

Australian Climate Service

Goal: To support a safer, adaptive and prosperous Australia, resilient and prepared for the climate challenges and natural disasters.

The Australian Climate Service (ACS) is responsible for providing data, intelligence and expert advice on climate and natural hazard risks and their impacts to inform decision-making. The ACS vision is to advance information and knowledge that is used to support a safer, adaptive and prosperous Australia, resilient and prepared for climate challenges and natural hazards.

The ACS is made up of world-leading expertise from the Bureau, CSIRO, the Australian Bureau of Statistics and Geoscience Australia. The partnership draws together the national data, systems and expertise needed to inform climate and natural disaster decision-making. Each of the partners brings knowledge and expertise to the partnership and collectively this knowledge and expertise provides better information for decision makers.

The Bureau of Meteorology	CSIRO	Australian Bureau of Statistics	Geoscience Australia
<p>The Bureau of Meteorology is the national weather, climate and water agency. It provides observational, meteorological, hydrological, oceanographic and space weather services.</p>	<p>CSIRO, as Australia’s national science agency, brings its world leading research, science and innovation with a focus on climate observations and modelling, projections, resilience, adaption and transformation science and practice.</p>	<p>The Australian Bureau of Statistics brings critical social and economic information to the partnership, enabling an improved picture of the vulnerability of communities and how these are changing across Australia.</p>	<p>Geoscience Australia, a trusted advisor on national geology and geography, brings national hazard and exposure information, and geospatial and location services.</p>

The Australian Climate Service partners

The ACS is included in this Annual Report as the Bureau of Meteorology hosts the ACS. The Bureau’s CEO and Director of Meteorology is the Accountable Authority and Senior Responsible Officer for the ACS.

The ACS seeks to achieve 2 main outcomes. The achievements in delivering these are discussed below.

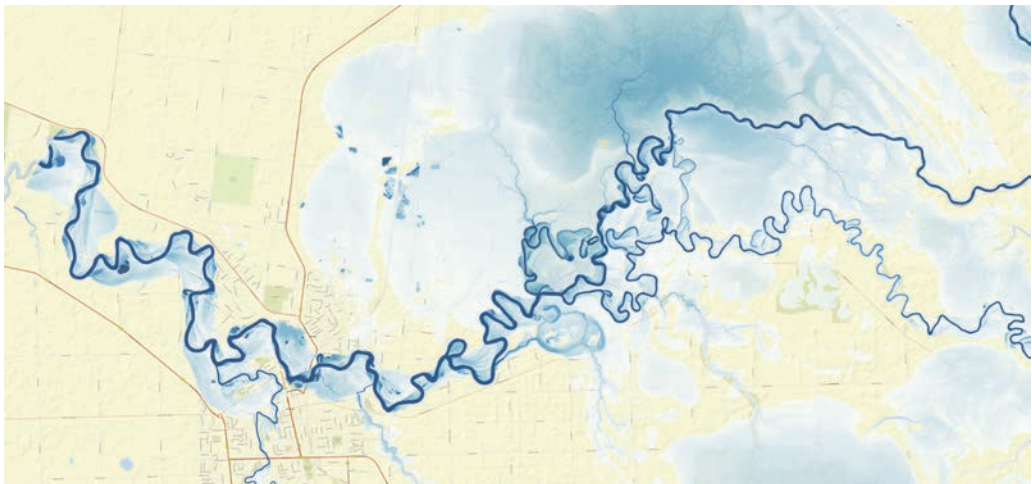
Outcome 1: Enhanced national climate and natural hazard intelligence capability.

Achieving the outcome

New and enhanced data for decision-making

During the year the ACS developed and trialled several new intelligence sources to support National Emergency Management Agency (NEMA) decision-making. Flood extent intelligence was delivered to NEMA in several ways. The first was through the trial of satellite detected flood extents, led by Geoscience Australia. This trial successfully provided near real-time flood extent information across all jurisdictions during the high-risk weather season and received positive feedback from both NEMA and state and territory governments.

