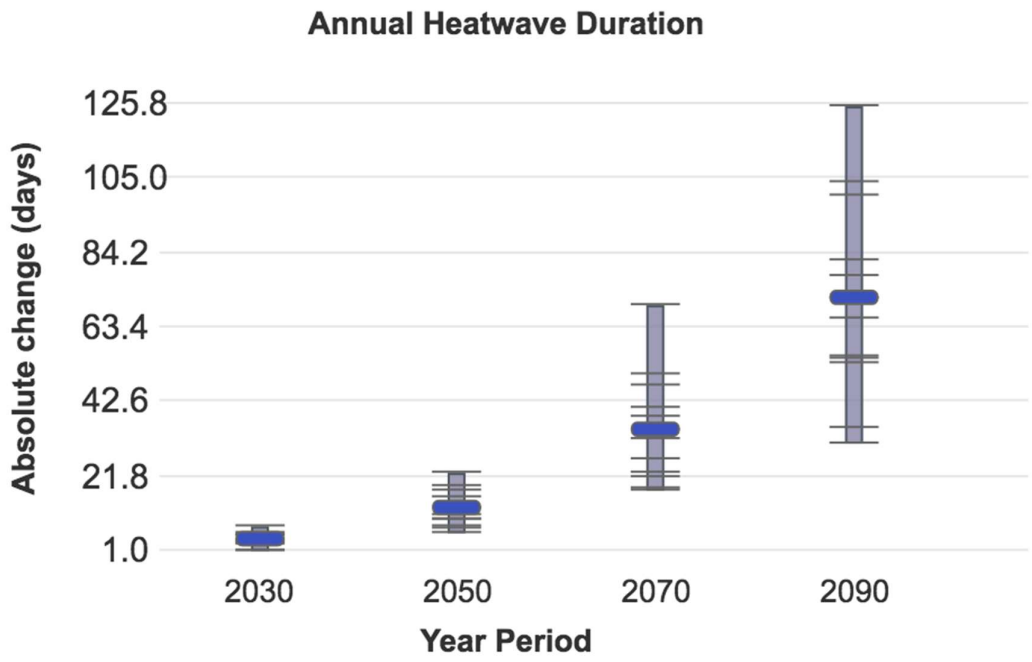
[13] Queensland Government (2018), Queensland Future Climate Dashboard, https://app.longpaddock.qld.gov.au/dashboard/#responseTab2

As well as becoming more frequent, heatwaves in the region are projected to become hotter and longer. Heatwave amplitude (the hottest heatwave day of the year) in the Townsville region is projected to increase by up to 5.6 degrees by 2090.

Currently heatwaves typically last a few days. The duration of heatwaves is projected to rise dramatically over coming decades. A single heatwave in Mackay is projected **to last up to 70 days** by 2070 and in 2090 it could be up to 125 days per year, as shown in Figure 9 below.[14]

Figure 10: Projected increase in annual heatwave duration Mackay LGA.



Source: QLD Government (2018) Future Climate Dashboard

Unprecedented catastrophic fires.

In November 2018 much of Queensland including the electorate of Dawson experienced unprecedented, catastrophic fires. On November 28, 138 fires burned across the state and 8,000 people were evacuated from Gracemere. The fire also

[14] Queensland Government (2018), Queensland Future Climate Dashboard, https://app.longpaddock.qld.gov.au/dashboard/#responseTab2

burned in the Mackay region of the Dawson electorate.[15] The 'catastrophic level' of the fire had never previously been reached in Queensland.

As the Fire Commissioner Katarina Carroll put it:

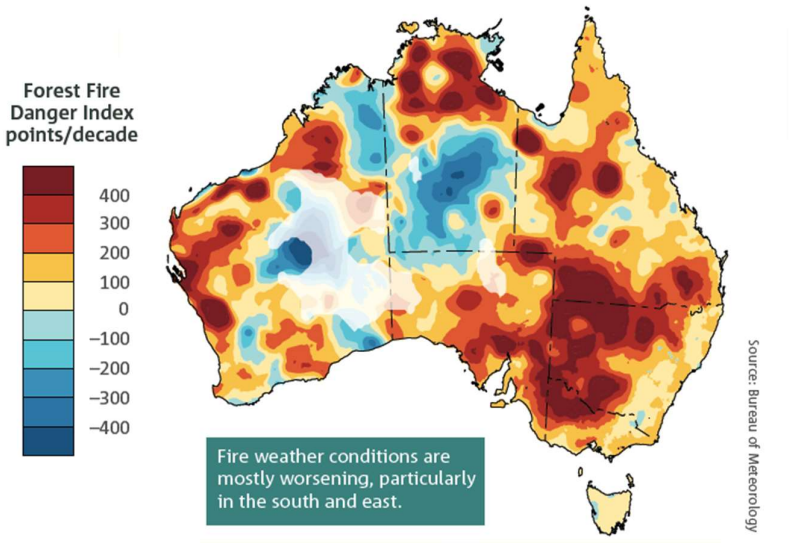
> "We have never, ever in this state been in this situation before, not at a catastrophic level, this is ... unchartered waters."[16]

