CLIMATE COUNCIL

EYE OF THE STORM: HOW CLIMATE POLLUTION FUELS MORE INTENSE AND DESTRUCTIVE CYCLONES

CLIMATECOUNCIL.ORG.AU

Thank you for making an impact.

The Climate Council is 100% independent and community-funded. We rely on word-of-mouth and donations from the general public to provide reliable and quality research, socialise it and then campaign for the solutions we need. If you'd like to support more reports like this go to: www.climatecouncil.org.au/donate

Published by the Climate Council of Australia Limited.

ISBN: 978-1-923329-12-6 (ebook)

Reviewers:
We are very grateful to the following reviewers for generously sharing their time and expertise: Professor Liz Ritchie-Tyo (School of Earth Atmosphere and Environment, Monash University / ARC Centre of Excellence for Weather of the 21st Century) and Associate Professor Andrew Dowdy (School of Geography, Earth and Atmospheric Sciences, University of Melbourne).

Responsibility for the final content of the report remains with the authors.

—

The Climate Council acknowledges the Traditional Owners of the lands on which we live, meet and work. We wish to pay our respects to Elders, past and present, and recognise the continuous connection of Aboriginal and Torres Strait Islander peoples to land, sea and sky. We acknowledge the ongoing leadership of First Nations people here and worldwide in protecting Country, and securing a safe and liveable climate for us all.

Dr Martin Rice
Research Director

Professor David Karoly
Climate Councillor

Dinah Arndt
Head of Strategic Communications

Josh Comer
Communications Director

Sean O'Rourke
Director, Emergency Leaders for Climate Action

Contents

Key findings

1 Tropical Cyclone Alfred was more intense and damaging due to climate pollution, as storm surges rode in on higher seas and washed away iconic beaches along 500 kilometres of coastline. Wild winds and extreme rainfall prompted the highest number of emergency call outs recorded in Queensland's history.

- Tropical Cyclone Alfred formed in the Coral Sea, where sea surface temperatures in summer 2024-25 were the highest on record. Excess ocean heat, driven by climate pollution from coal, oil and gas, provided more fuel for the wild winds, record waves and intense rainfall that followed.
- Storm surges and wind-driven waves from Tropical Cyclone Alfred rode on higher seas due to climate pollution. This led to a series of damaging waves, as tall as a four-storey building. A 12.3 metre wave was the highest ever recorded on the Gold Coast. This caused beach erosion so extreme that beaches disappeared, with sudden drops up to 6 metres high across newly formed dunes along Surfers Paradise.
- Wind gusts of over 120kmh (recorded in Byron Bay) in NSW and 107kmh (Gold Coast) in Queensland ripped trees out of the ground, peeled roofs off houses and damaged property up and down the coast.
- The electricity network was severely disrupted, as power lines were damaged, and half a million properties across New South Wales and Queensland were plunged into darkness. Queensland experienced a record high number of power outages caused by an extreme weather event.
- Significant rainfall was dumped on a number of communities. Brisbane experienced its wettest day in 50 years (since Tropical Cyclone Wanda) with 275mm recorded overnight to March 10. Hervey Bay experienced its heaviest daily downpour in 70 years, with more than 100mm in a single hour, while Nambour experienced its heaviest March rainfall in over a century.

2 Many of the places hit by Tropical Cyclone Alfred are the same places still rebuilding and recovering from recent major flooding events. These communities are being pushed to their limit by repeated damaging extreme rainfall events.

- A dozen local government areas (LGAs) in Queensland were under disaster declarations as Cyclone Alfred approached. All of those areas experienced flooding in 2022.
- Fourteen local government areas in New South Wales were under disaster declarations as Alfred approached, and some of them (Clarence Valley, Mid-Coast and Port Macquarie-Hastings) are among the most disaster-impacted LGAs in the state, having experienced fires, storms and floods multiple times since 2019.
- Brisbane has faced four major floods in the past 15 years (2011, 2013, 2022 and 2025). As climate change drives more frequent disasters, it is exhausting, traumatic and costly for communities affected over and over again.
- Studies have shown that, in the aftermath of severe storms, survivors demonstrated a 25% increase in the onset of depression, and that the more you're exposed to floodwaters in your home or business the worse the mental health impacts will be.

3 Tropical Cyclone Alfred was a slow-moving storm that gave communities and emergency responders time to prepare. But its prolonged nature meant that the impacts lasted longer, resulting in widespread damage which must be added to the high costs we're all paying due to worsening extreme weather.

- In the months ahead, affected people and communities will face the mounting costs of recovery and rebuilding. An "insurance catastrophe" has been declared, with more than 63,000 claims already made. It is estimated the damage bill could run into billions of dollars and pose a threat to inflation.

- The average cost of extreme weather sits at $1,532 per household nationwide (based on 2022 figures), with higher taxes, rising insurance, more uninsured damage and higher prices paid due to supply chain disruptions all factored in. This figure is expected to rise to more than $2,500 per household by 2050.
- Collectively, the storms and floods that affected Southeast Queensland and coastal New South Wales in February and March 2022 were equal to Australia's costliest ever extreme weather event, at $5.56 billion in insured losses arising from more than 236,000 claims.
- The cost of extreme weather disasters in Australia has more than doubled since the 1970s and the higher frequency of disasters is pushing up insurance premiums for us all. Australians are collectively paying an inflation-adjusted $30 billion more today on insurance than they were only 10 years ago.
- While Australian families, businesses, and communities bear these costs, many fossil fuel corporations that sell the polluting products overheating our planet continue to rake in eye-watering profits. Globally, the oil and gas industry takes between $US3 trillion and $US4 trillion a year in revenue.

4 Our weather is now more chaotic, unpredictable and dangerous due to climate pollution, which presents challenges for us all.

- After the immediate dangers of a flood subsides, the recovery affects people's health and wellbeing. From water contamination, to mould, to increases in mosquito borne disease and, of course, the trauma of experiencing the disaster and aftermath.
- The latest research shows for every degree of global warming, Australians will experience 7-28% more rain for hourly events, and 2-15% more for longer duration events; a range significantly higher than the 5% typically accounted for in Australia's flood planning standards.
- Over the course of Cyclone Alfred, 2.3 million days of learning were lost across 1,804 schools closed in Queensland and New South Wales. A recent Climate Risk Index report found two thirds of our schools already face high climate risk, and this is expected to rise to 84% by 2060.
- While Australia is now cutting climate pollution, it is not fast or far enough to do our fair share in limiting global heating to well under 2 degrees. We must slash climate pollution fast to reduce costly storm damages, as well as prepare communities and our infrastructure for the disasters we cannot avoid.

5 The southward drift of storms like Tropical Cyclone Alfred is a preview of what to expect if we keep extracting and burning fossil fuels, like coal, oil and gas. The future safety and prosperity of Australians depends on how rapidly we cut climate pollution this decade.

- Cyclones are fuelled by ocean heat and moisture. As the oceans heat up scientists worry that the cyclones we do have may track further south towards heavily populated areas and reach their maximum intensity closer to the coast.
- Heavy rainfall events that cause severe flooding are likely to intensify and become more common. Each degree of further warming could double the frequency of intense rainfall events around the world.
- Sea levels are continuing to rise, which will contribute to more damaging swells, coastal flooding and erosion.
- Australians are already paying dearly for the failure of former governments, here and around the world, to slash climate pollution. The severity of events we face into the future rests entirely on how quickly and deeply the world cuts pollution from coal, oil and gas.
- Any move to prolong the use of fossil fuels, either through approvals of new coal and gas projects or policies that delay the switch to renewable power backed by storage, will make future disasters more harmful on our society and endanger our children's lives even further for decades to come.

1. Introduction

Four million Australians living in Australia's third largest city and the heavily populated regions nearby were warned to get ready for Tropical Cyclone Alfred. Understandably, the anxiety surrounding its landfall was high.

Image 1: Tropical Cyclone Alfred caused flash flooding in heavily populated areas of Southeast Queensland and Northern NSW.

This storm hit a lot further south than Australia's east coast communities and emergency services are used to, moving slowly and erratically as it tracked towards Brisbane; drawing up energy from a hot and moist atmosphere and ocean as it crept closer.

In the end, the Category 2 tropical cyclone was rapidly downgraded upon making landfall. But its slow movement transformed Tropical Cyclone Alfred into a prolonged and dangerous event that caused torrential rains, coastal flooding, and powerful winds across large swathes of the country, with communities impacted as far north as Hervey Bay and as far south as Coffs Harbour over 600km away.

The intensity and devastation of this event was fuelled by climate pollution in three ways:

1. Record hot ocean temperatures in the Coral Sea over summer 2024-25 helped fuel its intensity.
2. Storm surges and wind-driven waves from Tropical Cyclone Alfred rode on higher seas, made worse by climate change.
3. A hotter, wetter atmosphere made the extreme rainfall worse than it otherwise would have been.

A dozen local government areas in Queensland were under disaster declarations as the cyclone approached, as well as 14 local government areas in New South Wales. Many of these communities are the same communities that suffered through the 2021-22 floods and other recent disasters.

The impacts were both widespread and record-breaking. Queensland's State Emergency Service fielded 3,676 calls within 24 hours - more than any other day in its history. Half a million properties went without power across both states - the largest loss of power, caused by extreme weather, in Queensland's history.