A proof of concept, dynamic flood inundation modelling system was also developed. Modelling impacts on supply routes using current hazard extent information from CSIRO's Transport logistics (TraNSIT) team provided NEMA an indication of how an unfolding flood was likely to affect the movement of commodities to communities and markets. This work provided valuable insights throughout the many flood events in 2022–23, in both remote and urban locations.



Map of the October 2022 Murray River flood event at Echuca produced using the ICEYE Flood Insights Product procured by Geoscience Australia, on behalf of the ACS as a trial to support the 2022–23 high-risk weather season. ICEYE Flood Insights were shared with Commonwealth and state and territory agencies to support decision-making across the disaster continuum and provide a nationally consistent picture of flood extends and depths. Image provided by Geoscience Australia. Sources: ICEYE Flood Insights © 2022 ICEYE Oy. Copyright in all ICEYE Products and Derivatives is and will remain held by ICEYE Oy. World Street Map: Esri, DeLorme, HERE, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), MapmyIndia, Tomtom.

Building understanding of climate risks and impacts

As Australia's climate becomes more challenging with more extremes, our understanding of the risks posed by these extremes and their potential impacts requires greater use of earth system models of the ocean, atmosphere and hydrology. Many hazards including heatwaves, dangerous fire weather, and coastal inundation are increasing in frequency and peak intensity.

In 2022–23, the ACS worked to define priorities for its hazard work and is developing long-range forecasts and projections for each of these hazards. Future outputs will include practical and accessible information on the characteristics of natural hazards, including past occurrence and impacts, and how they will change under a range of climate scenarios into the future.

Highlights and significant events

Harnessing spatial tools to map hazard impacts

The ACS has built several analytical tools that were implemented in 2022–23, enabling data to be visualised and communicated to key users.

Information on potential on-ground exposure and vulnerability to upcoming natural hazard threats such as flooding is now more easily accessible thanks to these visualisation tools. These tools can streamline and automate previously manual processes, making it easier to obtain data from the ACS and enable quicker insight development. This is achieved by combining and synthesising data from across the ACS partnership, including advanced satellite imagery.

Images are included in Australian Climate Service Impact Briefs that are provided as resources for NEMA. These are detailed briefings to provide situational awareness on natural hazards, along with their extent, types of vulnerabilities and impacts they could generate.

A community profile dashboard helps to provide a visual overview of the key socio-economic and built characteristics at the local government scale for Australia. This enables planning and response during a hazard event including information on:

- hazard warning locations
- population and demographics
- income and housing
- indicative reconstruction costs and impacts.

The information can be used to identify the broader characteristics of the exposed population and community, as well as to identify if specific at-risk populations and groups are present. The ACS used the new tools during the 2022–23 high-risk weather season to support the Australian Government’s National Situation Room and briefings facilitated by NEMA.



An extract from an ACS Impact Brief for the National Situation Room. This map depicts flood watches and warnings overlaid with key freight routes which may be affected by severe tropical cyclone Ilsa on 14 April 2023.

Using downscaled projections and modelling to prepare for the future

Australia's changing climate means that past data, which has typically been the basis for planning and decision-making, is no longer a reliable guide on its own for what to expect in the future. Almost every aspect of how we live is affected by these changes – whether it be the intensity, duration and increased frequency of heatwaves which mean that our health plans and infrastructure must prepare for harsher conditions, or rainfall intensity changes which impact on design standards for houses, roads and dams.

Given the scale and challenges of natural disaster risk reduction and climate change adaptation, it is vital that our future hazard information is as accurate as possible at scales which readily support decision-making.

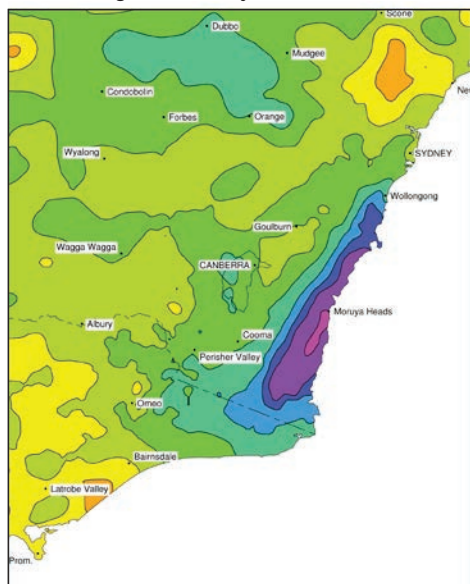
This is where climate and hazard projections are vital – they can:

- demonstrate how hazards are likely to change
- demonstrate where those changes might be most significant
- assist in targeting regions where associated risks are largest and actions are most beneficial.

