The ARC Centre of Excellence for Climate Extremes

29 March 2023
Committee Secretariat
Select Committee on Australia's Disaster Resilience
PO Box 6100
Parliament House
Canberra ACT 2600

Submission to Select Committee on Australia's Disaster Resilience

Dear Committee Chair,

Inquiry into Australia's Disaster Resilience

The **ARC Centre of Excellence for Climate Extremes** welcomes the opportunity to make a submission to the Inquiry into Australia's Disaster Resilience. We support the committee in highlighting this issue and in their investigations.

Australia has an on-going exposure to weather and climate extremes and consequent disasters. The impacts to Australian communities are being felt through interruptions to the access of resources such as food, water and fuel as well as damage leading to social, environmental and economic costs and prolonged recovery periods. With increasing risks from climate change, our region will face many more intense extremes in the future. Assessing Australia's disaster resilience is therefore timely.

We thank the committee for the opportunity to make a submission on this important issue and offer our expertise on weather and climate extremes. We are happy to provide further information on matters arising from this submission.

Yours sincerely,

Professor Andrew Pitman, AO, FAA
Centre Director
ARC Centre of Excellence for Climate Extremes

The ARC Centre of Excellence for Climate Extremes

The ARC Centre of Excellence for Climate Extremes is Australia's leading climate science centre consisting of five partner universities - The University of New South Wales, Monash University, The Australian National University, The University of Melbourne and The University of Tasmania as well as multiple national and international partner organisations. Its research focuses on understanding the underlying processes of climate extremes to reduce Australia's economic, social and environmental vulnerability.

Submission to the Senate Select Committee on Australia's Disaster Resilience

Weather and Climate extremes are already affecting many facets of Australian society. It is crucial that these disaster risks are well understood to adequately assess Australia's disaster resilience. This submission outlines the following aspects for the committee to consider:

1. Increases in the frequency and intensity of extreme climate and weather disasters.
2. Uncertainty, hazard exposure and compound events.
3. Maintaining and enhancing climate and weather research capability.

1.0 Increases in the frequency and intensity of extreme climate and weather disasters

Australia's climate is warming slightly faster than the global average temperature. The first two decades of the 21st century were both warmer than any decade in the 20th century. The latest report from the UN's Intergovernmental Panel on Climate Change (IPCC)[1] states climate change is causing greater impacts than anticipated, and these impacts are emerging at lower amounts of warming than expected. The report underlined the urgent need for emissions reductions to limit warming to below 2°C to avoid dangerous climate change, as stated in the Paris Agreement. In short, e*very additional fraction of a degree of warming increases the risk of extreme weather events.*

Future changes to Australia's climate depend on the cumulative total of greenhouse gases emitted over time. The more we emit now, the worse climate change will be in the future. With the impacts from climate extremes likely to increase with the warming that is already locked in, action towards future prevention is a national responsibility as well as a key component of disaster resilience**.**

Australia experienced major extreme events in 2022[2] (Figure 1) with extreme rain and flooding overshadowing all other events. Persistent, heavy rainfall broke multiple flood and rainfall records. As outlined in Australia's National Disaster Risk Reduction (homeaffairs.gov.au), and the United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster Risk Reduction 2015-2030 | UNDRR, one of the main priorities to prevent new, and reduce existing disaster risks, is to understand the weather and climate processes that contribute to risk. Building the understanding of the processes causing weather and climate extremes, and how these may change in the future, is the focus of research at our Centre. Understanding the latest developments in climate science research improves Australia's national capacity for assessing disaster risk.

Figure 1: Australia's major extreme events in 2022

2.0 Hazard exposure, uncertainty and compound events

The impact of severe weather on Australia's disaster resilience can result from floods, extreme temperatures, extreme winds and hail, all of which can be affected by human induced climate change. As weather related disruptions become more significant with climate change, the extent to which this increases risks for communities depends upon exposure to the hazard. Communities are exposed to multiple risks depending on location and the vulnerability of their location.