The Insurance Council of Australia declared an Insurance Catastrophe for Southeast Queensland and Northern New South Wales, with the most significant impacts felt in the Gold Coast, Brisbane, Hervey Bay and Northern Rivers. Beaches were washed away, infrastructure damaged and many communities were flooded once again. In the aftermath of Alfred, there are serious ramifications for people's health and livelihoods, particularly in communities hit by disaster after disaster in recent years.

It will take time to fully understand the consequences of this extreme weather event, but what is clear is that climate pollution made Tropical Cyclone Alfred more destructive and dangerous. Its slow-moving nature proved to be a double-edged sword: it allowed the storm to gather more energy and moisture as it crawled across the ocean, but it also gave communities and emergency responders more time to prepare.

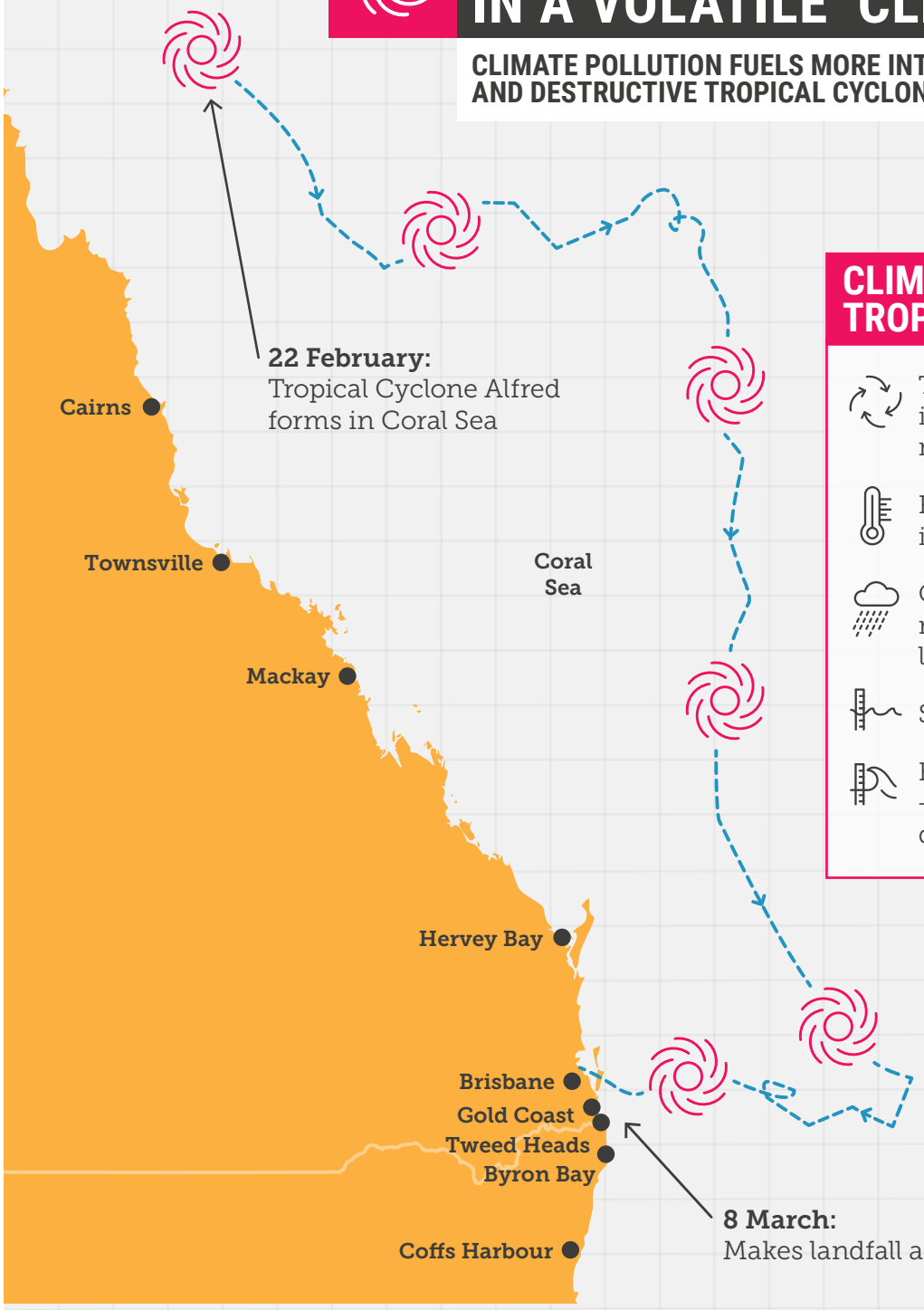
This report is a stark warning that the southward drift of Tropical Cyclone Alfred may be a preview of what's to come if we keep prolonging the use of coal, oil and gas. It is critical that we understand such disasters are no longer simply "natural". Unless we cut climate pollution further and faster, we will be exposed to even more damaging disasters.

It is vital that communities, emergency services, media and governments fully understand the risks presented by our changing climate to ensure we can tackle the root cause – pollution from coal, oil and gas – as well as prepare to face more destructive disasters into the future.

The bottom line is, climate pollution, caused by burning coal, oil and gas, is driving more ferocious extreme weather events like Tropical Cyclone Alfred.

TROPICAL CYCLONE ALFRED IN A VOLATILE CLIMATE

CLIMATE POLLUTION FUELS MORE INTENSE AND DESTRUCTIVE TROPICAL CYCLONES



CLIMATE CHANGE AND TROPICAL CYCLONE ALFRED

- Tropical cyclones are forming in a warmer, wetter and more energetic climate
- Record hot Coral Sea temps in summer 2024-25
- Cyclones are dumping more rain as they form and reach land → (+1°C = +7% moisture)
- Sea levels are > 20cm higher
- Higher seas + gale force winds + storm surges = more damaging waves

HOW TROPICAL CYCLONE ALFRED AFFECTED COMMUNITIES

- 500,000 homes and businesses lost power
- Insurance catastrophe declared for Southeast QLD and Northern NSW
- 1,804 school closures, 2.3 million days of learning lost

TROPICAL CYCLONE ALFRED'S KEY FACTS

- Gold Coast recorded its highest wave ever (12.3m)
- Powerful waves gouged millions of cubic metres of sand along 500km of coastline
- Heavy rain inundated K'gari / Fraser Island (300mm in 8 hours), Brisbane (30% average annual rainfall in 24 hours) and Dorrigo (893mm in one week)
- Wild wind gusts over 120kmh hit Byron Bay

2. Tropical Cyclone Alfred in a volatile climate

Tropical cyclones have long been part of life for many people in Australia and the Pacific, but climate change is affecting the conditions under which all tropical cyclones now form and develop.

In our changing and volatile climate, when tropical cyclones now form they do so in a world that is warmer, wetter, and more energetic than before. This means tropical cyclones can be more intense on average when they occur and may dump more rain for worse flood impacts. Some studies also suggest they could retain their strength for longer, and move more slowly – meaning they linger longer over a given area and cause more damage. Riding upon higher sea levels, they can drive even more dangerous storm surges and coastal flooding.

Image 2: Fallen trees damage property in northern New South Wales.

2.1 Hotter seas power more intense storms

Climate change means the world's oceans are absorbing vast amounts of excess heat, with devastating consequences that are now unfolding.

Water has a much higher heat capacity than air. Heating a cubic metre of sea water by 1°C requires around three thousand times the energy it takes to heat a cubic metre of air. The ocean's immense capacity to absorb and store heat means that the vast majority of the excess heat in our climate system from climate pollution - around 93 percent - has been absorbed by the ocean (IPCC 2019). The observed rate of ocean warming has increased dramatically in recent decades, more than doubling since the mid-1990s (IPCC 2019; Cheng et al. 2023).

Today, we are putting more than 10 zetajoules of extra heat energy into the ocean each year. That's the equivalent energy of five Hiroshima bomb explosions every second (Cheng et al. 2022, Cheng et al. 2023). Put another way, it's enough energy to boil all the water in Sydney Harbour every eight minutes (Climate Council 2024a).

Ocean temperatures around much of Australia's coast have been unusually warm. This helps cyclones to form, which typically need water temperatures of 26.5°C or more. The Coral Sea, where Cyclone Alfred formed, experienced the hottest temperatures on record for summer 2024-25 (Figures 1 and 2). In 2024, Australia sea surface waters were the hottest on record, at 0.89°C above the 1961–1990 average (BoM 2025a).

The equivalent of five Hiroshima nuclear bomb explosions worth of excess heat is being absorbed by our oceans every second.

