



**Earth Systems and  
Climate Change  
Hub**

National Environmental Science Programme



# Meeting Australia's climate challenges

# ABOUT THE HUB

The Earth Systems and Climate Change Hub is one of six research Hubs supported by funding through the Australian Government's National Environmental Science Program.

Established in 2015, the Hub is a partnership of Australia's leading Earth systems and climate change research institutions:

- CSIRO
- Bureau of Meteorology
- Australian National University
- Monash University
- University of Melbourne
- University of New South Wales
- University of Tasmania

The Hub's role is to ensure that Australia's policies and management decisions are effectively informed by Earth systems and climate change science, now and into the future.

The Hub's three key research priorities are to:

- improve our observations of our past and current climate so we can better understand the processes driving our climate system and how they are changing
- improve our understanding of how the climate system may change in the future so we can be better prepared to address challenges and take advantage of opportunities
- build the utility of Earth systems and climate change information so policy and decision makers have the best available tools to inform adaptation, planning and mitigation responses.

## A MESSAGE FROM THE HUB LEADER



From the excellent research findings produced to the new connections made with key industries and sectors across Australia, the first years of the Earth Systems and Climate Change Hub have been very successful.

Our application-focused research has delivered information and tools to address Australia's top climate challenges. This work has been underpinned by world-leading science in cross-cutting areas including climate modelling, climate change projections and ocean observations and monitoring.

The Hub's science outreach initiatives, including a series of regular science webinars, provide opportunities for more people to access our research. Engagement with Hub stakeholders continues to strengthen, particularly in the finance sector, and our Indigenous engagement activities demonstrate the value of co-production of knowledge and resources.

This publication provides a brief snapshot of some of the highlights from the Hub to date.

Professor David Karoly  
November 2018



# AUSTRALIA'S KEY CLIMATE CHALLENGES

## Hydroclimate and water resources

Australia's highly variable rainfall, soil moisture, rivers and dams provide the water we rely on to grow food, generate electricity, stay healthy and generally maintain our society, economy and environment. Soil moisture availability, stream flow and groundwater are already changing in response to climate change. Changing rainfall patterns and more frequent and/or more severe droughts will further affect water availability and quality.

By improving our understanding of climate variability and other processes that affect water availability, Hub research is providing a better insight into the impacts that climate change will have on surface and groundwater resources and the demand for water. This will contribute to more effective water resources planning, management and infrastructure investment.

## Food security, ecosystems and natural resource management

Australia's primary industries provide quality food and resources that contribute to our health and wellbeing, and economy. Our unique and varied ecosystems have intrinsic value and provide essential ecosystem services. In a changing climate, primary industries and the environment are vulnerable to rising temperature, changes in rainfall, more frequent and severe

extreme events, rising sea levels and temperatures, and ocean acidification.

By improving our ability to provide multi-year to multi-decadal climate information, Hub research is providing primary producers, resource managers and ecosystem managers with information at the timescales needed for effective decision-making and planning.

## Carbon cycle and future warming

Limiting future global climate change requires substantial and sustained reductions in net greenhouse gas emissions. We are still determining the best way to manage the carbon budget to reduce emissions, increase carbon sinks and protect existing carbon stocks, while managing feedbacks in the climate system.

By improving our understanding of past greenhouse gas emissions and predicting future changes, Hub research is informing Australia's emissions mitigation policy responses.

## Changes in coastal climate

Australia's coastal zone is economically, culturally, socially and environmentally important. Most of Australia's population and infrastructure is located here, along with a range of unique coastal and marine ecosystems. In a changing climate, Australia's coasts are

vulnerable to rising sea levels, more frequent and intense storms, ocean acidification and changes in rainfall, run-off, wave size and direction, and ocean currents. Impacts include shoreline erosion, flooding and saltwater inundation, as well as damage from storm surges and extreme weather events.

By improving our understanding of coastal and climate processes, Hub research is providing coastal planners, developers and decision-makers with the information they need to minimise risks and respond to the unavoidable impacts.

