Impacts of Extreme Heat on human health in Australia in the context of the most recently documented and continuing climatic changes.

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Abstract

Climate change trends indicate an ongoing increase in land and sea surface temperatures, a decline in polar ice sheet masses and increasing sea levels — all due to increases in greenhouse gas emissions (Luber and Prudent, 2009). This has led to vulnerabilities in so many areas affecting human civilisation that the International Panel on Climate Change (IPCC) in 2015 created 17 Sustainable Development Goals (SDG) as guidelines for member nations to achieve to "improve health and education, reduce inequality, and spur economic growth — all while tackling climate change and working to preserve our oceans and forests (United Nations Department of Economic and Social Affairs, 2020). SDG 3 is to 'Ensure healthy lives and promote well-being for all at all ages' (ibid.); an acknowledgement of the paramount importance of the health and well-being of humanity.

This study considers the overall global and local trends that are occurring to make clear the trajectory we are following and, in particular, how this affects the health and well-being of Australia's human population.

A literature review has been undertaken to identify global trends and those locally associated with and specific to the effect of extreme heat on human health. It further considered certain vulnerabilities that adaptation must address to ensure adequate future health resources.

Key Words: *Australian Extreme Weather, Cold waves, Cyclones, Drought, Fire, Floods, Heat waves, Health and Storms.*

Abbreviations:

ACORN-SAT	Australian Climate Observations Reference Network – Surface Air Temperature
BOM	Australian Bureau of Meteorology
COVID-19	A disease caused by a new strain of coronavirus. 'CO' stands for corona, 'VI' for virus, and 'D' for disease
ENSO	El Nino Southern Oscillation
GHG	Greenhouse Gas Emissions
GRACE	Gravity Recovery and Climate Experiment
IOD	Indian Ocean Dipole
IPCC	Intergovernmental Panel on Climate Change
NASA	National Aeronautics and Space Administration
NCDC	National Climatic Data Center
NIH	National Institute of Environmental Health Science
NINO3.4	The NINO3.4 index is defined as the average of SST anomalies over the region 5°N — 5°S and 170° — 120°W.
NOAA	National Oceanic and Atmospheric Administration
NSIDC	National Snow and Ice Data
Peril AUS	PerilAUS is a database of impacts and consequences of natural hazards in Australia, which has been used to better understand natural peril risks and provide evidence for public safety policies
RACGP	Royal Australian College of General Practitioners
SST	Sea Surface Temperature
SSTA	Sea Surface Temperature Anomaly
WMO	World Meteorological Organisation

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A. Introduction

On a global scale, ‘Climate change is a long-term change in the average weather patterns that have come to define Earth’s local, regional and global climates' and that:

> Changes observed in Earth’s climate since the early 20th century are primarily driven by human activities, particularly fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth’s atmosphere, raising Earth’s average surface temperature (NASA, 2021a)

Climate has changed throughout history, with the past 650,000 years having seen seven cycles of glacial advance and retreat, with the abrupt end of the last ice age about 11,700 years ago marking the beginning of the modern climate era — and human civilisation (NASA, 2020b). However, during the recent period, circa1950, change has been so rapid and unidirectional that it has become recognised as the ‘Great Acceleration’ concerning overall global climate change (Lewis & Maslin, 2015; Steffen & McNeill, 2007; McNeill & Engelke, 2016).

This climate change is a ‘threat to health worldwide’ (RACGP, 2021) and in particular, projected changes in the Australian context include:

> More frequent and widespread heatwaves and extreme heat increase the risks of heat stress, heat stroke, dehydration and mortality. Heatwaves contribute to acute cerebrovascular accidents and aggravate chronic respiratory, cardiac and kidney conditions and psychiatric illness. The current carbon dioxide emissions trajectory is projected to increase heatwave-related deaths threefold in Melbourne and Brisbane and fivefold in Sydney over the period 2013 to 2080, compared with current heat-related mortality (RACGP, 2019, p. 2)

Hence, the objective of this study is to consider the effects of this principal climatic element *of extreme heat events* affecting the health and well-being of Australia’s human population and subsequently outline its impact and how this may be improved.

The protocol followed has been to review current literature on this subject and then to highlight general global trends initially, how this reflects on the Australian situation specifically and looking at mitigation and adaptation responses available to counter future vulnerabilities.