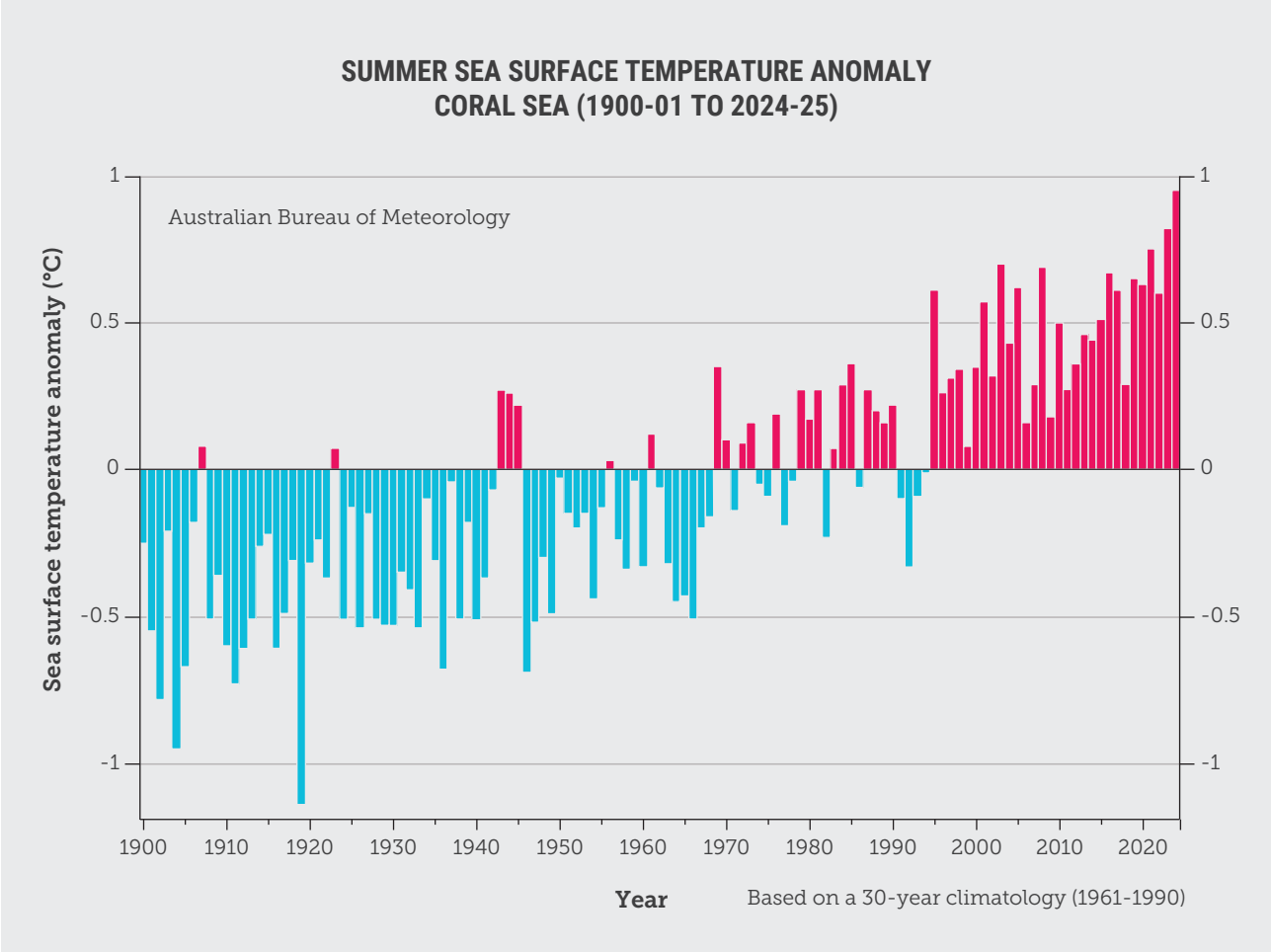


Figure 1: In hot water: sea surface temperatures of the Coral Sea have been rising for decades and were the highest on record in summer 2024-25. This figure shows the trend over time from 1900-01 to 2024-25. **Source:** Bureau of Meteorology (2025b), CC BY-NC-ND.

Australia's subtropical waters are warming up too. That means the energy available to power tropical cyclones in subtropical regions has also increased – largely due to rising ocean temperatures from the burning of fossil fuels. These above-average ocean temperatures allowed Tropical Cyclone Alfred to maintain its intensity as it travelled south (CSIRO 2025a).

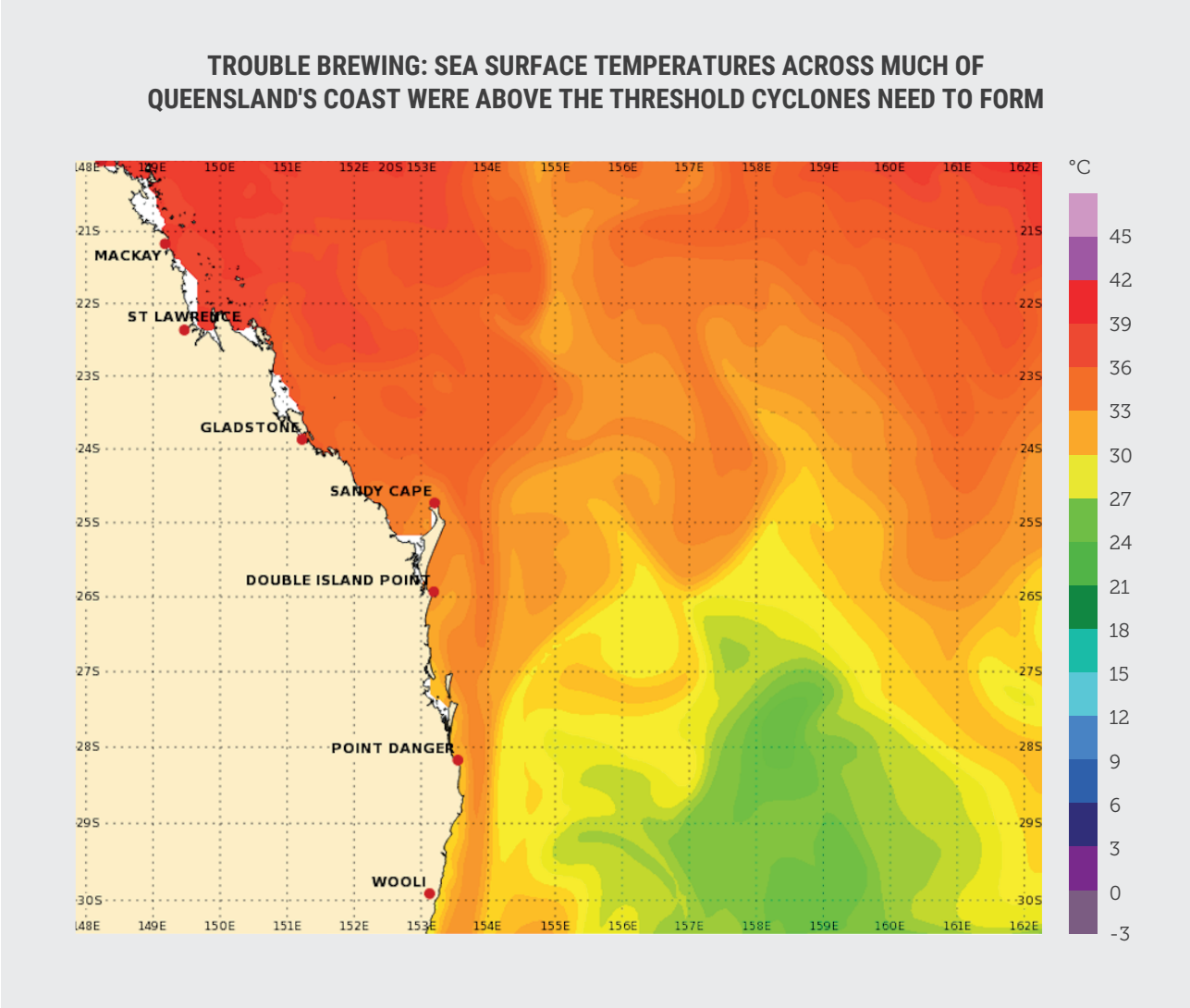


Figure 2: Sea surface Temperature (deg C): 24hr Average centrered on Thu 6 Mar 2025 00UTC. Model Base Time: Wed 5 Mar 2025 12UTC. **Source:** (c) Copyright Australian Bureau of Meteorology | OceanMAPS.

A record hot Coral Sea off the coast of Queensland made it possible for Tropical Cyclone Alfred to form.

2.2 Fewer but more intense cyclones

The best available climate science expects there to be fewer tropical cyclones overall in Australia, but a higher proportion of those that do form will be more intense and destructive (CSIRO and BoM 2024; Ritchie-Tyo, Dowdy and Ramsey 2025).

Tropical cyclones form most readily when there is a very warm ocean surface and a big difference in the temperature of the air at the surface and the air higher up (known as temperature gradient). A warming climate means that the temperature gradient is likely to decrease, so the conditions under which tropical cyclones form may occur less often. This means that the overall number of tropical cyclones is likely to decrease. In Australia, there has already been a decrease in the number of tropical cyclones observed (CSIRO and BoM 2024).

In the North Atlantic basin, observational records show a clear increase in the intensity of hurricanes over recent decades.[1] Until recently, there has not been enough historical data of sufficient quality to demonstrate a similar pattern in Southern Hemisphere tropical cyclones. However, in 2020 an analysis of nearly 40 years of satellite imagery concluded that maximum wind speeds are getting stronger for tropical cyclones in almost every region where they form, affirming what models had long predicted (Kossin et al. 2020).

Rising ocean surface temperatures and a warmer, wetter atmosphere means more fuel for tropical cyclones to draw on once they have formed. It is likely that tropical cyclones will become more intense with climate change in terms of maximum wind speed and the amount of rainfall they produce (IPCC 2023).

1 Since 1980, the number of North Atlantic hurricanes with winds stronger than 200kmh have doubled, and those with winds stronger than 250kmh have tripled (Rahmstorf et al. 2018).

2.3 Tropical Cyclones are dumping more rain

The intensity of a cyclone refers to the speed of the wind and size of the wind-affected area. However, a cyclone's rain field is also important: the areas that experience heavy rain produced by storms when they're at cyclone intensity, and afterwards as they become tropical lows.

