BUSHFIRE RESEARCH AND TECHNOLOGY: MAPPING AUSTRALIA'S CAPABILITY

June 2020

Office of the Chief Scientist

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List of Acronyms and Abbreviations

ACCESS	Australian Community Climate and Earth System Simulator
ACT RFS	Australian Capital Territory Rural Fire Service
AFAC	National Council for Fire and Emergency Services
AIA	Australian Arrangement for Interstate Assistance
AIDR	Australian Institute of Disaster Resilience
AJEM	Australian Journal of Emergency Management
ANSTO	Australia's Nuclear Science and Technology Organisation
ARC	Australian Research Council
ATN	Australian Technology Network
BNHCRC	Bushfire and Natural Hazards Cooperative Research Centre
BoM	Bureau of Meteorology
BPAD	Bushfire Planning and Design
CAS	Centre for Accelerator Science
CNRI	Category Normalised Relative Impact
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DELWP	Department of Environment, Land, Water & Planning (Victoria)
DESE	Department of Education, Skills and Employment
DISER	Department of Industry, Science, Energy and Resources
DST	Defence Science and Technology
EMA	Emergency Management Australia
EMV	Emergency Management Victoria
FTE	Full-time equivalent
GA	Geoscience Australia
Go8	Group of Eight
IAWF	International Association of Wildland Fire
IJWF	International Journal of Wildland Fire
IoT	Internet of Things
IRU	Innovative Research Universities
NCRIS	National Collaborative Research Infrastructure Strategy
NESP	National Environmental Science Programme
NGO	non-governmental organisation
NHMRC	National Health and Medical Research Council
NRSC	National Resource Sharing Centre (AFAC)
NSW RFS	NSW Rural Fire Service
OCS	Office of the Chief Scientist
PBSP	Powerline Bushfire Safety Program
PFRA	Publicly Funded Research Agency
QFES	Queensland Fire and Emergency Services
RUN	Regional Universities Network
STA	Science and Technology Australia
SWW	Southern Westerly Winds
UA	Universities Australia
VIC DPC	Victorian Department of Premier and Cabinet
VicCFA	Victorian Country Fire Authority
WDRP	Wildfire Disaster and Resilience Program

Executive Summary

Strong base of research

This mapping exercise highlights Australia's breadth of research capability in foundational and applied research related to bushfires across the national coordination initiatives (including the Australian Institute for Disaster Relief (AIDR), Emergency Management Australia (EMA), and the Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC), the university sector, and publicly funded research agencies (including the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Bureau of Meteorology (BoM), and Geoscience Australia (GA).

Individual researchers, groups, and concentrated hubs of activities across Australia's universities and research institutes form the critical foundation that underpins Australia's diverse and exemplary research capability in bushfire research. Australia's ability to adapt to a changing climate and increased incidence of bushfires and other crises will continue to depend on universities and research institutes to expand Australia's diverse knowledge base, critical thinking and research capability, and to translate the research into continued improvements in preparation, response and recovery.

There are also virtual concentrations of capability in a number of Australian Research Council (ARC) Centres of Excellence, Research Hubs and Training Centres as well as in hubs funded by the National Environmental Science Program (NESP).

Australia's publicly funded research agencies (PFRAs) also have a vast depth of knowledge and capability in bushfire related research. Drawing on a strong evidence-base from their own applied research, as well as that of the university sector, the PFRAs have developed tools, methods, guides, and technology to help prevent and respond to bushfires.

In addition, the BNHCRC conducts coordinated and interdisciplinary research that supports the development of cohesive, evidence-based policies, strategies, programs and tools to build a more disaster resilient Australia. Working in partnership with many Australian universities and other organisations, the BNHCRC provides a long-term research base that directly supports emergency services and other government and non-government agencies as they work to prevent, prepare for, respond to and recover from natural disasters.

Australia has ready access to international scientific expertise via the Learned Academies in Australia. The Australian Academy of Science maintains Australia's membership to international scientific bodies such as the International Science Council. Through these memberships the Academy is able to connect with experts around the globe via participation in the Inter Academy Partnership compromising distinguished researchers from over 140 Learned Academies and Royal Societies globally.

This collective research capability in bushfire related research is well supported by the Australian Government including through funding of the publicly funded research agencies, the BNHCRC, competitive grants administered by the ARC and the National Health and Medical Research Council (NHMRC), and the underpinning research infrastructure provided through National Collaborative Research Infrastructure Strategy (NCRIS).

Figure 1. Overview of Australia's Bushfire Capabilities provides an overview of organisations, initiatives, policies, and technologies related to bushfire as referred to in this report.

Discipline strengths

One way to measure impact of Australia's research capability is through an analysis of research output through publications. Australia is internationally recognised for its bushfire related research, with bibliometric analysis indicating Australian ranks second in the world in terms of research output. Importantly, Australia's research output is also recognised as being of high quality.

Beyond the broad bibliometric analysis, consultation with key stakeholders in the bushfire research sector has identified disciplines and areas that represent significant strengths in Australia's research capability.

A consistent theme was the expertise in fire ecology research. Australia is using world-leading methodologies to study the impact of fires on ecosystems and biodiversity, including fire exclusion, low-intensity prescribed burning, and impact of high-intensity bushfires. There is also an acceptance of fire as an essential part of the environment and a focus on living with fire as a part of the landscape, instead of aiming for suppression.

Additionally, Australia has strong capabilities in modelling and predicting fire behaviour. The capability for reconstructing past fires can be used to investigate their impacts and inform and improve future management practices. This research capability is consistently applied in collaboration with operational agencies and on-the-ground services to increase the efficiency and effectiveness of their response capacity.

Our communications to and engagement with communities and to prepare them for bushfires was also highlighted as an important aspect of the sector. Operational agencies are able to apply research to improve community preparedness and responses and integrate this research into practice. There is a growing community expectation around timeliness of communications and warnings before, during and after emergencies, emphasising potential opportunities for advancement in technology to achieve this.

Consultation also revealed considerable research capability regarding the health impacts of smoke and bushfires. This includes exposure mapping, smoke forecasting, and air quality monitoring. The effects for public health in regards to smoke hazard are well-documented but broader health consequences such as water quality and asbestos risk in fire-affected buildings could be further evaluated.

One of the considerations for Australia's research sector is the significant potential for work relating to Indigenous fire management practices and fire knowledge, in the context of broader hazard reduction. Australia's Indigenous communities carry knowledge unique to Australia's landscapes that may not be found elsewhere. While there has been substantial research conducted in northern and central Australia, there is less scientific evidence in south-eastern Australia about the impacts of cultural burning and traditional fire management practices. By combining scientific research with traditional knowledge, the

bushfire research sector could draw on thousands of years of experience in controlling the extent and impact of wildfires.

