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# Climate Assessment for the electorate of Herbert

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

Report

**Mark Ogge**  
**April 2019**

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# Summary

The electoral profile of Herbert describes the local industries as:

“Copper, nickel and zinc refineries, bulk sugar terminal, and tropical fruits, prawn and fishing industry, beef cattle and tourism. Townsville, noted for its port facilities, is also home to James Cook University, the Great Barrier Reef Marine Park Authority and large defence establishments at Lavarack Barracks (Army) and Garbutt (RAAF).

Most of these industries are likely suffer serious impacts from climate change. Many workers in copper, nickel and zinc refineries are required to work in spaces without air-conditioning. Soldiers, construction and mining workers are required to undertake strenuous work outdoors wearing heavy clothing and will be put at risk by increasing heatwaves. Tropical fruits and grazing both 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.

This climate assessment finds that:

- Unless strong action is taken on climate change, by 2070, well within our children’s lifetime, the electorate of Herbert is projected to experience:
  - Up to 30 percent increase in evaporation.
  - Up to 50 percent reduction in rainfall.
  - Up to 100 percent increase heatwave days per year.
  - Single heatwaves lasting up to over 50 days.
  - A 90-130 percent increase in the frequency of droughts and floods.
  - Coastal inundation effecting over 4000 properties in 23 suburbs (by 2100)
- 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.

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# Introduction

The electoral Division of Herbert includes Palm Island Aboriginal Shire Council, part of Hinchinbrook Shire Council, and part of the Townsville City 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*.<sup>1</sup> 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 *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.<sup>2</sup>

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<sup>1</sup> Queensland Government (2018) Future Climate Dashboard,  
<https://app.longpaddock.qld.gov.au/dashboard/#responseTab1>

<sup>2</sup> CSIRO/BOM, Climate Change in Australia: Projections for Australia's NRM regions,  
<https://www.climatechangeinaustralia.gov.au/en/>

# PROJECTED CHANGES TO HERBERT'S CLIMATE

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## Decreasing rainfall and increasing evaporation in Herbert

Water availability in the regions that make up the Herbert electorate are 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 25 percent by 2070 in mainland areas. Rainfall is also projected to be more concentrated, with floods and droughts expected to become more frequent.

### *Evaporation*

Increasing evaporation can exacerbate drought,<sup>3</sup> reduce soil moisture,<sup>4</sup> reduce water levels in dams and reservoirs,<sup>5</sup> and dry out vegetation increasing bushfire risk.<sup>6</sup>

Evaporation rates in the mainland areas of the Herbert electorate are expected to increase substantially. Projections range from increases of 6 percent to over 25 percent by 2070. For instance, as shown in Figure 1 the projections for Townsville City range from a 6 to 26 percent increase by 2070, with an average of all models being a rise of 15 percent.

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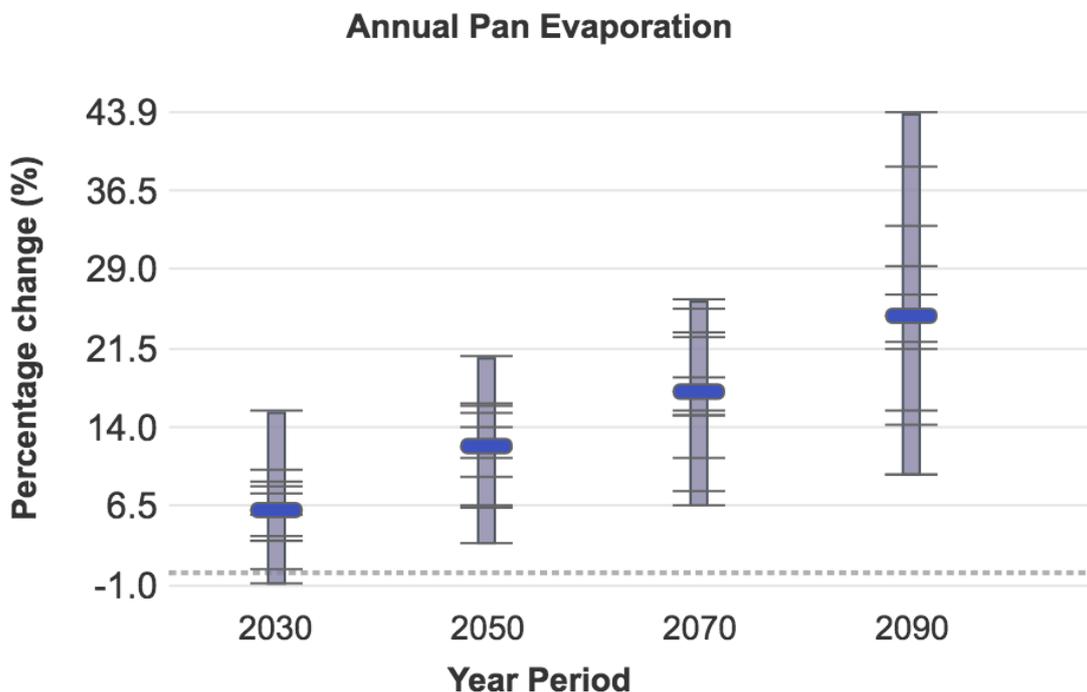
3 Hannan (2018), Record evaporation rates across eastern Australia exacerbate drought, <https://www.smh.com.au/environment/weather/record-evaporation-rates-across-eastern-australia-exacerbate-drought-20180821-p4zys3.html>

4 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>

5 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>

6 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](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 Townsville City 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 Herbert electorate.