This increase in the intensity of fires is being experienced across Australia, including Central Queensland. In the 2018 State of the Climate report, the Bureau of Meteorology identified an increasing length and intensity of the fire weather season. Figure 9 below is a visual representation from BOM of the areas of Australia likely to suffer the most sever increase in fire danger.

[15] Mortimer (December 2018) STAY INFORMED: Fires still active in Mackay region, https://www.dailymercury.com.au/news/stay-informed-fires-still-active-in-mackay-region/3591424/

[16] Cadwell (November 2018) https://www.brisbanetimes.com.au/national/queensland/unprecedented-catastrophic-fire-danger-warning-issued-for-central-queensland-20181128-p50ixd.html, https://www.brisbanetimes.com.au/national/queensland/unprecedented-catastrophic-fire-danger-warning-issued-for-central-queensland-20181128-p50ixd.html

Figure 11: Increasing extreme fire weather



Trends from 1978 to 2017 in the annual (July to June) sum of the daily Forest Fire Danger Index—an indicator of the severity of fire weather conditions. Positive trends, shown in the yellow to red colours, are indicative of an increasing length and intensity of the fire weather season. A trend of 300 FFDI points per decade is equivalent to an average trend of 30 FFDI points per year. Areas where there are sparse data coverage such as central parts of Western Australia are faded.

Source: BOM (2019) State of the Climate 2018

Increasing temperatures and dryness both increase the level of fire danger, and the frequency of extreme fire danger days. As discussed above, climate change is increasing temperatures and evaporation as well as reducing rainfall in the Dawson electorate.

If emissions continue to rise and these trends continue, these formerly "unprecedented" catastrophic fire conditions are likely to become more frequent.

The economic costs of climate change impacts in Dawson

NATURAL DISASTERS

The cost of natural disasters in Australia has been estimated by Deloitte Access Economics, in a report for the Australian Business Roundtable.

It found the total economic cost of natural disasters in Australia over the decade to 2016, averaged $18.2 billion per year and it is expected to rise to around $39 billion per annum by 2050 in present value terms. This is a conservative estimate of future disasters costs as it **does not** include projected climate change impacts.[17]

QLD is by far the most vulnerable state to natural disasters, with total economic costs of $6.2 billion per year currently, which are expected to rise to $18.3 billion per year by 2050.[18]

Looking at individual natural disasters, the costs are very high. For instance, the Queensland 2011 floods were estimated to have cost around $14 billion (requiring a national flood levy to cover the bill).[19]

The Queensland government estimated the floods, fires and heatwaves of the 2018-19 Queensland "Summer of Disasters" imposed $1.5 billion in costs on the state.[20] These costs will come out of other spending in the budget and could impact on services.

The total costs could be far higher. The $1.5 billion figure does not include insured and uninsured losses to private property, Commonwealth Government contributions to disaster relief and reconstruction or the wider economic and social costs.

To help cover rising disaster costs, the Commonwealth Government has set up a new $3.9 billion Disaster Recovery Fund. This was strongly criticised by the Australian

[17] Deloitte Access Economics (2017) *The economic cost of the social impact of natural disasters* http://australianbusinessroundtable.com.au/assets/documents/ABR_building-resilience-in-our-states-and-territories.pdf

[18] Deloitte Access Economics (2017) Ibid.

[19] Deloitte Access Economic (2017) Ibid.

[20] Sagunto (February 2019) *Summer of disasters' reveals the cost of climate change for Queensland taxpayers* https://www.abc.net.au/news/2019-02-19/climate-change-and-the-cost-of-qlds-summer-of-disasters/10826122

insurers with the Actuaries Institute calling it “short-sighted and disappointing” as it is focused too much on recovery over resilience to increasing climate impacts.[21]

As previously mentioned, BOM has found that “Pacific rainfall disruptions” that include floods and drought in Eastern Australia have already increased in frequency by 30 percent as a result of climate change and are projected to increase by 90 percent by mid-century.[22]

The BOM and CSIRO have also found that the frequency and intensity of extreme fire has increased significantly over much of Australia over recent decades and that climate change is contributing to these changes.[23]

Given the high cost of individual disasters, the projected increase in the frequency and intensity of these events will have a large impact on the overall cost of natural disasters in Queensland.