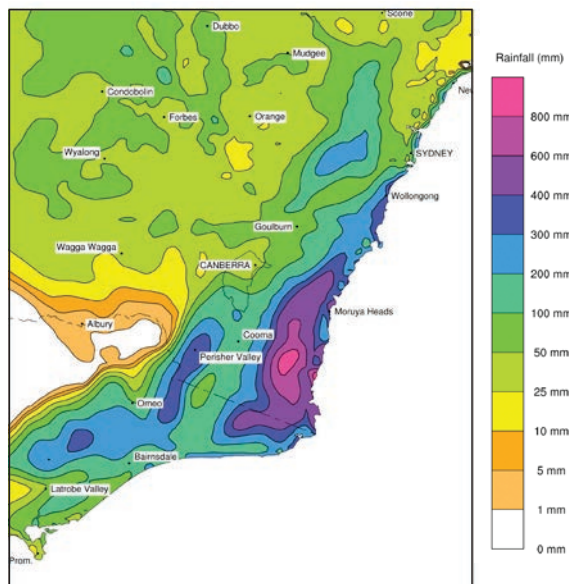
Developing the best hazard projections is a multi-step process, which draws on both Australian and international modelling. This starts with state-of-the-art global climate models provided by the International Panel on Climate Change (IPCC) Coupled Model Intercomparison Program Phase 6 (Eyring et al 2016) which are typically at scales of 50 –100 kilometres. These global models provide intelligence about broad patterns of change, such as shift in rainfall patterns and rising sea levels.

Australian rainfall analysis (mm)

Week ending 9th February 1971



18th to 25th June 2038



The maps above compare a 1971 rainfall event in Bega with a hypothetical future rainfall event in the same region. The future rainfall map depicts a hypothetical rainfall event in the future (~ 2050s) based on business-as-usual emissions from a downscaled climate model. This is a plausible future event, it is not a forecast, but a physical rendering of the types of extreme events we might anticipate in the coming decades in a warming world.

The ACS has been downscaling these models for Australia, which means translating global climate model output to scales of around 5 –10 kilometres through high resolution regional models. This is done using the:

- Bureau of Meteorology Atmospheric Regional Projections for Australia
- CSIRO Conformal Cubic Atmospheric Model climate models.

High resolution regional models can then be used to derive hazard information, for example, projections of intense rainfall can be used as an input for flood modelling. ACS results to date reveal the new projections provide greatly improved representation of Australia’s climate – for example, better capturing climate patterns in coastal zones and in the vicinity of topographic features. This information helps decision makers prepare for and adapt to climate and natural hazard risks and impacts.

Establishing a National Climate Risk Assessment Methodology

During 2022–23 the ACS collaborated with the Department of Climate Change, Energy, the Environment and Water (DCCEEW) to develop a methodology for delivering the first National Climate Risk Assessment (Risk Assessment).

The purpose of the Risk Assessment is to provide an understanding of nationally significant climate risks to Australia from climate change impacts. It will provide a shared national framework to inform Australia’s national priorities for climate adaptation and will enable consistent monitoring of climate risk across all Australian jurisdictions. This will be a collaborative effort which integrates expertise across the ACS partnership with other Australian Government resources.

The ACS and DCCEEW engaged with stakeholders from across all levels of government, the private sector and non-government organisations to develop a robust and repeatable methodology for the National Climate Risk Assessment. Consistent with international expertise, the method and assessment of risks will be improved into the future.

As well as integrating best practice across a range of disciplines, the most recent approaches to climate risk assessment from the IPCC and International Standards Organization (ISO) have been incorporated into the methodology. In particular, the latest thinking on how to effectively address systemic, cascading and compounding risks has been included.