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

	2030	2050	2070	2090
<b>Townsville</b>	1% decrease-16% increase	3-21% increase	6-26% increase	10-44% increase
<b>Hinchinbrook</b>	2% decrease -13% increase	2-20% increase	6-26% increase	8-46% increase
<b>Palm Island</b>	4% decrease-4% increase	5% decrease-2% increase	8% decrease-4% increase	11 decrease-4% increase

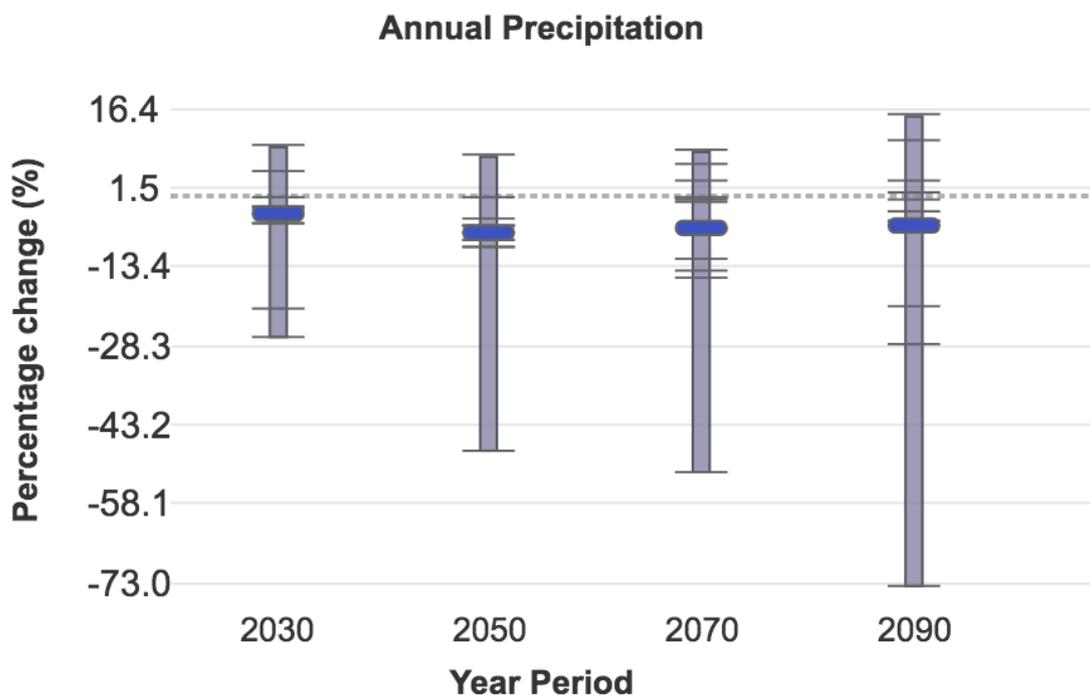
Source: QLD Government (2018) Future Climate Dashboard

### *Rainfall*

Rainfall projections for the Herbert electorate are uncertain. The overall range is from a small increase to large decrease. For instance, as shown in Figure 2 below the

projections for Townsville City LGA range from a 12 percent increase in rainfall by 2070 to a 50 percent decrease, and up to a 78 percent decrease by 2090.

**Figure 2: Projected change in annual precipitation Townsville City 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 Herbert electorate over the coming decades.

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

	2030	2050	2070	2090
<b>Townsville City</b>	2% increase-30% decrease	2% increase-49% decrease	% increase-49% decrease	16% increase-78% decrease
<b>Hinchinbrook</b>	1% increase-22% decrease	2% increase-42% decrease	4% increase-45% decrease	6% increase-70 %decrease
<b>Palm Island</b>	1% increase-28% decrease	1% increase-50% decrease	3%increase-54% decrease	9% increase-77% 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 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. That is projected to increase to 90 percent in the early part of this century and 130 percent increase as century progresses.<sup>7</sup>

## **Increasing extreme heat in Herbert**

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.<sup>8</sup> The World Bank considers 4 degree “devastating” with “extremely severe risks for vital human support systems.”<sup>9</sup>

QLD Government projections show an increase in the annual mean temperature for QLD as a whole of up to 5.5 degrees by 2090.<sup>10</sup> The projections for the regions within the electoral division of Herbert 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 Townsville.

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

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<sup>7</sup> 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>

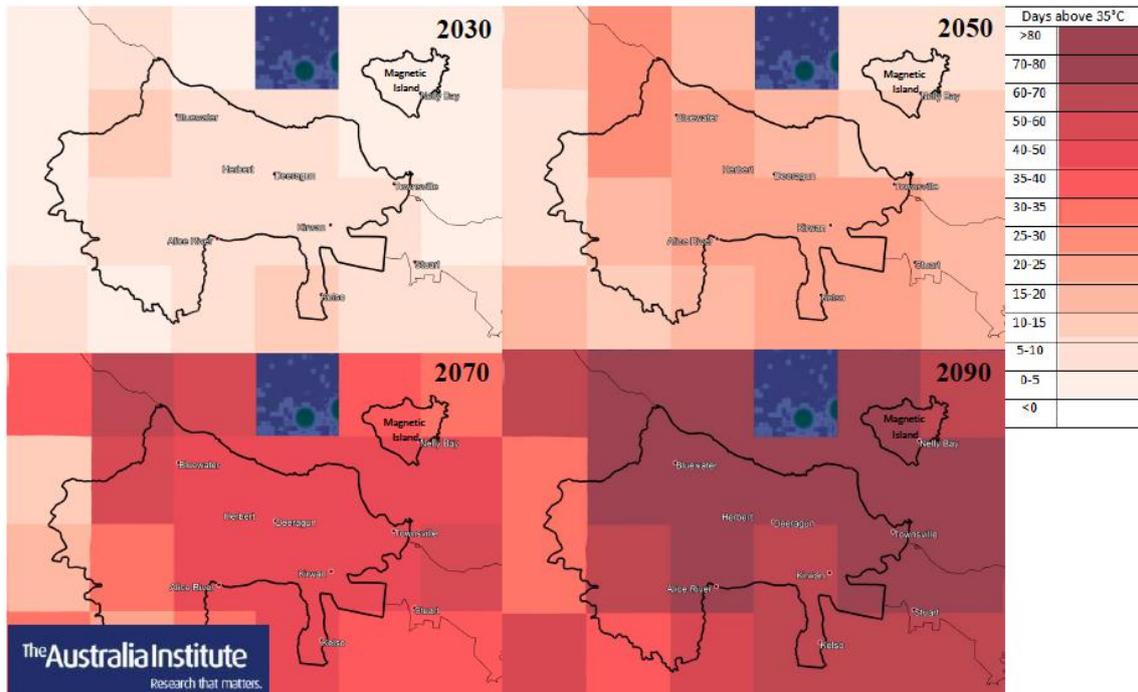
<sup>8</sup> BOM, CSIRO (2015) Australia’s changing climate, [https://www.climatechangeinaustralia.gov.au/media/ccia/2.1.6/cms\\_page\\_media/176/AUSTRALIAS\\_C HANGING\\_CLIMATE\\_1.pdf](https://www.climatechangeinaustralia.gov.au/media/ccia/2.1.6/cms_page_media/176/AUSTRALIAS_C HANGING_CLIMATE_1.pdf)

<sup>9</sup> World Bank (2012) Turn down the heat: Why a 4 degrees Celsius warmer world must be avoided, <https://openknowledge.worldbank.org/handle/10986/11860>

<sup>10</sup> Queensland Government (2018) Future Climate Dashboard, Mean Temperature QLD, <https://app.longpaddock.qld.gov.au/dashboard/#responseTab1>

extreme temperature days in the electorate of Herbert over the coming decades. The darker the shade of red, the greater the increase in the amount of hot days per year in that location.