Technology is key

Technology and its adoption and use by operational agencies and the general public is key to improving Australia's bushfire resilience, response and recovery.

Figure 2 highlights a number of bushfire relevant technologies used and developed by Australian research organisations.

These technologies can be broadly categorised into foundational (or enabling) technologies and operational technologies specifically relevant to bushfires. For example, the CSIRO's *Spark* and the BNHCRC's *Phoenix* utilises findings from bushfire-behaviour analysis, computerised simulation systems made possible by increased computing power (e.g. National Computational Infrastructure) and large datasets, such as real-time, detailed weather data provided by the BoM.

In addition, horizontal technologies such as machine learning and artificial intelligence are an important part of the technology picture.

Other actions undertaken following Minister Andrews' roundtable discussion specifically examine the potential for technology to contribute to solutions that minimise the impact of bushfires:

- CSIRO's *Bushfire Meets Industry* roundtable which is identifying industry capabilities that can contribute to addressing bushfire prevention, preparedness, response, recovery (PPRR) needs, determine what would make the most difference, and the potential for industry or government to help it come to fruition;
- BNHCRC's technology working group which is examining the novel applications of emerging technologies and technological advances that can assist fire response and management;
- Australian Space Agency's earth observation taskforce which will be updating satellite access and capability mapping for earth observation, including clarifying the utility of NovaSAR to penetrate smoke; and
- Minderoo Foundation's roundtable which is examining how the Minderoo Fire Fund Resilience Program can invest in application of evidence-based techniques and strategies.

A highly interconnected system with further opportunities to improve coordination and impact

Australia's bushfire research activity is highly interconnected between university researchers, PFRAs, government departments, the BNHCRC and some operational agencies. It is this cohesiveness and collaboration across the bushfire research system that provides the framework for ensuring Australia's significant research foundation is translated to tangible outcomes for end-users on the ground.

There is further potential to secure and bolster the connections across an extensive breadth of research capabilities to ensure operational agencies are able to engage with researchers to utilise and help shape the latest and best research being produced by Australia's foundational and applied research capability.

Finally, an optimal research system requires absorptive capacity in operational agencies to ensure Australia's high quality research is met with the appropriate demand pull. Engagement and participation from the operational services in developing research projects, providing clarity on intended use, and socialising the new technologies within their agencies is a critical element in successfully capitalising on strong research capabilities available across Australia. Given the increasing demands on rural fire agencies and their reliance on volunteers, a key question is whether they have the capabilities needed to articulate their research needs and to adopt improved products and processes into their practices.

National coordinators and knowledge brokers are vital

This preliminary assessment of Australia's bushfire research and technology capability highlights a vital role for organisations that span the basic to applied research through to the operational agencies. These coordinating organisations include knowledge brokers such as the National Council for Fire and Emergency Services (AFAC), EMA, AIDR, and the BNHCRC.

EMA is the Australian Government body responsible for emergency management coordination. EMA is a division of the Department of Home Affairs, and delivers programs, policies and services that strengthen Australia's national security and emergency management capability. State and territory governments manage emergency responses in their jurisdictions. EMA coordinates the Australian Government physical and financial support for disasters and emergencies.

AIDR deliver products and services around the country that have been developed by, and for, the emergency management sector. AIDR develops, maintains and shares knowledge and learning to support a disaster resilient Australia.

The BNHCRC has strong and broad links to operational agencies unmatched by any other actor in the research system. It has been central in the development of a national strategic vision, and has played a vital role in breaking down silos to enable the translation of research into high impact outcomes for end-users on the ground.

Knowledge brokers provide a critical two-way bridge between end-users (e.g. operational agencies) and researchers across Australia. Figure 3 shows knowledge brokers play an important role in setting the research priorities for the research sector through identification of needs on the ground. The knowledge brokers are also critical in communicating information, tools, policies, and new approaches from the broad base of researchers to the end-users.

The key consideration for Australia is how we go from good to great. How do we ensure we build on and improve the networks we have established and the pathways for translating excellent research into improved processes and practices? How can we make sure the research needs of end-users are being met, while maintaining our ability to understand the

deep drivers of bushfires and other natural disasters and to have the capability to adapt to changing circumstances?