For example, if “rainfall disruptions” causing a $14 billion flood or a $12.5 billion drought occur twice as often, there could be double the cost to the community, if not more. Climate change also has many impacts that are not classified as natural disasters but have very significant costs.

HEALTH

The impact of extreme heat on human health, particularly over extended periods, is severe. Although people living in hot areas do acclimatise to higher temperatures, there are limits.[24] A large increase in days above extreme heat thresholds as detailed above 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.[25]

[21] Fernyhough (April 2019) *Insurers slam budget's 'short-sighted' climate measures*https://www.afr.com/news/politics/national/insurers-slam-budget-s-short-sighted-climate-measures-20190403-p51a93

[22] BOM (2017) *Droughts and flooding rains already more likely as climate change plays havoc with Pacific weather* http://www.bom.gov.au/climate/updates/articles/a023.shtml

[23] BOM (2019) *State of the Climate 2018* http://www.bom.gov.au/state-of-the-climate/

[24] Hanna and Tait (2015) *Limitations to thermoregulation and acclimatisation challenges human adaptation to global warming,* Int J Environ Res Public Health 12

[25] NSW Government (2017) *Heat-related illness including heat stroke,* https://www.health.nsw.gov.au/environment/factsheets/Pages/heat-related-illness.aspx

WorkSafe Queensland lists a range of illnesses arising from extreme temperatures from cramps, rashes, and dehydration to severe injuries such as heat stroke, exhaustion and even death, if treatment is delayed.[26] 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.[27] 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 mortality and high night temperatures, particularly in stroke patients.[28] The 'synergistic effect' of night humidity and increased temperatures as a result of the urban heat Island effect (UHI)[29] has been estimated in some studies to double general mortality risk by the end of the century under the current global climate trajectory (the red line trajectory in Figure 3 - RCP 8.5).[30] Heatwaves have been dubbed the 'silent killer', causing more deaths in the last century in Australia than all natural disasters put together.[31]

[26] WorkSafe Queensland (n.d.) *Health effects,* https://www.worksafe.qld.gov.au/injury-prevention-safety/hazardous-exposures/heat-stress/health-effects

[27] 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

[28] 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

[29] The urban heat island effect is when cities are hotter than surrounding as a result of materials used in urban construction. Concrete and bitumen absorb heat and re-radiate into the urban environment, particularly at night.

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

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

Hot nights also increase insomnia and lack of rest. This can be exacerbated by high humidity. As sleep is vital for health, a deficit means more susceptibility to disease, obesity, chronic illness and harm to our psychological and cognitive functioning.[32]

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.[33]

HEAT STRESS AND DAWSON'S WORKFORCE

A significant proportion of the workforce in the electorate of Dawson is exposed to the heat. Construction, agriculture, manufacturing and mining are all significant employers in the region. Workers in these industries are particularly exposed to increasing temperatures.

These occupations almost always require strenuous activities and for workers to wear heavy protective clothing for health and safety reasons. Strenuous activity increases the risk of heat related illness, and heavy clothing reduces air circulation essential to cooling the body. Heavy equipment which adds to the level of exertion.

As discussed above, 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. There is a range of health impacts, from mild to severe. Heat stroke can cause permanent damage to the brain and other vital organs and can even result in death.[34] The US Army Research Institute of Environmental Medicine advises that all outdoor work with physical exertion be cancelled when the WGTB temperature exceeds 32 degrees.[35]

32 Obradovich et al (2017) Nighttime temperature and human sleep loss in a changing climate, Science Advances 3

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

[34] 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; Australian Mining Review (November 2017) *WA miners urged to guard against heat stress,* https://www.miningreview.com.au/wa-miners-urged-guard-heat-stress/

[35] Hanna (2016) *Microclimates and heat islands: Climate change exacerbates occupational heat exposures,* http://greenhouse.asnevents.com.au/assets/Greenhouse/Presentations/1420HannaMR2Wed.pdf

There is no temperature threshold for halting heavy outdoor work in Queensland.