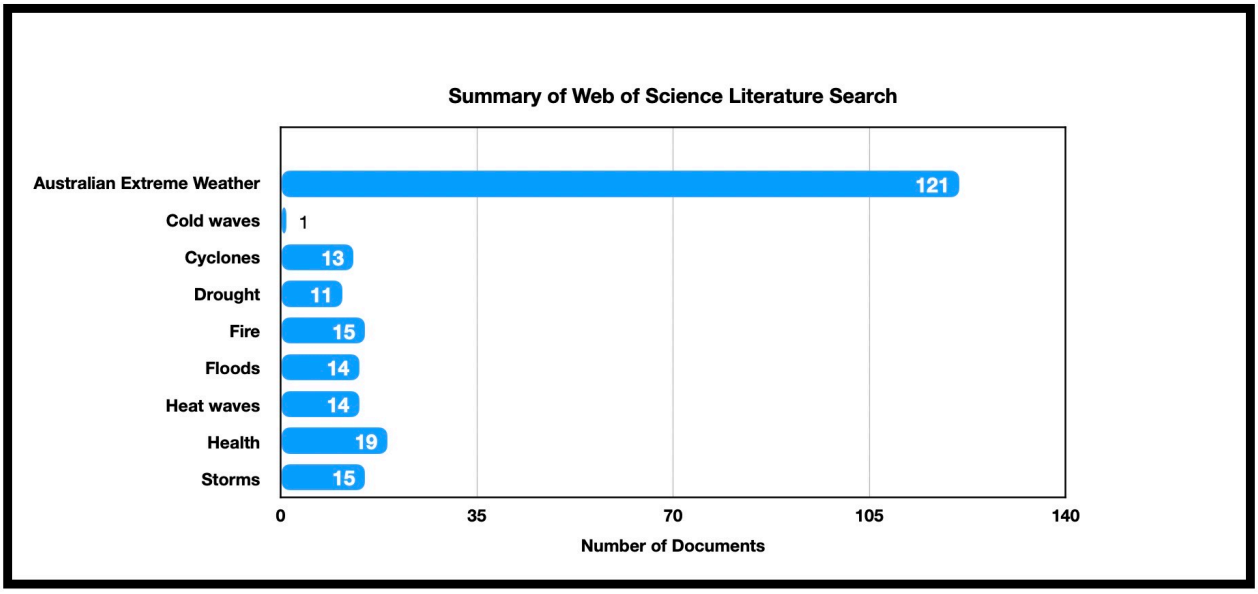

Figure 1. Summary of Web of Science Literature Search regarding Australian Extreme Weather events and Human health during the years 2017 to 2021

The study is then summarised and gives conclusions as to what the global and local climatic trends indicate and what future possibilities there may be to adapt to the consequences of change.

B. Literature Review

The literature search was conducted by choosing relevant peer-reviewed literature from 2017 to the present to assist in producing an essay to review the impacts of climate extremes on human health in Australia. These extremes of climatic disturbance are not unique to Australia but are reflected in other parts of the world (WMO, 2018).

However, as the Australian Academy of Science (2021) observes, ‘Since records began, the frequency, duration and intensity of heatwaves have increased over large parts of Australia, with trends accelerating since 1970.’

These conditions are considered to be the product of the principal climatic changes in greenhouse gas emissions, particularly concerning increasing carbon dioxide (CO2) production from excessive fossil fuel use, the resulting increase in global temperature and its effect on precipitation. In turn, this leads to worsening extreme events such as bushfires, droughts, floods, and heat waves.

Of particular concern is the effect these extreme outcomes have on our health and well-being. Cited by Doctors for the Environment Australia (2016, p.2):

> Climate change is widely regarded as the biggest threat to health in the 21st century (Costello et al. 2009; WHO 2015), yet how we deal with this threat is a significant opportunity to improve health locally and globally (Watts et al. 2015).

This gives more specific direction to the discussion in this report. Hence the main keywords used in the literature search are *Australian Extreme Weather, Cold waves, Cyclones, Drought, Fire, Floods, Heat waves, Health and Storms.*

From a basic literature search on the Web of Science database, the number of relevant documents was located as indicated in Figure 1. The events related directly to health and extreme heat represent approximately 49% of all Australian Extreme Weather events, and it is from these data alone inform this report.

Two key articles reviewed in this search are Davis and Hanna, 2020, *Seasonal temperature and rainfall extremes 1911-2017 for Northern Australian population centres: challenges for human activity* and Coates et al., 2014, *Exploring 167 years of vulnerability: An examination of extreme heat events in Australia 1844–2010.*

These articles emphasise the concerns of increased warming and extreme heat hazards, the most significant natural hazard the Australian population faces. These discuss the health ramifications of extreme heat events, particularly for those residing in the global tropics. In the context of a global population overview, they aver that concerning these events, if 'Left unchecked, continued warming poses a significant threat to their health and wellbeing, and continued economic viability for billions of people' (Davis & Hanna, 2020, p. 13).

From these two articles, a further 163 references have been identified, most of which were produced within the past 15 years.
This further literature has also been reviewed and would indicate a high degree of relevance and contemporaneity.

Further to this, reference has also been made to the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA) and the Australian Bureau of Meteorology (BOM) to give up-to-date data on both global and local trends.

C. Trends in Climate Change

a. Global Trends

To identify the impact of climate change locally, it is first necessary to identify the trends indicated globally.

The elements of Global Climate Change to be reviewed are:

1. Atmospheric Carbon Dioxide
2. Global Temperatures (Land and Ocean)
3. Arctic Sea Ice
4. Land Ice in Antarctica
5. Land Ice in Greenland
6. Sea level

The trends observed in each of these elements are graphically represented as follows:

1. Atmospheric Carbon Dioxide

Carbon Dioxide (CO2) is a heat-trapping gas released through human activities such as deforestation and fossil fuel use. The graph below shows CO2 levels measured at the Mauna Loa Observatory and indicates the latest measurement as 415ppm as of January 2021 (NASA, 2021c)

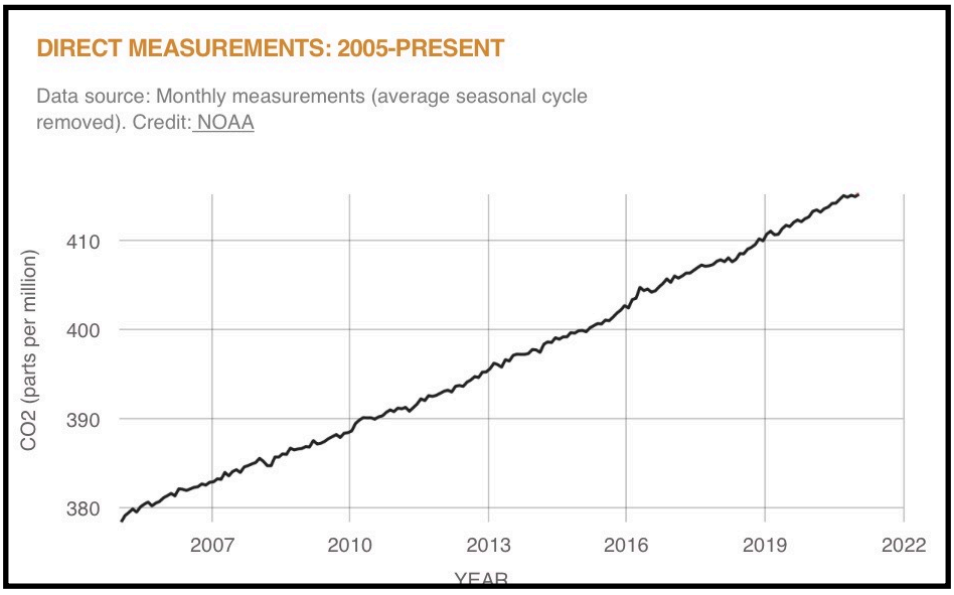

Figure 2. NASA Carbon Dioxide, 2021, Latest Measurement: January 2021, viewed 4 March 2021, https://climate.nasa.gov/vital-signs/carbon-dioxide/