Figure 1. Overview of Australia's Bushfire Capabilities

Figure 2. Examples of bushfire technology capabilities

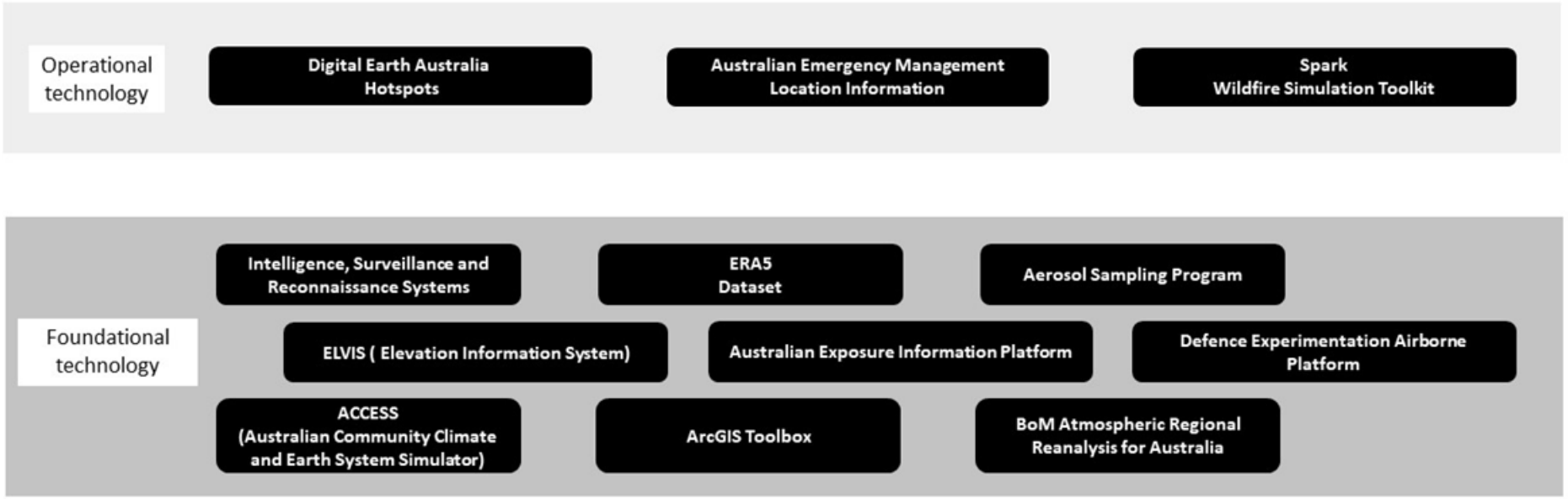
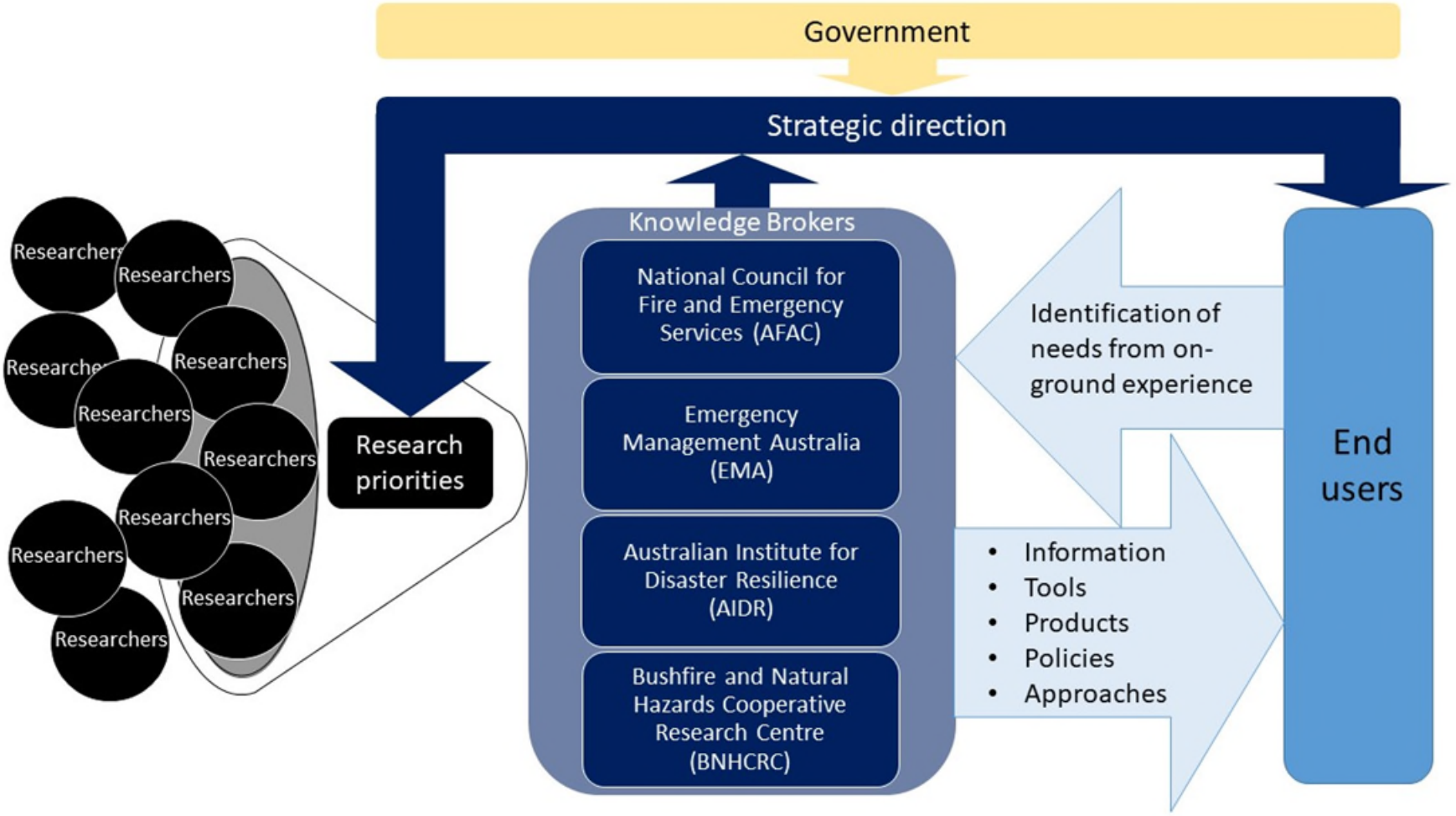


Figure 3. Knowledge brokers play a vital role in setting strategic research priorities and disseminating the findings from research



Introduction

Background

On 15 January 2020, Australia's Minister for Industry, Science and Technology, the Hon Karen Andrews MP, held a bushfire science roundtable to help better understand how the Australian science and research sector can contribute to bushfire response, resilience, and recovery.

Following this roundtable, Minister Andrews requested that the Office of the Chief Scientist (OCS) develop a map of Australia's research and technology capability relevant to bushfire response, resilience, and recovery to inform the activities of the National Bushfire Recovery Agency, Commonwealth, state and territory and local governments, research organisations, non-government and volunteer organisations, and philanthropic initiatives.

It will also be a useful input to the CSIRO Report on Climate and Disaster Resilience. The CSIRO report will provide the Council of Australian Governments with practical measures to implement in order to support and improve Australia's climate and disaster resilience. CSIRO is working with the Chief Scientist and an Expert Advisory Panel (EAP) which he chairs.

Scope

The following capability map presents a high-level overview of Australia's research and technology capabilities relevant to bushfire response, resilience, and recovery based on input provided by organisations across Australia's research sector. This mapping exercise has also included an analysis of Australia's competitive grant funding, and bibliometric analysis of Australia's bushfire related research publications. It primarily includes research activities funded by the Commonwealth Government, and does not specifically include state government funded research. However, it is important to acknowledge that many of the research capabilities listed here are likely to include contributions from state governments as well as other private funding sources.

The capability map identifies the roles of the various players in the research sector; from bottom-up basic and applied research in Australia's universities and publicly funded research agencies, to the knowledge brokers and national coordinating agencies who facilitate the dissemination of research findings to the operational agencies.

What is not included

This initial mapping exercise has intentionally been restricted in scope to understanding Australia's current capability in research directly relevant to bushfire response, resilience and recovery.

However, bushfires and other crises have long-term effects on our society and environment in multiple ways including impacts on community wellbeing, mental health, the economy, industrial and commercial activity. Whilst this capability map has touched on some of these interdisciplinary capabilities, it could be bolstered by further analysis on the capabilities that enable a multi-factor response to bushfires. In particular, the following map could be well complemented by a deeper analysis of Australia's research capabilities relevant to the

individual and community health impacts of bushfires, as well as the impacts on wildlife and biodiversity.