**Table 3: Projected increase in the number of days over 35 degrees per year in the electorate of Herbert**



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.

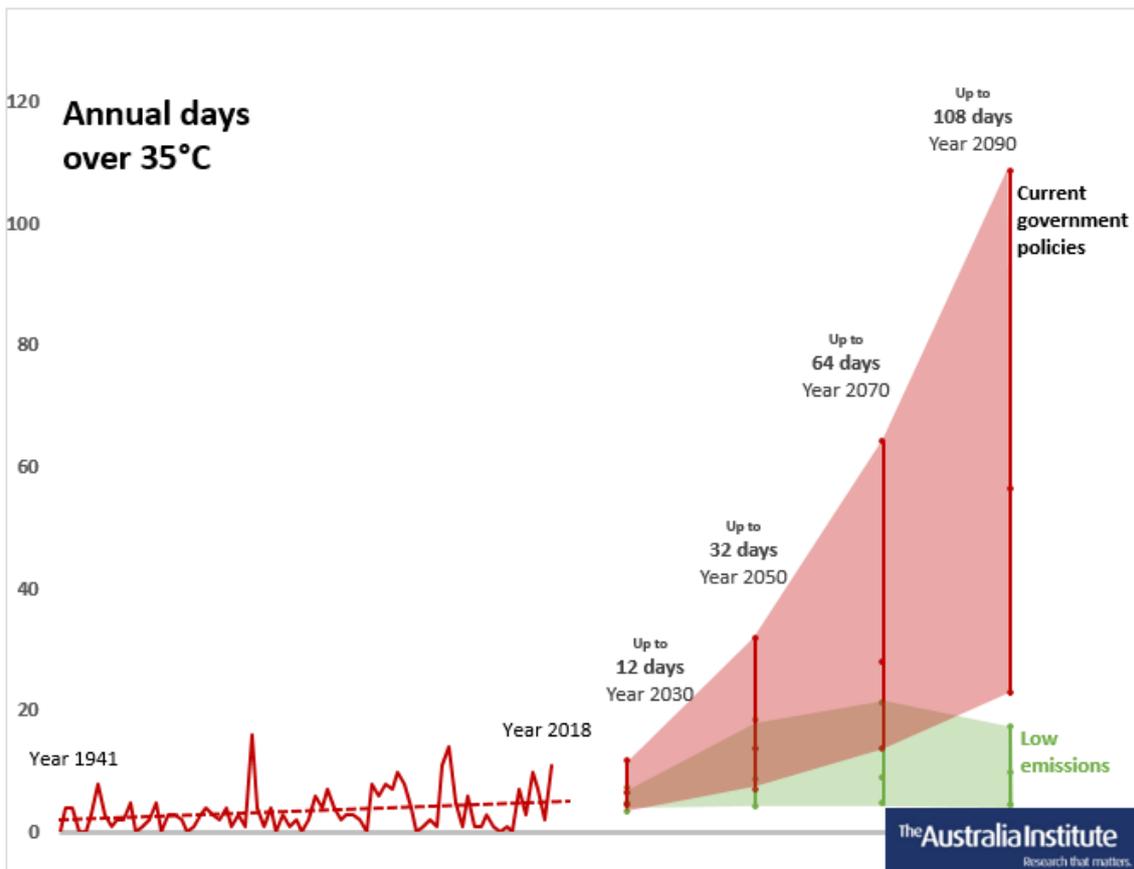
Figures 3 below shows the historic and projected increase in extreme heat days for Townsville. The red line shows actual recorded historic annual number of days over 35 degrees, with the dotted line showing the trend.

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 Climate Agreement.

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 Townsville**



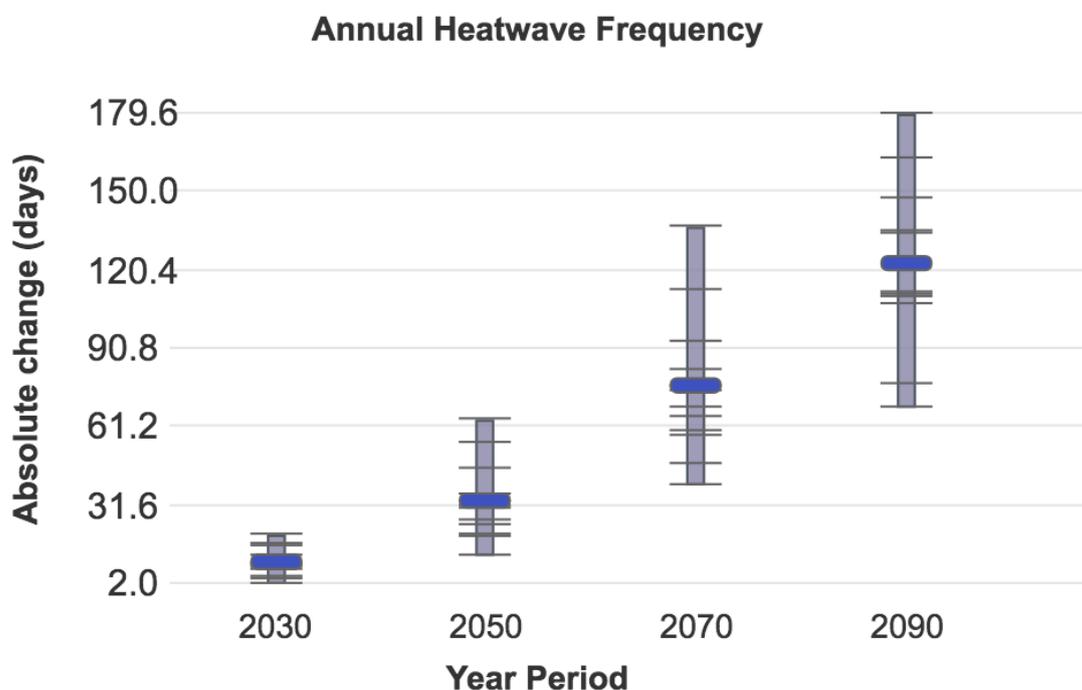
Source: Bureau of Meteorology (2019) *Climate data online*, <http://www.bom.gov.au/climate/data/index.shtml>; CSIRO and Bureau of Meteorology (2018) *Climate projections*, provided on request

