

An aerial photograph showing a vast area of flooding. In the foreground, a large body of brown water covers the landscape, with some trees and small islands of land visible. A highway bridge spans across the water. In the middle ground, a town with many houses and buildings is partially submerged. In the background, more land and distant hills are visible under a clear blue sky.

THE GREAT DELUGE: AUSTRALIA'S NEW ERA OF UNNATURAL DISASTERS

Thank you for supporting the Climate Council.

The Climate Council is an independent, crowd-funded organisation providing quality information on climate change to the Australian public. If you'd like to support more reports like this, head to www.climatecouncil.org.au/donate.

Emergency Leaders for Climate Action (ELCA) is a coalition of 40 former chiefs, commissioners and director generals of fire and emergency services from every state and territory. Formed in early 2019, ELCA exists to catalyse all levels of government to act on climate change.

Published by the Climate Council of Australia Limited.

ISBN: 978-1-922404-66-4 (print)
978-1-922404-67-1 (digital)

© Climate Council of Australia Ltd 2022.

This work is copyright the Climate Council of Australia Ltd. All material contained in this work is copyright the Climate Council of Australia Ltd except where a third party source is indicated.

Climate Council of Australia Ltd copyright material is licensed under the Creative Commons Attribution 3.0 Australia License. To view a copy of this license visit <http://creativecommons.org.au>.

You are free to copy, communicate and adapt the Climate Council of Australia Ltd copyright material so long as you attribute the Climate Council of Australia Ltd and the authors in the following manner: The great deluge: Australia's new era of unnatural disasters by the Climate Council of Australia and Emergency Leaders for Climate Action.

Authors and contributors: Climate Council: Dr Martin Rice, Hollie Cheung, Dr Annika Dean, Nathan Hart, Professor Hilary Bambrick, Vaidehi Shah, Dinah Arndt, Professor Lesley Hughes, Professor David Karoly, Kate O'Callaghan, and Dr Simon Bradshaw. ELCA: Greg Mullins, David Templeman, Chas Keys, Peter Dunn, and Lee Johnson.



We are grateful to the Larkin family in the Scenic Rim, Queensland for the courage and generosity to share their lived experience of the destructive impacts of accelerating climate change on Australians, our communities and businesses (see Box 2, Section 6).

—
Cover image: Flooding of Maitland NSW and surrounds. Photo by Airphoto Australia/Getty Images.

The Climate Council acknowledges the Traditional Custodians of the lands on which we live, meet and work. We wish to pay our respects to Elders past, present and emerging and recognise the continuous connection of Aboriginal and Torres Strait Islander people to Country.

This report is printed on 100% recycled paper.



facebook.com/climatecouncil



info@climatecouncil.org.au



twitter.com/climatecouncil



climatecouncil.org.au

Contents

Key findings	ii
1. Introduction.....	1
2. The Great Deluge: Climate extremes in action.....	4
3. Climate influences on the Great Deluge	6
3.1 La Niña	8
3.2 Indian Ocean Dipole	9
3.3 Southern Annular Mode	10
4. Impacts of the Great Deluge	12
4.1 Economic	13
4.2 Insurance	16
4.3 Agriculture	19
4.4 Infrastructure	21
5. The summer ahead: What else is in store?	23
5.1 Tropical cyclones	25
5.2 Bushfire risks	28
6. Australia is dangerously unprepared for climate-fuelled disasters	29
6.1 Knowledge gaps and funding cuts	30
6.2 Compounding disasters are stretching emergency services to the limit	31
7. Policy recommendations	35
8. Stay safe this summer	39
References	41
Image credits	44

Key findings

1 2022 will be remembered as the year of the Great Deluge, when rain and rolling floods swamped Eastern Australia breaking many records.

- › From Queensland to Tasmania all eastern states were affected by prolonged and intense rainfall events that led to wide-spread and repeat flooding.
- › Wettest monthly records were smashed for Brisbane (Queensland), Lismore, Sydney (New South Wales), Shepparton, Falls Creek (Victoria) and Lorrina (Tasmania), with up to three to nine times the typical rainfall recorded in these places.
- › Collectively, the storms and floods that affected southeast Queensland and coastal New South Wales in February and March were equal to Australia's costliest ever extreme weather event at \$5.56 billion in insured losses from more than 236,000 claims.
- › All Australians are bearing these costs with insurance premiums and food prices on the rise, and more than \$1.5 billion of essential infrastructure needing repair in New South Wales alone. In fact, the average cost per household of extreme weather disasters increased by 73 percent from the ten-year average to \$1,532 in 2021-2022.

2 The danger to Australians from climate-fuelled extreme weather is far from over with experts warning that the summer ahead portends several high risks.

- › Communities, emergency services and all levels of government should be ready for even worse this summer; with catchments already saturated, and further extreme rainfall and flooding expected.

- › The Bureau of Meteorology has predicted a high chance (73 percent) of more tropical cyclones than the typical 11 for the Australian region.

- › Some of our most important growing regions in Victoria, New South Wales and Queensland have flooded, which may lead to food shortages and higher supermarket prices for grocery staples like milk, fruit and vegetables.

- › The Great Deluge of 2022 has increased the risk of mosquito-borne diseases. There could be a major outbreak of the Japanese encephalitis virus here, with as many as 750,000 Australians at risk of exposure to the deadly virus.

3 Queensland suffers the most economic damage from such disasters. The Sunshine State's total losses from extreme weather since the 1970s were around three times those of Victoria and 50% greater than New South Wales.

- › The costs of climate change continued to rise in 2022, with Queensland bearing an estimated \$7.7 billion cost in social, financial and economic impacts because of record-breaking rainfall and floods in February and March.
- › The City of Brisbane suffered \$1.38 billion in insured losses from this year's floods; higher than any other local government area in Australia.
- › Spring 2022 flooding in New South Wales and Victoria could cause up to \$5 billion worth of damage to the East Coast grain harvest, with 10 million tonnes of produce already directly or indirectly damaged. Agricultural damage caused by the February 2022 floods in southeast Queensland was estimated to be \$254 million. 17 local government areas and 2,250 primary producers were affected, with the impact of the floods estimated to cost 30 percent of the total value of production.

- › Repairing essential infrastructure will take some time, with roads, transport and telecommunication networks severely impacted. In Southeast Queensland, for example, public infrastructure damages were estimated to be \$492 million, including 1,718 kilometres of state-controlled roads and ferry infrastructure.

4 This new era of climate-fuelled, unnatural disasters carries severe consequences for disaster and emergency management in Australia.

- › Those in the disaster and emergency management sector know we have entered a new era of escalating disaster threats, where the next impact often hits while communities are still reeling from the last. For some families in the Hawkesbury region, for instance, the July 2022 flood was the fourth time they had been inundated in 18 months.
- › Long-term recovery operations - which are already difficult and expensive - are being set back by subsequent climate disasters. For example, on the NSW South Coast many people made homeless by the 2019/20 Black Summer fires had their temporary accommodation flooded in 2020.
- › As a result, the systems we use to plan for and manage disasters no longer cut it. We need to rethink and transform our response to climate-driven disasters starting with more accurate and accessible risk models.
- › All governments should focus on reducing people's exposure and vulnerabilities to disasters. However, risk cannot be eliminated and much greater investment should be made in supporting communities to respond, recover and remain resilient through programs like 'Community First Responders'.

5 While Australian families, businesses and communities suffer through record-breaking climate disasters, the fossil fuel corporations that worsen climate change are making eye-watering profits.

- › We are facing a future of more destructive extreme weather events due to climate change, with very wet as well as very dry seasons and weather patterns set to intensify.
- › Climate change is primarily driven by the burning of coal, oil and gas, and scientists agree the only way to avoid a full catastrophe is by deeply cutting greenhouse gas emissions this decade.
- › Fossil fuel corporations are raking in billions of dollars in profits, yet many of them paid no income tax in Australia last financial year. Meanwhile, communities and critical sectors such as farming bear the brunt of escalating climate costs.
- › Australia should end fossil fuel subsidies and use savings to set up a climate disaster fund that meets the increasing costs of climate-fuelled disasters in Australia, and supports vulnerable communities.

1. Introduction

2022 will be remembered as the year of the Great Deluge, when record-breaking rain and floods lashed large parts of Eastern Australia, causing untold devastation for Australians and our economy. Climate change, driven by the burning of coal, oil and gas, was a major factor in the Great Deluge. It is consigning Australia to an era of climate disasters that we are not prepared for. This report is a stark warning that this is not over yet, and a call for all levels of government to speed up their emission reductions and disaster preparation efforts.

This year has seen large parts of Eastern Australia experience record-breaking rainfall and floods. From Queensland down to Tasmania, extreme weather events have taken people's lives, led to the evacuation of communities, damaged homes, belongings and businesses, destroyed crops and livestock, and saddled us with billions of dollars in rebuilding costs.

Many communities were affected by not one, but multiple consecutive floods this year, with little to no time to recover after each one. For some families in New South Wales' Hawkesbury region, for instance, the July 2022 flood was the fourth time in 18 months the region was inundated.

The fingerprints of climate change, which drives more intense storms and downpours, are on the Great Deluge of 2022. Across much of Queensland, New South Wales, Victoria and Tasmania, the floods are the latest in a long line of climate change-driven extreme weather events they have faced in recent years, including prolonged drought, scorching heatwaves, the Black Summer bushfires, and powerful storms.

Climate change is driving a new era of 'unnatural disasters' – and as a country we are not prepared to cope. This year, we have seen how consecutive, record-breaking events can overwhelm emergency services and devastate communities.



Figure 1: Business owners and volunteers clean up after November 2022 floods in Molong, New South Wales. Communities in Eastern Australia have endured multiple flooding events over the course of the Great Deluge.

We are in an era of climate-fuelled disasters because governments have thus far failed to substantially reduce emissions, and sentenced communities in Australia and worldwide to a far more dangerous future than if they had acted on repeated warnings from scientists.

There is no time to waste. The Intergovernmental Panel on Climate Change, the world's leading body for assessing the science related to climate change, has warned that past inaction means a gradual or slow response to the climate crisis is not enough to avoid catastrophe. Only truly transformative change will effectively deal with what has become an existential threat to us all.

Governments of all levels must immediately act to increase preparedness for worsening extreme weather events, and to rapidly reduce greenhouse gas emissions this decade.

"Our planet is fast approaching tipping points that will make climate chaos irreversible. We are on a highway to climate hell with our foot still on the accelerator."

— Secretary-General's remarks to High-Level opening of COP27, 7 November 2022 (UN 2022).

In Australia, action to reduce greenhouse gas emissions must be underpinned by phasing out fossil fuels – an industry that has raked in eye-watering profits this year. Many fossil fuel companies paid little to no income tax in the 2020-2021 financial year, while the rest of Australia racks up billions of dollars in damages from climate disasters.

At the same time, governments also need to urgently invest in measures that help emergency services cope with worsening disasters and empower communities to stay resilient when an extreme weather event hits. This includes more funding for emergency services, new research to understand looming climate risks, and support for communities to rebuild or relocate in a way that reduces their vulnerability to worsening climate change.

As Summer 2022-2023 approaches, saturated catchments and climate drivers including La Niña are set to fuel a season of potentially catastrophic unnatural disasters, including even worse flooding, a high chance of more tropical cyclones than is typical, and marine heatwaves. Communities, emergency services and all levels of government should prepare for the worst, while maintaining a laser focus on the urgent need to achieve deep, rapid emissions cuts this decade and ensure our emergency management efforts are fit for purpose in this new era of climate disasters. This is the only way to protect Australians now, as well as for generations to come.

All levels of government must ramp up their climate disaster preparedness and drastically reduce their emissions. Australians need both to happen - desperately.

2. The Great Deluge: Climate extremes in action

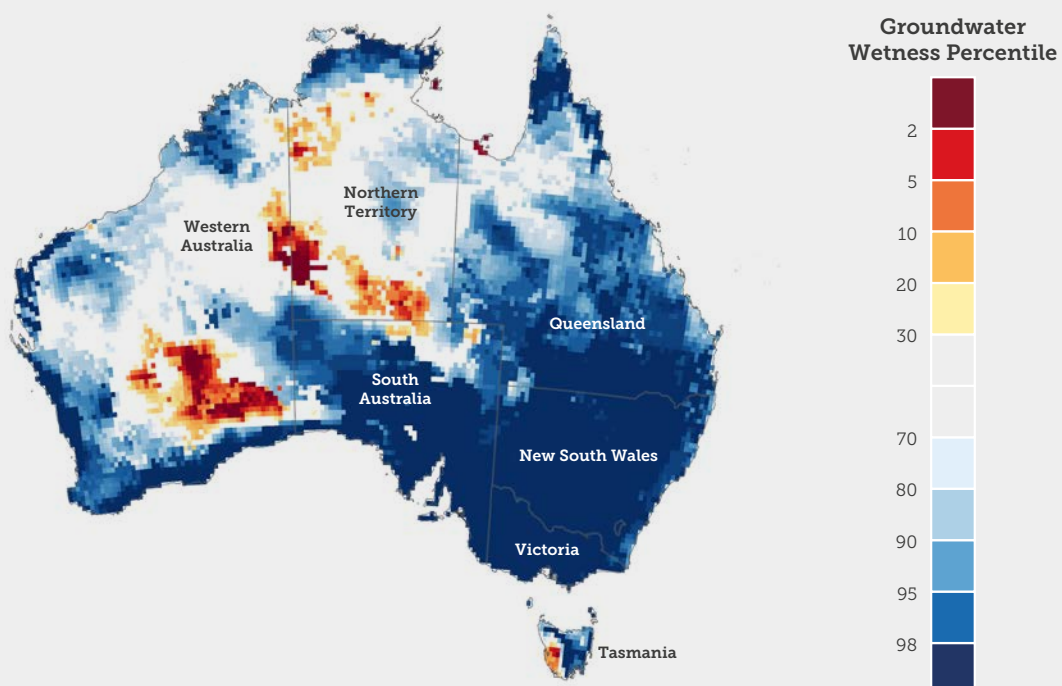
In 2022, all Eastern States and Territories from Queensland to Tasmania have been affected by prolonged and intense rainfall events over wide areas, resulting in flooding.