Bushfires have multiple short and long-term health impacts on individuals, including first responders. Research following the Black Saturday fires show that survivors are still suffering mental health disorders at rates sometimes twice the general population five years after the disaster.[1] The 2019-20 fire season also highlighted the importance of addressing our gap in understanding of the impacts of smoke on health. Thus, research capabilities of Australia's medical research institutes, and Australia's strong mental health research capabilities will be critical for understanding the human dimension of bushfire response, resilience and recovery. To this end, following the 2019-20 bushfires the Medical Research Future Fund and the National Health and Medical Research Council made a funding call to apply Australia's strong research capacity in health towards understanding the impacts of bushfires on health.[2]

In addition, Australia's research capability into how threatened animals and plants respond to fire to inform strategic decisions will be vitally important for the overall response and recovery effort. This capability map will touch on some of Australia's capabilities in this space, but a complete understanding will require deeper analysis across the sector. It is important to note, that the Minister of Environment, the Hon Sussan Ley MP, has convened an Expert Panel, Chaired by the Threatened Species Commissioner, Dr Sally Box, to assist in prioritising recovery actions for native species and ecological communities. The work of the Expert Panel, will be important in informing any future iterations of this capability map.

Finally, a detailed understanding of the research and technology capability embedded in the operational agencies is critical for a complete map of Australia's research and technology capabilities related to bushfires. However, due to the compounding effects of the 2019-20 fire season and the COVID-19 pandemic, the OCS has refrained from engaging these organisations during this difficult time. The report does, however, include an initial assessment of research capabilities within rural fire and land management agencies provided by the Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC).

Purpose and intended utility

By providing a high-level snap shot of existing research capability in this space, this map is intended to be used to inform decision makers, and others, of the general research landscape – the 'who's doing what' in bushfire research across Australia. Whilst it provides a basis to identify further areas of exploration, and identifies key stakeholders to consult and engage with for future analysis, it does not provide in depth analysis of capability within particular topic areas.

Given that bushfire response, resilience, and recovery involves a highly complex set of research capabilities, further analysis would be best undertaken in response to a prioritised list of specific topics, questions or goals. Some examples could include 'how do we improve our rapid response capabilities in remote and hard to access sites' or 'what characteristics do warning systems require in order to be used by and useful for the general public, and

[1] https://pursuit.unimelb.edu.au/articles/black-saturday-the-hidden-costs

[2] https://www.nhmrc.gov.au/funding/find-funding/mrff-emerging-priorities-and-consumer-driven-research-initiative-2020-bushfire-impact-research-grant-opportunity

lead to the preferred behaviours (early evacuation etc)?' It is likely that key questions will be identified through the Royal Commission, the CSIRO Report on Climate and Disaster Resilience and the range of other activities and inquiries occurring across Australia.

National Coordination Initiatives

Emergency Management Australia (EMA)

Emergency Management Australia (EMA), a division within the Department of Home Affairs, is Australia's national disaster management organisation. It leads the Australian Government's efforts in disaster risk reduction, preparedness, response and recovery.

EMA is leading the development of a National Disaster Risk Information Services Capability (NDRISC). NDRISC will focus on meeting immediate tactical and operational information and decision support requirements, as well as explore and resolve underlying constraints on data standards and information governance specific to hazard (e.g. bushfire) to ensure the flow of timely and accurate data.

National Council for Fire and Emergency Services (AFAC)

The National Council for Fire and Emergency Services (AFAC), formed in 1993, is the peak body responsible for representing fire, emergency services and land management agencies in the Australasian region.

AFAC is the facilitator and custodian of contemporary fire and emergency service knowledge and practice, for the benefit of their members and through them, the community. Through their collaboration framework AFAC assists the emergency management sector to identify and achieve strategic and operational priorities.

AFAC's Collaboration Model

AFAC facilitates national collaboration through the AFAC Collaboration Model[3] which encompasses 33 Groups, Technical Groups and Networks. The AFAC Collaboration Model aims to add value to AFAC Members, the fire and emergency services industry and ultimately enhance community safety. This approach facilitates and supports engagement, enabling members to jointly consider common challenges, generate solutions, develop doctrine including positions, guidelines and technical notes, and inspire new directions in practice.

AFAC's core membership consists of emergency services or fire management agencies of a state or territory government in Australia, or any other government agency with emergency management responsibilities. AFAC's affiliate membership are available to organisations that are engaged in aspects of emergency management but do not meet the criteria for Council membership.

A list of AFAC's core members as of October 2019 can be found at Attachment A.

[3] AFAC. (2018). "Collaboration Framework". *National Council for Fire and Emergency Services*. Retrieved from: https://www.afac.com.au/docs/default-source/network/afac-collaboration-framework.pdf?sfvrsn=18&download=false

AFAC National Resource Sharing Centre

AFAC National Resource Sharing Centre (NRSC) coordinates and facilitates international and interstate deployments through its established partnerships and national arrangements as authorised by the Commissioners and Chief Officers Strategic Committee.

AFAC NRSC integrates and utilises existing national and state emergency management capability and resources in any jurisdiction and can be activated in any suitable location as determined by the Commissioners and Chief Officers Strategic Committee.

Through the Australian Arrangement for Interstate Assistance (AIA), NRSC has provided a framework to facilitate interstate arrangements and allow for mutual assistance between Australian fire services, emergency services and land management.

Between July 2018 and April 2019, the AFAC NRSC coordinated deployments to five domestic and international large scale incidents in the United States, Queensland, Tasmania, and Victoria.

AFAC Research Utilisation Matrix

In 2016 and 2018, AFAC and the BNHCRC surveyed end user partners to understand how agencies are engaging in research and capitalising on research outputs. The survey results found that operational agencies are at different stages of building their research utilisation capacity.[4,5]

In response, AFAC has developed a draft Research Utilisation Maturity Matrix tool to help agencies assess how much and how well they are using research and identify gaps and opportunities for improvement.

AFAC Climate Change Group

The AFAC Climate Change Group is led by a partnership between AFAC and the Australian Institute for Disaster Resilience (AIDR) (see below).

Members of the group include key individuals from jurisdictional Emergency Management agencies and the BoM. The group is tasked with producing a body of work to strategically support effective climate change risk mitigation, planning and adaptation outcomes for AFAC members, their stakeholders and the wider community.

The Climate Change Group has recently produced two key documents that contribute to this agenda:

- *Fire and emergency services and climate change* position paper to inform good practice and support the emergency management sector's leadership role in reducing disaster risk due to climate change.
- *AFAC Climate Change Talking Points* – a communication resource to present key messages to inform frequently asked questions related to links between climate change and emergencies and disasters.

[4] Owen, C. Krusel, N. & Bethune, L. (2016). "Report on Research Utilisation Review". *Prepared for AFAC and the Bushfire and Natural Hazards CRC*. https://www.afac.com.au/docs/default-source/ru/research-utilisation-report-april-2016.pdf?sfvrsn=0

[5] Owen, C. Krusel, N. & Bethune, L. (2018). "Report on Research Utilisation Review". *Prepared for AFAC and the Bushfire and Natural Hazards CRC*. https://www.afac.com.au/docs/default-source/ru/report-on-research-utilisation-review-2018.pdf?sfvrsn=4

Australian Institute for Disaster Resilience (AIDR)

The AIDR delivers a range of disaster resilience, professional development and research utilisation services on behalf of the Government.