## Extremes and disaster risk management

Extreme events such as bushfires, floods and storms are a feature of Australia's variable climate. They have far-reaching costs, ranging from financial costs to governments, businesses and households, to environmental impacts, to physical and psychological impacts on individuals and the community. In a changing climate, extreme events are likely to become more severe and/or frequent, with a corresponding increase in economic, environmental and social costs.

By improving our understanding of how extreme events will change in the future, Hub research is providing disaster risk managers with better quality, relevant and targeted information that will enhance our resilience to extreme weather and climate events.



# HIGHLIGHTS

FOOD SECURITY, ECOSYSTEMS AND NATURAL RESOURCE MANAGEMENT

## Understanding the climate drivers of the 2015 Gulf of Carpentaria mangrove dieback

In late 2015 more than 7000 hectares of mangroves died along the south-west coastline of the Gulf of Carpentaria. Researchers from the Northern Australia Environmental Resources, Tropical Water Quality and Earth Systems and Climate Change Hubs examined how this might have occurred. ESCC Hub researchers discovered that unusually hot and dry conditions combined with very low sea level likely provided a stressful environment for the mangroves. This stress during most of 2015 almost certainly contributed to the major dieback. Understanding why this dieback happened is important for ongoing management of the mangroves to ensure the critical environmental services they provide are not compromised in the future. This work initiated a larger NESP study to assess the extent of dieback across the Gulf.



PROJECTIONS

## Climate change science app

Building on the vast resources of the Climate Change in Australia website ([www.climatechangeinaustralia.gov.au](http://www.climatechangeinaustralia.gov.au)), Hub researchers developed a prototype climate change projections mobile phone app. The app aims to provide an accessible interface to climate change projections data and to increase the use of climate change information among stakeholders from all levels of government and natural resource planners and managers. The prototype app is undergoing user testing before further development.

ONLINE

## Science webinar series

The Hub established a monthly science webinar series, which provides an opportunity to hear about the science being undertaken in the Hub directly from the researchers. The webinars are open to the research community and anyone interested in finding out more about the Hub's research.

HYDROCLIMATE AND WATER RESOURCES

## Supporting communication of climate challenges for water resources management in Western Australia

With variable rainfall against the backdrop of an extended drying trend, managing climate risk to water security in south-west Western Australia is a critical climate challenge. The Hub worked with the Western Australian Government to prepare communication materials to convey the latest climate change science, with a focus on rainfall in this region. These materials make the latest climate change science accessible to water suppliers and users in the region, so it can be used to inform and support decisions about water security. The communication materials developed by the Hub will be incorporated into the WA Department of Water and Environmental Regulation website and used by the Department when communicating with water users and water-related stakeholders.

COASTAL CLIMATE

## Trialling solutions for coastal environment management

The establishment of the National Centre for Coasts and Climate at the University of Melbourne provides increased capability to identify feasible solutions for addressing climate change impacts in coastal ecosystems. To date, researchers have developed methods to evaluate the sensitivity to and impacts of climate change, and have trialled solutions for coastal and marine environmental management challenges in Victoria.

INTERNATIONAL IMPACT

## Contributing to IPCC reports

Hub researchers are making significant contributions to Intergovernmental Panel on Climate Change (IPCC) reports, as authors and reviewers for the special reports on 1.5°C warming and on the ocean and cryosphere. Researchers are also participating in the development of the IPCC's sixth assessment report, which will be finalised in 2022.

## CARBON CYCLE AND FUTURE WARMING

**Tracking carbon sources and sinks in support of the Paris Agreement**

Understanding how the Australian and global carbon budget is tracking is vital for understanding the likelihood of meeting or exceeding the Paris Agreement targets of 1.5°C and 2°C. To assist in tracking these budgets, the Hub supports the Global Carbon Project – an international collaboration that provides an authoritative assessment of human-caused carbon sources and sinks. The Global Carbon Project's annual Global Carbon Budget provides information, data and communication products to inform and raise awareness about how the world is tracking against the carbon budget. This information is provided directly to policy and decision makers from across the globe through its annual release at the Conference of the Parties to the United Nations Framework Convention on Climate Change. Through this global initiative and the Hub's own carbon tracking research, the Hub's science informs both Australian and international climate change policy.