The Great Deluge of 2022 has smashed many records for rainfall totals, wettest days and months on record, flood levels, and river heights. With an ongoing flood emergency in parts of NSW at the time of publication, this tally is likely to be higher by the end of the year.

Here is a snapshot of some of the remarkable data that has characterised the Great Deluge.

Figure 2: Satellite measurements from space show how much many catchments in Eastern Australia are saturated after prolonged rainfall and flooding in 2022. The image depicts shallow groundwater storage in Australia from November 11–14 November as measured by the Gravity Recovery and Climate Experiment Follow-On (GRACE-FO) satellites. The colors depict the wetness percentile; that is, how the levels of groundwater compare to long-term records (1948–2012). Blue areas have more abundant water than usual, and orange and red areas have less. **Source:** Adapted from NASA 2022.

SHALLOW GROUNDWATER STORAGE IN AUSTRALIA FROM NOVEMBER 11–14, 2022



RAINFALL AND FLOODING 2022

QUEENSLAND TO TASMANIA

BRISBANE

- Wettest Jan-Oct on record with almost three times the average rainfall over the same period and almost two times the average annual rainfall.
- Wettest Feb on record, with almost nine times the average monthly rainfall.
- Feb had three of the wettest ten days on record.

LISMORE

- Wettest Jan-Oct on record with almost three times the average rainfall over the same period and almost two times the average annual rainfall.
- Wettest Feb on record, with 28 Feb the wettest day on record.
- February and March had over six and four times the average monthly rainfall, respectively.

SYDNEY

- Wettest Jan-Oct on record with over three times the average rainfall over the same period and over two times the average annual rainfall.
- Wettest March, July and October on record, with over five times the average rainfall for each month.

FORBES

- Lachlan River peaked at 10.67 metres in November 2022 (highest in 70 years).

WAGGA WAGGA

- Murrumbidgee River peaked at 9.72 metres in November 2022 (highest in 12 years).

SHEPPARTON

- Wettest October on record with almost six times the average monthly rainfall.

FALLS CREEK

- Wettest August and October on record with almost three and over four times the average monthly rainfall, respectively.

MURRAY-DARLING BASIN

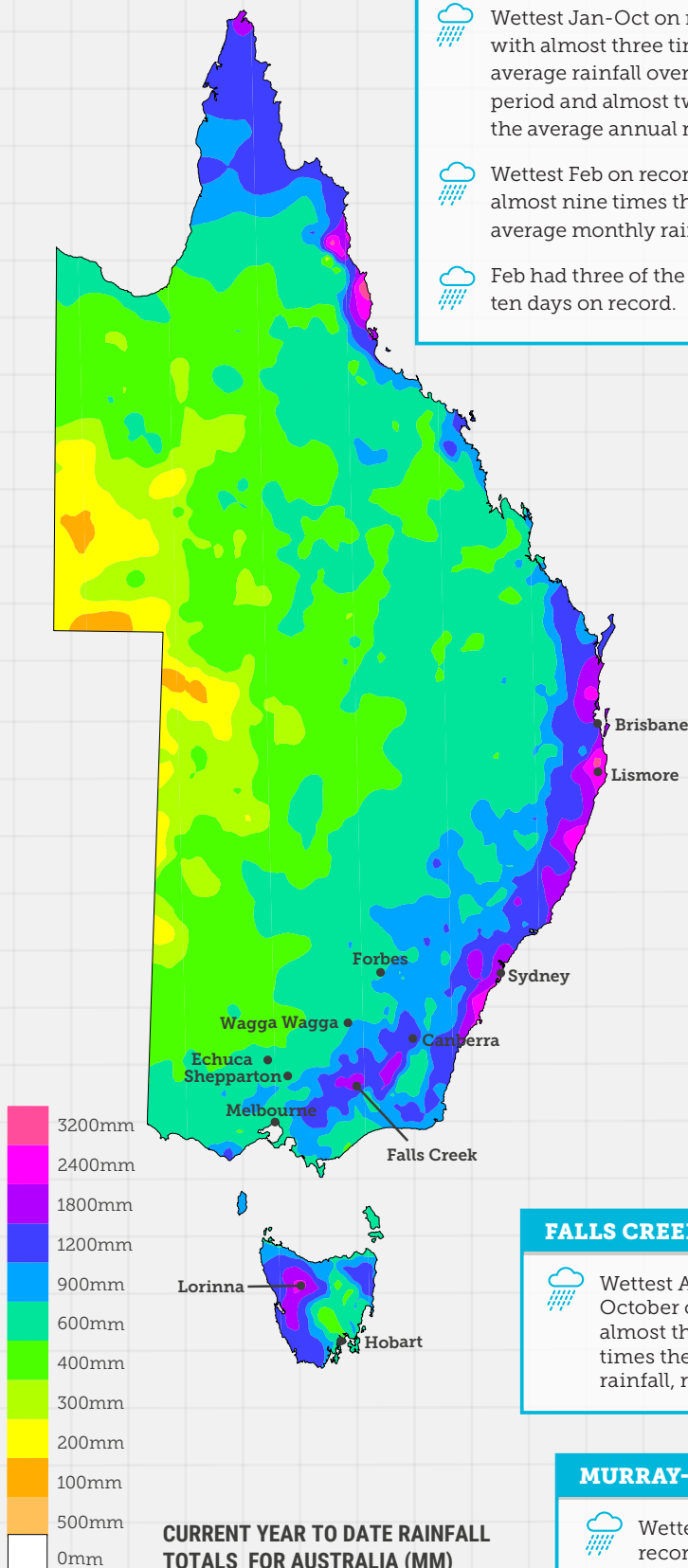
- Wettest October on record since 1950.

ECHUCA

- Murray River at Echuca peaked at 94.98 metres in October 2022 (highest in 29 years).

LORINNA

- Wettest Oct on record, with almost three times the monthly average rainfall.



3. Climate influences on the Great Deluge

The devastating extreme weather events of this year have been shaped by a particular combination of natural climate drivers—factors in the global climate system influenced by ocean currents and large-scale air circulation patterns—and supercharged by climate change.

All extreme weather events are occurring in an atmosphere supercharged by climate change, which is driven primarily by the burning of coal, oil, and gas. According to the Intergovernmental Panel on Climate Change (IPCC 2022a), the heavy rainfall events seen in recent years that led to catastrophic flooding were made more likely by climate change.

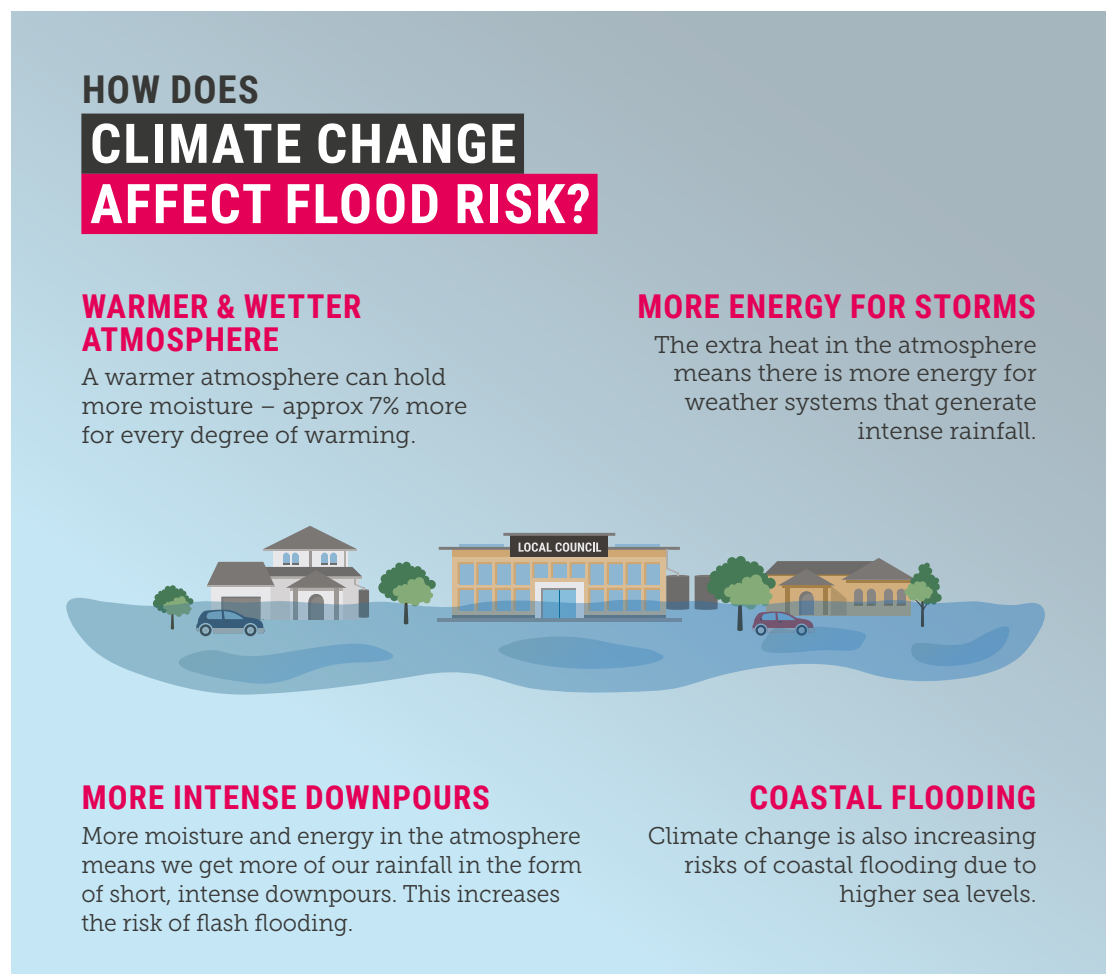


Figure 3: How does climate change affect flood risk?

Australia's climate has warmed by around 1.5°C between 1910 and 2020 (CSIRO and BoM 2022; BoM 2022a). Climate change, driven by the burning of coal, oil and gas, was a major factor in the Great Deluge:

- › **A warmer atmosphere holds more moisture, and more energy to fuel storms.** For each 1°C rise in global average temperature, the atmosphere can hold approximately 7 percent more moisture (Trenberth 2011). A warmer atmosphere also means there is more energy to fuel storms that generate heavy rainfall. These factors increase the likelihood of extreme downpours.
- › **Rainfall events in Australia are becoming more intense and frequent.** In recent decades, the intensity of short duration (hourly) extreme rainfall events has increased by around 10 percent in some regions, with larger increases observed in the north of Australia (CSIRO and BoM 2022). One study found that extreme and

potentially dangerous rapid rain bursts (sub-hourly heavy rainfall) over Greater Sydney have intensified by at least 40 percent over the past two decades (1997 to 2018) (Ayat et al. 2022).

- › **Each degree of further warming could double the frequency of intense rainfall events around the world.** Globally, the frequency of intense rainfall events experienced at the moment is likely to almost double with each degree of further warming (Myhre et al. 2019).

In addition to the influence of climate change, Australia's weather is also shaped by a number of climate drivers, including El Niño-Southern Oscillation, Indian Ocean Dipole, Southern Annular Mode and Madden-Julian Oscillation. These are cyclical fluctuations in ocean surface temperatures and ocean atmosphere interactions in the Pacific Ocean, Indian Ocean, Southern Ocean and the tropics respectively.



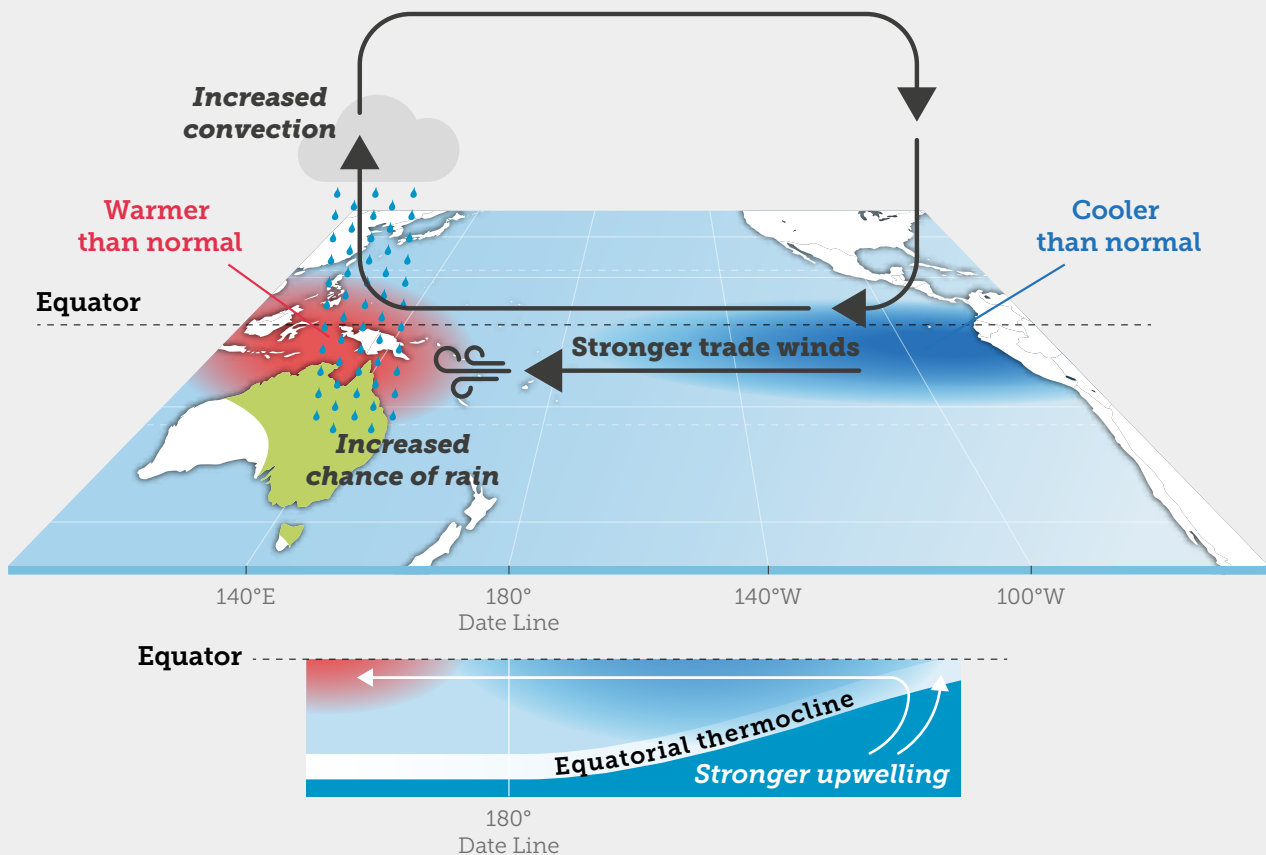
Figure 4: Flash flooding in Sydney CBD. Rapid rain bursts over Greater Sydney have intensified by at least 40 percent over the past twenty years (Ayat et al. 2022).