The cost of lost productivity because of extreme heat in Australia has been estimated at almost $7 billon in 2013-14 alone.[36]

Mining workers

Mining is currently a significant employer in the Dawson electorate. Extreme heat presents a significant health risk to mining workers. The Australasian Mining Safety Journal describes the risks as follows:

> When environmental temperatures exceed that of dry skin, sweating becomes the primary source of thermoregulation. However, as temperatures continue to rise, particularly in humid environments with poor airflow, this may not be enough. The body's core temperature rises, resulting in a continuum of ailments, collectively known as heat illness. This ranges from the relatively mild heat rash and muscle cramps, to heat exhaustion and the potentially fatal heat stroke.
>
> Heat illness can present as headache, nausea or vomiting, irritability, clammy skin, dizziness, fatigue, elevated heart rate, and rapid breathing rate. This translates to lower productivity, poor morale and higher rates of accidents in the workplace. When left untreated, heat illness can progress to heat stroke, where confusion, further reduced muscle coordination, convulsions and ultimately a loss of consciousness can occur.[37]

A survey of mine workers in Northern Australia found heat stress symptoms were experienced by 87% of open cut mine workers and 79% of underground mine workers. Around 80% of workers experienced these symptoms more than once. The survey also found that only 27% were well hydrated with 10% significantly dehydrated.[38]

There are also factors that compound the heat risks of mining in particular including having to wear heavy protective clothing that can reduce air circulation to the skin, long shifts and that water is not always readily available.

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[36] 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

[37] Australasian Mining Safety Journal (October 2015) *Handling the heat,* https://www.amsj.com.au/handling-the-heat/

[38] Hunt et al (2012) *Symptoms of heat illness in surface mine workers,* https://eprints.qut.edu.au/54048/

Despite Worksafe Queensland warnings that working in extreme heat can lead to serious injury and death,[39] there is no temperature level threshold for halting heavy outdoor work in Queensland. The death of a CSG worker near Roma in Queensland as a result of heat in 2016 prompted the Coroner to recommend temperature thresholds being adopted.[40]

Increasing extreme temperatures may also hasten the current trend of increasing automation of mining operations in the region, leading to fewer mining jobs in the region.

AGRICULTURE

Agriculture is a vital industry in the Dawson electorate, with a focus on tropical fruit growing and beef grazing.

Agriculture is on the frontline of global warming impacts in many ways. Increasing temperatures and falling precipitation can reduce cropping and livestock yields. Increasing temperatures can also reduce soil moisture and increase erosion. Extreme heat can damage crops and stress livestock. Floods can destroy crops, livestock and farm infrastructure including buildings, roads, machinery and fencing.

Impacts on cropping

A recent Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) report found that changes in the climate since 2000 have significantly reduced farm productivity and crop yield:

> The recent changes in climate have had a significant negative effect on the productivity of Australian cropping farms, particularly in south-western Australia and south–eastern Australia (Figure 2). In Western Australia, climate conditions between 2000–01 and 2014–15 lowered TFP by an average of 7.7 per cent—relative to what would have been seen under long-run average conditions (1914–15 to 2014–15). In New South Wales climate conditions post 2000–01 lowered productivity by an average of 6.5 per cent.

[39] WorkSafe Queensland (n.d.) *Health effects,* https://www.worksafe.qld.gov.au/injury-prevention-safety/hazardous-exposures/heat-stress/health-effects

[40] Briggs (2016) *Coroner calls for temperature threshold to stop outdoor work in extreme heat,* https://www.abc.net.au/news/2016-04-20/coroner-calls-temperature-threshold-to-stop-outdoor-work-heat/7342464

> A similar pattern is observed for wheat yields, although the climate effects are larger. Climate conditions between 2000–01 and 2014–15 lowered national wheat yields by around 11.9 per cent relative to long-run conditions (16.3 per cent in Western Australia and 14.8 per cent in Victoria).[41]

Recent CSIRO research has found potential wheat yields in Australia have already declined by 27% from 1990 to 2015 below what they would otherwise have been due to climate impacts, mostly the fall in rainfall and increasing temperatures over this period.[42]

As would be expected, increasing global warming will continue to reduce agricultural productivity and yields.

The 2009 Garnaut Review found that as a result of climate change, and without serious emission reductions, the Murray Darling Basin would be likely to lose up to half its annual irrigated agricultural output by mid-century.[43]

Impacts on grazing

A recent CSIRO report examined 25 locations in south eastern Australia and found that without adaptation meat production could be reduced by up to 92% by 2050 and wool production by up to 95% [44] This study examines the more gradual impact increasing annual average temperatures and decreasing annual average rainfall. However, the impact of individual extreme weather events on grazing (and crops) must also be considered. The most extreme of these events are referred to as natural disasters.