2. Global Temperatures

The graph below illustrates the change in global surface temperature relative to 1951-1980 average temperatures. It also indicates a present annual average anomaly:2019 of 0.99°C. Except for 1988, 19 of the 20 warmest years have all occurred since 2001 (NASA, 2021d)

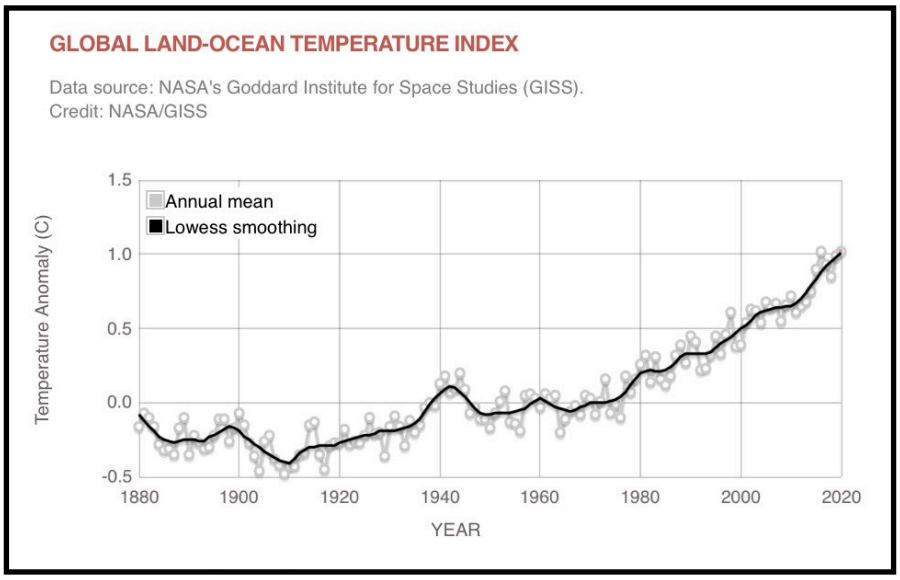

Figure 3. NASA Goddard Institute for Space Studies, 2021, Global Land-Ocean Temperature Index, Latest Annual Average Anomaly: 2019, viewed 4 March 2021, https://climate.nasa.gov/vital-signs/global-temperature/

3. Arctic Sea Ice

Arctic sea ice reaches its minimum each September. The graph below shows the rate of decline as 13.1 per cent per decade relative to the 1981 to 2010 average (NASA, 2021e)

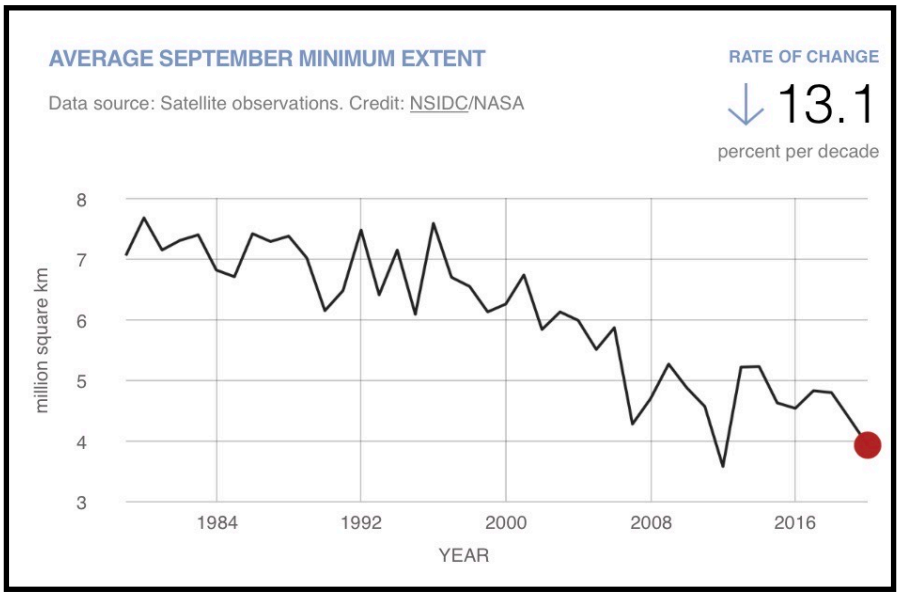

Figure 4. NSIDC/NASA Satellite observations, 2019, Arctic Sea Ice Minimum: Average September Extent, viewed 4 March 2021, https://climate.nasa.gov/vital-signs/arctic-sea-ice/

4. Land Ice in Antarctica

Land ice sheets in Antarctica have been losing mass since 2002 (NASA, 2021f).