3.1 La Niña

La Niña is an oceanic and atmospheric phenomenon – the colder sister of El Niño – and one phase of the El Niño-Southern Oscillation. La Niña occurs when trade winds across the equatorial Pacific become stronger, pushing warm surface water westwards where it pools in the western Pacific and to the north of Australia. The displaced water is replaced with cooler waters from deeper in the ocean, resulting in a cooling of the surface of the central and eastern tropical Pacific Ocean. Warmer

waters in the western Pacific mean more clouds develop as warm, moist air rises. This typically means increased rainfall across much of Australia, particularly in the north and east (Figure 5).

In September 2022, the Bureau of Meteorology declared another La Niña was underway - the third such event in as many years, which is rare and has only happened on two other occasions (1973-1976 and 1998-2001) (King 2022).



El Niño-Southern Oscillation (ENSO): **La Niña**

3.2 Indian Ocean Dipole

The Pacific is not the only ocean that influences Australia's climate. The Indian Ocean Dipole (IOD) – a phenomenon which tracks relative sea-surface temperatures between the western and eastern parts of the Indian ocean (Figure 6) – is now in a negative phase. That is, the western part of the Indian Ocean is colder than the eastern part.

A negative IOD phase tends to increase the likelihood that cloud bands bringing above-average rain to Southeastern Australia will bring wet weather to the western side of the Great Dividing Range – just as it did in October 2022. This, combined with a La Niña event and a supercharged climate, contributed to parts of New South Wales and Victoria being affected by widespread flooding.

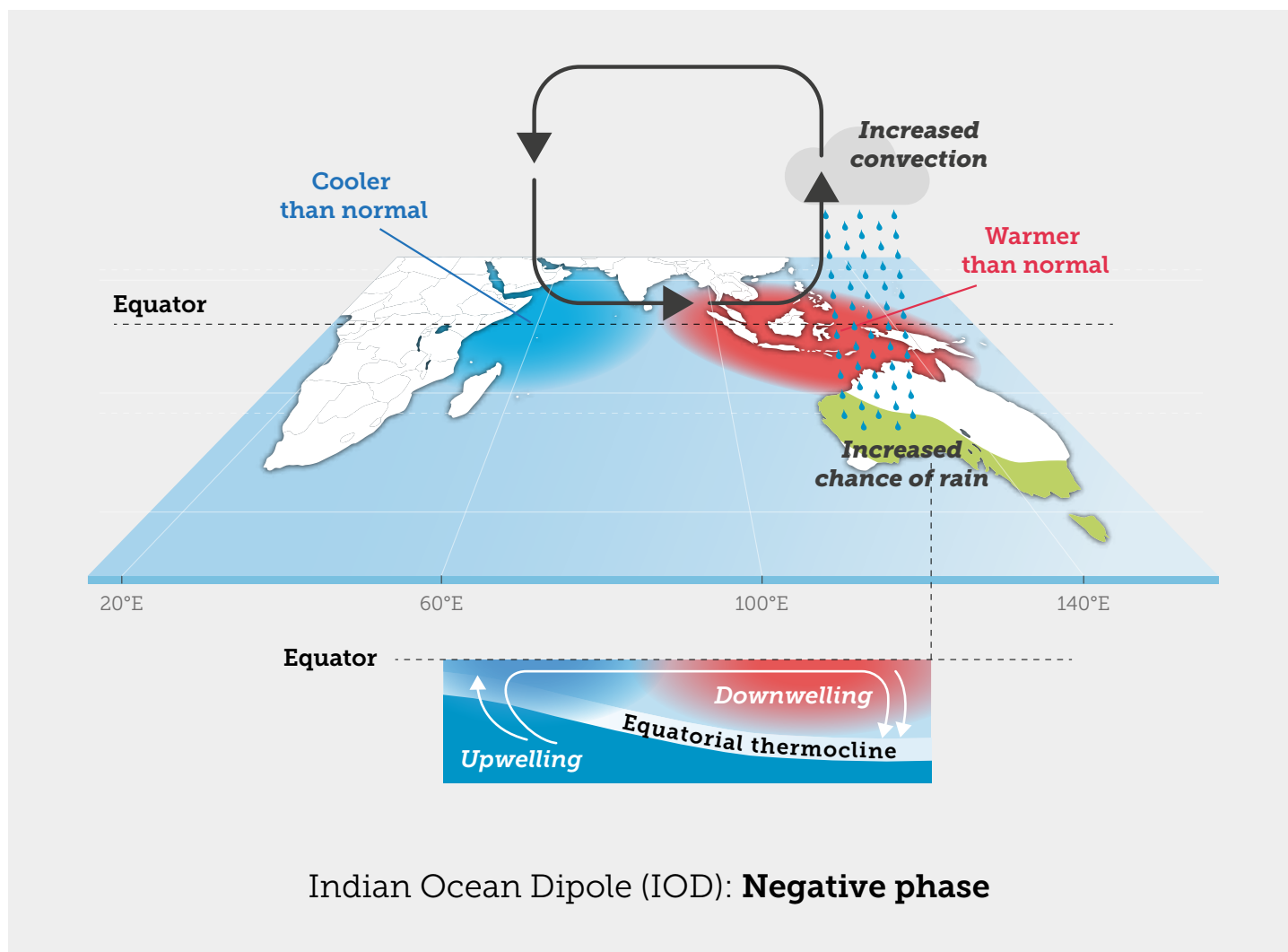
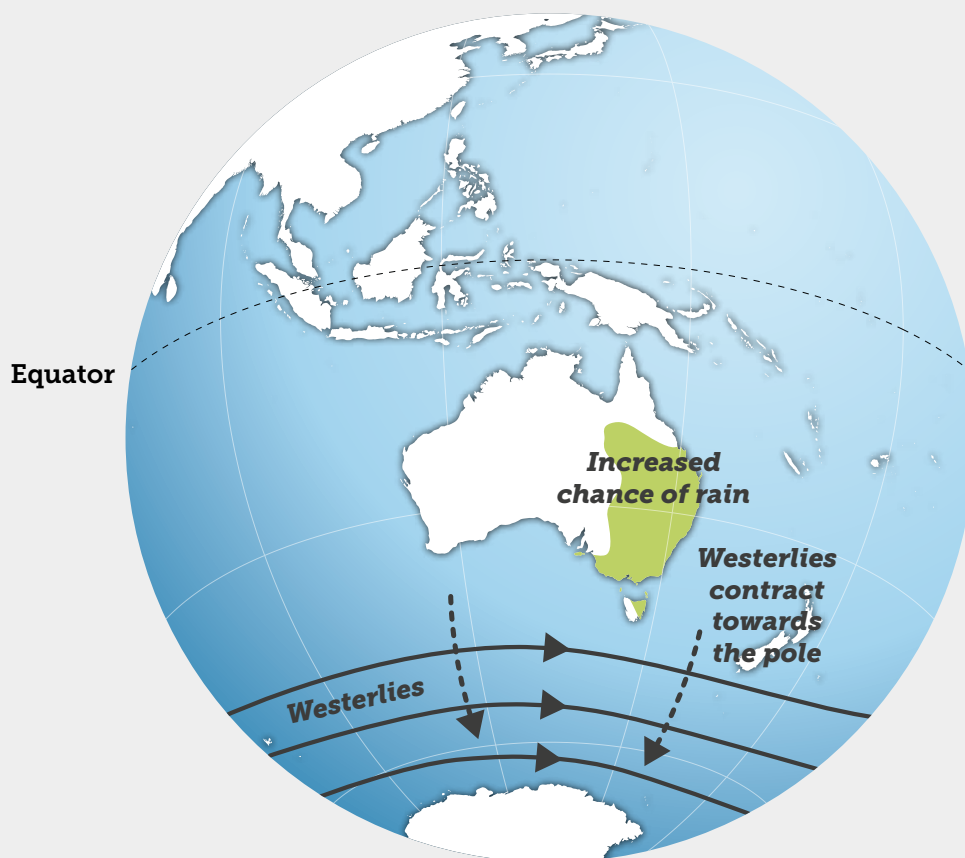


Figure 6: Schematic of a negative Indian Ocean Dipole. Adapted from Commonwealth of Australia 2013.

3.3 Southern Annular Mode

The Southern Ocean has also been primed to contribute additional rainfall to southern parts of Australia in 2022.

The Southern Annular Mode, or SAM, can affect rainfall in southern Australia, and refers to the north-south movement of the strong westerly winds that dominate the middle to higher latitudes of the Southern Hemisphere (Figure 7). The belt of strong westerly winds in the Southern Hemisphere is also associated with the storm systems and cold fronts that move from west to east.



Southern Annular Mode (SAM): **Positive phase (summer)**

During the summer and autumn months (December through to May), the SAM is showing an increasing tendency to remain in a positive phase, with westerly winds contracted towards the south pole. A positive SAM increases the chance of above average rainfall for parts of Eastern New South Wales, Eastern Victoria, and Southeastern Queensland.

While these climate drivers, and a particular combination of weather systems, influenced the Great Deluge in 2022 it is also important to note that these short-term cyclical drivers now occur in the context of a warming climate.

The influence of climate change on climate drivers such as the El Niño Southern Oscillation, including the frequency and intensity of La Niña events, is one of the most complex areas of climate science. Some models suggest that both El Niño and La Niña events will become more intense as the world continues to warm (e.g. Cai et al. 2021), while others project an overall weakening (e.g. Callahan et al. 2021).

What is clear, however, is that very wet or dry seasons and weather patterns will intensify in a warming climate, meaning wet spells are highly likely to become wetter and dry spells drier (Douville et al. 2021). We are facing a future of more intense extreme weather events due to climate change.

See BoM's latest '[Climate Driver Update](#)' for more information.

Whilst a range of climate drivers influenced the weather patterns seen in 2022, it is clear that climate change is adding to the intensity and frequency of extreme weather events.

4. Impacts of the Great Deluge

Like all climate disasters, intense rainfall and flooding events have devastating consequences for communities, businesses and the economy.

These include: loss of life and hospital admissions, mental health impacts, property damage, destruction of crops and livestock, clean up costs, loss of productivity and emergency response. Recovery from these impacts can take a long time. This section captures some of the main impacts of extreme weather events in a supercharged climate, and tallies the fall-out from the Great Deluge of 2022.

Figure 8: Flooding of the Hawkesbury river in farmlands in Sackville, New South Wales, March 2022. The Hawkesbury region is one area that has been inundated by floods multiple times over the last 18 months, with devastating impacts on the community.



4.1 Economic

The cost of weather-related disasters in Australia has risen significantly in recent decades, according to data from the International Disaster Database (EM-DAT), based on estimates of damage to property, crops and livestock. After adjusting for inflation, the costs have more than doubled since the 1970s (Figure 9) (Climate Council 2021).