The recent Queensland floods and the current drought are a reminder of the devasting impact of extreme events on grazing. As previously discussed, the frequency of Pacific

[41] ABARE (2017) Farm performance and climate Climate-adjusted productivity for broadacre cropping farms, http://data.daff.gov.au/data/warehouse/9aas/2017/FarmPerformanceClimate/FarmPerformanceClimate_v1.0.0.pdf

[42] Hochman et al (2017) Climate trends account for stalled wheat yields in Australia since 1990, https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.13604

[43] The Garnaut climate change review (2009) Chapter 6, Climate Change Impacts on Australia, http://www.garnautreview.org.au/chp6.htm

[44] Gaharamani and Moore (2014) Systemic adaptations to climate change in southern Australian grasslands and livestock: Production, profitability, methane emission and ecosystem function, https://www.researchgate.net/publication/269106683_Systemic_adaptations_to_climate_change_in_southern_Australian_grasslands_and_livestock_Production_profitability_methane_emission_and_ecosystem_function

rainfall disruptions including drought and flooding have already increased by 30 percent and are projected to increase by 90 percent in the early part of this century, and 130 percent increase as century progresses.[45]

An AgForce survey in October 2018 found that about half of Queensland's farmers had lost more than half their annual income due to drought. [46]

The floods that followed in February 2019 in and around Townsville were the highest on record since records began in 1888, with rainfall records set as far west as Mt Isa.[47] Agforce has estimated Queensland graziers alone have lost up to 500,000 head of cattle with an estimated value of $500 million.[48]

INFRASTRUCTURE AND INDUSTRY

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 of increased use of air-conditioning during extreme heat conditions. Last year, there were 56 breakdowns of coal and gas power stations in Queensland, many of which are likely to be as a result of extreme heat. In addition, the newest black coal fired power stations in Queensland were even more unreliable and prone to breakdown (per gigawatt) than the older models.[49]

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.

[45] BOM (2017) Droughts and flooding rains already more likely as climate change plays havoc with Pacific weather, http://www.bom.gov.au/climate/updates/articles/a023.shtml

[46] AgForce (October 2018) Media Release: Impact of drought laid bare in survey of Queensland farmers, https://agforceqld.org.au/index.php?tgtPage=news&id=view,763

[47] Bureau of Meteorology (February 2019) Special Climate Statement 69—an extended period of heavy rainfall and flooding in tropical Queensland, http://www.bom.gov.au/climate/current/statements/scs69.pdf

[48] Crockford (February 2019) Queensland floods damage bill estimates top $1 billion, https://www.brisbanetimes.com.au/national/queensland/queensland-floods-damage-bill-estimates-top-1-billion-20190216-p50ya1.html

[49] Ogge and Brown (2019) *Suboptimal Supercritical* http://www.tai.org.au/sites/default/files/P604%20Suboptimal%20Supercritical%20Report%20%5BWeb%5D_1.pdf

There were 374 deaths recorded as a result of this heatwave overall. The estimated economic cost of the heatwave was $800 million.[50]

An efficient transport system is fundamental to regional areas like Dawson, and climate change impacts transport infrastructure in many ways.

The Queensland floods are estimated to have had a total economic cost of $14.1 billion,[51] including an estimated $157 million on road reconstruction[52]. The floods also affected over 3000 km of rail track in some way.[53]

Extreme heat can also disrupt transport infrastructure. It can cause roads can melt[54] and rail can buckle,[55] and disruption to airlines.[56]

[50] 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

[51] Deloitte (2013), The economic cost of the social impact of natural disasters, costshttp://australianbusinessroundtable.com.au/assets/documents/Report%20-%20Social%20costs/Report%20-%20The%20economic%20cost%20of%20the%20social%20impact%20of%20natural%20disasters.pdf

[52] Creighton (2016) Queensland floods 2011: The floods by the numbers, https://www.brisbanetimes.com.au/national/queensland/queensland-floods-2011-the-floods-by-the-numbers-20160112-gm4czk.html

[53] Queensland Floods Commission of Inquiry: Final Report (2013) Chapter 10, Essential Services p155, http://www.floodcommission.qld.gov.au/__data/assets/pdf_file/0014/11714/QFCI-Final-Report-Chapter-10-Essential-services.pdf

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

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

[56] Coffell and Horton (August 2017) How hot weather – and climate change – affect airline flights, https://theconversation.com/how-hot-weather-and-climate-change-affect-airline-flights-80795

Conclusion

The electorate of Dawson stands to be heavily impacted by climate change.