Image 3: Submerged playground in Ipswich, an outer suburb of Brisbane, following Tropical Cyclone Alfred.

More cyclones are moving slowly (Kossin 2018), which may be the result of a slowdown in atmospheric circulation (Zhang et al. 2020). This is one factor that might increase the rain per cyclone, on average (CSIRO 2025a).

Rising ocean temperatures mean more water evaporates off the sea surface, so cyclones can absorb more moisture and dump more rain as they form and reach land. It has long been established that for every 1°C of global warming, rainfall intensity increases by 7% (WMO 2025a). Newer research is showing the rate may actually be double this, or even higher (Wasko et al. 2024; Tran et al. 2024) as the process of condensation releases heat that can also trigger more rain (Ritchie-Tyo, Dowdy and Ramsey 2025).

For Australia, the latest research shows for every degree of global warming we will experience about 7–28% more rain for hourly or shorter duration extreme rainfall events, and 2–15% more rain for daily or longer duration extreme rainfall events (Wasko et al. 2024). This range is much higher than the 5% figures that are used in existing flood planning standards used by the likes of policy makers, engineers and urban planners (Dowdy et al. 2024; Wasko et al. 2024).

2.4 Higher sea levels, bigger storm surges

Sea levels are on average about 20 centimetres higher than they were before 1880 (NOAA 2023). When a cyclone is about to make landfall, its intense winds push up a body of seawater ahead of it – known as the storm surge. Because baseline sea levels have already risen due to climate change, storm surges can now reach further inland (Ritchie-Tyo, Dowdy and Ramsey 2025). The area of sea water flooding may extend along the coast for hundreds of kilometres, with water pushing several kilometres inland if the land is low-lying. The worst impacts of a storm surge occur when it coincides with a particularly high tide (Figure 3).

Climate change is causing rising sea levels globally because of warming oceans and melting ice sheets and glaciers on land. This means that storm surges are now riding on higher sea levels than they were earlier, increasing the extent and severity of flooding damage from tropical cyclones and other weather systems that can drive storm surges.

Storm surge was one factor in coastal erosion from Tropical Cyclone Alfred. Wind-driven waves and swell accounted for most of the loss of sand on the Queensland and New South Wales beaches.

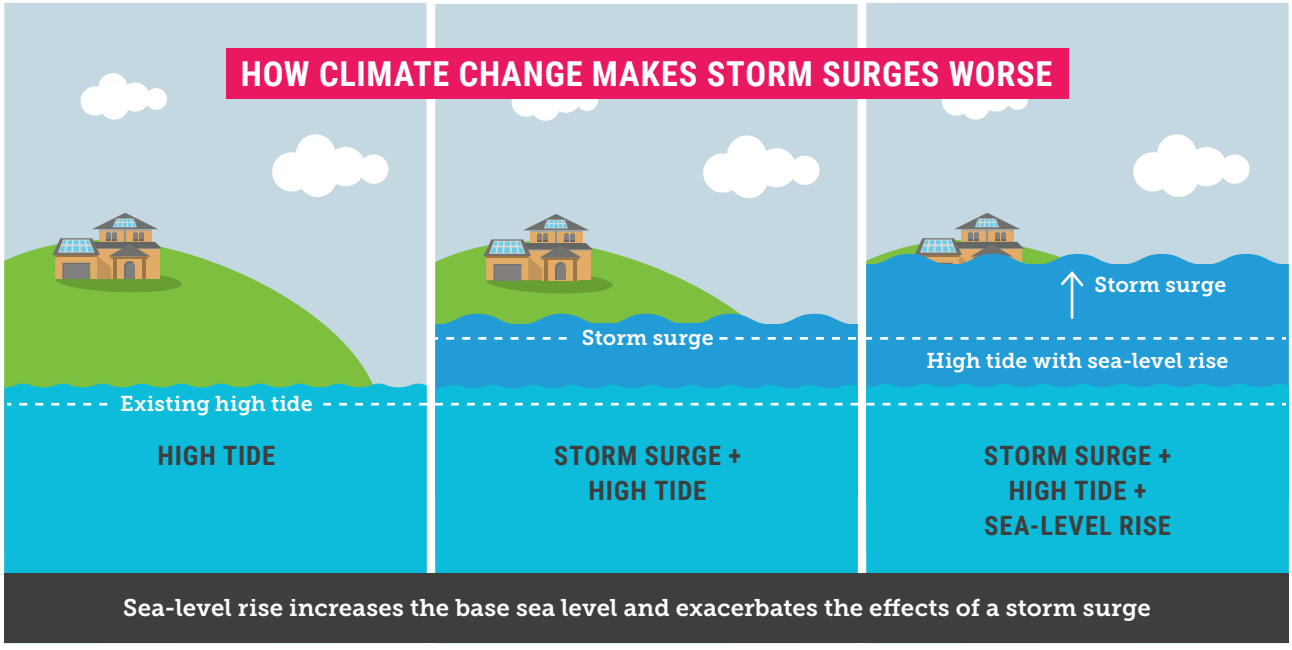


Figure 3: Climate Change increases the base sea level, while other factors, such as wave setup and atmospheric pressure, exacerbate the effects of a storm surge on coastal flooding. **Source:** Climate Commission 2013.

3. Tropical cyclones: an ongoing threat for Australian communities

Tropical cyclones are among the most destructive of extreme weather events.

A cyclone can form when warm humid ocean air rises creating a low-pressure area below it. More warm, moist air rushes in to replace the rising air and that warm, moist air then rises too, fuelling the system like an engine. At higher altitude the air cools, forming clouds and releasing energy. The Earth's rotation makes the storm spin, creating the familiar cyclone shape. In the right conditions the cyclone strengthens. But once it moves over land or cooler water, it starts to lose energy and weakens, with other factors such as strong wind shear (large differences in winds at different heights) are also able to weaken a tropical cyclone.

In Australia, tropical cyclones are an ongoing threat during our cyclone season, which generally runs from November to April (the wet season in the tropical north). On average, Australia experiences 11 cyclones a year, although only four to five of these typically make landfall (BoM 2025d; CSIRO 2025b).

Prior to Alfred, Tropical Cyclone Zelia crossed the coast at Category 4 strength near the De Grey River mouth northeast of Port Hedland, Western Australia on 14 February 2025. It was a Category 5 tropical cyclone before it approached the coast. Rainfall and flooding caused significant impacts to remote communities in WA's Pilbara region. Severe Tropical Cyclone Zelia was the fifth tropical cyclone in the Australian region for the 2024/25 season, and the first to make landfall (CSIRO 2025b).

Image 4: Tropical Cyclone Alfred's powerful and relentless waves gouged millions of cubic metres of sand along the QLD and NSW coastline.

3.1 From triplet, to rare southern cyclone

Powered by climate pollution from the burning of fossil fuels, Tropical Cyclone Alfred was an unusually southern storm for Australia's east coast. Moving erratically, it drew up energy from a hot and moist atmosphere and ocean as it tracked towards Brisbane, Australia's third largest city, and other heavily populated areas across Southeast Queensland and Northern New South Wales.

The tropical cyclone formed over the Coral Sea approximately 1,300 kilometres north of Brisbane on February 22, 2025. On February 27 it reached Category 4 offshore from Mackay (Leon 2025). At one point, Alfred coexisted in the South Pacific with two other tropical cyclones, Seru and Rae. It tracked South and Southeast for about a week as a Category 2 storm but staying offshore.

Coral Sea tropical cyclones tend to be escorted east or south by upper troughs in the atmosphere - cold air masses - that steer them into the "cyclone graveyard" in the Tasman Sea. However, on March 4, Tropical Cyclone Alfred made a sharp turn to the west, steered by a high-pressure ridge to the south (Doermann 2025).

Tropical Cyclone Alfred's slow movement, barely faster than walking pace, made it a prolonged and dangerous event, bringing torrential rains, coastal flooding, and powerful winds. Its path was erratic because of complex wind and weather systems, while record warm summer 2024-25 sea surface temperatures in the Coral Sea helped fuel its intensity. As Alfred loomed over Southeast Queensland and Northern New South Wales, residents braced for worsening conditions and severe flooding warnings were issued by the Bureau of Meteorology.

Tropical Cyclone Alfred's slow moving nature gave communities and emergency services time to prepare, but it also made the disaster more prolonged and destructive.

3.2 Tropical Cyclone Alfred's destructive path

On March 7, Cyclone Alfred reached Queensland's offshore islands (Moreton, North Stradbroke and Bribie Islands) just north of Brisbane as a Category 1 tropical cyclone. On interacting with the islands, the system stalled and began weakening, with wind gusts easing below cyclone intensity saving Brisbane from a much more intense storm. Ex Tropical Cyclone Alfred made landfall on March 8, with its path of destruction hitting more than 600km of our coastline - from Hervey Bay on the Fraser Coast region of Queensland down to Coffs Harbour on the north coast of New South Wales - as well as communities further inland.

Image 5: Coastal damage near Byron Bay, northern NSW, during Tropical Cyclone Alfred.