Floods are our nation's most expensive extreme weather event, making up the greatest proportion (29 percent) of economic damages in Australia over the past decade (Climate Council 2021a; Figure 10). Between 2010 and 2019, floods caused more than \$10 billion in damages.²

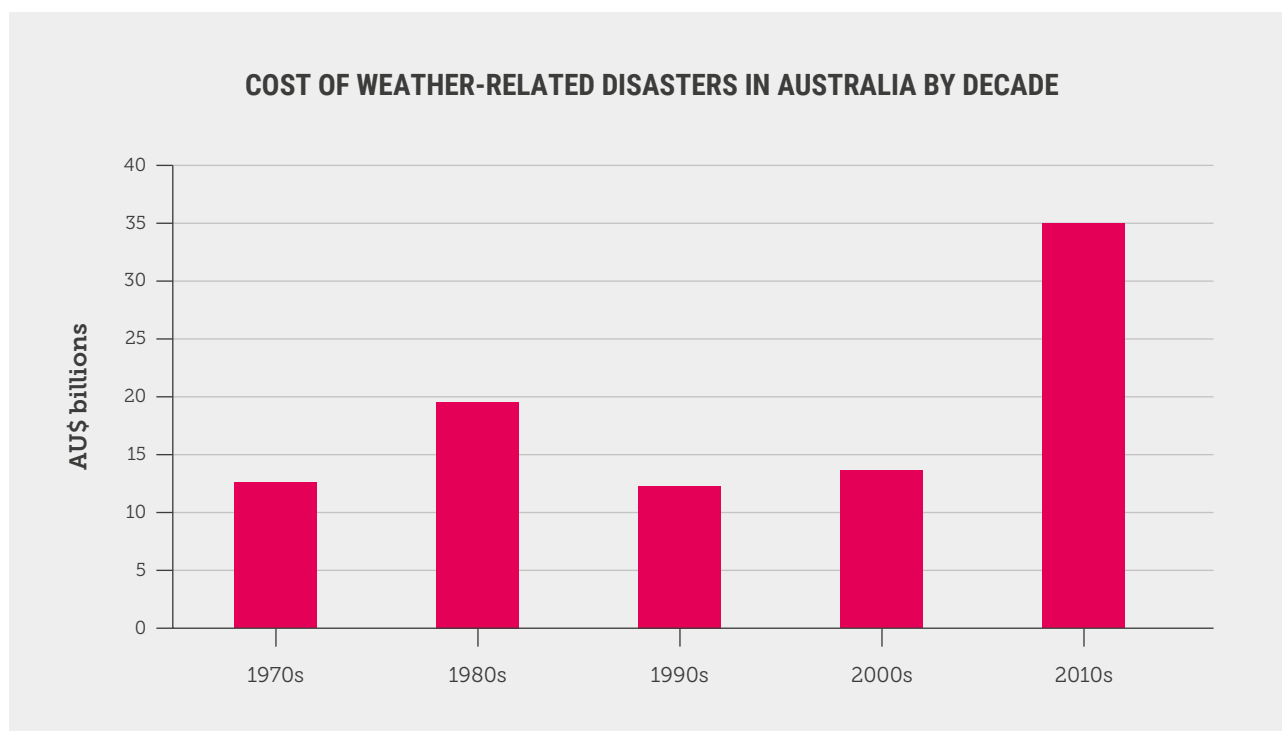


Figure 9: Cost of weather-related disasters in Australia by decade.¹ Based on data from EM-DAT, the International Disaster Database: <https://www.emdat.be/> (See Appendix 1 for more details).

¹ EM-DAT: <https://www.emdat.be/> Exchange rate data: <https://www.rba.gov.au/statistics/historical-data.html>. Inflation data: <https://www.rba.gov.au/calculator/annualDecimal.html>. The rise in cost is likely due to both climate and non-climate-related factors. The latter include growth in population and the number of people living in exposed areas.

² Based on data from EM-DAT, Climate Council calculated the cost of extreme weather disasters in Australia between 2010-2019 to be \$35bn (Climate Council 2021). Floods accounted for 29% of this total, or over \$10bn.

Floods are our nation's most expensive extreme weather event, making up the greatest proportion (29 percent) of economic damages in Australia over the past decade.

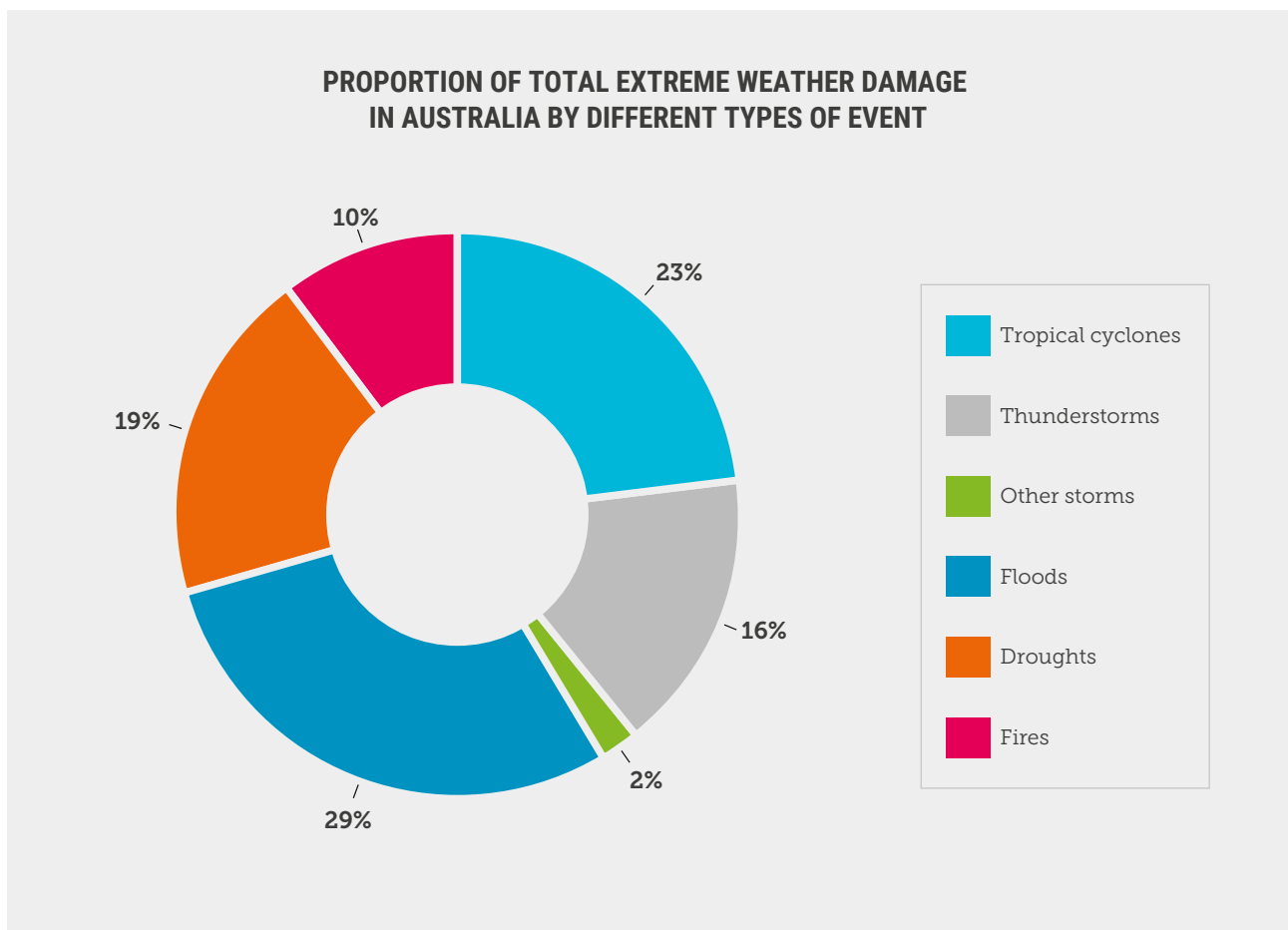


Figure 10: Proportion of total extreme weather damage in Australia (2010-2019) by different type of event.³
Based on data from EM-DAT, the International Disaster Database. <http://www.emdat.be/>

³ 'Floods' includes coastal floods, flash floods and riverine floods.

Queensland is on the frontline of escalating climate impacts, bearing higher climate disaster costs than any other Australian state or territory.

Queensland carries the greatest weight of disaster costs among Australian states and territories (Figure 11).

The Sunshine State's total losses from extreme weather disasters since the 1970s were around three times those of Victoria, and about 50% greater than NSW. On a per person basis, Queensland's losses were more than twice the national average. New South Wales suffered the second highest economic losses in the country, due to heavy damage from floods, drought, fires and storms.

The costs of climate change continued to rise in 2022, with Queensland bearing an estimated \$7.7 billion cost in social, financial and economic impacts because of record-breaking rainfall and floods in February and March (Deloitte 2022).

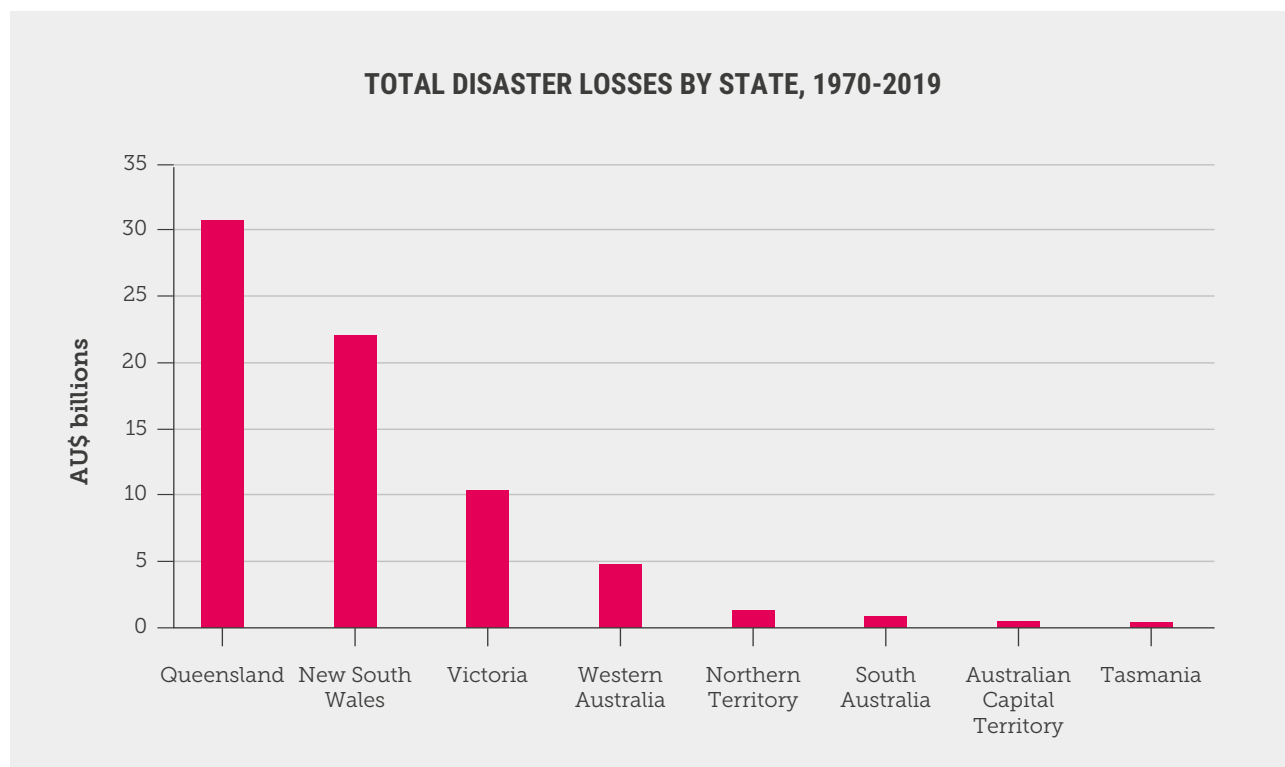


Figure 11: Cumulative economic damages by state/territory (1970-2019).⁴ Based on data from EM-DAT, the International Disaster Database: <https://www.emdat.be/>

4 This analysis covers all weather-related events in the EM-DAT database for Australia between 1970 and 2019, in accordance with the following classifications: storm (convective storm, extra-tropical storm, tropical cyclone), flood (coastal flood, flash flood, riverine flood), wildfire, drought, extreme temperature (cold wave, heat wave, severe winter conditions) between 1970 and 2019. The costs are as recorded at the time of the event, and have been converted from US\$ to AU\$ using the rate in 2019.

4.2 Insurance

In Australia, flooding along our densely populated coasts is a significant risk to communities. The most damaging consequences can arise when inland flooding, storm surges and high tides – all of which are exacerbated by climate change – occur at the same time. The inundation resulting from such floods can severely damage or destroy homes; as climate change cranks up the intensity and frequency of floods, it is getting more expensive – and in some cases too expensive – to insure against this damage. The Actuaries Institute estimates that by 2050, if greenhouse gas emissions continue unabated, premium affordability will likely deteriorate a further 20 percent for vulnerable households (e.g. households where insurance premiums are already very high relative to household income) (Paddam et al. 2022).

The insurance challenges arising from climate change are made worse by continuing urban development in risky and disaster-prone areas of Australia.

The Insurance Council of Australia estimates that the storms and floods that affected Southeast Queensland and coastal New South Wales in February and March 2022 caused \$5.56 billion in insured losses from more than 236,000 claims (ICA 2022b). Collectively, they were Australia's costliest floods ever, and now share the title of the costliest extreme weather event in Australia's history with the 1999 Sydney hailstorm.

Extreme weather events over the past 12 months cost every Australian household, on average, \$1,532. Over the last ten years, extreme weather has annually cost every household \$888 on average (The McKell Institute 2022), but this figure is expected to jump to more than \$2,500 a year by 2050.

Many fossil fuel corporations paid either no or negligible income tax in Australia in 2020/21, while communities and critical sectors such as farming bore the brunt of escalating costs of climate change.



Figure 12: A couple in Brisbane move their belongings by boat during the March 2022 floods. Australian households and communities are on the frontline of accelerating climate change and worsening extreme weather.

The average household cost of extreme weather disasters increased from \$888 in previous years to \$1,532 in 2021-2022. This big jump is largely attributable to the cost of the record-breaking February-March floods, and includes expenses paid for through taxes, insurance costs, uninsured damage, and increased prices due to supply chain disruptions.

The City of Brisbane suffered \$1.38 billion in insured losses from this year's floods, higher than any other local government area. This was followed by Lismore at \$508 million (as of August 2022). On a per-adult basis, Lismore suffered \$20,000 loss per adult, while Brisbane suffered \$1,500 per adult. Claims from Lismore averaged almost \$80,000, Ballina \$64,000, Byron and Richmond Valley both around \$50,000, and Brisbane around \$30,000 (ICA 2022c).

While Australian families, businesses, and communities suffered record-breaking economic damages from climate impacts in the past year, many fossil fuel corporations—which are largely responsible for accelerating climate change—paid little to no income tax

in the 2020-2021 financial year (see ATO 2022), and continue to rake in eye-watering profits (e.g. Santos 2022).