When assessing hazard exposure, it is important to provide a rationale for decisions before any investment. Any analysis or interpretation of climate hazard data to inform climate resilience decisions should be performed cautiously and with expert help. The climate science community can provide technical expertise and guidance as part of this process.

Using historical observations of severe weather events can provide a useful starting framework for a future risk assessment. A storyline approach to future climate scenarios can then extend this assessment to include multiple lines of evidence. These strategies are necessarily customised depending on the hazard and location in question.

Looking ahead to future scenarios and 'war-gaming' potential disaster situations, climate projections can provide useful data. This must be performed within a robust governance framework to record and provide assurance around climate data including methodology, assumptions and sources of data. This includes what data were used, where it came from, how it was generated and how uncertainty is assessed. Using data from climate projections without a detailed understanding of how they were created risks investment in maladaptation.

Assessing Australia's disaster resilience requires understanding the causes of events and how these impact socioeconomic systems. However, navigating risks associated with climate and weather events is complex because extremes are always caused by a range of physical processes, which is then coupled with social, political and economic complexities that impact how risk is experienced.

We would like to highlight two aspects of climate research: uncertainty and compound events, which are important when considering disaster events.

2.1 Uncertainty

Uncertainty arises from current limitations in climate projections, natural climate variability of the climate system and knowledge gaps in our understanding. Uncertainty is amplified by social, political and economic complexities which impact how risk is experienced. Ultimately, there is considerable uncertainty when quantifying the risk of future climate extremes. For example: it is difficult to robustly predict if more intense rainfall will impact a specific suburb despite knowing, on average, rainfall intensity will increase.

Attempts to provide false certainty around climate projections risks economically costly investments in climate resilience measures. Responding to risk often requires local scale bespoke solutions, which cannot be robustly informed by current climate projections in many cases.

2.2 Compound events

Compound events arise from multiple hazards or drivers, a succession of hazards, hazards in multiple connected locations, or simply a more severe event as the result of preconditioning which combine to have an impact on a system[3]. Compound events are difficult to capture in risk assessment, as they are caused by multiple factors. For example: an increase in rainfall or in wind gusts of 10% in isolation are unlikely to be significant. However, if they both occur simultaneously the impact can be considerable. An East Coast Low affecting the Sydney Basin can increase water storages. Three East Coast Lows affecting the Sydney Basin within a few weeks could be catastrophic.

Australia has experienced a variety of compound events that have led to loss of life and negatively impacted the Australian economy over the past decades. In early 2022, South-eastern Queensland and eastern New South Wales experienced a series of storms which combined to cause a compound event (Figure 2). Persistent, heavy rainfall which broke multi-day rainfall records in many locations, with some regions experiencing over five times their monthly average rainfall.

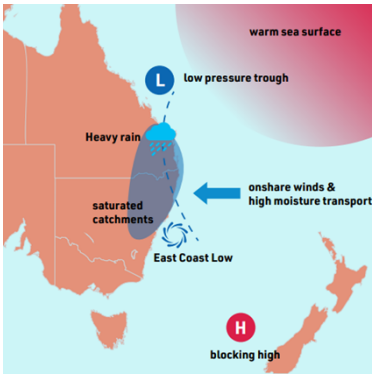

Figure 2: conditions that lead to the devastating floods in Queensland and Northern New South Wales in February/March 2022. SOURCE: ARC Centre of Excellence for Climate Extremes

In this compound event, a combination of meteorological phenomena caused persistent, heavy rain to fall on catchments that were already saturated and primed for flooding due to sequential La Niña events. The antecedent conditions, and the La Nina raised the risk. For the risk to be realised the extreme rainfall event was necessary, something that was not predictable beyond a week in advance.

Future climate risk assessments should consider compound events.

Our research has found that future climate change will lead to an increase in prolonged hot and dry compound events over all of Australia[3]. Current climate models project an increase in wet and windy

compound events in the northern parts of Australia dominated by tropical cyclones and thunderstorms, and a decrease in events in the south where fronts and frontal systems are the dominant drivers of extreme wind and rain.