Pounding waves, disappearing beaches

Large swells and powerful waves on top of the higher sea level pummelled the Queensland coast for several days in the lead up to Tropical Cyclone Alfred's landfall, causing coastal erosion and inundation. One of the first impacts to be felt was the waves, as Tropical Cyclone Alfred's offshore ferocity pounded the coast with towering waves. It included a 12.3 metre wave off Main Beach on the Gold Coast, the highest recorded for this location in 38 years of measurements (ABC 2025a). These powerful and relentless waves gouged millions of cubic metres of sand across about 500 kilometres of Southeast Queensland and Northern NSW coastline. Tropical Cyclone Alfred has caused beach erosion so extreme, it has left escarpments up to six metres high in some dunes, including on the iconic Surfers Paradise on the Gold Coast (ABC 2025b).

Deluge and flooding

For many areas, it was the deluge before Tropical Cyclone Alfred made landfall that delivered the most significant impact. Tropical Cyclone Alfred brought heavy rain to populated coastal and hinterland areas, including Brisbane, Gold Coast, Byron Bay, and Coffs Harbour hinterland.

Overnight on Sunday March 9, rain and thunderstorms brought widespread falls of 200-400mm across Brisbane, the Gold Coast, the Scenic Rim, and the Lockyer Valley. It included a deluge of 275mm for Brisbane in the 24 hours to 9am Monday March 10, making it the city's wettest day in half a century. The last time the city had a higher daily rainfall total was in January 1974, when the Brisbane River flooded in the wake of Tropical Cyclone Wanda and 314mm fell in 24 hours (ABC 2025b).

Parts of Hervey Bay and K'gari (Fraser Island) were also inundated after an intense, near-stationary thunderstorm formed over the area, dumping more than 300mm of rain on Hervey Bay over eight hours (ABC 2025b). This included more than 100mm in the space of just one hour on Sunday morning. The onslaught was the heaviest daily rainfall recorded in 70 years for the region (a combination of four sites in Hervey Bay) (ABC 2025b). Further south, Nambour on the Sunshine Coast had well over 300 millimetres of rain from 9am on Sunday, its heaviest March rain since 1893 (ABC 2025c; ABC 2025d).

Tropical Cyclone Alfred's powerful and relentless waves gouged millions of cubic metres of sand along the QLD and NSW coastline.

BOX 1: DRENCHED

Significant 24-hour rainfall to 9am Monday

- Nambour 365mm — heaviest rain in 33 years
- Brisbane 275mm — heaviest rain in 51 years (Wanda 1974)
- Archerfield 273mm — heaviest rain in 94 years (since 1931)
- Diamond Valley 433mm
- Wongawallan 410mm
- Mount Coot-Tha 341mm
- Green Hill Reservoir 361mm
- Gold Coast Seaway 138mm

Significant 24-hour rainfall to 9am Sunday

- Hervey Bay 261mm — heaviest rain since 1955 in the region

Significant 7-day rain totals to 9am Monday

- Upper Springbrook 1146mm (more than Brisbane's entire annual average rainfall).
- Dorrigo 893mm

Source: BoM 2025e; ABC 2025b as of March 11, 2025).

Image 6: Vehicles drive through submerged roads in Northern NSW, March 2025.

Gale force winds

Tropical Cyclone Alfred delivered gale force winds along coastal Southeast Queensland and Northern New South Wales. Peak gusts up to 120 kilometres an hour (kph) were recorded at Byron Bay, while Coolangatta reached gusts of up to 100kph (its highest in 21 years), and on the Gold Coast, a wind gust of 107kph was recorded in the suburb of Labrador (ABC 2025b).

For many areas, it was the deluge before Tropical Cyclone Alfred made landfall that delivered the most significant impact.

Image 7: 100 kilometre per hour-plus winds wreaked havoc across Southeast QLD and Northern NSW.

4. Communities in the firing line

Climate pollution from the burning of coal, oil and gas is fuelling increasingly severe bushfires, floods and destructive storms such as cyclones.

Queenslanders are being repeatedly pummelled by these events, with the majority of people having experienced one or more floods (70%), heatwaves (86%) and/or cyclones and destructive storms (57%) over the past five years – more people than in any other state or territory. Half (52%) of all Queenslanders have been forced to relocate due to disaster or known someone who has during this period (Climate Council 2024b).

Image 8: Queensland is Australia's most disaster-prone state, with major flood events such as the 2011 floods inundating a state that's on the frontlines of climate change.

Queensland: Our most disaster-prone state

As Australia's most disaster-prone state, Queensland is on the frontlines of climate change. Since 1910, average temperatures in Queensland have increased by more than 1.5°C largely because of the burning of coal, oil and gas. As temperatures continue to rise, unnatural disasters will become more severe and, in some instances, more frequent. Communities across Queensland are already seeing some of these impacts firsthand, experiencing devastating bushfires, severe storms, and tropical cyclones. 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 that of Victoria and 50% greater than New South Wales (Climate Council 2021).

The great deluge of 2022

Wettest monthly records were smashed for Brisbane and Lismore during the 2022 flooding event dubbed the "great deluge", with many times the typical rainfall recorded in these places.

BOX 2: GREAT DELUGE OF 2022 BRINGS RECORD RAINFALL

Brisbane:

- Wettest Jan-Oct on record with three times the typical rainfall over the same period and almost two times the typical annual rainfall.
- Wettest February on record, with almost nine times the typical monthly rainfall.
- February had three of the wettest 10 days on record.

Lismore:

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

Source: Climate Council and ELCA (2022).

The high price of severe storms

Collectively, the storms and floods that affected Southeast Queensland and coastal New South Wales in February and March 2022 were equal to Australia's costliest ever extreme weather event at $5.56 billion in insured losses arising from more than 236,000 claims.

Ultimately, all Australians bear these costs with insurance premiums and food prices on the rise adding to inflation, 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 to $1,532 in 2021-2022, based on the previous 10-year average (The McKell Institute 2022).

From Christmas Eve 2023 through to 3 January 2024, communities in Southeast Queensland experienced severe storms and rainfall, leading to flash flooding, hail, land slips, damage to properties and widespread power outages (BoM 2024a, Queensland Government 2024a). Due to the damage left by the storms and rainfall, eight local government areas were activated for disaster assistance from the state and Commonwealth governments (Queensland Government 2024b). The severe storm – which also hit communities in New South Wales and Victoria – resulted in almost 100,000 insurance claims, costing $1.33 billion in damages (Insurance Council of Australia 2024).

Back-to-back extreme weather is placing communities in New South Wales and Queensland under severe strain and sending the price of essentials through the roof for all Australian households.

5. Counting the costs

Information and data on the costs of Tropical Cyclone Alfred are still coming in, but the storm could cost the economy billions of dollars to rebuild damaged property and cover the rising cost of insurance and essential food (ABC 2025e). The Federal Treasury has warned of a $1.2 billion hit to the federal budget and increased pressure on inflation (SMH 2025a).

Image 9: Australians are feeling the toll of back-to-back extreme weather events devastating communities.

Disaster response and declarations

After Tropical Cyclone Alfred slammed into the coast north of Brisbane, Queensland's State Emergency Service fielded 3,676 calls for help in 24 hours (March 9 and 10), and swift water rescue teams saved 35 people from flood waters (The Guardian 2025a).

> *"That is the largest 24-hour period in the history of Queensland State Emergency Service"*
>
> *Queensland Premier David Crisafulli (ABC 2025c).*

Queensland

Twelve local government areas in Queensland were under disaster declarations as Tropical Cyclone Alfred approached. In the wake of Alfred, 14 local government areas in Queensland are able to access Disaster Recovery Funding Arrangement support to assist recovery. All of these local government areas experienced floods in February 2022, nine were impacted by floods multiple times over 2022 and 12 were impacted by the Black Summer bushfires in 2019-20.

New South Wales

Fourteen local government areas and Lord Howe Island in New South Wales were under disaster declarations when Tropical Cyclone Alfred was approaching. Some of them, including Clarence Valley, Mid-Coast and Port Macquarie-Hastings are among the most disaster impacted local government areas in the state, based upon Disaster Recovery Funding Arrangement activations (ELCA and Climate Council 2024).

All of these local government areas were impacted by the Black Summer bushfires in 2019-20. Half of them were impacted by fires twice - in July and August 2019. All of these local government areas were impacted by the severe weather and subsequent flooding that occurred in February 2022. Over half of them (9) were hit again by severe weather and flood events in June and September 2022. In the wake of Alfred, 19 local government and unincorporated areas in New South Wales are able to access Disaster Recovery Funding Arrangement support to assist recovery.

The NSW State Disaster Mitigation Plan has identified local government areas at high risk of disaster due to floods (Clarence Valley, Tweed and Ballina), coastal inundation (Tweed, Port Macquarie-Hastings), storms and cyclones (Byron, Ballina and Tweed). These disaster risks are projected to worsen due to climate change (NSW Government 2024).

"It's been the biggest post-disaster power restoration in Queensland's history: 500,000 properties, 9,000km of line patrols, 1,600 wires on the deck, and thousands of responders over 11 monster days and nights" (Energex 2025b).

Power outages

Severe weather from Tropical Cyclone Alfred laid bare major weaknesses in critical infrastructure (Desha 2025). Half a million households and businesses across Queensland and News South Wales lost power during the storm (Energex 2025a and SMH 2025b). Queensland experienced record high power outages caused by a disaster.

Insurance claims

The Insurance Council of Australia declared an Insurance Catastrophe for Southeast Queensland and northern New South Wales on March 9, with the most significant impacts felt in the Gold Coast, Brisbane, Hervey Bay and Northern Rivers (ICA 2025a). More than 63,000 insurance claims linked to Tropical Cyclone Alfred in Southeast Queensland and New South Wales had been lodged as of Monday, March 17 - and more claims were expected to come in the following days (ICA 2025b).