The approach for Australia integrates climate hazards with exposure and vulnerability to identify and prioritise risks to the social, built, economic, and natural environments.



The ACS is assessing climate risks on health and electricity systems.

To test the method, the ACS led a deep dive analysis of the interaction of heatwaves with health and electricity systems to illustrate the sort of practical outputs that will be developed during the final risk assessment process.

This work will support decision-making for Australian Government adaptation planning processes. The assessment of priority risks will be used by many Australian Government agencies, including the National Emergency Management Agency. The national assessment will also inform other governments, industries and communities.

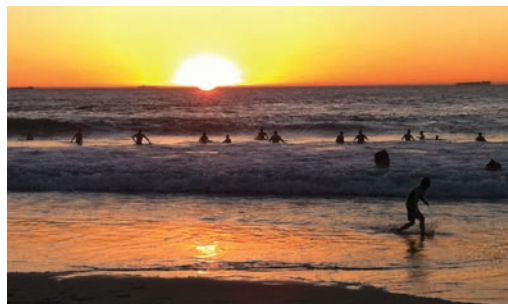
Understanding current and changing heat risk to human health in Australia

To support development of the National Climate Risk Assessment methodology, the ACS conducted a case study analysis of extreme heat impacts on human health. This work provides a theoretical, methodological and practical framework for understanding historical and future heat-health impacts and provides insights on how other complex climate risks could be understood and analysed.

Heatwaves are an enduring feature of Australia's climate and have significant social, health (physical and mental) and economic impacts. Extreme heat leads to more deaths and hospital admissions than any other hazard in Australia, can cause significant disruptions to infrastructure and business, and impacts everyday quality of life.

The latest understanding of climate risk from the IPCC was used to develop a conceptual framework that was applied to a novel, integrated, cross-domain dataset. This included data on the heatwave hazard, on exposure, vulnerability, impacts and consequences. This data asset was then used for in-depth analysis of social and spatial variation in heat-health risk factors and the likelihood of heat related deaths and illness.

Heatwaves are projected to become longer and more intense with a changing climate, however, as impacts vary between populations and locations, evidence concerning vulnerable people and places is critical for effective policy interventions. This activity provides a nationally consistent approach for understanding how the risk varies geographically so warnings, targeted response plans, and other outreach methods can be customised for specific places and segments of the population.



Trigg Beach in Western Australia during a summer heatwave.

Next steps

Key activities to be delivered in 2023–24 to help achieve Outcome 1 include:

- delivering stage 1 of the National Climate Risk Assessment for the Australian Government
- informing national understanding of climate and natural hazard risks in the context of broader socio-economic information through a series of national assessments
- fill critical information gaps to support the decision-making needs of the National Emergency Management Agency
- engaging state and territory governments to contribute to a national capability that can better inform how we plan and respond to natural hazards and broader climate risks.

Outcome 2: Improved access to trusted climate and natural hazard data, information and expert advice.

Achieving the outcome

Maturing our support to the Australian Government's National Situation Room

The Australian Government significantly upgraded its National Situation Room in December 2022. The ACS has played a key role in improving access to technical and expert information and advice to the National Situation Room. This has improved the Australian Government's responses to a range of natural disaster events in 2022–23.

When there is a natural hazard event, one of the roles of the ACS is to provide detailed briefings to NEMA and the Australian Government's National Situation Room. These briefings are delivered daily when requested and include available information customised to the needs of decision makers. Through the support of the ACS, weather and hazard services and expertise from the Bureau are embedded in the National Situation Room, enabling access to direct support to help preparedness for and response to natural disaster situations.

ACS Impact Briefs serve as a comprehensive synthesis of data, insights and intelligence from various sources, presenting all impact-related information in a practical and accessible format. The ACS Impact Briefs are delivered directly to decision-makers within NEMA. Notable projects like the National Bushfire Intelligence Capability and supply chain analysis through CSIRO Transport Network Strategic Investment Tool (TraNSIT) continually enhance their outputs. Geoscience Australia, through uplift of its situational awareness products, has also contributed to the ongoing improvement of Impact Briefs by leveraging the best available inputs from across the ACS.