## Increasing Heatwaves in Herbert

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.<sup>11</sup>

Heatwaves in Herbert are projected to become more frequent, hotter and longer. In the Townsville region for example, as shown in Figure 8 below, the annual number of heatwave days is projected to increase by up to around 180 percent by 2070.<sup>12</sup>

**Figure 4: Projected increase in annual heatwave days Townsville LGA.**



Source: QLD Government (2018) Future Climate Dashboard

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

<sup>11</sup> McMichael et al (2003) Climate change and human health, risks and responses, p 53, <https://www.who.int/globalchange/publications/climchange.pdf>

<sup>12</sup> Queensland Government (2018), Queensland Future Climate Dashboard, <https://app.longpaddock.qld.gov.au/dashboard/#responseTab2>

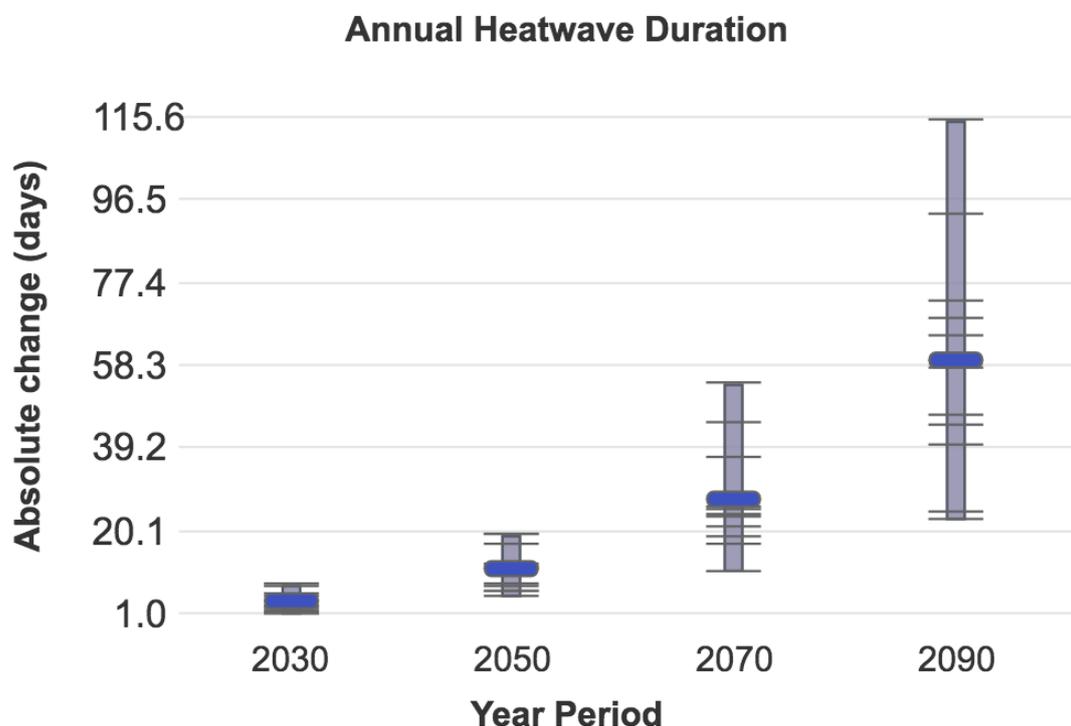
**Figure 5: Projected increase in annual heatwave days of Local Government Areas within the electorate of Herbert.**

	2030	2050	2070	2090
<b>Townsville City</b>	2-20%	13-65%	40-137%	69-179%
<b>Hinchinbrook</b>	2-24%	14-77%	55-155%	103-188%
<b>Palm Island</b>	7-52%	26-101%	58-161%	93-189%

Source: QLD Government (2018) Future Climate Dashboard

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 the Townsville region in 2070 is projected to last up to 54 days and by 2090, it could be up to 115 days per year, as shown in Figure 9 below.<sup>13</sup>

**Figure 6: Projected increase in annual heatwave duration Townsville City LGA.**



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

## Sea level rise and coastal inundation

Townsville is a low-lying city that will be heavily impacted by sea level rise and coastal inundation.

In 2012, a study was undertaken by global engineering firm GHD for the Townsville City Council examining the potential ongoing cumulative impacts of sea level rise and coastal inundation on the community.<sup>14</sup> The Study was supported by the Australian and Queensland Governments, Griffith University and the Local Government Association of Queensland (LGAQ).

The study found that with a 0.8 meter sea level rise by 2100 would result in 4,400 properties in 23 suburbs being impacted by inundation. The total cost impact was estimated to be over \$2.5 billion. The report recommended measures to defend Townsville's inner suburbs, to consider defending 7 other suburbs and to retreat from another 13 suburbs.

Alarming, sea level rise projections have increased dramatically since the report came out. Since the IPCC Fifth Assessment in 2014, there have been a number of key studies suggesting sea level rise could rise much faster. The National Oceanic and Atmospheric Administration in the US found sea levels could rise to up to 2 meters by 2100 if emissions remain high.<sup>15</sup>

One of the key factors that could lead to a rapid acceleration in sea level rise is the melting of the Antarctic ice sheets. Alarming, recent research has found a sixfold increase in the melting Antarctic Ice Sheet from 40 billion tonnes per year between 1979-1990, to 252 billion tonnes per year between 2009-2017.<sup>16</sup>

If these more dramatic scenarios of sea level rise eventuate, the impacts on Townsville will be far worse.

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<sup>14</sup> GHD (2012) Coastal Hazard adaptation strategy for Townsville City Council, [https://www.townsville.qld.gov.au/\\_\\_data/assets/pdf\\_file/0016/7036/Coastal\\_Hazard\\_Adaptation\\_Strategy.pdf](https://www.townsville.qld.gov.au/__data/assets/pdf_file/0016/7036/Coastal_Hazard_Adaptation_Strategy.pdf)

<sup>15</sup> Op. cit. NOAA

<sup>16</sup> Rignot et al (2019) Four decades of Antarctic Ice Sheet mass balance from 1979–2017, <https://www.pnas.org/content/early/2019/01/08/1812883116>

**Figure 7: Projected inundation of Townsville at highest tide with 0.74 sea level rise in 2100**



Source: Coastal Risk Australia, <http://coastalrisk.com.au/viewer>

# The economic costs of climate change impacts in Herbert

## NATURAL DISASTERS

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

It found the total economic cost of natural disasters in Australia over the decade to 2016, averaged \$18.2 billion per year and 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.<sup>17</sup>

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.<sup>18</sup>

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).<sup>19</sup>

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.<sup>20</sup> 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

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<sup>17</sup> 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](http://australianbusinessroundtable.com.au/assets/documents/ABR_building-resilience-in-our-states-and-territories.pdf)

<sup>18</sup> Deloitte Access Economics (2017) Ibid.