## EXTREMES AND DISASTER RISK MANAGEMENT

**Characterising extreme fire conditions**

The series of severe fire seasons in recent years has resulted in the loss of property and life, and stretched the capabilities of fire services and communities. Understanding how weather conditions that influence fire activity have changed and how future risks may need to be managed will help with planning to minimise future losses. Hub researchers produced a dataset of fire weather conditions that extends back to 1950 and is updated daily. The Bureau of Meteorology Climate Information Services group is using this dataset to provide planning information to emergency services. The dataset has also been drawn on directly to inform the Australasian Fire and Emergency Services Authorities Council (AFAC). As a result, climate risks will be better managed and considered in future AFAC policy and practices for emergency management throughout Australia.



Photo: Sasha Grant, Flickr

## UNDERPINNING SCIENCE

**Improving ocean monitoring data**

Hub researchers are improving the quality of ocean monitoring data from historical archives, Argo floats and research vessels so that ocean processes are better represented in climate models. This activity will improve projections of future warming and sea-level rise for Australia. Hub researchers have submitted two data sets from GO-SHIP, a coordinated global program to collect ship-based observations, to data centres for use by researchers around the world.



## UNDERPINNING SCIENCE

**Climate modelling**

Hub researchers are undertaking ongoing development of our national climate model, the Australian Community Climate and Earth System Simulator (ACCESS), including preparation for inclusion of ACCESS in the international Coupled Model Intercomparison Project Phase 6 (CMIP6). Involvement in CMIP6 ensures ACCESS simulation data are discoverable and accessible by the broader international community and can be used to inform global climate assessments, such as the IPCC assessments, which inform decision-making and climate policies.

# HIGHLIGHTS

## BANKING AND FINANCE

### Supporting the next generation of knowledge providers and decision-makers

While the realities of climate change are already apparent, the impacts and risk will continue and increase. This means the responsibility for developing and applying new scientific knowledge to inform adaptation and climate-related risk management policy and planning will increasingly fall on the shoulders of future generations of scientists and decision-makers within government and the private sector. The Hub established a Young Professionals Network to support both early career climate science researchers and sector-based young professionals to develop technical capacity to deliver and apply climate change science to policies and decisions, and to enhance links within and between these two key groups. New professional relationships are being created through this network which will facilitate ongoing engagements and relationships that will be advantageous in the process of addressing long-term climate risks for Australia.



## COASTAL CLIMATE

### Making coastal hazards information accessible

Hub researchers developed the Sea Level, Waves & Coastal Extremes web portal at [research.csiro.au/slrwavescoast](https://research.csiro.au/slrwavescoast) to consolidate, update and extend information on a wide range of coastal hazards. The portal makes this data and information more accessible for a range of users. It also provides the underpinning science and data on sea level and coastal extremes, which is used in adaptation tools, such as CoastAdapt (see back page).

## PUBLICATION

### Using climate information to 2030

The Hub prepared a short publication that explains climate change and climate variability and how to take both into account for short-term (10-20 year time horizon) decision-making. Download the brochure at [nesplclimate.com.au/publications](https://nesplclimate.com.au/publications).

## CITIZEN SCIENCE

### Breathing new life into old tide records

Long-term tide records of high temporal (e.g. hourly) resolution allow us to not only better understand how mean sea level has changed in the past but also how extreme sea levels such as storm surges have changed along with the weather systems that cause them. At present, Australia has only two such records available digitally – Fort Denison, Sydney (with data from 1912) and Fremantle, Perth (with data from 1880). Other long-term records exist, but the data is recorded in old charts (marigrams) and books and so is unavailable for modelling and analysis. The Hub is using ‘people power’ to unlock the data in these old hard-copy records, so the data they contain can be used to analyse how extreme sea levels in Australia have changed over time. Student volunteers have been working on marigrams from Williamstown in Victoria, and so far have digitised records from 1950–1965. Work on records from the 1940s is now under way.