The graph below indicates a rate of change in mass variation in Antarctica at 150 Gigatonnes per year

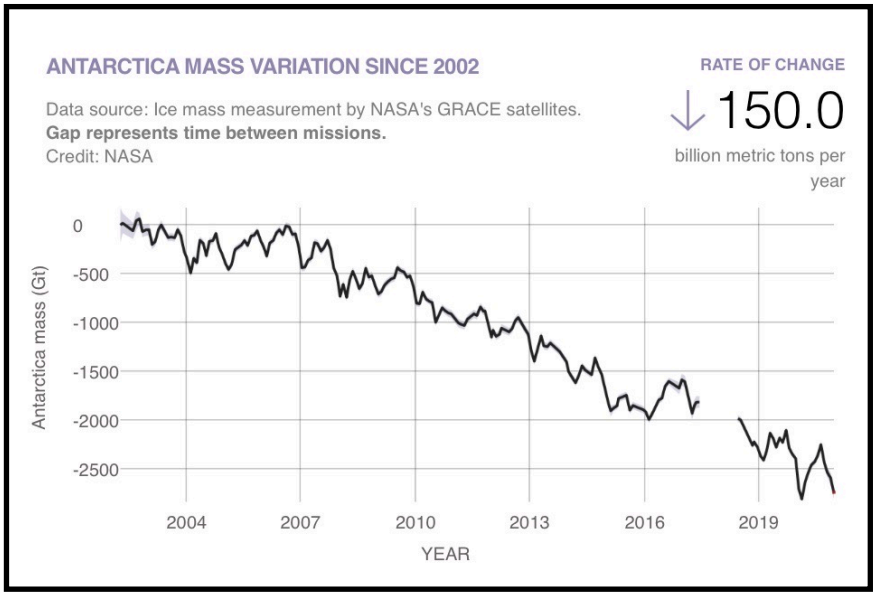

Figure 5. NASA/GRACE (Gravity Recovery and Climate Experiment), 2021, Antarctica Mass Variation Since 2002, viewed 4 March 2021, https://climate.nasa.gov/vital-signs/ice-sheets/

5. Land Ice in Greenland

Land ice sheets in Greenland have been losing mass since 2002 (NASA, 2021g).

The graph below indicates a rate of change in mass variation in Greenland at 278 Gigatonnes per year

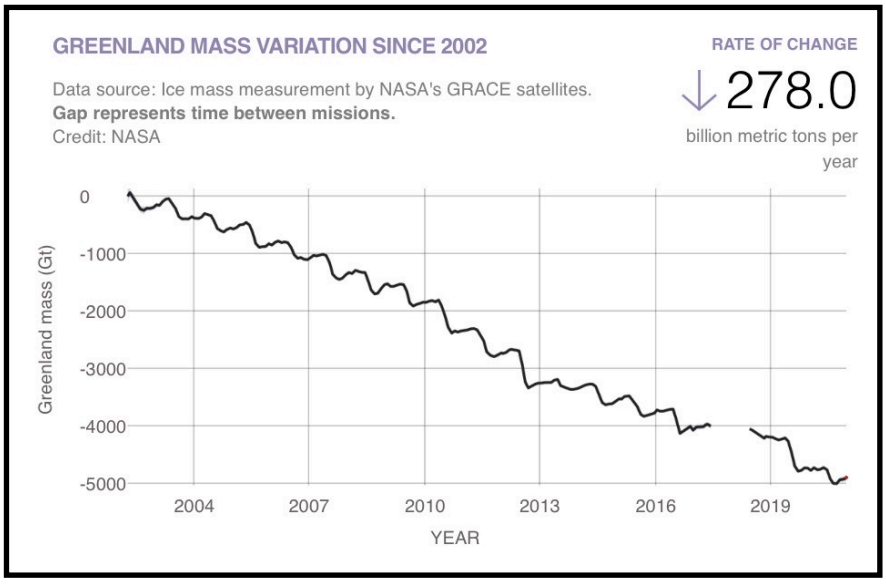

Figure 6. NASA/GRACE (Gravity Recovery and Climate Experiment), 2021, Greenland Mass Variation Since 2002, viewed 4 March 2021, https://climate.nasa.gov/vital-signs/ice-sheets/

6. Sea Level Rise

Sea level rise is caused by the thermal expansion of water warming and the increased melting of land ice sheets and glaciers (NOAA, 2019). The following graph indicates a current annual sea level rise rate of change of 3.3 millimetres per year

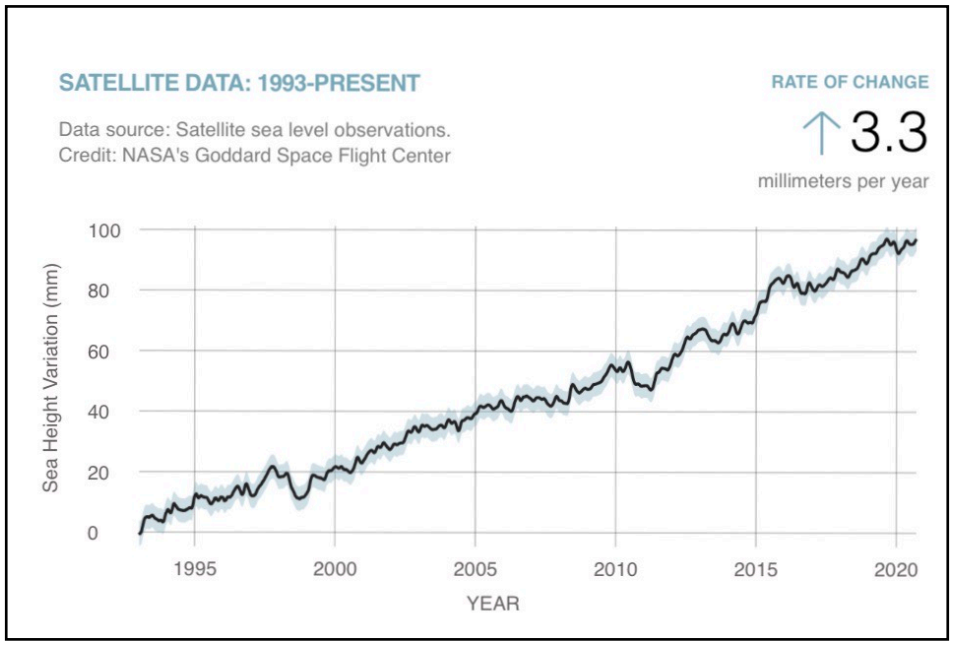

Figure 7. NASA Goddard Space Flight Center, 2021, Sea Level, Latest Measurement: September 2020, viewed 4 March 2021, https://climate.nasa.gov/vital-signs/sea-level/

The following table indicates the key information given by the foregoing graphical representations.