AIDR operates as a partnership between the Government and a consortium consisting of the Australasian Fire and Emergency Service Authorities Council, the Australian Red Cross and the BNHCRC. The partnership represents a wide range of emergency management expertise from operational, humanitarian and research backgrounds. It shares and builds on experience in emergency management drawn from Australian and overseas.

Since its establishment in 2015, AIDR has built a strong reputation as a national organisation supporting local communities. Its growing network of stakeholders encompasses governments at all levels, businesses, NGOs, social services, community organisations and volunteer groups. It is a well-regarded fixture of the sector and supports a close and pragmatic partnership between government and industry. AIDR facilitates the exchange of knowledge on behalf of Government, which is critical to Australia's ability to prevent, prepare for, respond to and recover from a changing and escalating disaster landscape. AIDR also develops authoritative, principles-based doctrine on matters such as evacuation planning, public information, lessons management, and community recovery. Its professional development activities connect research to practice and foster collaboration among volunteers, educators, practitioners, students and policymakers.

Australian Disaster Resilience Knowledge Hub

The Australian Disaster Resilience Knowledge Hub (Knowledge Hub) is a national, open-source platform that supports and informs policy, planning, decision making, and contemporary good practice in disaster resilience.

The Knowledge Hub is a key platform to share disaster resilience knowledge, and is home to curated collections of knowledge and resources. It brings together official data, new research and historical collections to provide people and organisations with information to support building a safer Australia. The collection includes:

- frameworks and resources for disaster risk reduction;
- Emergency Management Library – one of the largest emergency management libraries in the southern hemisphere;
- resources, information and publications focused on recovery in Australia and internationally;
- Australian Journal of Emergency Management – Australia's premier journal for emergency management covering resilience, disaster risk reduction, natural hazards and emergencies which has been developed through strong partnerships with academia, including the resources of the BNHCRC;
- Australian Disaster Resilience Handbook Collection – the authoritative source of national principles and practices for disaster resilience (see below);

- historical records of disaster events that have affected Australia; and
- information on best practice and research to inform prescribed burning planning and implementation from the Centre of Excellence for Prescribed Burning (see below).

Australian Disaster Resilience Handbook Collection

The Australian Disaster Resilience Handbook Collection (Handbook Collection) is an authoritative portfolio of resources that provide nationally agreed principles and guidance for good practice across a range of disaster risk reduction and resilience themes.

The Handbook Collection draws on the expertise and insights of leading disaster risk reduction, resilience and emergency management practitioners and scholars from all Australian jurisdictions and sectors, as well as applied research and data analysis from trusted Australian and international knowledge sources.

The Handbook Collection continues to gain prominence as Australia's leading authority on disaster risk reduction and resilience.

Centre of Excellence for Prescribed Burning

The Centre of Excellence for Prescribed Burning is a practical hub for prescribed burning practitioners to share knowledge and experience for increased capability.

The Centre communicates guiding frameworks and principles developed under the National Burning Project, to promote a holistic and consistent approach to prescribed burning practices, and supports the implementation of those practices by agencies. The Centre also facilitates ongoing engagement across the industry, building agency capability to deliver prescribed burning informed by research and good practice.

Awareness of the Centre of Excellence products and their utilisation is achieved through strong engagement at conferences, forums and facilitated workshops in all jurisdictions across the country.

Access to Experts

Learned Academies

Collectively, Australia's four Learned Academies have access to an extensive network of Australia's preeminent scientists and scholars across the disciplines. The Academies also play a critical role in promoting international engagement and providing opportunities for researchers and innovators to connect with counterparts.

In addition, the Australian Academy of Science's video production and digital content dissemination to mass audiences, provides a key communication capability allowing messages to be delivered from organisations to broad or targeted audiences as needed.

The Learned Academies also have a key role at the intersection of research and policy in providing independent, authoritative and evidence-based advice to government.

Peak Bodies – Science and Technology Australia (STA)

Peak bodies such as Science and Technology Australia (STA) play a role in facilitating connections between scientific experts and industry leaders.

For example, STA connects scientists and technologists directly with policy makers through *Science meets Policymakers*. STA also facilitates interaction between scientists and businesses through event such as *Science meets Business*, and between science, technology, engineering and mathematics professionals and industry leaders.

CSIRO's Expert Connect Platform

CSIRO's Expert Connect is a publicly searchable database of Australia's research expertise containing more than 70,000 academic profiles from over 220 research organisations. The platform has been designed to boost industry-researcher collaboration, with profiles for researchers being automatically created by drawing on authoritative sources, including:

- patent data from IP Australia
- grant data from Australian Research Council (ARC) & NHMRC
- journal articles from Clarivate Analytics' Web of Science
- author profiles and media articles from The Conversation Media Group
- profile data from ORCID and research organisation directories.

Anyone can search for a topic of interest using simple, non-scientific language, and find the most relevant researchers to connect with. The platform considers both academic expertise and industry nous, presenting users with a list of relevant experts that are most likely to understand the business context.

Bushfire and Natural Hazards Cooperative Research Centre (BNHCRC)

The BNHCRC is a strong and established knowledge network that brings together:

- All state and territory fire and emergency service organisations and land management agencies across Australia, and with representation from New Zealand. Commonwealth representation is through Emergency Management Australia and statutory research and service providers (BoM, GA);
- Recovery agencies (e.g. Queensland Reconstruction Authority, EMA recovery team, state and territory recovery teams);
- Insurance sector, electricity networks and public infrastructure owners;
- Over 25 Australian and New Zealand universities and other research organisations are actively engaged in our programs, with many others engaging on a one-off basis for specific projects;
- Over 150 research higher degree students across Australia and New Zealand; and
- International partnerships and collaborations directly through the BNHCRC and through our research and end user networks.

The strength of the BNHCRC lays in its collective nature. As a cooperative research centre, the BNHCRC is a collection of people and individual organisations that bring a range of values to the whole. The BNHCRC operates as a hub in the broad emergency and hazards sector, creating a pool of resources and insights at the local, national and international level. The BNHCRC creates a bridge that link disparate and diverse groups together in a network focused on innovation.

With more than 250 researchers and 250 agency staff in Australia and internationally directly involved in the research projects - with many more indirectly involved - the collective strength is an efficient and effective way to advance the science of natural hazards. The BNHCRC provides a research capacity that is not feasible at the individual state or territory or agency level, nor with any one university or research organisation.

A forum for independent knowledge

The BNHCRC is seen as the go-to organisation by government, the agencies, the media and the community for authoritative and independent advice and commentary on all matters in natural hazards.

The BNHCRC has created a space for discussion, learning and development of natural hazards science and disaster resilience through well-attended conferences and other research-based forums, plus regular academic and community focused publications.