Increasing heatwaves and falling water availability will impact the community's health, infrastructure and vital industries particularly agriculture tourism.

However, none of this is inevitable. Climate projections clearly show that if the world achieves the 1.5 degree target agreed to by 196 countries in the Paris agreement, most of these impacts can be avoided.

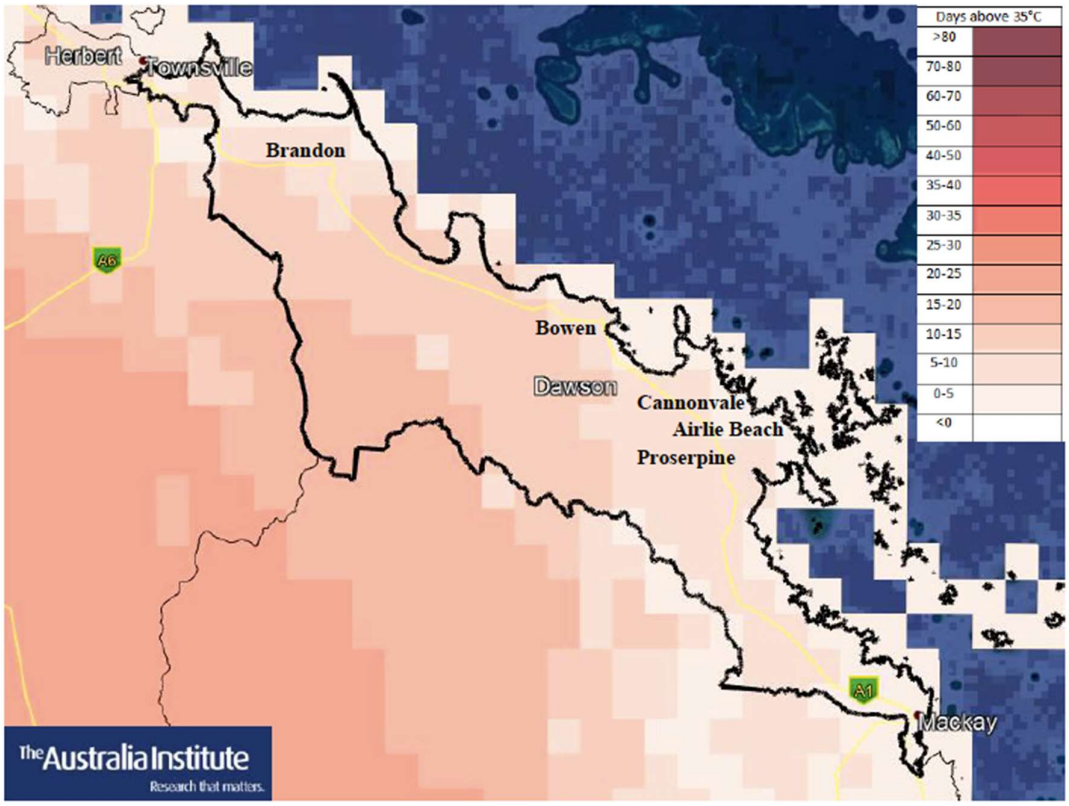
Fortunately, the measures we need to take to tackle climate change are consistent with a prosperous future and growing employment in the region. The electorate of Dawson has an excellent solar resource providing opportunities for renewable energy development that will boost regional development and provide ongoing power sector jobs. As the cost of renewable energy is already lower than new coal or gas, the region also has a potential competitive advantage in developing new industries that can take advantage of this clean, low cost power.

There are also ample opportunities for land use sequestration that could provide additional income streams for farmers, as well as necessary adaptation measures to build resilience in our communities, farms, businesses and infrastructure. Besides avoiding costs from climate impacts, these measures will also provide jobs and flow on economic benefits to the region.

However, leadership will be required to grasp these opportunities. It requires leaders with an understanding of the issues and, most importantly, a willingness to rise to the challenge.