<sup>19</sup> Deloitte Access Economic (2017) Ibid.

<sup>20</sup> 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.<sup>21</sup>

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.<sup>22</sup>

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.<sup>23</sup>

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

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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.<sup>24</sup> 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.<sup>25</sup>

WorkSafe Queensland lists a range of illnesses arising from extreme temperatures from cramps, rashes, and dehydration to severe injuries such as heat stroke,

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<sup>21</sup> 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>

<sup>22</sup> 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>

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

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

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

exhaustion and even death, if treatment is delayed.<sup>26</sup> 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.<sup>27</sup> 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.<sup>28</sup> The 'synergistic effect' of night humidity and increased temperatures as a result of the urban heat Island effect (UHI)<sup>29</sup> 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).<sup>30</sup> Heatwaves have been dubbed the 'silent killer', causing more deaths in the last century in Australia than all natural disasters put together.<sup>31</sup>

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.<sup>32</sup>

Productivity decreases significantly under these stresses as people are affected with the consequences of extreme heat. Workplace safety and the ability to work declines.

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

<sup>27</sup> 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>

<sup>28</sup> 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

<sup>29</sup> 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.

<sup>30</sup> Zhao et al (2018) *Interactions between urban heat islands and heat waves*, *Environmental Research Letters* 13

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

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

This can also be displayed in economic terms as costs rise to account for the lack of labour productivity and changes needed in workplaces.<sup>33</sup>

## HEAT STRESS AND TOWNSVILLE'S WORKFORCE

Increasing extreme heat will have serious consequences for the health and safety of many of Townsville's workforce.

There is no temperature threshold for halting heavy outdoor work in Queensland. This is important to Townsville, where over 13,000 workers are technicians and trades workers. Of these, over 5,000 work in agriculture, mining, manufacturing or construction, which are industries that require a large amount of work exposed to the heat in many roles.<sup>34</sup> There are also around 10,000 labourers, which is another occupation regularly requiring strenuous work outside or in non-air conditioned spaces.

Table 4 below shows the number of workers in Townsville in some of the occupations that are very likely to require strenuous work outdoor work, or in non-air-conditioned indoor spaces which can be even hotter.

**Table 4: Selected occupations and industries in Townsville likely to exposed to extreme heat.**

	Technicians and Trades Workers	Machinery Operators and Drivers	Labourers	Total
<b>Agriculture, Forestry and Fishing</b>	118	445	773	<b>1,336</b>
<b>Mining</b>	256	358	78	<b>692</b>
<b>Manufacturing</b>	1,732	929	962	<b>3,623</b>
<b>Electricity, Gas, Water and Waste Services</b>	466	164	94	<b>724</b>
<b>Construction</b>	3,001	698	900	<b>4,599</b>
<b>Transport, Postal and Warehousing</b>	325	2,111	314	<b>2,750</b>
<b>Total</b>	<b>5,898</b>	<b>4,705</b>	<b>3,121</b>	<b>13,724</b>

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

<sup>34</sup> ABS (2016) 2016 Census Community Profile, Working Population Profile, [http://quickstats.censusdata.abs.gov.au/census\\_services/getproduct/census/2016/communityprofile/318?opendocument](http://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/communityprofile/318?opendocument)

Source: ABS (2016) *2016 Census Community Profile, Working Population Profile*, [http://quickstats.censusdata.abs.gov.au/census\\_services/getproduct/census/2016/communityprofile/318?opendocument](http://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/communityprofile/318?opendocument)

Townsville hosts the largest garrison in the Australian Defence Force (ADF) and is home to 15,000 defence force personal and their families, making up 8% of the Townsville population.<sup>35</sup> Soldiers are required to train strenuously in heavy clothing which reduces air circulation essential to cooling the body, and heavy equipment which adds to the level of exertion. The tragic consequences of excessive training in the heat can be seen in the case of the death of a young a soldier due to heat stress at the ADF Puckapunyal base in Victoria last year.<sup>36</sup>

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.<sup>37</sup> The US Army Research Institute of Environmental Medicine advises that all outdoor work with physical exertion be cancelled when the Wet Bulb Globe Temperature WBGT temperature exceeds 32 degrees.<sup>38</sup> The WBGT is a measure of heat stress that takes into account temperature, humidity and some other factors.

## Mining workers

Although mining is currently a relatively small employer in the Townsville region, employing fewer than 1000 workers, around 1% of the workforce,<sup>39</sup> there are have

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<sup>35</sup> Townsville City Council (2017) *Defence Fact Sheet: Australian Defence Force*, [https://www.townsville.qld.gov.au/\\_\\_data/assets/pdf\\_file/0018/9360/Defence-Fact-Sheet-17.pdf](https://www.townsville.qld.gov.au/__data/assets/pdf_file/0018/9360/Defence-Fact-Sheet-17.pdf)

<sup>36</sup> Smith (2019) *Australian soldier dies during exercise at Puckapunyal Army base in Victoria*, <https://www.news.com.au/national/victoria/news/australian-soldier-dies-during-exercise-at-puckapunyal-army-base-in-victoria/news-story/452c965683ad8e2ecdb7f2017dff98c9>

<sup>37</sup> 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/>

<sup>38</sup> Hanna (2016) *Microclimates and heat islands: Climate change exacerbates occupational heat exposures*, <http://greenhouse.asnevents.com.au/assets/Greenhouse/Presentations/1420HannaMR2Wed.pdf>

<sup>39</sup> ABS (2016) *2016 Census Community Profile, Working Population Profile*, [http://quickstats.censusdata.abs.gov.au/census\\_services/getproduct/census/2016/communityprofile/318?opendocument](http://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/communityprofile/318?opendocument)

been calls to support an expansion of mining in the region.<sup>40</sup> 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.<sup>41</sup>

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.<sup>42</sup>

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.