## INTERNATIONAL IMPACT

### Turning climate change science into services in the Pacific

Hub researchers and staff travelled to the Solomon Islands as specialist advisors for a workshop to develop the capacity of Pacific Island countries to use climate change information for decision-making.

While the Hub's focus is on Australia, regional climate science – such as research examining rainfall in the Pacific – is directly adding to the knowledge base of Pacific climate change information that is drawn on by countries across the region.

The Hub's work applying climate change science, and making it more accessible and usable across a range of user groups, also benefits our Pacific neighbours. Hub researchers can draw on and share experiences and expertise developed through the Hub that their Pacific colleagues can, in turn, share in their own countries.

## INDIGENOUS ENGAGEMENT

### Understanding climate change implications for Torres Strait fisheries and marine ecosystems

Fisheries and marine ecosystems in the Torres Strait are economically and culturally important but are vulnerable to the changing climate. Helping Torres Strait islanders understand their climate risks requires careful relationship fostering between islanders and knowledge providers. The Hub partnered with the Torres Strait Regional Authority to gather together climate change, marine and fisheries scientists, fisheries managers and traditional owners to discuss the implications of climate change on local fisheries and marine ecosystems. The relationships built and information needs and research priorities identified through this activity provided a new level of understanding around the climate risks to Torres Strait fisheries and marine ecosystems. This understanding and the new relationships built will form the basis of ongoing activities to ensure traditional owners in the Torres Strait have the best available information and tools to help manage climate change impacts on their communities, country and businesses.



## INDIGENOUS ENGAGEMENT

### Preparing for climate change and coastal erosion in the Tiwi Islands

Climate change will have significant social, environmental and financial impacts on the communities of the Tiwi Islands, which are largely coastal and remote. Coastal erosion will be a particular issue. However, it is often difficult for the people of the Tiwi Islands to relate the big scales of climate change impacts to local social and environmental processes. Previous engagement with the Tiwi around climate change has alarmed local residents and escalated feelings of powerlessness. The Hub worked with the Tiwi Land Council on engagement and knowledge brokering activities to discuss climate adaptation with local communities. The information, discussions and relationships built during these activities provide a foundation for future work with the Tiwi to develop practical and useful guidelines for adaptive management of coastal erosion in the islands.

## NORTHERN AUSTRALIA

### Informing northern development

The Hub presented information about climate change science for northern Australia at the Developing Northern Australia conference and spoke to delegates about how they could use climate change science to assess climate risk and inform policy, planning and business decisions. This engagement opened up a number of opportunities for case studies to demonstrate the application of climate change science.

# HIGHLIGHTS

## LOCAL GOVERNMENT

### Overcoming barriers to using climate change information

To guide the development and delivery of information products for local government, the Hub carried out a small pilot study to see how climate change information is being accessed and used by local councils. The study found that time, understanding and the overwhelming amount of climate change information available are barriers to its use in council activities. Existing climate change information is not accessible or applicable to many council operational tasks, and council staff are not resourced nor required to interpret and apply existing information.

As a result of this work, the Hub identified the need for simple guidelines that step users through the process of finding and applying climate change information, so it can then be used in risk assessments. The Hub is working with councils to develop and test the guidelines which should make it easier for planning and policy decisions to be appropriately informed by the latest climate change science.



## COASTS

### Sea-level information for councils

With millions of people and billions of dollars worth of infrastructure in Australia's coastal regions, rising sea levels pose a significant threat to coastal communities.

Hub researchers prepared comprehensive sea-level projections for all coastal councils in Australia, making it easier for council planners and managers to know how sea-level rise will affect their council. Researchers also developed corresponding allowances – the height that coastal defences need to be raised in order to provide the same level of protection as they do today.

The sea-level rise projections and allowances are available through CoastAdapt ([www.coastadapt.com.au](http://www.coastadapt.com.au)), an online coastal risk management tool developed by the National Climate Change Adaptation Research Facility (NCCARF).

For more information, please contact [info@nespclimate.com.au](mailto:info@nespclimate.com.au) or visit [www.nespclimate.com.au](http://www.nespclimate.com.au).

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