The BNHCRC is regularly called upon for independent advice on fires and other hazards by government and agency partners. The 2009 Victorian Bushfires Royal Commission relied upon the predecessor to the BNHCRC, the Bushfire CRC (BCRC), for access to credible

research findings and respected researchers and noted this contribution in its final report. Since then, the BNHCRC and its researchers have regularly been called upon for independent advice and research on major issues including hazard reduction burning and fire season preparation, and for post-fire field research into fire behaviour and community safety.

End-user engagement

At a national level, the BNHCRC has worked with an expanded group of end users to develop National Research Priorities for Natural Hazards Emergency Management,[6] which has recently been expanded to include national research priorities for Australian electricity networks.[7]

These research priorities reflect the needs of those who are tasked with responsibilities for leading and managing Australia's capability development for mitigation, response to, and recovery from the impacts of natural hazards.

At a project level, project identification at the BNHCRC is undertaken as a joint activity with end users:

- The research needs are defined by end-user groups as the foundation of new research projects;
- Research partners then propose solutions to address the research needs, and the outcomes required by the end users;
- Researchers and end users collectively manage progress of the research projects and review progress and deliverables.

End users and researchers engage regularly at a project level, and national research forums to review, critique, share knowledge and explore linkages between projects.

BNHCRC Research Capabilities

The BNHCRC's current research portfolio should be viewed from two complementary perspectives: through the research themes (research based, input focused) and through the intended application of research outcomes (impact based, outcome focused).

The BNHCRC's research program consists of three distinct research themes, each with clusters of specialisation:

Policy and economics of hazards

- Modelling scenarios and loss
- Economics of hazards
- Policy and planning.

[6] Bushfire & Natural Hazards CRC. (2017). "National Priorities". *Bushfire & Natural Hazards CRC.* Retrieved from: https://www.bnhcrc.com.au/nationalpriorities

[7] Bushfire & Natural Hazards CRC. (2019). "Australian electricity networks – a statement on national research priorities for natural hazards emergency management and resilience". *Bushfire & Natural Hazards CRC.* Retrieved from: https://www.bnhcrc.com.au/nationalpriorities/electricitynetworks

Resilience to hazards

- Emergency management capacity and capability
- Risk communication
- Sustainable volunteering
- Recovery
- Understanding and enhancing resilience.

Understanding and mitigating hazards

- Built environment
- Prescribed burning & fuel management
- Flood and coastal management
- Bushfire science
- Severe and high impact weather.

BNHCRC's Role in National Capability Development

The BNHCRC (and previously the BCRC) have played a significant role in funding and developing the capabilities across our research partners (more than 25 Australian universities, and CSIRO), the fire and emergency services and land management agencies.

That capability development resides in research groups, and in the research workforce that has developed through the research projects and student program. The BNHCRC alone has over 140 affiliated research students.

BNHCRC research impact areas

The BNHCRC's research program is assessed against seven impact areas:

- Bushfire mitigation: prescribed burning, carbon, fuel and land management.
- Northern Australia: natural hazards, people and economics
- Extreme weather: predicting, modelling and managing its impacts
- Thought leadership: economics, policy and planning
- Improving outcomes for people: communications, community engagement and recovery
- Workforce 2030: workforce, volunteering and readiness for new and emerging technologies
- Fire predictive service: understanding and measuring the risk and behaviour of fires across the landscape.

Communication and Engagement

The BNHCRC approach to communication and engagement has multiple linked elements. The BNHCRC's engagement with the group of knowledgeable professionals across the emergency management, operations and policy sectors, is fundamentally supported by the strength of knowledge networks that have been nurtured over many years. Importantly, this knowledge network is welcoming of new members and strengthened by open and innovative thought.

From the start of the BCRC in 2003 through to the current BNHCRC, the CRCs have created and used a portfolio of engagement approaches to build relationships and share knowledge across the knowledge network. These include:

Sector wide conference and events

Traditional engagement includes a calendar of significant industry conferences with research content or streams:

- AFAC Research Forum and Conference: Annual conference of Australian and New Zealand emergency services[8]
- Australasian New Zealand Disaster and Emergency Management Conference
- Emergency Media and Public Affairs conference
- Emergency Management Conference.

Specialised conference and events

- Australasian Natural Hazards Management Conference
- Asia Pacific Ministerial Conference on Disaster Risk Reduction
- North Australia Fire Managers Forum.

Targeted research forums

- Broad physical and social science forums
- Targeted forums, including: managing the landscape, northern Australia, fire predictive services
- Project specific forums.

Special purpose events

- International Day for Disaster Risk Reduction: an annual public event focusing on local debate around the UN Sendai Seven Global Targets (2016 – 2022).

Closed Networks

The BNHCRC participates directly in a number of specialist groups and forums through the Australasian Fire and Emergency Services Council, the AIDR, state and territory governments, and universities. Examples include:

- Australian Fire Danger Ratings Board
- Rural and Land Management Group
- Forest Fire Management Group
- Fire Predictive Services Group
- QFES Strategy 2030 development
- Fire and emergency services Workforce Management Group
- National Warnings Group.

[8] The BNHCRC coordinates the research program for the Australian and New Zealand emergency services.

Scientific journals and magazines

The BNHCRC publishes research in scientific journals as a major communication tool and plays a senior editorial role in Australian and international curated publications:

- Fire Australia
- Australian Journal of Emergency Management (free, open access)
- Wildfire and the International Journal of Wildland Fire, publications of the International Association of Wildland Fire.

Selected examples and case studies from the BNHCRC

Warnings that save lives

The BNHCRC has conducted multi-disciplinary research to improve the timeliness and effectiveness of community warnings that have resulted in reductions in the loss of life and property in floods and bushfires.

Australian lives are being saved by BNHCRC research that is shaping warnings and public information campaigns to prepare and protect communities threatened by flood, fire, heatwave and other natural hazards.

The insights from BNHCRC researchers at the Queensland University of Technology are equipping emergency service agencies around Australia with better-targeted long-term public safety campaigns as well as evidence-based warning messages delivered to at-risk populations in the face of imminent natural hazard threats. The goal of the project was to save lives and empower communities to act to ensure their safety, by improving community warning messages.

The research underpinned the National Emergency Management Handbook on Public Information and Warnings and the companion guide Warning Message Construction: Choosing Your Words, both published by the AIDR. The publications drew directly on the research to give guidance on the key considerations for writing effective warning messages, including structures and language styles for specific audiences, such as high-risk groups and non-English speaking communities.

Emergency service agencies have drawn from the project and have collaborated at the national level to determine a style and structure for official public messages now used in routine bushfire incidents. Queensland Premier the Hon Annastacia Palaszczuk MP credited the warnings research, combined with BNHCRC fire prediction tools detailed below, with saving lives and the township of Gracemere in the November 2018 fires.