For example, Adani Mining Pty Ltd, Ampol, ExxonMobil Australia, two Glencore entities, a Peabody Australia holding company, Santos, two Shell energy entities, Whitehaven coal, Woodside Petroleum, and Yancoal Australia all paid zero in income tax. Meanwhile, fossil fuel giant Chevron paid just \$30 of income tax in Australia—on a total income of \$9.1 billion and a taxable income of \$113 million (The Guardian 2022).

As extreme weather worsens and insurance claims rise, insurance is likely to become more costly, especially for people in flood-prone areas. One in 25 Australian properties are projected to have insurance premiums that are effectively unaffordable by 2030, due to rising risks of extreme weather and climate change (Climate Council 2022a). Typically, where homeowners and small businesses cannot afford insurance, the costs for rebuilding then fall back onto taxpayers, charities and communities.

WHO'S PAYING FOR CLIMATE CHANGE?

To meet the increasing costs of climate-fuelled disasters, the Australian Government must end fossil fuel subsidies and with the savings create a climate disaster fund. This would support vulnerable communities in Australia and around the world to recover from, and cope with, future extreme weather events.

Accelerating climate change and worsening extreme weather is driven by the burning of coal, oil and gas.



MANY FOSSIL FUEL COMPANIES MAKE EYE-WATERING PROFITS WHILE PAYING NO INCOME TAX IN AUSTRALIA

Adani Mining Pty Ltd, Ampol, ExxonMobil Australia, two Glencore entities, a Peabody Australia holding company, Santos, two Shell energy entities, Whitehaven coal, Woodside Petroleum, and Yancoal Australia all paid zero in income tax in 2020/21. \$30 Chevron.

Source: Tax figures from ATO 2022.

PAID \$0 INCOME TAX IN 2020/21



AUSSIE COMMUNITIES ARE PAYING THE PRICE

Extreme weather events over the past 12 months cost every Australian household on average \$1,532.

Cost of 2022 floods for Brisbane local government area (LGA) \$1.38 billion; Lismore LGA: \$508 million.

Source: Data from The Mckell Institute 2022 and ICA 2022c.

COST \$1,532 PER HOUSEHOLD

THE AUSTRALIAN GOVERNMENT NEEDS TO END FOSSIL FUEL SUBSIDIES AND USE THE SAVINGS FOR A CLIMATE DISASTER FUND

4.3 Agriculture

Australian farm businesses have faced a relentless string of extreme events over the past five years, from drought, to the mouse plague to unprecedented bushfires. Now, floods are destroying crops just when many are about to be harvested, drowning livestock, and damaging equipment and infrastructure. Beyond the direct impacts on farms, road closures and electricity outages due to floods can also severely interrupt farm operations, disrupt supply chains, damage products and harm animals (Vogel 2022). Spring 2022 flooding in New South Wales and Victoria could cause up to \$5 billion worth of damage to the East Coast grain harvest, with 10 million tonnes of produce already directly or indirectly damaged (AFR 2022a; The Weekly Times 2022).

The February 2022 floods in Southeast Queensland caused an estimated \$254 million in agricultural damages (for financial year 2021-22) with ongoing impacts (Deloitte 2022). Seventeen local government areas and 2,250 primary producers were affected. The impact of the floods is estimated to cost 30 percent of the total value of production. In Victoria, the October 2022 floods may lead to food shortages and higher supermarket

prices for milk, fruit, vegetables and other farm products (ABC 2022a). About one fifth of Victoria's milk is produced in flood-affected regions, and millions of litres may go to waste. Some of Victoria's most important growing regions, including Shepparton, Rochester and Echuca, are the hardest hit by current flooding (Vogel 2022). In New South Wales, the grain-growing hub of the Northwest is estimated to have lost at least 120,000 hectares of wheat that was almost ready to harvest in October 2022, and the damage bill for wheat losses alone could exceed \$150 million (ABC 2022b). Floods also caused significant damage to crops in Central West New South Wales. It is estimated that total agricultural loss is in excess of \$720 million, although losses will vary depending on the severity of water inundation, yield loss and the ability to harvest. As of 13 October 2022, over 145,000 hectares of pasture are estimated to have been affected with many landholders yet to report damage due to access and other issues (Grain Central 2022). Recent flooding and continued extreme weather is expected to decrease NSW's food and livestock production by 10 percent 2022 (roughly \$3 billion) (AFR 2022b).

Flood damage on farms can last long after the water has receded. Farm activities may be interrupted by waterlogged soils for days, or even weeks. The loss of fertile topsoil due to water erosion can lead to long-term yield declines, while waterlogged land can make it difficult or impossible for farmers to get equipment into paddocks to plant crops. Even when farmers can access crops, wet conditions make growth unlikely with reports of crops such as wheat rotting in the ground (AFR 2022c). Livestock can also be harmed. For example, the 2019 flood in Queensland killed hundreds of thousands of cows. Surviving, flood-affected livestock can suffer long-term health problems, including parasites and bacterial infections. This has serious implications for animal welfare and farm productivity.

The indirect impacts of flooding on farm businesses, such as power outages or supply chain disruptions due to road closures, can be equally harmful. For example, power outages mean many Victorian farmers cannot milk their cows, or must dispose of milk that cannot be transported to processing sites in time. This may lead to large losses for producers and higher supermarket prices for Australians (Vogel 2022).



Figure 13: Local grain grower assesses water-damaged wheat crop near Forbes, New South Wales. Farmers in the state fear damage to barley, wheat and cotton crops will lead to hundreds of millions of dollars in losses (The Canberra Times 2022a).

4.4 Infrastructure

Heavy rainfall and floods can significantly damage critical infrastructure such as roads, transport, power, telecommunications, water and waste disposal, and disrupt the delivery of essential services. These critical infrastructure outages can continue well beyond a flood event, as communities wait for repairs. For example, some NSW residents experienced loss of power for periods between 13 days and three months following some of the NSW floods (Fuller and O'Kane 2022).

In New South Wales, the February-March 2022 floods damaged more than 2,000 kilometres of state and local roads. As at May 2022, initial estimates indicated the cost of damage to state, regional and local roads, vehicular ferry infrastructure and rail infrastructure was over \$1.5 billion (Fuller and O'Kane 2022). In Southeast Queensland, public infrastructure damages were estimated to be \$492 million including 1,718 kilometres of state-controlled roads and ferry infrastructure (Deloitte 2022).

Figure 14: Road bridge badly damaged in Lismore in early 2022. The Feb-March floods in New South Wales badly damaged transport infrastructure costing at least \$1.5 billion.



In addition to damage to road and transport systems, extreme weather also affects telecommunications networks, with widespread mains power loss and flood damage. As of March 2022, almost 325,000 services over the National Broadband Network (NBN) were affected across Queensland and New South Wales (NBN 2022). Landline, mobile internet coverage and phone reception were all significantly affected during the floods. These are critical services during disasters for people to access real-time information, emergency services, contact with friends and family and support post-disaster recovery (Commonwealth of Australia 2021). In early March 2022, for example, 11,252 Telstra landlines / ADSL (internet connection) and 74 mobile sites were affected (Telstra 2022).

The storms and floods that impacted coastal New South Wales and Southeast Queensland in February and March 2022 were Australia's costliest flood event ever.

5. The summer ahead: What else is in store?

The Bureau of Meteorology's Severe Weather Long Forecast Outlook shows it is likely to be wetter than average for Eastern parts of Australia, with higher risk of heavy rainfall and widespread flooding given that catchments are already saturated. The rain has promoted prolific growth of grass and scrub, and these increased fuel loads could result in widespread grass and scrub fires once the new vegetation dries out. Another risk to watch out for over Summer 2022-23 is above-average tropical cyclone and tropical low activity, and early season tropical cyclone activity (BoM and NEMA 2022; Figure 15).

Climate drivers currently stack the odds for above average rainfall across eastern parts of the continent. La Niña is expected to persist for the remainder of 2022, but may ease in early 2023. The Indian Ocean Dipole negative phase is expected to remain until December 2022, and the Southern Annular Mode is likely to remain in a generally positive phase into early summer. Sea surface temperatures around Australia are above average, which also contributes to the wet seasonal outlook. The risk of marine heatwaves is also likely to increase during summer.

Meanwhile, large parts of Western Australia - where La Niña has a much smaller effect - can expect extreme heat and fire danger over summer. Many parts of the state are experiencing a period of below average rainfall (See Section 8, Figure 21 for more details).

NATIONAL SEVERE WEATHER OUTLOOK: OCTOBER 2022–APRIL 2023 SUMMARY










Impact		Likelihood compared to recent decades	
	Widespread flooding	↑	More likely for eastern Australia
	Coastal flooding	↑	More likely
	Severe storms	●	Similar
	Bushfire risk	● ↑	More likely in parts of NT and WA (spring)
	Heatwave	● ↑	More likely in northern Australia
	Marine heatwave	↑	Increased during summer
	Drought	↓	Less likely apart from south-western WA and western Tas
	Dust	↓	Less likely
	Tropical cyclone	↑	Early first tropical cyclone and above average seasonal activity likely

Figure 15: National severe weather outlook for October 2022–April 2023. Source: Adapted from BoM and NEMA 2022.

5.1 Tropical cyclones

There are typically more cyclones in the Australian region during La Niña years than in non-La Niña years. During the 2010-12 La Niña there were several notable cyclones, including Cyclone Yasi – one of the strongest and costliest in Australia's history. Typically, 11 tropical cyclones form or pass through the

Australian region in a season, with around four of these crossing the Australian coast ([BoM 2022](#)). The Bureau of Meteorology has predicted that there is a 73 percent chance of having more tropical cyclones than average during the Australian 2022/23 tropical cyclone season (November - April).

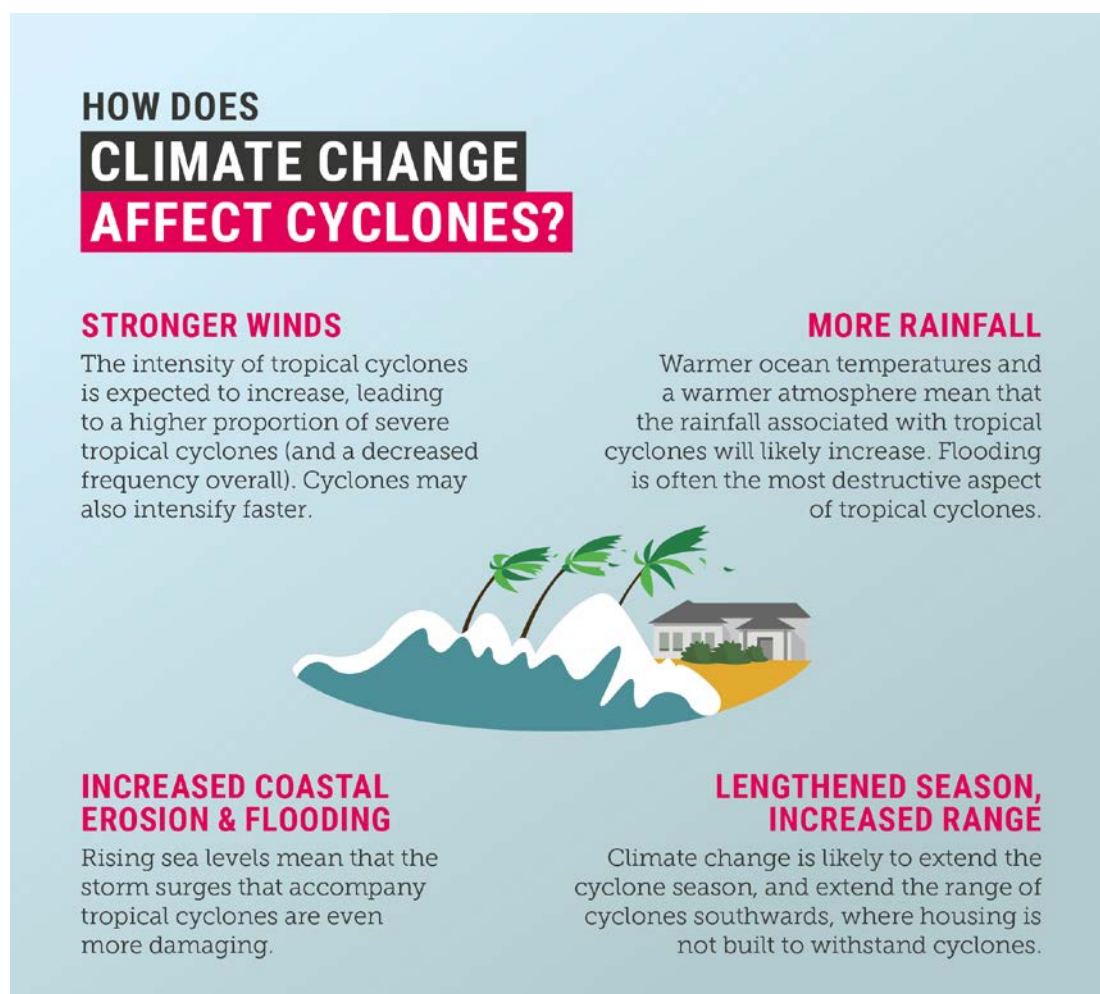


Figure 16: How does climate change affect cyclones?

Climate change is affecting the conditions under which tropical cyclones form and develop. Research links climate change to many different aspects of tropical cyclone formation and behaviour including how often they form, maximum windspeed, amount of rainfall (IPCC 2012), the speed at which a system intensifies (Bhatia et al. 2019), the speed at which a system moves (known as translation speed) (Kossin 2018), how much strength is retained after reaching land (Li and Chakraborty 2020), the duration of tropical cyclone seasons, and geographic range (Kossin et al. 2014).