Summary of Data and Graphical representations of Six Climate Characteristics

Climate element	Period covered	Current value	Trend	References (in conjunction withhttps://climate.nasa.gov/vital-signs/ice-sheets/)
Carbon Dioxide (CO2)	2005 - 2021	415ppm	2.4ppm/ year	https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide
Global Temperature	1881 - 2020	1.02 °C annual average anomaly	0.18 °C since 1981	https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature
Arctic Sea Ice	1979 -2020	9300 km3	Decline of 13.1% per decade	http://psc.apl.uw.edu/research/projects/arctic-sea-ice-volume-anomaly/
Land Ice in Antarctica	2002 - 2020	Approx. 14M Gt	Decline of 148 Gt pa 1993-2019	https://nsidc.org/cryosphere/sotc/ice_sheets.html
Land Ice in Greenland	2002 - 2020	Approx. 1.7M Gt	Decline of 279 Gt pa 1993-2019	https://nsidc.org/cryosphere/sotc/ice_sheets.html
Sea Level Rise	1993 - 2020	97+/-4mm increase since 1993	Increase of 3.3 mm pa	https://climate.nasa.gov/vital-signs/sea-level/

Table1. Data indicating changing climate elements with particular reference to the period covered, current values, trends and relevant organisational references.

b. Climate change trends affecting the Australian continent

The global trends of most relevance to the future situation in the Australian Continent are those reflecting the effects of temperature increases as a result of increased GHG emissions and how it affects the health and well-being of its human population. These increases are evident from the data reflected in the graphical representation produced by the Australian Government's Bureau of Meteorology (BOM).

1. Land Temperature anomalies

According to the BOM (2021), the annual maximum, mean and minimum temperature anomalies (1910 - 2019) are trending unidirectionally upwards as indicated in Figures 8 - 10 that follow:

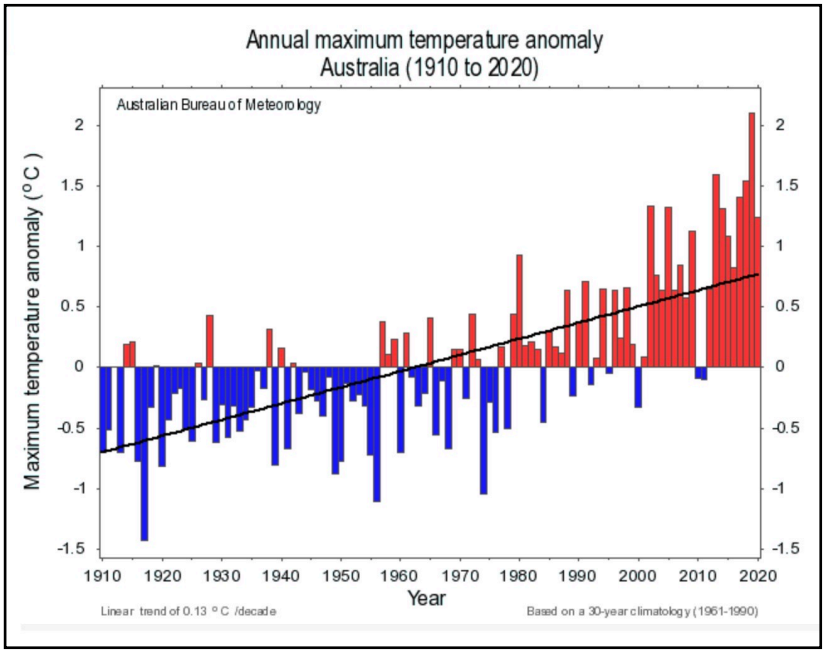

Figure 8: Bureau of Meteorology (BOM), Annual **maximum temperature** anomaly Australia (1910 - 2020) viewed 4 March 2021, http://www.bom.gov.au/climate/change/#tabs=Tracker&tracker=timeseries

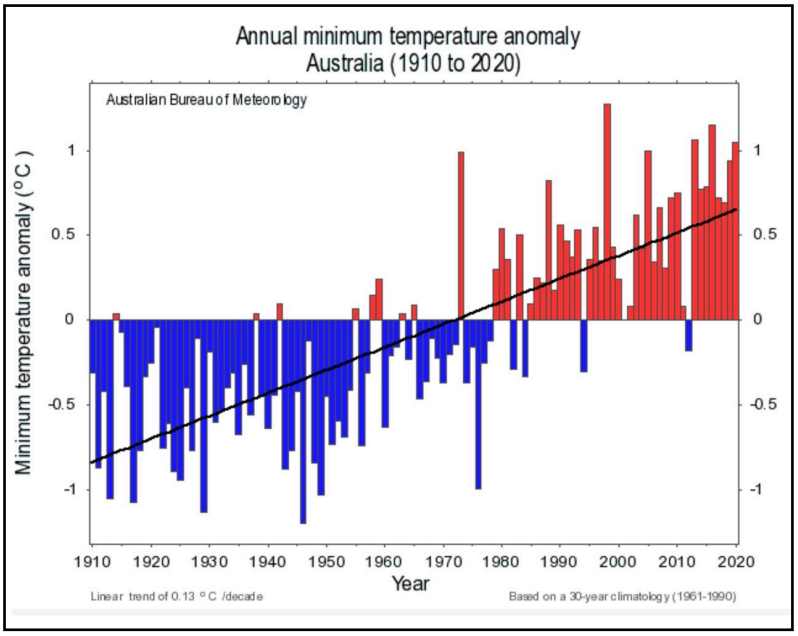

Figure 9: Bureau of Meteorology (BOM), Annual **minimum temperature** anomaly Australia (1910 - 2020) viewed 4 March 2021, http://www.bom.gov.au/climate/change/#tabs=Tracker&tracker=timeseries