Despite Worksafe Queensland warnings that working in extreme heat can lead to serious injury and death,<sup>43</sup> there is no temperature level threshold for halting heavy outdoor work in Queensland. The death of a coal seam gas worker near Roma in

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<sup>40</sup> Ludlow, Macilroy (2019) *CFMEU and miners tell Labor to stop playing games over Adani mine*, <https://www.afr.com/news/politics/cfmeu-and-miners-tell-labor-to-stop-playing-games-over-adani-mine-20190221-h1bj4c>

<sup>41</sup> Australasian Mining Safety Journal (October 2015) *Handling the heat*, <https://www.amsj.com.au/handling-the-heat/>

<sup>42</sup> Hunt et al (2012) *Symptoms of heat illness in surface mine workers*, <https://eprints.qut.edu.au/54048/>

<sup>43</sup> WorkSafe Queensland (n.d.) *Health effects*, <https://www.worksafe.qld.gov.au/injury-prevention-safety/hazardous-exposures/heat-stress/health-effects>

Queensland as a result of heat in 2016 prompted the Coroner to recommend temperature thresholds being adopted.<sup>44</sup>

The health and safety risks of heatwave are likely to accelerate the process of fully automating mining operations from mine to port, as multi-national corporation Adani have already indicated they aim to do at their proposed Carmichael mine. This will mean even fewer mining jobs in the region.<sup>45</sup>

## AGRICULTURE

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Agriculture is a vital industry in the Townsville region and the Herbert 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.

A similar pattern is observed for wheat yields, although the climate effects are larger. Climate conditions between 2000–01 and 2014–15 lowered national

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<sup>44</sup> 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>

<sup>45</sup> Krien (June 2017) *Revealed: Gautam Adani's coal play in the state facing global-warming hell*, <https://www.smh.com.au/lifestyle/adani-how-we-got-conned-by-coal-20170525-gwcv5h.html>

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).<sup>46</sup>

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.<sup>47</sup>

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.<sup>48</sup>

## 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%<sup>49</sup> 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 devastating impact of extreme events on grazing. As previously discussed, the frequency of pacific rainfall disruptions including drought and flooding have already increased by 30

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<sup>46</sup> 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](http://data.daff.gov.au/data/warehouse/9aas/2017/FarmPerformanceClimate/FarmPerformanceClimate_v1.0.0.pdf)

<sup>47</sup> 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>

<sup>48</sup> The Garnaut climate change review (2009) Chapter 6, Climate Change Impacts on Australia,  
<http://www.garnautreview.org.au/chp6.htm>

<sup>49</sup> 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](https://www.researchgate.net/publication/269106683_Systemic_adaptations_to_climate_change_in_southern_Australian_grasslands_and_livestock_Production_profitability_methane_emission_and_ecosystem_function)

percent and are projected to increase by 90 percent in the early part of this century, and 130 percent increase as century progresses.<sup>50</sup>

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.<sup>51</sup>

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.<sup>52</sup> Agforce has estimated Queensland graziers alone have lost up to 500,000 head of cattle with an estimated value of \$500 million.<sup>53</sup>

## INFRASTRUCTURE AND INDUSTRY

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Townsville's infrastructure is at risk from sea level rise and coastal inundation, flooding from extreme weather events and extreme heat.

23 of Townsville's suburbs are considered at risk from inundation with a 0.8 meter sea level rise by 2100, with an estimated cost of over \$2.5 billion. These suburbs include the CBD, residential and industrial areas, as well as important civic infrastructure such as sewerage treatment plants.<sup>54</sup> If this is inundation is realised it would render the city inhospitable.

Extreme heat can cause failures to critical infrastructure, particularly transport and electricity supply.

Coal and gas power stations in particular are highly vulnerable to extreme heat, experiencing both reduced output and an increased level of breakdowns. This is exacerbated by high electricity demand as a result increased use of air-conditioning during extreme heat conditions. Last year there were 56 breakdowns of coal and gas

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<sup>50</sup> 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>

<sup>51</sup> 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>

<sup>52</sup> 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>

<sup>53</sup> 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>

<sup>54</sup> GHD (2012) Coastal Hazard adaptation strategy for Townsville City Council, [https://www.townsville.qld.gov.au/\\_\\_data/assets/pdf\\_file/0016/7036/Coastal\\_Hazard\\_Adaptation\\_Strategy.pdf](https://www.townsville.qld.gov.au/__data/assets/pdf_file/0016/7036/Coastal_Hazard_Adaptation_Strategy.pdf)

power stations, in Queensland, many of which are likely to be as a result of extreme heat.

The Queensland floods are estimated to have had a total economic cost of \$14.1 billion,<sup>55</sup> including an estimated \$157 million on road reconstruction.<sup>56</sup> The floods also affected over 3000 km of rail track in some way.<sup>57</sup>

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

Extreme heat can also disrupt transport infrastructure. It can cause roads can melt<sup>58</sup> and rail can buckle,<sup>59</sup> and disruption to airlines.<sup>60</sup>

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<sup>55</sup> Deloitte (2013), The economic cost of the social impact of natural disasters, costs <http://australianbusinessroundtable.com.au/assets/documents/Report%20-%20Social%20costs/Report%20-%20The%20economic%20cost%20of%20the%20social%20impact%20of%20natural%20disasters.pdf>

<sup>56</sup> 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>

<sup>57</sup> 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](http://www.floodcommission.qld.gov.au/__data/assets/pdf_file/0014/11714/QFCI-Final-Report-Chapter-10-Essential-services.pdf)

<sup>58</sup> 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>

<sup>59</sup> Lauder (2009) *Melbourne railway buckles under heat*, <http://www.abc.net.au/worldtoday/content/2008/s2477350.htm>

<sup>60</sup> 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 Herbert stands to be heavily impacted by climate change.

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

However, none of this is inevitable. Climate projections clearly show that if the world achieves the 1.5-degree target agreed to by virtually every nation on earth under the Paris Agreement, most of these impacts can be avoided (see the green shaded line in Figure 3 for example).

Fortunately, the measures we need to take to tackle climate change are consistent with a prosperous future and growing employment in the region. Renewable energy jobs doubled in Queensland in the last two years<sup>61</sup> and the electorate of Herbert has an excellent solar resource providing opportunities for more renewable 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 measure to build resilience in our communities, farms, businesses and infrastructure to the changes already locked in. Besides avoiding costs from climate impacts, these measures will also provide jobs and flow on economic benefits to the region.