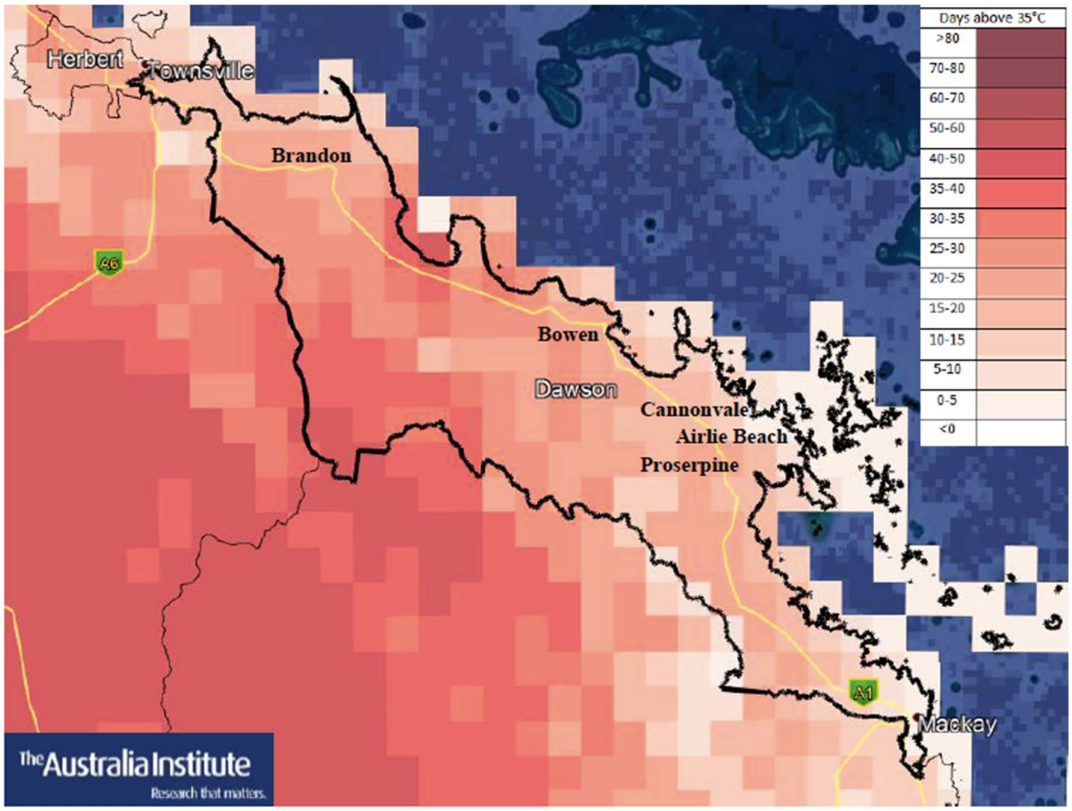
Appendix

Figure 12: Projected increase in days over 35 degrees per year above current levels in the electorate of Dawson 2030



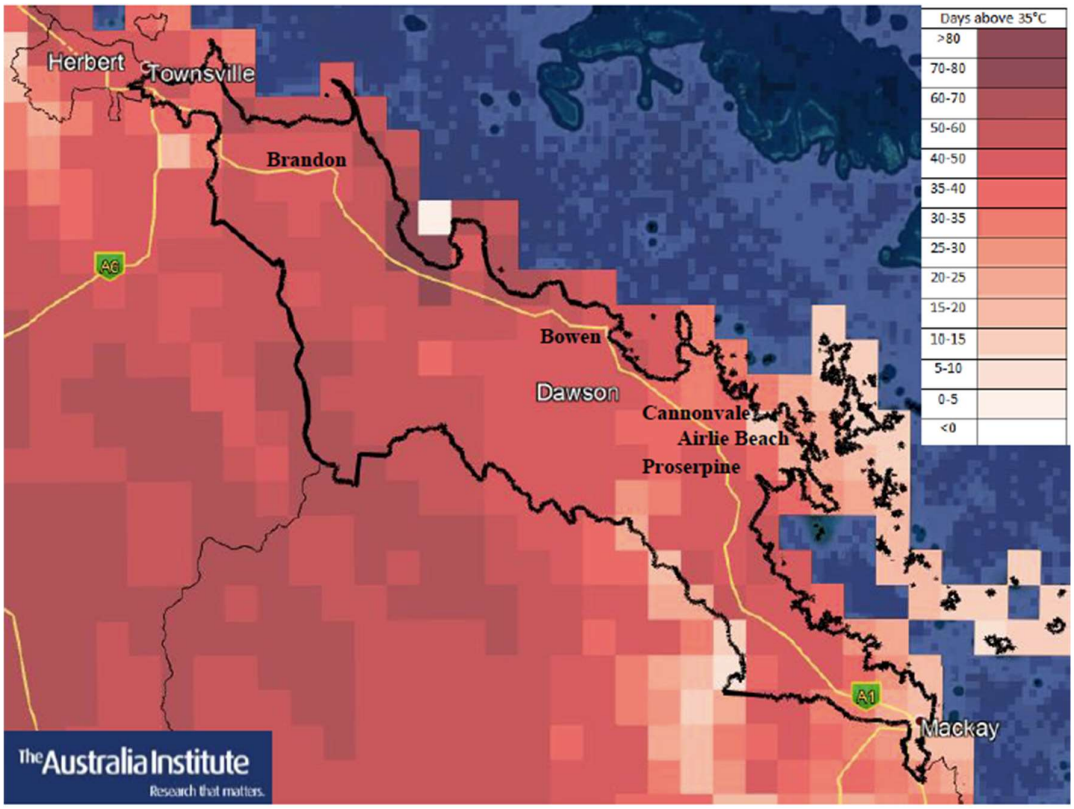
Source: QLD Government (2018) Future Climate Dashboard