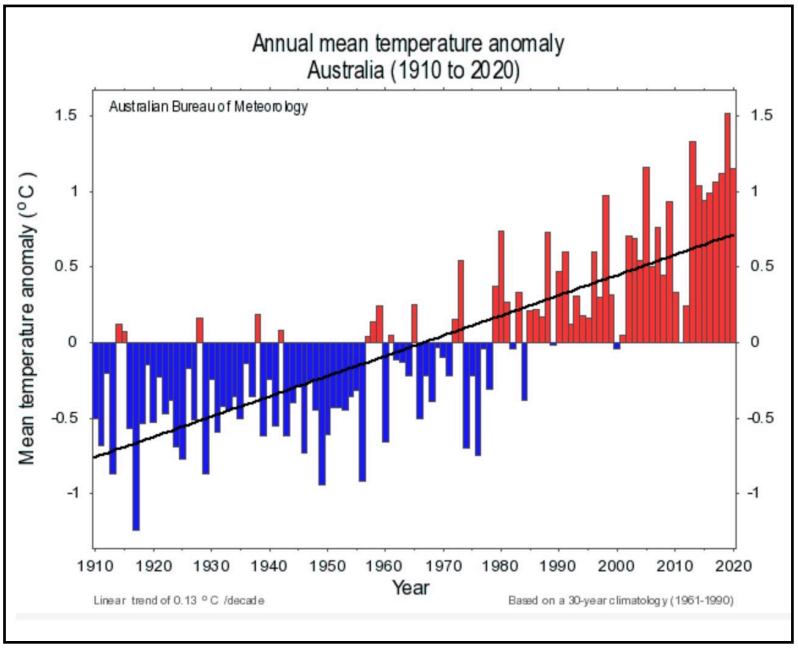

Figure 10: Bureau of Meteorology (BOM), Annual **mean temperature** anomaly Australia (1910 - 2020) viewed 4 March 2021, http://www.bom.gov.au/climate/change/#tabs=Tracker&tracker=timeseries

2. Surface Sea Temperature (SST)

Further to these data, the relationship between the El Niño–Southern Oscillation (ENSO) and the tropical Pacific sea surface temperature (SST) is of particular relevance to climate

prediction. This in turn indicates preparedness and resources required for further extreme variations in climatic conditions. These data are also available from the BOM as represented in Figure 11 below indicating the sea surface temperature anomalies experienced in the NINO3.4 area of the tropical South Pacific.

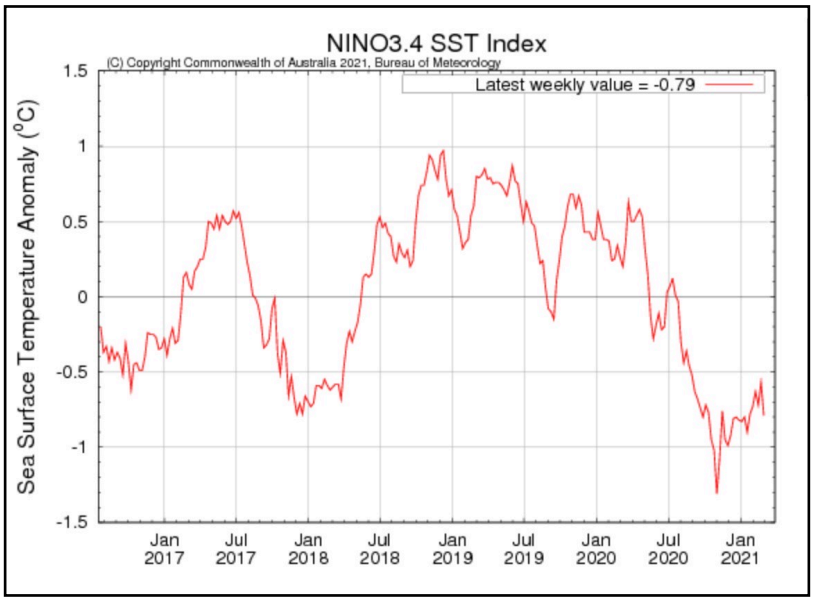

Figure 11: Bureau of Meteorology (BOM), NINO3.4 SST Index (January 2017 - January 2021) viewed 4 March 2021, http://www.bom.gov.au/climate/change/#tabs=Tracker&tracker=timeseries

According to BOM (2021):

> The mean temperature for the 10 years from 2011 to 2020 was the highest on record, at 0.94 °C above average, and 0.33 °C warmer than the 10 years 2001–2010. All years since 2013 have been amongst the ten warmest on record for Australia. Of the ten warmest years, only one (1998) occurred before 2005.

Given these above examples of data together with further information available from the BOM such as the Australian Climate Observations Reference Network - Surface Air Temperature (ACORN-SAT), predictions may be made regarding the possibilities of future climatic conditions such as Cold waves, Cyclones, Drought, Fire, Floods, Heat waves, and Storms. All of these climatic conditions present their concerns for the health and well-being of Australia's population but "heatwaves and hot weather are responsible for the greatest number of deaths from any type of natural disaster, and contribute significantly to morbidity, particularly among the elderly."(Climate Council, 2014).
In a more moderate tone of predictive ability, however, Davis and Hanna (2020) aver that:

> Although intensification of climatic extremes is projected, the stochastic element in climate system behaviour means that climate scientists cannot accurately forecast where and what types of climatic extremes will occur, nor precisely when. Therefore, localised analysis of climate trends provides valuable insights into future climatic challenges. Understanding trends is a powerful tool for future planning decisions (p.13).