Better fire danger ratings

The CRC has conducted research into fire behaviour that has improved the national fire danger ratings system, resulting in better warnings for the community.

A new National Fire Danger Ratings System is drawing from a range of BNHCRC projects in fire behaviour, fire ecology, weather and climate, predictive services, and communications and warnings. Based on this research, the new system will improve community awareness of risk exposure, provide greater scientific accuracy behind decisions, advice and warnings and give communities greater confidence in the information being provided.

Fire prediction

The CRC-developed fire spread modelling system provides better real-time information on the likely path of bushfires, enabling better operational decisions to be made.

Phoenix RapidFire, developed through CRC research, is the main fire modelling and prediction software in Australia that predicts the movement of a bushfire across different types of topography and vegetation, taking account of fire history, roads and other structures, and weather (temperature and wind) conditions.

Fire managers use this software to estimate the potential impact of bushfires and determine which communities need to be warned and where resources need to be deployed.

A seasonal view of bushfire

The unique research and partner networks of the BNHCRC has enabled it to coordinate the production of a national seasonal bushfire outlook, which serves as a trigger for communities around the country to prepare for the coming season.

Strategic decisions on resources, prescribed fire management and community warnings have for the past 16 years been underpinned by the BNHCRC's Seasonal Bushfire Outlook (Outlook). Information from the Outlook is used by ABC Emergency to coordinate its national ABC Radio seasonal awareness and training program for its journalists.

Governments and fire authorities nationally are using the Outlook for planning purposes in the lead-up to their bushfire seasons, including refining their public messages that communicate bushfire risk and highlight areas with the highest potential for fire.

The BNHCRC leads the preparation of the Outlook in close consultation with the BoM, AFAC, and emergency service agencies in each state and territory. The Outlooks cover the Northern and Southern fire seasons and are published annually around June, September and November. In 2020, at the request of BNHCRC partner agencies, the Outlook will shift to a quarterly release to better reflect the year-round nature of fire management and operations across Australia.

Mental health of first responders

The BNHCRC worked with Beyond Blue to undertake a word-first study to better understand the mental health issues of emergency services workers.

A national research collaboration between the BNHCRC and Beyond Blue with the University of Western Australia provided insights into the impacts of workplace culture, mental health and wellbeing of police and emergency service personnel. This research, the most comprehensive study of its type in Australia, is being used by the sector to review current mental health support strategies and to identify opportunities to modify existing or introduce new support programs.

Fire fighter safety

The Bushfire CRC's early work validated the many safety systems that are now standard in fire fighting vehicles, saving firefighter lives should they get caught in a fire.

Early research by the BCRC has led to the wide adoption of vehicle sprinkler protection systems that protect fire crews in burnover situations. Other research has established standards for rest and hydration, and for heat and smoke protection, while acknowledging that the nature of firefighting involves strenuous shifts under hot and smoky conditions.

Volunteers

The CRC undertook research that has helped to ensure that the emergency services have sufficient capacity to fight bushfires and flood, though better understanding of the volunteer workforce.

Issues of recruitment, retention, diversity, and wellbeing among fire and emergency service volunteers have been identified in CRC studies since 2003 and backed with strategies to attract and support volunteer workforces. Research has resulted in agencies reviewing the way they manage volunteers with enhanced training and leadership skills, more support for volunteers and their families, and recruitment campaigns that target a younger and more diverse demographic.

Disaster resilience education for young people

The BNHCRC's work in understanding how children can be involved in their own natural hazards education, and how they can educate their families, has become a standard part of school curriculum in many schools.

Educating children and youth about disaster risk reduction and resilience is now front and centre around Australia, based on BNHCRC research that identified the valuable role children play in the safety of their households and communities. This research began with a BNHCRC PhD project that developed an interactive eBook to help parents discuss bushfire preparation and safety with their children. The research has since been expanded to support state fire agency children's education campaigns, as well as curriculum materials designed for primary and early secondary school.

House and vehicle safety

Early work of the CRC into how houses are lost in bushfire, has resulted in changes to the building standards for new properties.

Research drawing from both field and laboratory-based testing is providing fire agencies and communities with guidance on design and materials for house construction, pre-hazard season preparation of properties, and sheltering in vehicles during bushfires.

Managing bushfire research portfolios for land managers

The CRC has managed research projects for DELWP that have delivered outcomes that have allowed DELWP to maintain to use research evidence to support their decision making and continually improve their land management capabilities.

For close to 10 years, the CRC has coordinated and managed a major portfolio of bushfire risk management research projects for the Victorian Department of Environment, Land Water & Planning, using the knowledge, connections and reach of the CRC to deliver outcomes that support DELPW's ongoing programs for fire and land management. More recently, this has been expanded to include management of projects for the Victorian Country Fire Authority, through Victoria's Safer Together program.

Decisions under fire

The multi-disciplinary research of the CRC undertaken in the aftermath of disasters with the communities has enabled better understanding of community decision making, ensuring that public safety messaging is more targeted and effective.

Public bushfire safety campaigns across Australia have been shaped by a decade of CRC research that identified the reasons why people under a direct threat of fire make their choice to either leave, stay and defend, or wait and see what develops.

Based on the evidence of the 2009 Victorian Bushfires Royal Commission and household interviews following those fires and other major fires across Australia, researchers were tasked to identify the principal drivers of resident's actions under threat of bushfire. The critical influences on their actions were found to be the priorities that shaped their intentions in the lead-up to the fire season. These included the safety of their families, protection of their homes and assets, and their own perceptions of their risk under particular fire scenarios.

Safer houses in high winds

Research work partially undertaken by the BNHCRC has resulted in a Queensland Government grant program to retrofit properties against cyclones for vulnerable communities in northern Australia.

The award-winning Queensland Government Household Resilience Program, backed by research from the BNHCRC, is increasing the resilience of homes to tropical cyclones. Owners of properties upgraded through this program are now seeing reductions in their insurance premiums.

The Cyclone Testing Station at James Cook University worked with the Queensland Government to create the program, which provides Queensland homeowners with a grant for the upgrade of the roof structure, protection of windows and strengthening of doors – the key areas identified by the research as being at the highest risk of damage during strong cyclonic winds.

Research Capability in Operational Agencies

Successful transfer of research from knowledge production to the creation of applicable technologies to end-users requires an evaluation of the readiness of the end-users and their ability to exploit these technologies. To this end, it important to understand how operational agencies engage with the research sector and whether they have sufficient absorptive capacity to implement new research and technology.

Due to the compounding effects of the 2019-20 bushfire season and the COVID-19 pandemic, direct engagement with operational agencies was not possible. The content below is drawn from limited input and should be fact checked, as required.

Research in Land Management Agencies

Research capability in the land management agencies is primarily delivered through a partnership model.