Throughout 2022–23 the ACS provided more than 800 briefings to the National Situation Room, including 229 Daily All Hazards Weather Briefs, 236 ACS Impacts Briefs and 21 Australian Government Crisis and Recovery Committee Briefings.



Prime Minister the Hon Anthony Albanese MP opening the new National Situation Room. The National Joint Common Operating Picture behind Prime Minister Albanese demonstrates some of the data provided by the ACS partnership (Credit: National Emergency Management Agency).

Making climate information more accessible

The ACS is providing data and information from across the partnership to NEMA, through direct feeds into the National Joint Common Operating Picture, analysis products and on-ground expertise.

In May 2023, the ACS completed a refresh of its public facing website with additional information about natural hazards, the changing climate, and climate risks added to better inform the public about these important topics. More broadly, the ACS has contributed to climate science and natural disaster risk and resilience conferences, sharing its expertise and commitment to supporting natural disaster risk reduction efforts. This has included ACS participating in a session on data at the Asia-Pacific Ministerial Conference on Disaster Risk Reduction, with representatives across the partnership contributing to the event held by the Australian Government with the United Nations Office for Disaster Risk Reduction.

The ACS has also been planning the development of a more comprehensive data and analytics platform which will provide users with a single access portal to curated information and insights on climate, hazards, exposure and vulnerabilities across 4 domains (social, economic, built and natural).



Dr. Andrew Johnson, CEO and Director of Meteorology and the Senior Responsible Officer of the ACS with the ACS's Martin Brady and Maxine Kerr at the Asia-Pacific Ministerial Conference on Disaster Risk Reduction hosted by the Australian Government and the United Nations Office for Disaster Risk Reduction.

Highlights and significant events

Combining capabilities and expertise for effective flood response in the Kimberley

On 8 January 2023, major flooding in northern Western Australia caused by ex-tropical cyclone Ellie, resulted in extensive road closures and damage impacting access to supplies for communities in the region. Drawing on the diverse expertise of the partnership, the ACS assisted the Australian Government's National Situation Room in responding to the event, providing a profile of the communities affected by the floods to help in planning the evacuation of vulnerable residents and the delivery of essential supplies.

The Kimberley region affected by the flood is large and sparsely populated with isolated cattle stations and small rural towns. There are also significant numbers of First Nations communities, some with fewer than 50 people. This made it very challenging to know who was likely to be affected by the flooding and where they were.

To meet the needs of the National Situation Room, the ACS drew on the capabilities of its partnership to respond. Geoscience Australia provided satellite images of the flooded area which were overlaid with data from the 2021 Census by the Australian Bureau of Statistics to provide an estimate of the number of people within the flood footprint, and those likely to be directly affected (for example the number of people cut off from supplies or telecommunications).

Based on this intelligence, NEMA was able to plan and coordinate the highly resource intensive and time-critical response involving helicopter, aircraft and Australian Defence Force personnel to provide relief and support to affected communities.



Members of the Yungngora people exit an Australian Army CH-47 Chinook helicopter that was tasked with repatriating 22 members of the Yungngora people to their homes in Noonkanbah on the Fitzroy River after they were evacuated due to flooding in the area (Image courtesy of the Department of Defence).

Informing scenario planning for the 2022–23 high-risk weather season

Every year NEMA requires a long-range forecast and advice on potential impacts to help plan and prepare for the high-risk weather season from October to April.

For the last 2 years, the ACS has provided detailed national scenarios, integrating climate and hazard information with data on possible exposure and vulnerability, to illustrate how plausible extreme weather for the season ahead may impact individuals and communities. These scenarios are shared with emergency response agencies, community groups, charities and government agencies across the country to assist in preparing for the season ahead.

The national scenarios build on the Bureau's long-range forecasting capabilities bringing data across social, built, economic and natural environments into the scenarios, as well as impact and consequence narratives, to support seasonal preparedness and exercising.