Many communities in these impacted areas were already reeling from compound extreme weather events. The annual Household, Income and Labour Dynamics in Australia (HILDA) survey found that in 2022, 4.5% of the population reported their home was severely damaged or destroyed by a weather-related event (HILDA 2025), roughly 1-in-22 people nationwide (Botha 2025).

Physical health

Immediate physical health effects of floods include drowning, falls and injuries. Chronic diseases such as diabetes or renal disease can also flare up because of reduced access to transport, health-care services, medications and hospitals. Exposure to contaminated floodwaters can cause skin infections, while respiratory problems can occur due to mould and damp housing in the aftermath of floods. Floods also create ideal conditions for mosquito-borne infections such as Ross River virus and Murray Valley encephalitis, while also spreading infectious diseases including leptospirosis, a bacterial infection from contaminated soil (Bailie et al. 2025).

Cases of Melioidosis, a bacterial infection found in tropical climates, that is sometimes referred to as a 'mudbug', have sharply risen in Australia since early 2025. Queensland Health recorded 111 melioidosis cases as of March 2, more than three times the number for the same period in 2024, with the majority in Cairns and Townsville resulting from disastrous North Queensland floods in February. Sixteen people have reportedly died from the disease this year (Burge 2025). In the wake of Tropical Cyclone Alfred, authorities are warning that this rare but potentially fatal bacterial disease could occur in Southeast Queensland (The Guardian 2025b).

Mental health

Extreme weather events like Tropical Cyclone Alfred are taking a heavy toll on the mental health of Australians.

A national poll of more than 2,000 people commissioned by the Climate Council showed that the majority (80%) of Australians have experienced some form of extreme weather disaster since 2019. More than half (51%) of the Australians who had experienced a climate change-fuelled disaster since 2019 felt their mental health had been somewhat impacted, and one in five (21%) claimed that the disaster they went through had a "major or moderate impact" on their mental health. People in Queensland and New South Wales were the most likely to have experienced multiple disasters since 2019. Specifically, 38% of Queenslanders and 34% of people in New South Wales reported experiencing flooding more than once since 2019 (well above the national average of 24%) (Climate Council and Beyond Blue 2023; Climate Council 2024b).

In addition to storms causing immense physical damage, they can harm communities and individuals in a myriad of other ways. Studies have shown that in the aftermath of severe storms, survivors demonstrated a 25% increase in the onset of depression. Emotional stress can undermine the resilience of individuals and communities, placing further physical, emotional and financial burdens onto recovery efforts (Martin 2015).

> *"I experience Post Traumatic Stress Disorder, depression and anxiety particularly when it rains. This has been the case since a life-threatening experience in the 2017 floods where I was trapped in my North Lismore home, and has been exacerbated by every flood since then up to the February 2022 floods."*
>
> *- A Lismore, NSW resident who experienced the 2017 and 2022 floods (Source: Climate Council and Beyond Blue 2023).*

The more you're exposed to floodwaters in your home or business, the worse your mental health impacts are likely to be. The 'After the Flood' study examined mental health and wellbeing outcomes six months after the 2017 floods in the Northern Rivers. It found people who had floodwater in their home, yard or business, or who were displaced from their home for more than six months, were much more likely to suffer from post-traumatic stress disorder, anxiety or depression, compared to those who didn't experience flooding or weren't displaced (University Centre for Rural Health 2025).

> *"We physically bailed for two days to keep the water out of the house, which was exhausting both physically and mentally and we still lost the battle. That's when the despair hit."*
>
> *- A Brisbane resident who experienced floods in 2022. (Source: Climate Council and Beyond Blue 2023).*

Repeated natural disasters can compound these mental health consequences. Southeast Queensland and the Northern Rivers in NSW have experienced multiple disasters over recent years. The Northern Rivers faced major flooding in 2017, bushfires in 2020, further major floods in 2022, and now Tropical Cyclone Alfred in 2025. These repeated disasters have taken a toll on the community creating a seemingly never-ending cycle of recovery, rebuilding and preparation for the next disaster (Bailie et al. 2025).

For Tropical Cyclone Alfred impacted communities that have also experienced other, recent extreme weather events, mental health is a serious concern. A recent Australian study showed exposure to repeated disasters has a compounding effect on people's mental health, leading to worse mental health outcomes compared to people who experience a single disaster (Mitchell et al. 2024). Young Australians who have lived through disasters are up to 4.5% more likely to experience psychological distress, compared to their peers who have avoided climate impacts (UNICEF Australia 2024).

School closures

Over the course of the storm, 1,804 schools across Queensland and New South Wales closed for at least a day, with the majority of schools (1,068) closed for four days. At least 650,000 students were affected and 2.3 million days of learning were lost due to cyclone-related closures in March 2025 (Parent for Climate 2025).

A recent Climate Risk Index report found two thirds of schools in Australia face high climate risk, and this is expected to rise to 84% by 2060 (Zurich-Mandala 2025). UNICEF Australia reported that more than 1.4 million Australian children and young people experience disasters on average per year, leading to lifelong impacts. Young people who have gone through disasters are 4.2% less likely to finish year 12, and as a consequence earn less over their lifetimes (UNICEF Australia 2024).

6. Cost of living crunch

Climate pollution is driving more ferocious extreme weather events like Cyclone Alfred.

The cost of extreme weather disasters in Australia has more than doubled since the 1970s and the higher frequency of disasters is pushing up insurance premiums for us all (Climate Council 2021). Collectively, Australians are paying $30 billion more today on insurance than they were only 10 years ago (ICA 2024).

Image 10: Extreme weather, caused by the burning of coal, oil and gas, is fuelling cost of living pressure for Australian households by driving up taxes, insurance and higher prices for essential items.

Over the past decade, extreme weather has annually cost every Australian household $888 on average (The McKell Institute 2022). This jumped to $1,532 in 2021-2022 - largely because of the cost of the record breaking February-March floods of 2022. This includes expenses paid through higher taxes, insurance costs, uninsured damage, and increased prices due to supply chain disruptions. This figure is expected to jump to more than $2,500 a year per household by 2050 (The McKell Institute 2022).

While Australian families, businesses, and communities bear the cost of record-breaking economic damages from climate impacts, the fossil fuel corporations, which are selling the polluting products that are accelerating climate change, continue to rake in eye-watering profits (ACTU 2022). Globally, the oil and gas industry takes between $US3 trillion and $US4 trillion a year in revenue (SMH 2025c).

Safeguarding science to save lives and secure our economy

In Australia, governments, emergency management agencies, farmers, communities and businesses all rely on climate change information from universities and agencies, such as CSIRO and the Bureau of Meteorology, to make countless important decisions.

The climate science capability of the US, a major provider of vital global climate information, is under threat as the Trump Administration freezes funding and cuts jobs (CBS news 2025; The Guardian 2025c). Here in Australia, the previous Federal Government dismantled decades of institutional climate science capability (Climate Council 2019).

Without such knowledge there is an increased likelihood that more lives will be lost and more property damaged, and livelihoods lost. Critically, in a rapidly changing climate where the nature of risks is constantly changing, ongoing research is required to continually improve our knowledge base. It is essential to understand and monitor how the climate is changing, and to project future changes, in order to ensure we understand the evolving nature and extent of the challenge facing Australia. Right now, Australia effectively has no publicly available national risk assessment or adaptation strategy. Both of these must be delivered as a priority by the Federal Government.

We cannot afford to fly blind in a volatile climate. Lives and our economy depend on timely and robust climate information.

7. Conclusion

As our oceans heat up, Australians are expected to experience fewer cyclones but those that reach us will be more extreme with greater impacts. In other words, the cyclones we now face will be more devastating as a result of climate change.

With rising sea levels and a projected increase in cyclone intensity, there is likely to be an increased risk of coastal flooding, especially in low-lying areas exposed to cyclones and storm surges. For example, the risk of flooding in Cairns caused by a one-in-100-year storm surge is likely to more than double by the middle of this century (CSIRO 2025b). The intensity of extreme rainfall in Australia is increasing in a warmer climate, with sub-daily and daily rainfall extremes increasing by about 15% and 8%, respectively, for each degree of global heating (Wasko et al. 2024). This means that damaging

Image 11: Homes, communities and critical infrastructure across Southeastern QLD and Northern NSW was left under water in the wake of Tropical Cyclone Alfred.

floods from extreme rain, as occurred with Tropical Cyclone Alfred, is already likely to be exacerbated by climate change, given that over 1 degree of human-caused global heating has already occurred.

Tropical Cyclone Alfred may serve as a preview into the future. In a warmer world, powerful cyclones could track further south (Kossin et al. 2014; CSIRO and BoM 2015) and intensify closer to the coast (Wang and Toumi 2021), and impact heavily populated communities and critical infrastructure that is not designed to cope with such destructive storms.

While Australia has started cutting climate pollution at a national level, this is not occurring fast enough to prevent even worse events into the future. Both climate pollution (Global Carbon Project 2024) and global temperatures (WMO 2025b). reached record levels in 2024 and, right now, the global response to climate change remains woefully inadequate. There is a glaring gap between what the science says is required to limit global warming to well below 2 degrees and the political response so far, in terms of the commitments of countries demonstrated by their emission reduction targets (UNEP 2024).