Emphasis should therefore be given to the realisation of what degree of severity extreme temperatures have on the population and how to address this concern.

D. Extreme Heat Impacts affecting Australian Health

Climate extremes are a threat to human life, but it has been recognised that heat exposure accounts for more human lives lost per year than all other severe weather events combined (Coates et al. 2014, p.20).

Although documentation of heat-associated deaths appears to be not well represented (ibid.) that which is available gives a fairly reliable comparison of fatalities from Australian natural hazards. This is reflected in the following Table 2.

Natural hazard	Deaths 1900–2011	% total natural hazard deaths 1900–2011
Extreme heat	4,555	55.2
Flood	1,221	14.8
Tropical cyclone	1,285	15.6
Bush/grassfire	866	10.5
Lightning	85	1
Landslide	88	1.1
Wind storm	68	0.8
Tornado	42	0.5
Hail storm	16	0.2
Earthquake	16	0.2
Rain storm	14	0.2

Table 2. Comparison of fatality totals with other Australian natural hazards (from PerilAUS). Coates et al., 2014, https://doi.org/10.1016/j.envsci.2014.05.003

These data alone support the observation that increased heat exposure accounts for an increase in heat exhaustion, heat stroke and death. This is of particular concern in ‘High concentrations of buildings in urban areas [that] cause urban heat island effect, generation and absorbing heat, making the urban centre several degrees warmer than surrounding areas.’ (NIH, 2017)

As a local example of this:

> In Northern Australia, particularly during the 2019–2020 Wet season, where records for intensity and heatwave duration broke previous records by very large margins and where Australia experienced its hottest day on record on 18 December 2019, with many regions above 48 °C, a continental average of 41.88 °C. Australia and its tropical north have little wriggle room to cope with additional warming (Davis & Hanna, 2020, p. 10).

In these scenarios, any urban heat island effect, in addition to heat extremes experienced, will exacerbate an already dangerous health situation and require much greater awareness of mitigation and adaptation protocols to follow.

E. Strategic Management & Adaptation

According to the National Institute of Environmental Health Services (NIH, 2019):

> Certain adverse health effects can be minimised or avoided with sound mitigation and adaptation strategies. Strategies for mitigating and adapting to climate change can prevent illness and death in people now while also protecting the environment and health of future generations.

However, according to Zillman (2015), 'the climate change 'debate' in Australia has become embroiled in economic and ideological issues rather than ones based on scientific evidence', and even though the Australian Government in 2015 outlined a proposal to invest $6 billion to develop Northern Australia, (Office of the Prime Minister and Cabinet 2015), there was no reference for the need for climate risk analysis. (Davis & Hanna, 2020, p. 2).

More work should be performed in this regard, and any analysis undertaken should include mitigation and adaptation protocols such as those suggested by the NIH (2021) for general populations:

- Heat early warning systems and proactive heat wave response plans
- Increased air conditioning use
- Decreased time spent outdoors during extreme heat events
- Increased use of sun-shielding clothing

Further sources of information in this regard can be found on the website of Workplace Health & Safety Queensland - WorkSafe. qld.gov.au. and from the Heatwave Management Sub-Plan produced by Queensland Health in June 2019.

F. Summary

Initially, this study conducted a comprehensive literature review focussing on critical global climate trends and those specifically affecting the Australian continent
This followed through with a discussion of increasing temperatures on land and sea and in particular the increasing frequency and impacts of heat extremes on the health of our population. Some protocols have then been reviewed or recommended to minimise the effects of these impacts on both the general population and those in an occupational setting.
These changes are affected by climatic drivers such as ENSO and require further study to give a clearer apprehension of the extent of future extreme heat events and how we can become prepared to deal with them.

G. Conclusions

Data has been obtained from reputable sources such as the National Aeronautics and Space Administration (NASA), National Climatic Data Center (NCDC), National Oceanic and Atmospheric Administration (NOAA) and the Australian Government's Bureau of Meteorology (BOM). This is supported by considerable peer-reviewed research on the changes to both global and local climatic changes.

It is with little doubt that temperature, through the capture of excess heat due to increasing GHG emissions, is increasing at an accelerated rate. This is creating climatic disturbances that are increasing in frequency and intensity.

This is proving increasingly problematic for decisions to be made in adapting to protocols for managing changes — especially regarding the resources required to provide appropriate assistance for the health and well-being of Australia's population.

Davis & Hanna (2020) observe that with the stochastic element of climate system behaviour, variations in data gained to make it difficult to accurately predict the frequency and intensities of extreme conditions earlier referred to (p.13).

This suggests a need for a better understanding of the role of the driving forces such as the effects of ENSO such that we can defend our population from the disastrous effects of extreme climatic conditions and in particular those relating to the development of extreme heat events.

H. References

Australian Academy of Science, 2021, 5. How are extreme events changing? viewed 5 March 2021, <https://www.science.org.au/learning/general-audience/science-climate-change/5-how-are-extreme-events-changing>

Australian Government Department of the Prime Minister and Cabinet, 2015, 2015-2016 Annual Report, viewed 5 March 2021, <https://www.pmc.gov.au/sites/default/files/publications/annual_reports/2015-16/>.

Bureau of Meteorology, 2021, NINO3.4 SST Index, viewed 4 March 2021, <http://www.bom.gov.au/climate/enso/indices.shtml>.

Climate Council, 2014, Heatwaves: Hotter, Longer, More Often, viewed 4 March 2021, <https://www.climatecouncil.org.au/resources/heatwaves-report/>.