Figure 13: Projected increase in days over 35 degrees per year above current levels in the electorate of Dawson 2050



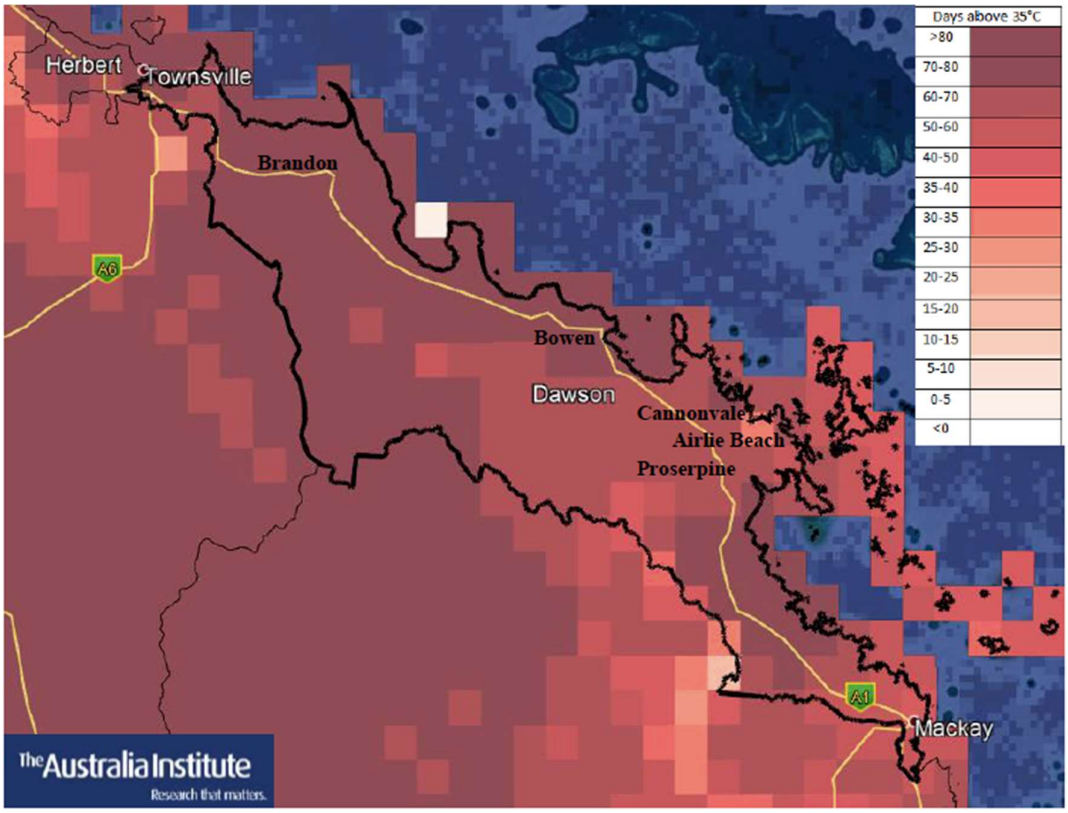
Source: QLD Government (2018) Future Climate Dashboard

Figure 14: Projected increase in days over 35 degrees per year above current levels in the electorate of Dawson 2070



Source: QLD Government (2018) Future Climate Dashboard

Figure 15: Projected increase in days over 35 degrees per year above current levels in the electorate of Dawson 2090



Source: QLD Government (2018) Future Climate Dashboard