As we reach the mid-point in the critical decade for action on climate, everything we do now matters. All the decisions taken by our political leaders and all the policies they choose to adopt, or ignore, will each play a pivotal role in our race to secure a safer future for our kids.

Unless we act quickly to cut global climate pollution, the slow moving, south tracking Tropical Cyclone Alfred may be remembered as offering a glimpse into a more dangerous and destructive future for vulnerable Australian communities.

References

ABC (Australian Broadcasting Corporation) (2025a) Biggest wave recorded at 12.3 metres off Gold Coast as Cyclone Alfred moves south. By Zema Chamas. Accessed at https://www.abc.net.au/news/2025-03-06/biggest-wave-on-record-off-gold-coast-amid-cyclone-alfred/105017280.

ABC (2025b) Ex-Tropical Cyclone Alfred brings highest rainfall in decades to south-east Queensland. By Tyne Logan and Tom Saunders. Accessed at https://www.abc.net.au/news/2025-03-10/brings-highest-rainfall-in-decades-to-south-east-queensland/105031782.

ABC (2025c) Emergency alerts in place for parts of Queensland, 200,000 without power. Accessed at https://www.abc.net.au/news/2025-03-10/qld-nsw-ex-tropical-cyclone-alfred-flooding-clean-up/105030178.

ABC (2025d) Multiple people rescued from cars after flash flooding hits Sunshine Coast. By Josh Dye and Jennifer Nichols. Accessed at https://www.abc.net.au/news/2025-03-10/heavy-rain-flash-flooding-sunshine-coast-hinterland/105031194.

ABC (2025e) The economic cost of ex-Cyclone Alfred could be $1 billion a day. By Daniel Ziffer. Accessed at https://www.abc.net.au/news/2025-03-11/economic-cost-ex-tropical-cyclone-alfred-insurance/105032864.

ACTU (Australian Council of Trade Unions) (2022) Oil giants' sky-high profits fuels cost of living crisis. Media Release - August 3, 2022.

Bailie J, Longman J, McNaught R, Bailie R (2025) Ex-Cyclone Alfred has left flooding in its wake. Here's how floods affect our health. The Conversation, March 9, 2025. Accessed at https://theconversation.com/ex-cyclone-alfred-has-left-flooding-in-its-wake-heres-how-floods-affect-our-health-251488.

Botha F (2025) HILDA data shows income inequality is at a 20-year high. The Conversation, March 6, 2025. Accessed at https://theconversation.com/hilda-data-shows-income-inequality-is-at-a-20-year-high-251596.

Burge K (2025) GPNews. Fatal melioidosis outbreak continues to grow. Accessed at https://www1.racgp.org.au/newsgp/clinical/fatal-melioidosis-outbreak-continues-to-grow.

Bureau of Meteorology (BoM) (2025a) Summer sea surface temperature anomaly Coral Sea (1900-01 to 2024-25). Accessed at http://www.bom.gov.au/cgi-bin/climate/change/timeseries.cgi?graph=sst&area=cor&season=1202&ave_yr=0&ave_period=6190.

Bureau of Meteorology (BoM) (2025b) February sea surface temperature anomaly Coral Sea (1900 to 2025).

Bureau of Meteorology (BoM) (2025c) Sea temperatures & currents. Accessed at http://www.bom.gov.au/oceanography/forecasts/idyoc300.shtml?region=SEQLD&forecast=SST.

Bureau of Meteorology (BoM) (2025d) Tropical cyclone knowledge centre. Accessed at http://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/.

Bureau of Meteorology (BoM) (2025e) Rainfall update. Accessed at http://www.bom.gov.au/climate/rainfall/.

CBC News (2025) Job cuts at NOAA drive concerns about extreme weather forecasts, as climate change worsens natural disasters. By Emily Mae Czachor.

Chand S, Dowdy AJ, Ramsay HA, Walsh KJE, Tory KJ, Power SB, Bell SS, Lavender SL, Ye H, Kuleshov Y (2019) Review of tropical cyclones in the Australian region: climatology, variability, predictability, and trends WIREs Climate Change, 10 (2019), Article e602.

Chand SS, Walsh KJ, Camargo SJ, Kossin JP, Tory KJ, Wehner MF, Cha JC, Klotzbach PJ, Dowdy AJ, Bell SS, Ramsay HA (2022) Declining tropical cyclone frequency under global warming. *Nature Climate Change*, *12*(7), 655-661.

Cheng L, von Scheckmann K, Abraham J P, Trenberth K E, Mann M E, Zanna L, England M H, Zika J D, Fasullo J T, Yu Y, Pan Y, Zhu J, Newsom E R, Bronselaer B, Lin X (2022) Past and Future Ocean Warming. Nature Reviews Earth and Environment.

Cheng L, Abraham J, Trenberth K E, Fasullo J, Boyer T, Mann M E, Zhu J, Wang F, Locarcini R, Li Y, Zhang B, Fujiang Y, Wan L, Chen X, Feng L. Song X, Liu Y, Reseghetti F, Simoncelli S, Gouretski V, Chen G, Mishonov A, Reagan J, Li G (2023) Another Year of Record Heat for the Oceans. Advances in Atmospheric Science. Vol 40, 963–974.

Climate Commission (2013) The critical decade: extreme weather. Steffen W, Hughes L and Karoly D.

Climate Council (2019) Climate cuts, cover-ups and censorship Accessed at https://www.climatecouncil.org.au/wp-content/uploads/2019/04/Climate-Cuts-Cover-Ups-and-Censorship.pdf.

Climate Council (2021) Hitting Home: The Compounding Costs of Climate Inaction. Steffen W and Bradshaw S. Accessed at https://www.climatecouncil.org.au/resources/hitting-homecompounding-costs-climate-inaction/.

Climate Council (2024a) Code Blue: Our oceans in crisis. Morgan W, Bradshaw S, King T, Gardner J, Hughes L, Karoly D, Pecl G. Accessed at https://www.climatecouncil.org.au/resources/code-blue-our-oceans-in-crisis/.

Climate Council (2024b) Climate Trauma: The Growing Toll of Climate Change On The Mental Health Of Australians. By Bradshaw S, Gardner J, Gergis J and Blashki G. Accessed at https://www.climatecouncil.org.au/wp-content/uploads/2023/02/Report-Climate-Change-and-Mental-Health.pdf.

Climate Council and Beyond Blue (2023) Summary of Results From National Study Of The Impact Of Climate-Fuelled Disasters On The Mental Health Of Australians. Accessed at https://www.climatecouncil.org.au/resources/survey-results-climate-disasters-mental-health/.

Climate Council and ELCA (2022) The Great Deluge: Australia's new era of unnatural disasters. By Rice M, Cheung H, Dean A, Hart N, Bambrick H, Shah V, Arndt D, Hughes L, Karoly D, O'Callaghan K, Bradshaw S, Mullins G, Templeman D, Keys C, Dunn P, Johnson L. Accessed at https://www.climatecouncil.org.au/resources/the-great-deluge-australias-new-era-of-unnatural-disasters/.

CSIRO (2025a) Cyclone Alfred is slowing – and that could make it more destructive. Here's how climate change might have influenced it. Accessed at https://www.csiro.au/en/news/All/Articles/2025/March/Climate-change-cyclone-alfred.

CSIRO (2025b) Here are seven things to know about tropical cyclones. Accessed at https://www.csiro.au/en/news/All/Articles/2025/March/things-to-know-about-tropical-cyclones.

CSIRO and BoM (2015) Climate Change in Australia – Technical Report.

CSIRO and BoM (2024) State of the Climate 2024. Accessed at http://www.bom.gov.au/state-of-the-climate/.

Desha C (2025) 'A serious wake-up call': Cyclone Alfred exposes weaknesses in Australia's vital infrastructure. The Conversation, March 10. Accessed at https://theconversation.com/a-serious-wake-up-call-cyclone-alfred-exposes-weaknesses-in-australias-vital-infrastructure-251814.

Doermann L (2025) This Cyclone Broke Every Rule – And Now It's Wreaking Havoc. NASA Earth Observatory, March 10, 2025.

Dowdy A, Wasko C, Catto J, Westra S (2024) Supercharged thunderstorms: have we underestimated how climate change drives extreme rain and floods? The Conversation, May 9, 2024. Accessed at https://theconversation.com/supercharged-thunderstorms-have-we-underestimated-how-climate-change-drives-extreme-rain-and-floods-228896.

ELCA (Emergency Leaders for Climate Action) and Climate Council (2024) Too Close to Home: How we keep communities safer from escalating climate impacts. Accessed at https://www.climatecouncil.org.au/wp-content/uploads/2024/06/Too-Close-to-Home_ELCA-and-Climate-Council-report.pdf.

Energex (2025a) Ex-Tropical Cyclone Alfred Update - 12 March. Accessed at https://www.energex.com.au/news/2025/ex-tropical-cyclone-alfred-update-12-march.

Energex (2025b) It's a wrap: Power restored to 500,000 in SEQ 8:30pm - Sunday, 16 Mar 2025.

Global Carbon Project (2024) Global Carbon Budget 2024. Accessed at https://globalcarbonbudget.org/.

HILDA (2025) HILDA Statistical Report. Melbourne Institute of Applied Economic and Social Research. Accessed at https://melbourneinstitute.unimelb.edu.au/hilda/publications/hilda-statistical-reports.

ICA (Insurance Council of Australia) (2024) Insurance Catastrophe Resilience Report 2023/24. Accessed: https://insurancecouncil.com.au/resource/catastropheresiliencereport23-24/.