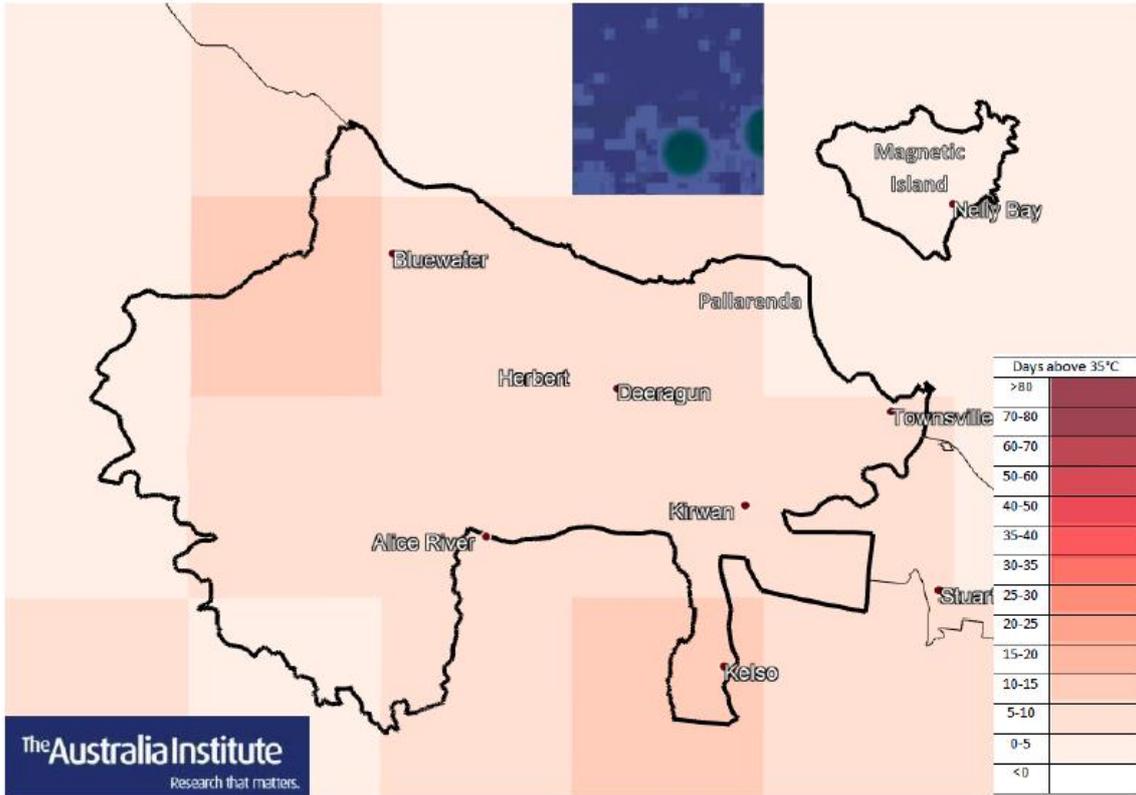
However, leadership will be required to grasp these opportunities. It requires leaders with an understanding of the issues and a willingness to rise to the challenge.

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<sup>61</sup> Australian Bureau of Statistics (2019) 4631.0 - *Employment in Renewable Energy Activities, Australia, 2017-18* <https://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4631.0Main+Features12017-18?OpenDocument>

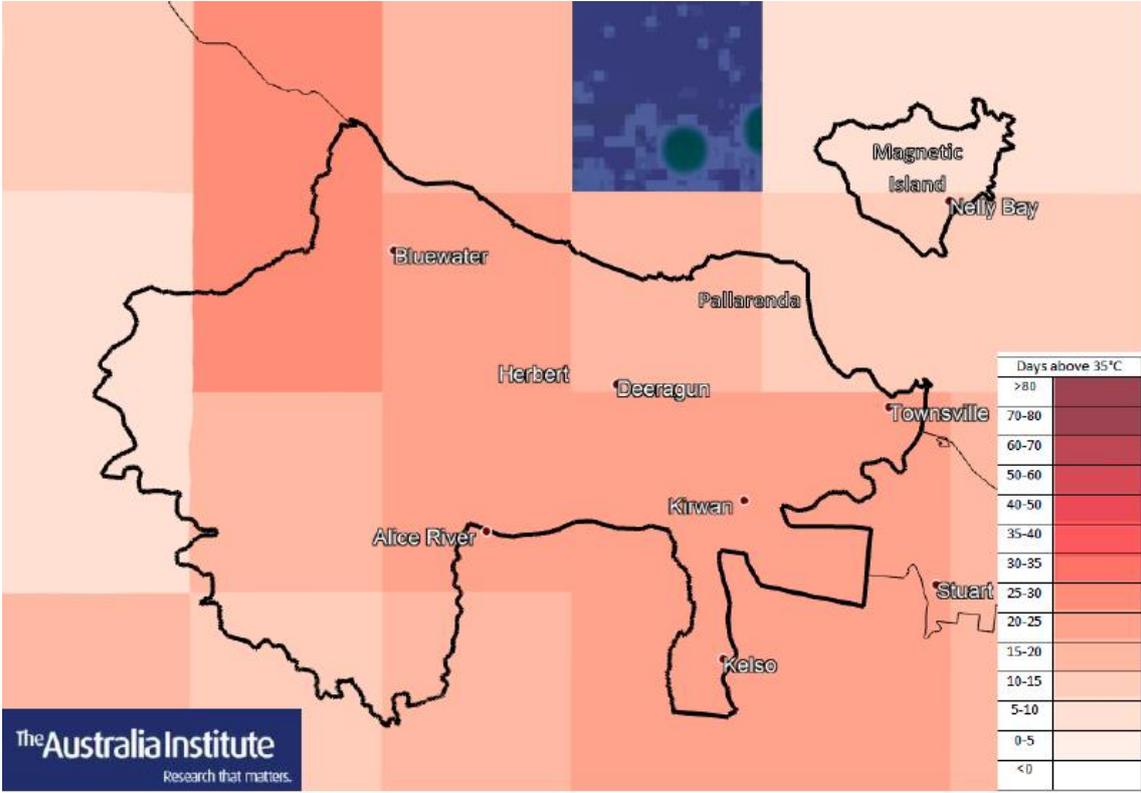
# Appendix

Figure 8: Projected increase in days over 35 degrees per year above current levels in the electorate of Herbert 2030