While there is limited knowledge about the influence of climate change on these various trends, there is little doubt that overall climate change is increasing the destructive power of tropical cyclones. This is especially true when considering other climate impacts that, while not directly affecting tropical cyclone behaviour, are nonetheless increasing the dangers. For example, tropical cyclones are now riding upon higher sea levels. This means storm surges – often the deadliest aspect of a cyclone – are higher and penetrate further inland than they would otherwise. Climate change is also damaging many natural coastal defences, including coral reefs and mangroves, leaving communities and infrastructure more exposed.

Scientists from Insurance Australia Group and the US National Oceanic and Atmospheric Administration predict escalating risks of damaging winds and major flooding from cyclones by the end of the century. Southeast Queensland is among the regions under threat, as ocean temperature rises, fuelling more destructive storms. The models showed the area of land along the east coast of Australia subject to category 5 storms will double, while the areas experiencing extreme rainfall will triple (Bruyère et al. 2022).

BOX 1: A HIGHER RISK OF MOSQUITO-BORNE DISEASE THIS SUMMER?

Mosquitoes can transmit severe disease between humans, or between animals and humans (and vice-versa). Mosquito-borne disease affects around 9,000 people in Australia per year (Australian Government 2019). Nearly all cases are non-fatal, but infection can cause painful and debilitating symptoms and can sometimes last for several months.

The main mosquito-borne diseases of concern in Australia currently are Ross River virus, Barmah Forest virus, and dengue, which is usually only transmitted in northern Australia. There are four other notifiable mosquito-borne diseases transmitted in Australia, which, although mostly rare, can be fatal. These are Murray Valley encephalitis, Japanese encephalitis, Kunjin virus, and malaria (usually confined to Torres Strait).

The symptoms of these infections include fever, headache, vomiting, and seizures, and people who survive severe illness can have lasting neurological damage.

A range of mosquito species are responsible for transmitting these diseases, and while their precise ecologies vary, climate change is increasing the overall risk of mosquito-borne disease in Australia.

Generally, warmer temperatures mean that mosquitoes feed more often, lay more eggs, develop more quickly into adults, and survive for longer—and more mosquitoes means increased opportunities for disease transmission. Warmer temperatures also speed up disease transmission.

Figure 17: Recent flooding in Southeast Australia increases the risk of transmission of debilitating Ross River and Barmah Forest viruses but also more deadly Murray Valley and Japanese encephalitis, and Kunjin virus.



BOX 1: CONTINUED

A more humid climate with increased rainfall and flooding — conditions which are also being exacerbated by climate change — provides more pools of standing water for mosquitoes to breed in, and enhances their survival.

Rainfall and flooding can also increase the abundance of animal host species such as kangaroos, waterbirds, and mice, and also increase proximity of animal and human populations, facilitating virus transmission.

The Great Deluge of 2022 has increased the risk of transmission of not only the debilitating Ross River and Barmah Forest viruses but also more deadly Murray Valley and Japanese encephalitis, and Kunjin virus.

There could be a major outbreak of Japanese encephalitis virus (JEV) in Australia this summer, according to Research led by medical research institute QIMR Berghofer. As many as 750,000 people could be at risk of exposure to the virus. This risk is driven partly by a third consecutive La Niña which is already causing widespread flooding.

Up until only last year, JEV was confined to Asia and far northern Australia, meaning that most Australians have not been previously exposed to the virus, and thus have no immunity (QIMR Berghofer 2022).

5.2 Bushfire risks

Above-average rainfall in eastern parts of the continent may seem like good news when it comes to reducing bushfire risks. However, rain in spring and early summer results in substantial grass and scrub growth. When this vegetation subsequently dries out in warm weather, the risk of fast-running

grass fires increases. To the centre and west of Australia, dry conditions and rising temperatures could cause above-normal fire potential in southern Northern Territory and northern Western Australia (BoM and NEMA 2022).

6. Australia is dangerously unprepared for climate-fuelled disasters

The intensifying effect of climate change on weather extremes driving more frequent, damaging disasters is now well established (CSIRO and BoM 2022; IPCC 2022). We are now in a new era of climate-fuelled 'unnatural disasters', with severe consequences for disaster and emergency management in Australia. Authorities are periodically overwhelmed by off the chart disasters that are far worse than current models predicted, and emergency services simply do not have the capacity and resources to cope with multiple back-to-back disasters.

In short, climate change has pushed us into a new era of increasingly severe and frequent disaster threats. Our emergency management, response and recovery arrangements, which were set up to cope with a much tamer environment in the 1990s, are falling short of what is needed today. Without major changes, they will certainly not be able to handle worsening threats as global warming escalates.

6.1 Knowledge gaps and funding cuts

As noted by the Royal Commission into National Natural Disaster Arrangements (Binskin, Bennett and Macintosh 2020) and by the 2022 NSW Flood Inquiry (Fuller and O’Kane 2022), “a disaster occurs when natural hazards intersect with people and things of value, and when the impacts of hazards exceed the community’s ability to avoid, cope or recover from them.”

Unfortunately, this is exactly what is happening due to the supercharging effect of climate change on extreme weather events in Australia.

The first criteria for effective prevention, planning, response and recovery arrangements is the accurate identification of how hazards affect people and things of value, including the natural environment. Examples include the establishment of bushfire and flood planning rules for the construction of homes, and the resourcing of local emergency services in line with expected extreme weather events. If local, regional, state/territory, and national risk profiles are not up to date or well understood, then emergency management arrangements can fall short when out-of-scale challenges occur.

As climate change intensifies weather extremes, formerly well understood norms and risk scenarios may no longer provide a suitable evidence-base for disaster planning.

This is already evident in several recent disasters:

- › The hot and dry conditions across Australia in 2019 that drove bushfires of a duration, size, scale and level of destructiveness never before experienced or predicted (Binskin, Bennett and Macintosh 2020). Overwhelmed fire services were unable to share sufficient firefighting resources across borders because for the first time there were simultaneous major fires across all national jurisdictions (Binskin, Bennett and Macintosh 2020).
- › Floods in Lismore in early 2022 exceeded the historic flood peak by around 2 metres, resulting in many previously ‘safe’ homes being inundated. Emergency services scrambled to cope with the number of rescues required, ultimately having to rely on assistance from spontaneous community volunteers (Fuller and O’Kane 2022).
- › In November 2022, the Lachlan river in NSW rose fast causing a major flood emergency in Forbes and Eugowra. One-in-five residents had to be rescued from rising flood waters in Eugowra on 14 November 2022 (ABC 2022c), and on 15 November around 1,000 people in NSW town of Forbes were told to evacuate before expected major flooding (SBS 2022).

While climate change is reducing the effectiveness of the risk models used in emergency and disaster planning, a decade of cuts in federal government funding for climate research agencies such as the Commonwealth Scientific Industrial Research Organisation (CSIRO) (Climate Council 2021) and the Bureau of Meteorology (BoM) (The Australian 2022; The Saturday Paper 2022) has made matters much worse.

The practical effect of this knowledge gap and lack of research funding is that when unnatural disasters strike, emergency services and subsequent disaster recovery arrangements can be overwhelmed, increasing the danger for communities.

6.2 Compounding disasters are stretching emergency services to the limit

Against a background of more frequent, consecutive and compounding disasters—that is, when the effects of multiple disasters occur at the same time—governments are being called upon to coordinate long-term recovery operations to re-establish devastated communities. This work is difficult, expensive, and easily set back by a subsequent disaster.

For instance, following the 2019/2020 Black Summer Bushfires many areas were hit by flooding rains in March 2020. On the NSW South Coast, many people made homeless by the fires were living in tents and caravans (The Canberra Times 2022b), and their temporary accommodation was flooded. Soon after this, the COVID-19 pandemic hit, and Australia, like other countries, scrambled to set up effective responses.

BOX 2: AUSTRALIAN FAMILIES AND BUSINESSES ARE DEEPLY IMPACTED BY WORSENING CLIMATE EXTREMES

“Our lived experience of successive climate impacts in the past four years has convinced us that the only path to future business success is to drive community action and force governments to act on climate change.” Innes Larkin, owner Mount Barney Lodge

For two generations, the Larkin family has owned and operated Mt Barney Lodge, an ecotourism retreat situated at the base of Mount Barney within the Scenic Rim on the Gold Coast. Nearby attractions include mountain ranges, beautiful rainforests, hidden waterfalls and hiking trails.

Now, climate change is directly impacting the Lodge and the Larkins’ livelihood. From bushfires to flooding and landslides, tourism operations including the Larkins’ business, have had to close on multiple occasions in the past five years due to relentless extreme weather events.

In September 2019, unprecedented fire conditions swept through the Scenic Rim, sparking a fire in the mountain ranges. Lodge co-owner Innes Larkin had never seen such intense fires before, nor experienced the level of concern shown by emergency services.

As the fire raged on, thousands of hectares of World Heritage-listed forest was destroyed and hundreds of Queensland native wildlife, including koalas, were killed. The Larkins evacuated their guests, and Innes stayed behind to defend the property.

The resulting loss of tourism income to the area was huge, only to be compounded by post-bushfire flooding, the Covid-19 pandemic and then, multiple floods throughout 2022. The floods triggered multiple closures including the cancellation of the annual Scenic Rim Adventure Festival held at the property.

The threat to the Larkins and the region is not over. Extreme rainfall has already saturated local catchments, with more rain predicted over summer. Fuel loads in the region are also worryingly high following a third consecutive summer of La Niña conditions, increasing the potential for a catastrophic bushfire in the near future.

The Larkin family has been resilient through multiple shocks. Facing another summer of extreme weather, and the potentially catastrophic conditions it may bring, is what keeps them fighting for climate action.



Figure 18: Innes and Tracey Larkin at their ecotourism retreat, situated in the Scenic Rim in Southeast Queensland. Their property, and ecotourism business, has been impacted by a series of devastating extreme weather events over recent years including the Black Summer bushfires and multiple floods.

Those in the disaster and emergency management sector know without a doubt that we have entered a new era of escalating disaster threats, where the next impact often lands while communities are still reeling from the last. Our emergency management, response and recovery arrangements are not currently equipped to handle this.

It is sobering to note that the supercharged-climate disasters which are periodically overwhelming governments and emergency services, and the resulting devastation for communities, are occurring in a world that is 1.2°C warmer on average than pre-industrial times. However, we are on a trajectory for more than 2°C of warming by this century based on existing international emissions reduction commitments (UNEP 2022). This equates to a barely survivable future and impacts to which it will be impossible to adapt, unless we act quickly.

This is why governments at all levels need to urgently invest in measures that help communities withstand and cope with worsening climate impacts, and prevent or manage disasters more effectively. Policymakers must urgently increase funding for emergency services, which also need more full-time staff and volunteers. Emergency management agencies also need a standing capability to initiate and manage long-term disaster recovery efforts.

These efforts to build our resilience to the impacts of climate change must go hand in hand with far stronger efforts to move beyond fossil fuels and ensure Australia and the world's emissions plummet this decade. By the Climate Council's assessment, given the scale of the global emissions reduction task, and taking into account Australia's very high level of emissions and our huge renewable energy resources, Australia should aim to reduce its national emissions by 75% below 2005 levels by 2030, and to reach net zero by 2035.

BOX 3: GLOBAL CLIMATE DISASTERS IN 2022

Escalating weather-driven disasters are not confined to Australia. 2022 has seen extreme weather records broken on every continent (Climate Council 2022b). Some countries and regions have faced multiple disasters, swinging from deadly heat and drought into cataclysmic floods, with no time to recover. After experiencing one of its hottest March-April periods on record, with devastating impacts on crops and critical shortages of water and power, just months later Pakistan suffered the worst floods in its history, affecting more than 30 million people and killing well over 1,000 (Climate Council 2022b; The Hindu 2022; Figure 19). In 2022, a heatwave in England saw

unprecedented outbreaks of bush and grass fires in many areas, with homes destroyed on the outskirts of London. California has experienced an escalation in the size and destructiveness of bushfires as the state faces relentless drying. In 2018 about 20,000 buildings were destroyed in fires, including the city of Paradise, leading to nearly 100 deaths. In 2022 the US state of Colorado experienced gale-force winds during a drought. Despite cold temperatures that saw snowfall the next day, around 1,000 homes were destroyed by rapidly moving grassfires in a single afternoon. Many other countries are experiencing major floods, heatwaves and droughts (Trenberth 2022).

Figure 19: In Pakistan 1,700 lives were lost and millions displaced as a result of cataclysmic floods that inundated almost a third of the country in 2022 (The Hindu 2022).



7. Policy recommendations

The following recommendations form the basis of a whole of government response to climate-fuelled disasters. The recommendations primarily focus on reducing the exposure and vulnerabilities to disasters before they occur. However, it is impossible to eliminate all risk and thus our recommendations are designed to improve the community's ability to respond and recover more generally.

Historically, far too much emphasis has been placed on response once a disaster has already occurred, and far too little on reducing the damage. For example, the Federal Government's Final Budget Outcome (2005 -2022) showed \$23.99 billion was spent on disaster recovery and relief, while only \$0.51 billion was allocated to resilience (Australian Government 2022).

Figure 20: Lismore school flood damage in early 2022. The vast majority of all disaster funding (98%) is channelled into disaster preparedness, while only a fraction (2%) goes towards climate resilience.



Some recommendations are specific to the Commonwealth, such as resourcing the National Emergency Management Agency and Australian Climate Service to produce downscaled modelling, some are directed at state and territory levels and others at local governments. Many of the recommendations require coordination across all levels of government. It is unacceptable for governments at any level to say that disaster response is not their responsibility. Effectively reducing the exposure and risk to disasters requires all levels to transform the way they do things, by:

1. Getting emissions to plummet this decade

To avoid the worst climate impacts, emissions need to plummet this decade with developed economies like Australia going even further. The Climate Council published [Power Up: Ten Climate Game Changers](#), listing ten things governments at all levels could implement straight away to help rapidly decarbonise our economy.