ICA (2025a) Ex-Tropical Cyclone Alfred insurance update. News release Monday, 10 March 2025 Accessed at https://insurancecouncil.com.au/resource/ex-tropical-cyclone-alfred-insurance-update/.

ICA (2025b) Insurer update on ex-TC Alfred. News release Monday, 17 March 2025. Accessed at https://insurancecouncil.com.au/resource/insurer-update-on-ex-tc-alfred/

IPCC (Intergovernmental Panel on Climate Change) (2019) Special Report on the Ocean and Cryosphere in a Changing Climate.

IPCC (2023) AR6 Synthesis Report Climate Change 2023.

Kossin, J.P. (2018) A global slowdown of tropical-cyclone translation speed. Nature 558. https://doi.org/10.1038/s41586-018-0158-3.

Kossin JP, Emanuel KA and Vecchi GA (2014) The poleward migration of the location of tropical cyclone maximum intensity. Nature volume 509, pages349–352.

Knutson, T., Camargo, S.J., Chan, J.C., Emanuel, K., Ho, C.H., Kossin, J., Mohapatra, M., Satoh, M., Sugi, M., Walsh, K. and Wu, L., 2019. Tropical cyclones and climate change assessment: Part I: Detection and attribution. *Bulletin of the American Meteorological Society*, *100*(10), 1987-2007.

Knutson, T., Camargo, S.J., Chan, J.C., Emanuel, K., Ho, C.H., Kossin, J., Mohapatra, M., Satoh, M., Sugi, M., Walsh, K. and Wu, L., 2020. Tropical cyclones and climate change assessment: Part II: Projected response to anthropogenic warming. *Bulletin of the American Meteorological Society*, *101*(3), E303-E322

Leon J (2025) Beloved beaches were washed offshore by Cyclone Alfred – but most of this sand will return. The Conversation, March 11. Accessed at https://theconversation.com/beloved-beaches-were-washed-offshore-by-cyclone-alfred-but-most-of-this-sand-will-return-251599.

Martin U (2015) Health after disaster: A perspective of psychological/health reactions to disaster, Cogent Psychology, 2:1, 1053741, DOI: 10.1080/23311908.2015.1053741.

Mitchell A, Maheen H and Bowen K (2024) Mental health impacts from repeated climate disasters: an Australian longitudinal analysis. The Lancet: Regional Health – Western Pacific, Volume 47101087June 2024. Accessed at https://www.thelancet.com/journals/lanwpc/article/PIIS2666-6065(24)00081-6/fulltext.

NESP (National Environmental Science Programme) (2019) Tropical cyclones and climate change in Australia. Earth System and Climate Change Hub. Accessed at https://nespclimate.com.au/wp-content/uploads/2019/11/A4_4pp_brochure_NESP_ESCC_Tropical_Cyclones_FINAL_Nov11_2019_WEB.pdf.

NOAA (National Atmospheric and Oceanic Administration) (2023) Climate Change: Global Sea Level. By Rebecca Lindsey. Accessed at https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level.

NSW Government (2024) State Disaster Mitigation Plan 2024 – 2026.

Parents for Climate (2025) 2.3 million days of lost learning due to ex-Tropical Cyclone Alfred: Parents call for action on school safety.

Queensland Government (2024a) Queensland Disaster Management Committee: Annual Report 2023-24.

Queensland Government (2024b) 2023-24 South Queensland Severe Storms - recovery operation, accessed on 2 September 2024 from https://www.qra.qld.gov.au/2023-24-South-Queensland-Severe-Storms.

Richie-Tyo, Dowdy and Ramsey (2025) Cyclone Alfred is slowing – and that could make it more destructive. Here's how climate change might have influenced it. The Conversation, March 6, 2025. Accessed at https://theconversation.com/cyclone-alfred-is-slowing-and-that-could-make-it-more-destructive-heres-how-climate-change-might-have-influenced-it-251594.

SMH (*The Sydney Morning Herald)* (2025a) Chalmers reveals Alfred's damage to the budget, inflation and growth. By Shane Wright. Accessed at https://www.smh.com.au/politics/federal/chalmers-reveals-alfred-s-damage-to-the-budget-inflation-and-growth-20250314-p5ljp6.html.

SMH (2025b) Lismore prepared for the worst. Now boxes are being unpacked as life returns to normal. By Riley Walter and Penry Buckley. Accessed at https://www.smh.com.au/national/not-out-of-the-woods-yet-nsw-still-in-response-mode-as-alfred-weakens-20250310-p5libz.html.

SMH (2025c) Their profit, our cost: Should fossil fuel companies pay for climate disasters? By Nick O'Malley, March 13, 2025. Accessed at https://www.smh.com.au/environment/climate-change/their-profit-our-cost-should-fossil-fuel-companies-pay-for-climate-disasters-20250312-p5livu.html.

The Guardian (2025a) BoM defends forecasts after claim coastal community not properly warned. By Ben Smee and Andrew Messenger. Accessed at https://www.theguardian.com/australia-news/2025/mar/10/residents-warned-to-head-for-high-ground-as-flood-waters-rise-in-wake-of-ex-tropical-cyclone-alfred.

The Guardian (2025b) hat is melioidosis and why do cases spike after flooding and heavy rainfall? By Natasha May. Accessed at https://www.theguardian.com/australia-news/2025/mar/06/what-is-melioidosis-explainer-queensland-case-spike-floods-rainfall-tropical-cyclone-alfred.

The Guardian (2025c) Trump cuts to have 'chilling effect' on climate science and 'degrade' Australia's ability to forecast weather. By Donna Lu, 18 March 2025. Accessed at https://www.theguardian.com/science/2025/mar/17/trump-cuts-to-have-chilling-effect-on-climate-science-and-degrade-australias-ability-to-forecast-weather

The McKell Institute (2022) The Cost of Extreme Weather. Accessed at https://mckellinstitute.org.au/research/reports/the-cost-of-extreme-weather-1/.

Tran TL, Ritchie EA, Perkins-Kirkpatrick SE, Bui H, Luong TM (2024). Variations in rainfall structure of western North Pacific landfalling tropical cyclones in the warming climates. Earth's Future, 12, e2024EF004808. https://doi.org/10.1029/2024EF004808.

UNEP (United Nations Environment Programme) (2024) Emissions Gap Report 2024. Accessed at https://www.unep.org/resources/emissions-gap-report-2024.

UNICEF Australia (2024) Climate disasters set back young Australians earnings and mental health.

University Centre for Rural Health (2025). After The Flood. Accessed at https://ucrh.edu.au/project/after-the-flood/.

Wang S and Toumi R (2021) Recent migration of tropical cyclones toward coasts. Science, 29 Jan 2021, Vol 371, Issue 6528, pp. 514-517, DOI: 10.1126/science.abb9038.

Wasko C, Westra S, Nathan R, Pepler A, Raupach TH, Dowdy A, Johnson F, Ho M, McInnes KL, Jakob D, Evans J, Villarini G, Fowler HJ (2024) A systematic review of climate change science relevant to Australian design flood estimation. Hydrology and Earth System Science, https://doi.org/10.5194/hess-28-1251-2024.

World Meteorological Organization (WMO) (2025a) Extreme weather. Accessed at https://wmo.int/topics/extreme-weather.

WMO (2025b) WMO confirms 2024 as warmest year on record at about 1.55°C above pre-industrial level. Press Release. 10 January 2025.

Zhang, G., Murakami, H., Knutson, T. R., Mizuta, R., Yoshida, K. (2020) Tropical cyclone motion in a changing climate. Science Advances 6. https://doi.org/10.1126/sciadv.aaz7610.

Zurich-Mandala (2025) The Zurich-Mandala Climate Risk Index: The impact of climate change on Australia's schools.

Image credits

Front cover: Credit: Alex Cimbal / Shutterstock

Image 1: Credit: Trevor King

Image 2: Credit: Trevor King

Image 3: Credit: wallaby / Shutterstock

Image 4: Credit: Petar B photography / Shutterstock

Image 5: Credit: Trevor King

Image 6 : Credit: Trevor King

Image 7: Credit: Trevor King

Image 8: Credit: paintings / Shutterstok

Image 9: Credit: Jelena Stanojkovic / Shutterstock

Image 10: Supplied by Pexels. Photography of Factory.
Photo contributor: Chris LeBoutillier.

Image 11: Credit: Trevor King

The Climate Council is a fearless champion of the climate solutions that Australia needs. People power got us started and we are proudly community-funded and independent.

The Climate Council acknowledges the Traditional Owners of the lands on which we live, meet and work. We wish to pay our respects to Elders, past and present, and recognise the continuous connection of Aboriginal and Torres Strait Islander peoples to land, sea and sky. We acknowledge the ongoing leadership of First Nations people here and worldwide in protecting Country, and securing a safe and liveable climate for us all.

CONNECT WITH US!

facebook.com/climatecouncil

x.com/climatecouncil

instagram.com/theclimatecouncil

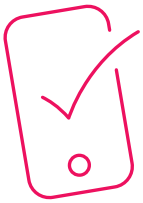
tiktok.com/@theclimatecouncil

youtube.com/climatecouncil

linkedin.com/company/climate-council

info@climatecouncil.org.au

climatecouncil.org.au



Subscribe to the Climate Council today for your exclusive inside take on the latest climate science, impacts and solutions.

Visit climatecouncil.org.au/join/

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