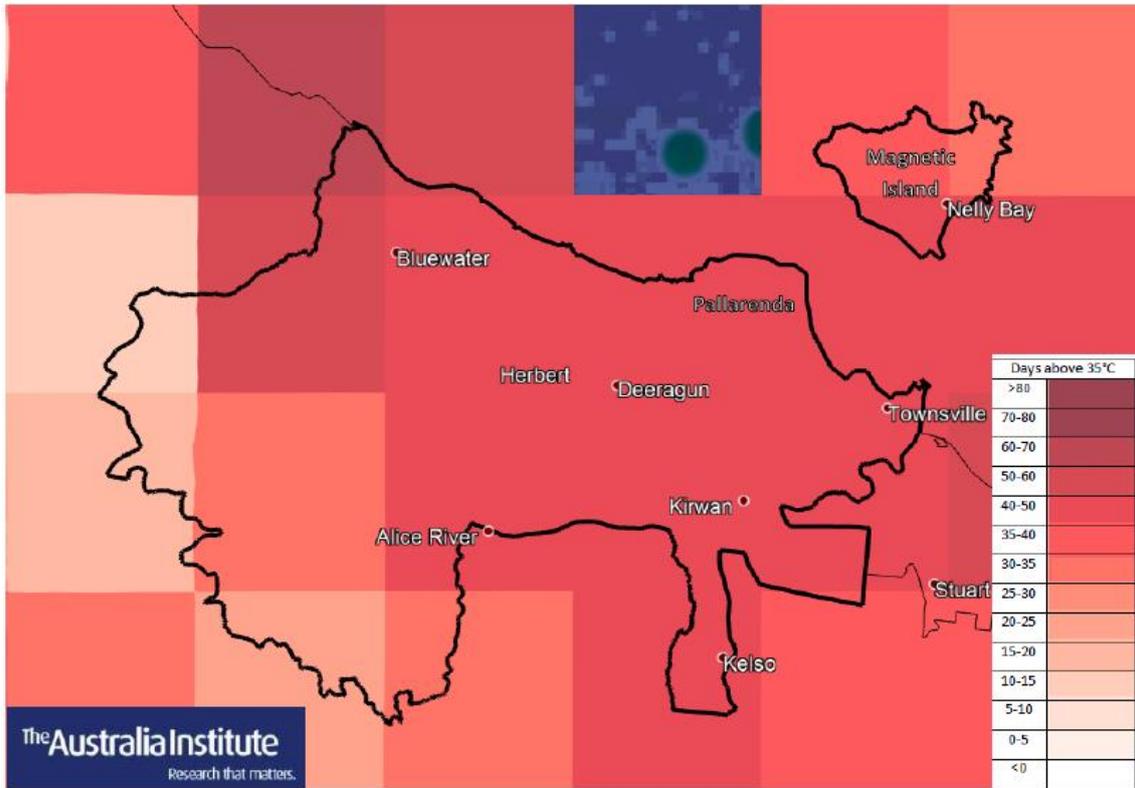
Source: QLD Government (2018) Future Climate Dashboard, AEC.

**Figure 9: Projected increase in days over 35 degrees per year above current levels in the electorate of Herbert 2050**



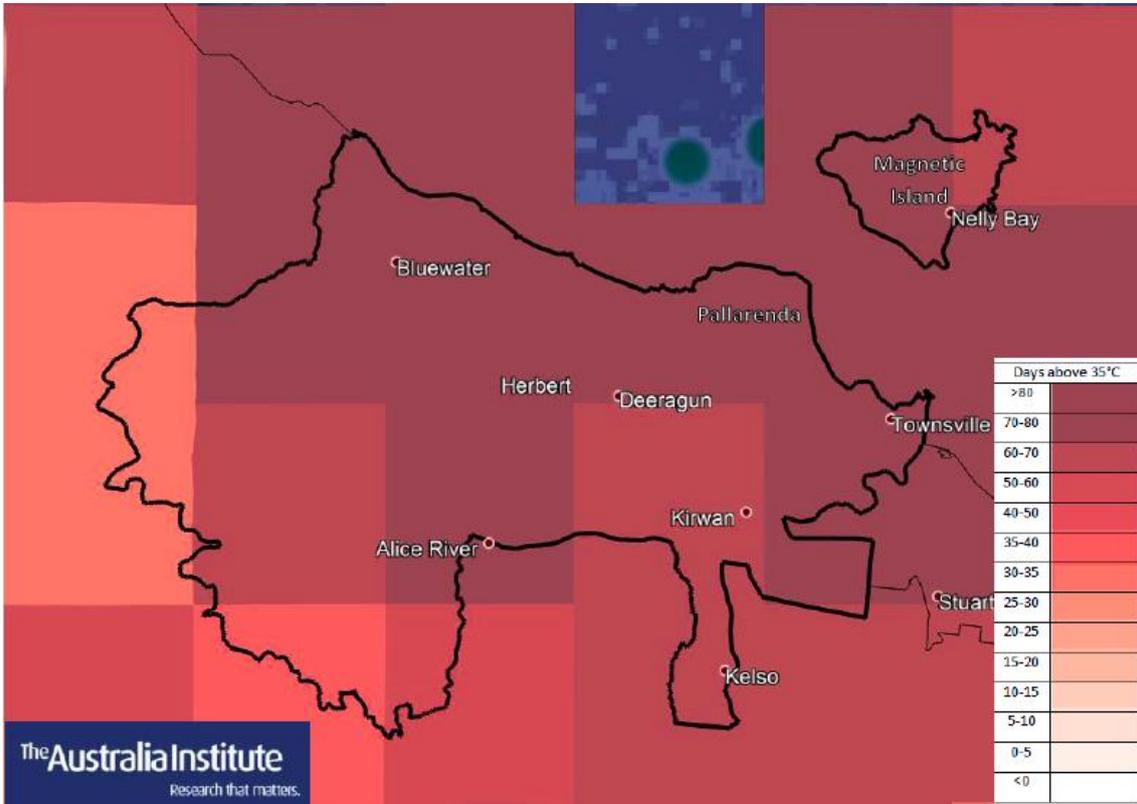
Source: QLD Government (2018) Future Climate Dashboard, AEC.

**Figure 10: Projected increase in days over 35 degrees per year above current levels in the electorate of Herbert 2070**



Source: QLD Government (2018) Future Climate Dashboard, AEC.

**Figure 11: Projected increase in days over 35 degrees per year above current levels in the electorate of Herbert 2070**



Source: QLD Government (2018) Future Climate Dashboard, AEC.