2. Strengthening disaster management coordination

Currently, Australia has different strategies for addressing climate change adaptation and disaster risks (the National Climate Resilience and Adaptation Strategy and the National Disaster Risk Reduction Framework and supporting action plans). This makes little sense, as the two areas are intertwined and should be integrated across strategy, planning and institutional arrangements. To ensure improved coordination, and to minimise duplication and waste, the Federal Government should develop an integrated National Adaptation and Disaster Resilience Strategy and supporting action plan with set deadlines for implementation and an ongoing process of review and improvement every five years.

3. Implementing recommendations from expert inquiries

Since the 1939 bushfires there have been dozens of reviews and inquiries into disasters and extreme weather events in Australia, but many of their recommendations have not been put in place. Governments, at all levels, should coordinate to implement these recommendations, prioritising the [Royal Commission Into National Natural Disaster Arrangements](#), the [NSW Bushfire Inquiry](#), [The NSW 2022 Independent Flood Inquiry](#), and the [Independent inquiry into the 2019-2020 Victorian fire season](#). Many of the recommendations in these state-based inquiries cover similar themes, such as identifying and reinforcing critical infrastructure (energy/telecommunications/ bridges and roads), warnings, evacuation routes and shelters, communications, access to primary healthcare, coordination and better decision making.

4. Prioritising investment in resilience

The Federal Government's Final Budget Outcome (2005 -2022) showed \$23.99 billion⁵ was spent on disaster recovery and relief, while only \$0.51 billion was allocated to resilience (Australian Government 2022; The McKell Institute 2022). Investing in risk reduction and resilience provides a 'triple dividend' of avoided loss and suffering, reduced disaster costs and potential economic and social benefits even in the absence of hazards occurring. There is a need to upscale public investments in resilience and develop innovative financing pathways. The process for allocating public funds towards resilience projects must be independent and data driven, ideally deploying an accepted needs-based funding model that ensures funds focus on the most at-risk and vulnerable communities. The Climate Council welcomes the work being

⁵ Based on 2022 prices.

done to amend the Emergency Response Fund, which will make one billion dollars available for adaptation over the next five years. This is a positive first step to reversing the funding trend that sees the vast majority of disaster-related funds going towards response and recovery. To build resilience to the out-of-scale disasters we can expect to see occurring more often much more funding will be needed.

Most current hazard maps are based on historical experience and patterns. Changing risk patterns due to climate change means that many building codes and land use planning decisions are based on outdated historical data that leads to climate risk estimates that are underdone.

There is an urgent need for a National Climate Change Risk Assessment to be conducted as a baseline for all levels of government to focus on and coordinate climate adaptation and mitigation efforts. The Assessment should underpin production of a national strategy and plan enabling climate risk information to be mainstreamed across all government agencies and sectors and at-risk communities.

Concurrent with development of the National Climate Change Risk Assessment, the National Emergency Management Agency and Australian Climate Service should focus on combining climate science and hazard analysis to produce downscaled climate modelling and making the data available to all levels of government in forms useful for both planning/policy and emergency management. Improved policy settings are required across all levels of government to prevent buildings being constructed or rebuilt in areas that are, or will be, highly exposed to climate hazards. A key piece is accounting for the 'moving' nature of risk and compound impacts from more frequent and severe disasters, and updating hazard maps.

A whole of government response to climate-fuelled disasters is urgently required.

5. Supporting communities to 'build back better'

When local governments rebuild infrastructure with federal funds they must build 'like for like', but this fails to improve resilience and actively embeds vulnerabilities. Towns, cities and communities must be rebuilt – where appropriate to do so – in a way that takes into account the inevitable future changes in climate and makes them more resilient. In some very high-risk locations, this may mean not rebuilding at all. Managed relocations must be discussed as an option for some of the most vulnerable and exposed communities. The joint announcement between the New South Wales and Commonwealth governments on land buybacks and relocations in the aftermath of the 2022 NSW/QLD floods is an example of this. However, further schemes must be made available to at-risk communities before a disaster strikes so they can relocate as soon as practical. Diverting some of the more than \$11 billion in public money each year that subsidises the fossil fuel industry to this would be a better use of our taxpayer money.

6. Putting community first

Communities suffering due to climate change must be at the heart of all emergency and disaster prevention, preparation, response and recovery plans and arrangements. Governments at all levels – Australian, state and territory and local – must significantly increase funding that reduces risk and builds community resilience, improves infrastructure, and increases the capabilities of emergency response and recovery agencies, with a greater focus on planning and coordination between all levels of government. Recommendation 6, the Community First Responders Programme, from the 2022 Independent NSW Flood Inquiry is a practical example of what this can look like. Programs like this should be funded equally by federal and state governments, and rolled out at pace in at-risk communities.

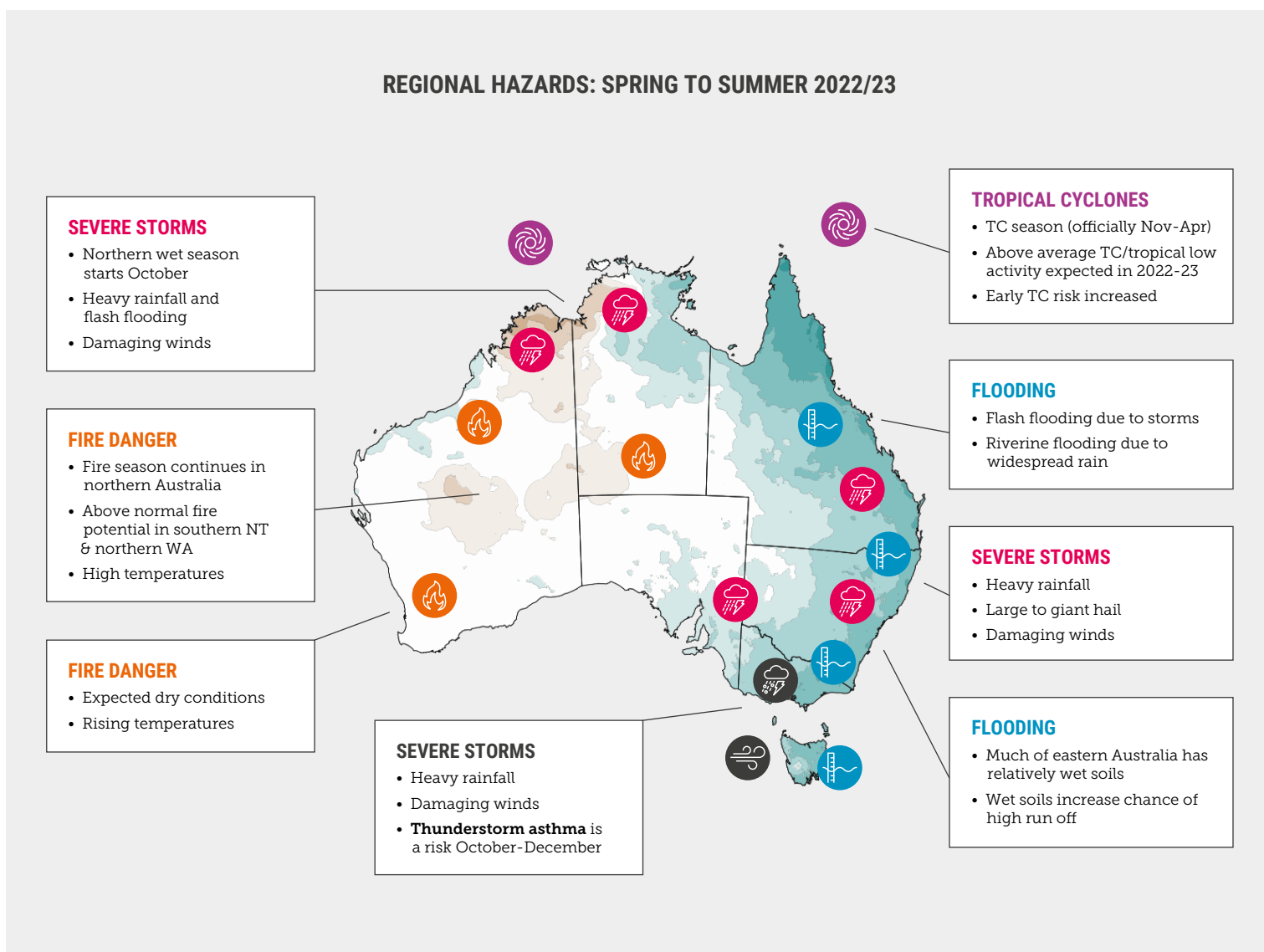
7. End fossil fuel subsidies and create a climate disaster fund

We must accept and prepare for worsening extreme weather events into the future. To meet the increasing costs of climate-fuelled disasters the Government must create a climate disaster fund as a matter of urgency, and could raise the money required by ending public subsidies for fossil fuel producers.

8. Stay safe this summer

The Bureau of Meteorology has forecast the following regional hazards for spring to summer 2022/23 (Figure 21). See here for the latest [long-range forecast overview](#) by the Bureau (BoM 2022d).

Figure 21: Regional hazards for spring to summer 2022/23. Adapted from BoM and NEMA 2022.



Stay safe, and if you haven't already done so, check your state/territory's fire and emergency agency for advice on how to manage the summer's extreme weather risks.



[New South Wales State Emergency Service](#)

.....



[Victorian State Emergency Service](#)

.....



[Queensland State Emergency Service](#)

.....



[Western Australia State Emergency Service](#)

.....



[Northern Territory Emergency Service](#)

.....



[South Australian State Emergency Service](#)

.....



[ACT State Emergency Service](#)

.....



[Tasmanian State Emergency Service](#)

Other useful links:



ABC Emergency: [Plan for an emergency: Flood](#)

.....



ABC Emergency: [Plan for an emergency: Storm](#)

References

- ABC (Australian Broadcasting Corporation) (2022a) Farmers fear millions of litres of milk will be lost due to Victorian flooding. Accessed at <https://www.abc.net.au/news/rural/2022-10-18/flooded-dairies-likely-to-waste-milk/101542838>.
- ABC (2022b) Most productive NSW Agricultural shire counts hundreds of millions of dollars in crop losses. Accessed at <https://www.abc.net.au/news/rural/2022-10-24/crop-flood-damage-estimates-north-west-nsw/101569484>
- ABC (2022c) Thousands stranded in homes as flash flooding batters Central West NSW, Wyangala Dam spills at record rate. By Kenji Sato and Lauren Pezet, 14 November 2022. Accessed at <https://www.abc.net.au/news/2022-11-14/nsw-battered-by-flash-floods-molong-canowindra-central-west/101649204>.
- AFR (Australian Financial Review) (2022a) Fruit prices to leap, but 'not to iceberg lettuce peak'. Gus McCubbing, 28 October 2022. Accessed at <https://www.afr.com/companies/agriculture/floods-to-cause-fruit-prices-to-soar-20221028-p5btpq>.
- AFR (2022b) La Nina, flooding to crunch NSW farm output by 10pc. Samantha Hutchinson, 17 November 2022. Accessed at <https://www.afr.com/politics/la-nina-flooding-to-crunch-nsw-farm-output-by-10pc-20221116-p5bywa>.
- AFR (2022c) NSW floods leave crops unplanted, seeds rotting in the ground. Accessed at <https://www.afr.com/companies/agriculture/nsw-floods-leave-crops-unplanted-seeds-rotting-in-the-ground-20220705-p5az5w>
- AIDR (Australian Institute for Disaster Resilience) (2020) Emergency Planning Handbook. Australian Government. [Emergency Planning Handbook \(aidr.org.au\)](https://www.aidr.org.au)
- ATO (Australian Tax Office) (2022) Corporate tax transparency report for the 2020–21 income year. Accessed at <https://www.ato.gov.au/Business/Large-business/In-detail/Tax-transparency/Corporate-tax-transparency-report-for-the-2020-21-income-year/>.
- Australian Government (2014) Productivity Commission Inquiry Report: Natural Disaster Funding Arrangements. December 2014. Accessed at www.pc.gov.au/inquiries/completed/disaster-funding/report.
- Australian Government (2019) Department of Health. National Notifiable Diseases Surveillance System, 2019.
- Australian Government (2022) Department of Finance. (2022). Emergency Response Fund. Australian Government. Accessed at <https://www.finance.gov.au/government/emergency-response-fund>.
- Ayat H, Evans JP, Sherwood SC and Soderhold J (2022) Intensification of subhourly heavy rainfall. *Science*, 10 Nov 2022, Vol 378, Issue 6620, pp. 655–659, doi: 10.1126/science.abn8657.
- Bhatia KT, Vecchi GA, Knuston TR, Murakami H, Kossin J, Dixon KW, Whitlock CE (2019) Recent increases in tropical cyclone intensification rates. *Nature Communications*, 10. <https://doi.org/10.1038/s41467-019-08471-z>.
- Binskin, M., Bennett, A., and Macintosh, A. Royal Commission into National Natural Disaster Arrangements - Report., Commonwealth of Australia, Canberra, 2020.
- BoM (Bureau of Meteorology) (2022a) Climate outlooks—weeks, months and seasons. Issued 3 November 2022. Accessed at <http://www.bom.gov.au/climate/outlooks/#/overview/influences>.
- BoM (2022b) Australian Tropical Cyclone Outlook for 2022 to 2023. Accessed at <http://www.bom.gov.au/climate/cyclones/australia/#msdynttrid=XvwoGYLkYtQX6rVntJRoluUdGktm66PQCcQiMaAC21U>.
- BoM (2022c) Annual climate statement 2021: Analysis of Australia's temperature, rainfall, water, oceans, significant weather and influences during 2021. Accessed at <http://www.bom.gov.au/climate/current/annual/aus/#tabs=Temperature>.
- BoM (2022d) Long-range forecast overview. Issued 24 November 2022. Accessed at <http://www.bom.gov.au/climate/outlooks/#/overview/summary/>.
- BoM and NEMA (National Emergency Management Agency) (2022) High Risk Weather Season Briefing 2022–2023: Non-Government Organisations.
- Bruyère CL, Buckley B, Jaye AB, Done JM, Leplastrier M, Aldridge J, Chan P, Towler E, and Ge M (2022) Using large climate model ensembles to assess historical and future tropical cyclone activity along the Australian east coast. *Weather and Climate Extremes*, Volume 38, 100507, doi: org/10.1016/j.wace.2022.100507.
- Cai, W., Santoso, A., Collins, M. et al. Changing El Niño–Southern Oscillation in a warming climate. *Nat Rev Earth Environ* 2, 628–644 (2021). <https://doi.org/10.1038/s43017-021-00199-z>.
- Callahan, C.W., Chen, C., Rugenstein, M. et al. Robust decrease in El Niño/Southern Oscillation amplitude under long-term warming. *Nat. Clim. Chang.* 11, 752–757 (2021). <https://doi.org/10.1038/s41558-021-01099-2>.
- Climate Council (2021a) Hitting Home: The Compounding Costs of Climate Inaction. Accessed at <https://www.climatecouncil.org.au/resources/hitting-home-compounding-costs-climate-inaction/>.
- Climate Council (2021b) The Lost Years: Counting the costs of climate inaction in Australia. Accessed at <https://www.climatecouncil.org.au/resources/lost-years-counting-costs-climate-inaction-in-australia/>.
- Climate Council (2022a) Uninsurable Nation: Australia's most climate-vulnerable places. Accessed at <https://www.climatecouncil.org.au/resources/uninsurable-nation-australias-most-climate-vulnerable-places/>.