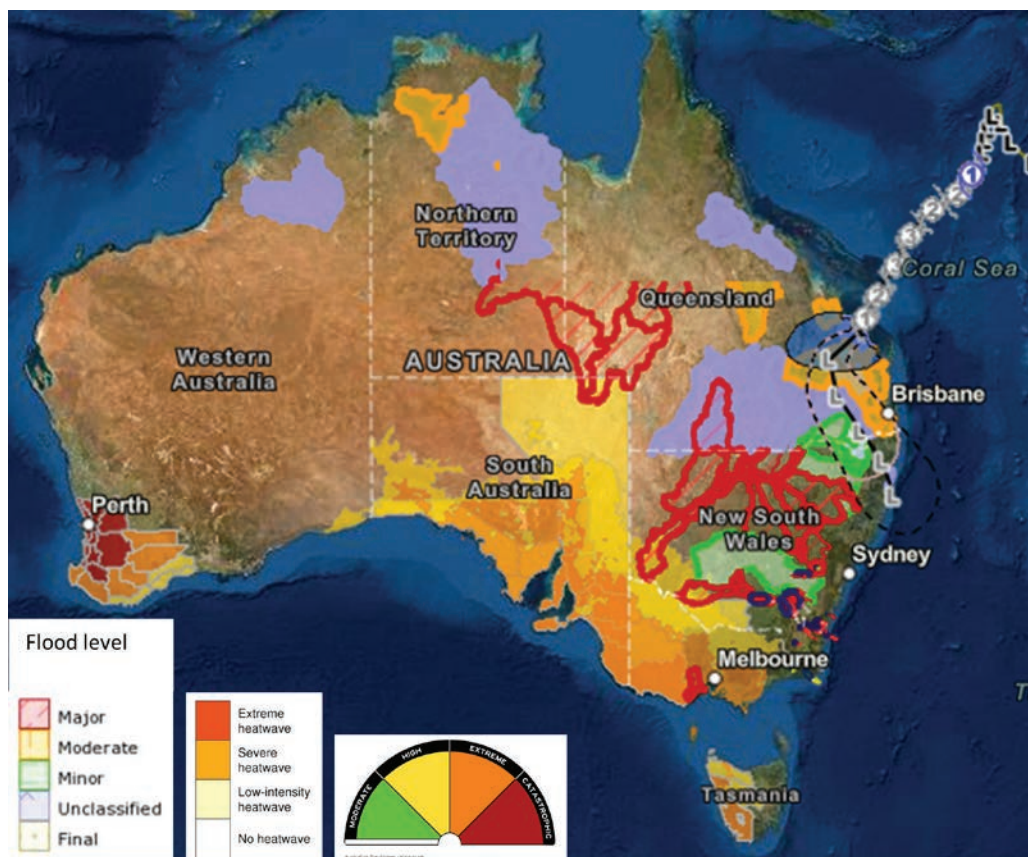
Each element of the scenarios includes:

- hazards – such as flooding, bushfires and heatwaves
- locations – regions and towns impacted
- timing – of the hazards including concurrent hazards and impacts.

This is then used to build a:

- demographic and economic profile (Australian Bureau of Statistics)
- damage profile (Geoscience Australia)
- impact analysis, including analysis from CSIRO such as supply chain impacts
- narrative impact and consequence information based on expert advice from all the partners.

The whole scenario has a national focus while also incorporating at least one case study in each state and territory using plausible extreme hazards from the forecast.



Hazard mapping on the National Joint Common Operating Picture as part of scenario planning for the high-risk weather season. To support hazard preparedness activities in the National Emergency Management Agency, the ACS builds national scenarios of multiple concurrent high-impact natural hazards across Australia. The scenario incorporates catastrophic fire danger, flood across major catchments, heatwave and tropical cyclone. This image does not depict data from an actual event.

Next steps

Key activities to be delivered in 2023–24 to help achieve Outcome 2 include:

- contributing to national crisis management exercises and briefing emergency services authorities to assist with seasonal preparations
- supplying additional data feeds into NEMA's National Joint Common Operating Picture
- continue to upgrade the ACS Platform to provide efficient data sharing and visualisation.