Climate Council, 2021, Hitting Home: The Compounding Cost of Climate Inaction, viewed 17 March 2021, <https://apo.org.au/sites/default/files/resource-files/2021-01/apo-nid310703.pdf>.

Coates L, Haynes K, O'Brien J, McAneney J, de Oliveira FD, 2014, Exploring 167 years of vulnerability: an examination of extreme heat events in Australia 1844–2010. *Environmental Science & Policy* vol. 42, pp 33–44, viewed 5 March 2021, < https://doi.org/10.1016/j.envsci.2014.05.003>

Costello, A, Abbas, M, Allen, A, Ball, S, Bell, S, Bellamy, R, Friel, S, Groce, N, Johnson, A, Kett, M, Lee, M, Levy, C, Maslin, M, McCoy, D, McGuire, B, Montgomery, H, Napier, D, Pagel, C, Patel, J, Antonio Puppim de Oliveira, J, Redclift, N, Rees, H, Rogger, D, Scott, J, Stephenson, J, Twigg, J, Wolff, J, Patterson, C, 2009. Managing the health effects of climate change. *The Lancet,* 373(9676), pp.1693–1733, viewed 5 March 2021, <https://climateandhealthalliance.org/wp-content/uploads/2018/02/UCL-Lancet-Managing-the-Health-Effects-of-Climate-Change.pdf>.

Davis, CJ & Hanna, EG, 2020, Seasonal temperature and rainfall extremes 1911–2017 for Northern Australian population centres: challenges for human activity, *Regional Environmental Change*, vol 20, no, 4,p. 28, viewed 4 March 2021,< https://link.springer.com/article 10.1007/s10113-020-01706-6>

Doctors for the Environment Australia, 2017, *Climate Change & Health in Australia,* viewed 5 March 2021, <https://www.dea.org.au/wp-content/uploads/2017/02/DEA_Climate_Change__Health_Fact_Sheet_final.pdf>.

Finlayson, BL, and McMahon, TA, 1988, Australia v. the world: A comparative analysis of streamflow characteristics, in *Fluvial Geomorphology of Australia,* edited by R. F. Warner, pp. 17–40, Academic, Sydney, Australia.

Lewis, S, & Maslin, M, 2015, Defining the Anthropocene, *Nature* vol. 519, pp.171–180.viewed 5 March 2021, <https://doi.org/10.1038/nature14258>.

Luber G, Prudent N, 2009, Climate change and human health. *Transactions of the American Clinical and Climatological Association.* vol. 120, pp 113-117.

McNeill, JR, & Engelke, P, 2016, The Great Acceleration: *An Environmental History of the Anthropocene since 1945*, Cambridge, Massachusetts, The Belknap Press of Harvard University Press

NASA, 2021a, Overview: Weather, Global Warming and Climate Change, viewed 5 March 2021, <https://climate.nasa.gov/resources/global-warming-vs-climate-change/>

NASA, 2021b, NASA's Eyes on Extreme Weather, viewed 3 March 2021, <https://www.jpl.nasa.gov/edu/news/2019/10/18/nasas-eyes-on-extreme-weather/>

NASA, 2021c, Global Climate Change: Overview: Carbon Dioxide, viewed 4 March 2021, <https://climate.nasa.gov/vital-signs/carbon-dioxide/>

NASA, Goddard Institute for Space Studies, 2021d, Global Land-Ocean Temperature Index, Latest Annual Average Anomaly: 2019, viewed 4 March 2021, <https://climate.nasa.gov/vital-signs/global-temperature/>

NASA, 2021e, Global Climate Change: Overview: Arctic Sea Ice Minimum, viewed 4 March 2021, <https://climate.nasa.gov/vital-signs/arctic-sea-ice/>

NASA, 2021f, Global Climate Change: Ice Sheets, viewed 4 March 2021, <https://climate.nasa.gov/vital-signs/ice-sheets/>

NIH, 2017, Effects of Heat - Climate and Human Health, Viewed 5 March 2021, <https://www.niehs.nih.gov/...change/health_impacts/index.cfm>

NIH, 2019, Health Impacts - Climate and Human Health, Viewed 5 March 2021, <https://www.niehs.nih.gov/...change/health_impacts/index.cfm>

NOAA, National Ocean Service: Is sea level rising? viewed 4 March 2021, <https://oceanservice.noaa.gov/facts/sealevel.html>

RACGP, 2019, Climate-change-and-human-health. pdf

RACGP, 2021, The impact of climate change on human health, viewed 4 March 2021, <https://www.racgp.org.au/advocacy/position-statements/view-all-position-statements/clinical-and-practice-management/the-impact-of-climate-change-on-human-health>

Steffen, W, Crutzen & P.J & McNeill, JR 2007, The Anthropocene: are humans now overwhelming the great forces of nature?, Ambio, vol. 36, pp.614–621

State of Queensland (Queensland Health), 2019, Heatwave Management Sub-Plan, viewed 5 March 2021, <https://www.health.qld.gov.au/__data/assets/pdf_file/0032/628268/heatwave-response-plan.pdf>.

United Nations Department of Economic and Social Affairs, 2020, Viewed 5 March 2021, <https://www.un.org/development/desa/en/page/2>.

Watts, N, et al., 2015. Health and climate change: policy responses to protect public health. *Lancet*, June.

WHS Queensland, 2021, Managing heat stress in the workplace, viewed 5 March 2021, <https://www.worksafe.qld.gov.au/resources/campaigns/safe-work-month/2019-content/injury-prevention-and-return-to-work-conference-2019-presentation-podcasts/managing-heat-stress-in-the-workplace>

WMO, 2018, WMO Archive of Weather and Climate Extremes, viewed 3 March 2021, <https://public.wmo.int/en/resources/bulletin/wmo-archive-of-weather-and-climate-extremes>