- Climate Council (2022b) G'Day COP27: Australia's global climate reset. Accessed at [to add]
- Commonwealth Government of Australia (2021). 2021 Regional Telecommunications Review A step change in demand. Accessed at <https://www.infrastructure.gov.au/sites/default/files/documents/2021-rtirc-report-a-step-change-in-demand.pdf>
- CSIRO and BoM (2022) State of the Climate 2022. Australian Government. Accessed at <https://www.csiro.au/en/research/environmental-impacts/climate-change/state-of-the-climate>
- Deloitte Access Economics (2022) The social, financial and economic costs of the 2022 South East Queensland Rainfall and flooding Event. Accessed at https://www.qra.qld.gov.au/sites/default/files/2022-07/dae_report_-_south_east_queensland_rainfall_and_flooding_event_-_8_june_2022.pdf
- Douville, H., K. Raghavan, J. Renwick, R.P. Allan, P.A. Arias, M. Barlow, R. Cerezo-Mota, A. Cherchi, T.Y. Gan, J. Gergis, D. Jiang, A. Khan, W. Pokam Mba, D. Rosenfeld, J. Tierney, and O. Zolina, 2021: Water Cycle Changes. In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. *Cambridge University Press*, Cambridge, United Kingdom and New York, NY, USA, pp. 1055–1210, doi:10.1017/9781009157896.010.
- Frölicher TL, Fischer EM and Gruber N (2018) Marine heatwaves under global warming. *Nature* 560, 360–364. <https://doi.org/10.1038/s41586-018-0383-9>.
- Fuller M and O'Kane M. (2022) 2022 Flood Inquiry. Volume 2. Full Report. 2022 Flood Inquiry (nsw.gov.au).
- Hay T and Williams CJ (2022) Effects of climate change such as flooding makes existing disadvantages for Indigenous communities so much worse. *The Conversation*, 15 November 2022. Accessed at <https://theconversation.com/effects-of-climate-change-such-as-flooding-makes-existing-disadvantages-for-indigenous-communities-so-much-worse-192090>.
- Heron, S.F. van Hooidonk, R. Maynard, J. Anderson, K. Day, J.C. Geiger, E. Hoegh-Guldberg, O. Hughes, T. Marshall, P. Obura, D. Eakin, C.M. (2018) Impacts of Climate Change on World Heritage Reefs: Update to the First Global Scientific Assessment. <https://apo.org.au/sites/default/files/resource-files/2018-09/aponid193206.pdf>.
- Hobday AJ, Alexander LV, Perkins SE, Smale DA, Straub SC, Oliver ECJ, Benthuyzen J, Burrows MT, Donat MG, Feng M, Holbrook N, Moore P, Scanell H, Gupta AS, and Wernberg T (2016) A hierarchical approach to defining marine heatwaves. *Progress in Oceanography* 141:227–238, <https://doi.org/10.1016/j.pocean.2015.12.014>.
- Human Rights Watch (2022) Australia: Flood Response Failed to Protect Most at Risk Accessed at <https://www.hrw.org/news/2022/11/03/australia-flood-response-failed-protect-most-risk>.
- ICA (Insurance Council of Australia) (2022a) Updated data shows 2022 flood was Australia's costliest. News release, Friday, 28 October 2022. Accessed at <https://insurancecouncil.com.au/resource/insurance-council-welcomes-800-million-nsw-flood-resilience-package/>.
- ICA (2022b) Insurance Council welcomes \$800 million NSW flood resilience package.
- ICA (2022c) Insurance Catastrophe Resilience Report 2021–22. Accessed at <https://insurancecouncil.com.au/resource/new-research-shows-every-australian-pays-for-extreme-weather/>.
- Intergovernmental Panel on Climate Change (IPCC) (2012) Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Accessed at https://www.ipcc.ch/site/assets/uploads/2018/03/SREX_Full_Report-1.pdf.
- IPCC (2022a) Climate Change 2022: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Minterbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. *Cambridge University Press*. Cambridge University Press, Cambridge, UK and New York, NY, USA, 3056 pp., doi:10.1017/9781009325844.
- IPCC (2022b) Working Group II contribution to the IPCC Sixth Assessment Report. Impacts, Adaptation and Vulnerability. Chapter 11: Australasia. https://report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_FinalDraft_Chapter11.pdf
- King A (2022) La Niña, 3 years in a row: a climate scientist on what flood-weary Australians can expect this summer. *The Conversation*, 13 September 2022. Accessed at <https://theconversation.com/la-nina-3-years-in-a-row-a-climate-scientist-on-what-flood-weary-australians-can-expect-this-summer-190542>.
- Kossin JP, Emanuel KA, Vecchi GA (2014) The poleward migration of the location of tropical cyclone maximum intensity. *Nature*, 509. Accessed at <http://doi.org/10.1038/nature13278>
- Kossin JP (2018) A global slowdown of tropical-cyclone translation speed. *Nature*, 558. Accessed at <https://doi.org/10.1038/s41586-018-0158-3>.
- Li L and Chakraborty P (2020) Slower decay of landfalling hurricanes in a warming world. *Nature* 587. Accessed at <https://doi.org/10.1038/s41586-020-2867-7>.
- Luke H and McArthur A (1978) Bushfires in Australia. Australian Government Publishing Service. Canberra.

NASA (National Aeronautics and Space Administration) (2022) More flooding in Australia's soggy southeast. NASA's earth observatory. Accessed at https://earthobservatory.nasa.gov/images/150625/more-flooding-in-australias-soggy-southeast?utm_source=TWITTER&utm_medium=NASAEarth&utm_campaign=NASASocial&linkId=190628990.

NBN Co. (National Broadband Network) (2022) Severe weather affecting Queensland. Accessed at <https://www.nbnco.com.au/blog/the-nbn-project/severe-weather-affecting-queensland-february-2022>

Paddam S, Liu C and Philip S (2022) Home insurance affordability and socioeconomic equity in a changing climate. Green Paper commissioned by the Actuaries Institute, August 2022. Access at <https://actuaries.asn.au/Library/Opinion/2022/HIAGreenPaper.pdf>.

QIMR Berghofer (2022) Extreme concern over Japanese encephalitis risk this summer. Accessed at <https://www.qimrberghofer.edu.au/news/extreme-concern-over-japanese-encephalitis-risk-this-summer/>.

Santos (2022) 2022 Half-Year Results. Issued 17 August 2022. Accessed at <https://www.santos.com/news/2022-half-year-results-2/>.

SBS (2022) Forbes residents told to evacuate as NSW town prepares for second major flood in a fortnight. Accessed at <https://www.sbs.com.au/news/article/forbes-residents-told-to-evacuate-as-nsw-town-prepares-for-second-major-flood-in-a-fortnight/23ejkls1c>.

Smith KE, Burrows MT, Hobday AJ, Gupta AS, Moore PJ, Wernberg T, and Smale DA (2021) Socioeconomic impacts of marine heatwaves: Global issues and opportunities. *Science*, 22 Oct 2021, Vol 374, Issue 6566, DOI: 10.1126/science.abj3593.

Telstra (2022) Disaster relief for our flood-affected customers in QLD and Northern NSW. Accessed at <https://exchange.telstra.com.au/disaster-relief-for-our-flood-affected-customers-in-qld-and-northern-nsw/>

The Australian (2022) Under-fire BoM 'has been failed on funding'. 31 March 2022.

The Canberra Times (2022a) The long-lasting tail of flood devastation. Stephanie Gardiner, 10 November 2022. Accessed at <https://www.canberratimes.com.au/story/7976111/the-long-lasting-tail-of-flood-devastation/?cs=14264>.

The Canberra Times (2022b) Floods of despair on bushfire anniversary. Maeve Bannister, 2 January 2022. Accessed at <https://www.canberratimes.com.au/story/7568081/floods-of-despair-on-bushfire-anniversary/>.

The Guardian (2022) Almost a third of Australia's large companies pay no income tax. Christopher Knaus, 3 November 2022. Accessed at <https://www.theguardian.com/australia-news/2022/nov/03/australia-tax-transparency-report-almost-a-third-large-companies-pay-zero-income-tax>.

The Hindu (2022) Pakistan floods' death toll nears 1,700, puts pressure on fragile economy. Accessed at <https://www.thehindu.com/news/international/pakistan-floods-death-toll-nears-1700-puts-pressure-on-fragile-economy/article65959347.ece>.

The McKell Institute (2022) The Costs of Extreme Weather: Building resilience in the face of disaster by Marni Lefebvre and Joey Reinhard. Supported by the Insurance Council of Australia. Accessed at <https://mckellinstitute.org.au/research/reports/the-cost-of-extreme-weather-1/>.

The Saturday Paper (2022) 'It's kind of horrific': BoM cuts compromise forecasts. Rick Morton, 29 Oct - 4 Nov.

The Weekly Times (2022) The tragic toll of floods on farmers.

Trenberth KE (2011) Changes in precipitation with climate change. *Climate Research*, 47: 123-138, DOI: 10.3354/cr00953.

Trenberth K (2022) 2022's supercharged summer of climate extremes: How global warming and La Niña fueled disasters on top of disasters. *The Conversation*, 15 September 2022. Accessed at <https://theconversation.com/2022s-supercharged-summer-of-climate-extremes-how-global-warming-and-la-nina-fueled-disasters-on-top-of-disasters-190546>

UN (United Nations) (2022) Secretary-General's remarks to High-Level opening of COP27, 7 November 2022. Accessed at <https://www.un.org/sg/en/content/sg/speeches/2022-11-07/secretary-generals-remarks-high-level-opening-of-cop27>.

Vogel E (2022) Farm floods will hit food supplies and drive up prices. Farmers need help to adapt as weather extremes worsen. *The Conversation*, 19 October 2022. Accessed at <https://theconversation.com/farm-floods-will-hit-food-supplies-and-drive-up-prices-farmers-need-help-to-adapt-as-weather-extremes-worsen-192731>.

Image credits

Front cover: Flooding of Maitland NSW and surrounds.
Photo by Airphoto Australia/Getty Images.

Figure 1 - Page 2: NSW floods. AAP Image/Murray McCloskey.

Figure 4 - Page 7: Flooding in Sydney Chinatown with tram - stock photo. Mark Snodgrass/Getty Images.

Figure 8 - Page 12: Photo by Harley Kingston via Shutterstock. Stock Photo ID: 2133731985.

Figure 12 - Page 17: Eastern Australia Faces Ongoing Flood Emergency. Peter Wallis/Getty Images.

Figure 13 - Page 20: NSW Floods, local grain grower. Stuart Walmsley/APP.

Figure 14 - Page 21: Road bridge badly damaged in Lismore in early 2022. Cassandra Scott-Finn.

Figure 17 - Page 27: 'Brown mozzie empty' by Flickr user John Tann. Licensed under Attribution 2.0 Generic (CC BY 2.0).

Figure 18 - Page 32: Innes and Tracey Larkin at their ecotourism retreat, situated in the Scenic Rim in Southeast Queensland. Photo by Innes Larkin.

Figure 19 - Page 34: 'Pakistan: EU humanitarian aid reaches survivors of devastating floods' by Flickr user EU Civil Protection and Humanitarian Aid. Licensed under Attribution 2.0 Generic (CC BY 2.0).

Figure 20 - Page 35: Lismore school damage. Cassandra Scott-Finn.


The Climate Council is an independent, crowd-funded organisation providing quality information on climate change to the Australian public.

The Climate Council acknowledges the Traditional Custodians of the lands on which we live, meet and work. We wish to pay our respects to Elders past, present and emerging and recognise the continuous connection of Aboriginal and Torres Strait Islander peoples to Country.

CLIMATE COUNCIL

 facebook.com/climatecouncil

 twitter.com/climatecouncil

 info@climatecouncil.org.au

 climatecouncil.org.au

The Climate Council is a not-for-profit organisation. We rely upon donations from the public. We really appreciate your contributions.

DONATE

climatecouncil.org.au/donate