Our understanding of many compound events is insufficient to reliably assess the risk they pose. Current observational records are not sufficiently long and/or are too sparse to perform reliable analyses. The ARC Centre of Excellence for Climate Extremes continues to incorporate compound event research into its program of research.

3.0 Maintaining and enhancing climate and weather research capability

Several submissions to this inquiry have already commented on the need for disaster resilience planning and preparation. Improving Australia's resilience relies on incorporating our knowledge of current disaster events into a robust resilience framework.

Mitigating the risk of disasters depends on several aspects of the disaster itself: what are we preparing for, when will it happen, where will it happen, how often will it happen and how big will it be. Although it is impossible to answer definitively, there are strategies that would increase our ability to plan for and cope with future disasters.

Australia's research capacity is critical to predict what may happen in the future, including our capacity as a nation to forecast disasters in the short and long term. Forecasting is highly complex and long-range predictability is generally beyond our current predictive skill. However, the ARC Centre of Excellence for Climate Extremes is amongst many organisations (including the Bureau of Meteorology, Natural Hazards Research Australia, the Australian Climate Service, CSIRO and research organisations worldwide) supporting and developing these skills through fundamental research. Investment in these organisations lacks an overarching strategy, any defined common goals, or strategies to cross-fertilise innovation. These organisations are effectively encouraged to compete which, in a resource constrained world may not maximise Australia's capacity to build resilience.

Increasing our understanding of how the climate is changing in the context of major disasters is necessary for resilience. A selection of cutting-edge research from the ARC Centre of Excellence for Climate extremes below demonstrates contributions towards Australia's national research capability.

Rainfall/Flash flooding

Australia's rainfall varies strongly by region and season, driven by a diverse set of weather systems. Our rainfall is characterized by periods of extremely heavy rainfall and drought, leading to substantial impacts on our environment and society.

- Short-duration, high intensity rainfall events have increased by 40% over the past 20 years in the Sydney region[5]. This has already increased the risk flash flooding with impacts to infrastructure. Better understanding of such extremes is vital for effective climate adaptation and to reduce the vulnerability of populated regions.
- Recent work relevant to all regions of Australia have highlighted the atmospheric conditions required for extreme rainfall. In brief, simultaneous occurrence of very high moisture content and strong upward vertical motion is required[6]. We can now explore these two mechanisms together to examine how extreme rainfall will change over Australia.

Fire

Increasing our ability to predict wildfire occurrence will reduce loss of life and property.

- The 2019/20 bushfire disaster occurred during Australia's hottest and driest year on record, 2019. This year was characterised by exceptionally dry fuel loads that primed the landscape to burn when exposed to dangerous fire weather and ignition. The combination of climate variability and long-term climate trends generated the climate extremes experienced in 2019[7]. Improving local and national adaptation measures while also pursuing ambitious global climate change mitigation efforts would help limit further increases in fire risk.

Heatwaves

- Research[8] found that groundwater influences heatwave intensity, reducing maximum air temperatures by up to 3 °C at the surface and up to 1 °C in the atmosphere.

- Research[9] suggests possible opportunities for land-surface radiation management. Enhancing crop reflectance by 10% reduces the frequency of heatwave days over Europe and North America by 10 to 20 days per year, and reduces how hot the heatwaves were.

Drought

- Changes to daily rainfall were examined during periods of drought development and recovery[10]. Remarkably, the difference between drought and recovery was only around 1-5 days of heavy (20 mm or 50 mm per day) rainfall in a year.

- Research[11] has isolated the sources of rainfall in eastern Australia associated with La Niña and El Niño. This helps understanding of how climate change will influence future rainfall.

Thank you for the opportunity to make this submission. The Centre is happy to provide further information on climate extremes and disaster resilience to the committee.

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4. Professor Andy Pitman, AO, FAA is the Director of the ARC Centre of Excellence for Climate Extremes. Dr Michael Barnes and Dr Kim Reid are Research Fellows in the ARC Centre of Excellence for Climate Extremes based at Monash University. Dr Andrew King is from the University of Melbourne. A/Professor Andrea Taschetto is from UNSW Sydney.
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