For example, in New South Wales (NSW), the NSW National Parks and Wildlife Services (NPWS) has invested in a Bushfire Risk Management Research Hub that is coordinated through the University of Wollongong, and an Adaptation Research Hub which undertakes research through NSW universities, in collaboration with the CSIRO, Taronga Zoo, the Royal Botanic Gardens, and others.

Agencies employ research-trained staff to coordinate and provide end-user input into the research.

Research in Rural Fire Agencies

The most significant research-enabled rural fire services are the NSW Rural Fire Service (NSW RFS) and Victorian Country Fire Authority (VicCFA).

As examples of the roles played by rural fire agencies:

- The NSW RFS is currently coordinating the national implementation of the Australian Fire Danger Rating System – converting an empirical predictive capability to a significantly higher resolution digital system. This work is a national scale integration, prototyping, evaluation, and implementation project drawing off many streams of research output from many research providers, including the Bureau of Meteorology. The project is coordinated by research-trained technical experts within NSW RFS.
- VicCFA is coordinating a significant project attempting to build an accurate matrix of the fire suppression rates for all forms of fire suppression across multiple terrain and fuel profiles in multiple fore weather scenarios.

In most cases, the rural fire agencies across Australia provide field research environments that allow researchers to collect data, to test hypotheses or to evaluate potential systems and interventions. Many of the rural fire agencies employ research-qualified and research-trained staff.

Rural fire agencies (and other emergency service agencies) also use consultancy firms and market research firms to undertake specific projects that address knowledge gaps, although these studies may not always have the rigour, peer review and independence attributed to academic research.

Publicly Funded Research Agencies and Commonwealth Government Departments and Agencies

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

Since the 1950's CSIRO has developed a long track record of working in bushfire-related research from understanding and modelling impact of bushfires on different vegetation types and terrain, to improving infrastructure design in bushfire affected locations. Scientists at CSIRO develop tools to predict bushfire behaviour, and advance fire spread prediction and bushfire suppression systems.

CSIRO's Bushfire Related Research Areas

In early 2020, CSIRO's bushfire research capability was underpinned by 77 FTE[9] staff working across three broad research areas:

Table 1. CSIRO Broad Research Areas

CSIRO broad research areas		**FTE**
Fire prediction and management	Bushfire prediction methods and modelling frameworks	4
	Bushfire behaviour (including vertical wind tunnel and Pyrotron infrastructure); fluid dynamics/ boundary layer turbulence (including horizontal wind tunnel)	4
	Indigenous fire management	5
	Remote and near-Earth sensing: using remote sensing to generate mapping products, fuel loads and fuel condition	5
Environment and community impacts and influences	Impacts of non-native vegetation on bushfire behaviour, including plantation forestry, broadacre crops and invasive grass species	2
	Bushfire carbon emissions and carbon emission mitigation; greenhouse gas emissions and carbon cycle; natural capital accounting	7
	Smoke hazard predictions, monitoring and impact; smoke exposure predictions and assessments; air quality forecasting; air quality and health impacts	4
	Biodiversity responses to bushfire; quantitative modelling of biodiversity; conservation decision-making	8
	Bushfire impacts on landform and erosion, nutrient and sediment movement; water quality and quantity; black-water events	8
	Climate change and bushfires (attribution and future projections); biennial State of the Climate Reporting	5

[9] Average full time equivalent capability deployed, which may include partial allocations of a larger number of individuals working on multiple projects or research areas.

	Community preparedness and response, community resilience	4
	Landscape and ecosystem restoration, seed sourcing and development	5
Infrastructure and services	Performance based bushfire testing: bushfire impacts on infrastructure; regulatory compliance testing and reform of construction products for use in bushfire prone environments and their linkage with Bushfire Construction Standards (including the Mogo burn-over facility); evaluation of personal and community fire shelters/ refuges.	5
	Mapping risks to, and from, infrastructure, for protection and mitigation	1
	Sensor networks and instrumentation for investigating bushfire behaviour: intensity, spread, heat penetration	4
	Autonomous vehicles for survey and assessment purposes	6
Total		**77**

CSIRO trains all state fire agencies in fire behaviour and prediction, and uses world class facilities and models to understand and manage fires under future climate conditions. The tools and software to understand and predict the behaviour and spread of bushfires which are used throughout Australia today are a direct product of CSIRO's continuous research to improve the foundational understanding of fire spread and behaviour.

CSIRO's bushfire related research has included:

- development of fire data analysis tools
- disaster management
- understanding and predicting bushfire behaviour
- impact of bushfires on infrastructure
- ecological responses to fire
- Indigenous fire knowledge
- pollutants and greenhouse gases as a result of bushfires
- smoke forecasting for bushfires and prescribed burns
- building community resilience and risk management
- reducing impacts in the face of disasters
- preparing for climate change and extreme events

Through this work, CSIRO has developed many tools, methods, guides and training materials that are in operational use by relevant fire emergency services agencies across Australia. Of particular note was the development of the Forest Fire Danger Index in 1967, which today forms the basis of Australia's fire-risk warning system.

CSIRO also undertakes research on understanding the complex interconnected social, physical and economic factors surrounding community and government responses to bushfire risk and how to build resilience and support behaviour change, including involvement in the development of the federal government's national resilience measures.

CSIRO's Research Case Studies under Broad Research Areas

Fire Prediction and Management

Bushfire behaviour and risks – focuses on the study of the behaviour of bushfires and the development of systems to predict their spread and behaviour.

Project Vesta – investigated the behaviour and spread of high-intensity bushfires in eucalypt forests. The project produced a fire behaviour model for fire spread, flame height and spotting distance in dry eucalypt forests; a fuel hazard assessment guide; and important fire safety information for fire-fighters. Project outcomes were shared with via training guidelines with all Australian states.

The fire behaviour models are the current state of the art for eucalypt forests and are used to predict wildfire progression by fire suppression agencies, and have been used to allocate resources and issue warnings.

Spark - This bushfire spread modelling and analysis capability has been evaluated in an operational context by QFES, NSW RFS, ACT RFS, SA Country Fire Service and RFS Tasmania. This evaluation phase has led to strong support by these agencies for an operational nationally consistent tool based on Spark. Such an operational version of Spark will be closely integrated with the National Fire Danger Rating System that is being developed by AFAC with its partner (contributing) state agencies. There is no nationally consistent operational bushfire model currently, making it difficult to attain a range of outcomes including: working at boundaries between states effectively, learning from state-based episodes and for the development of operationally consistent nationwide methodologies.

New data integration - Data61, CSIRO's data and digital specialist data sciences arm, has started developing data assimilation techniques that will allow us to integrate satellite data with bushfire predictive models such as Spark to create hybrid data driven and model informed predictions.

Environment and community impacts and influences

Climate studies

- State of the Climate - CSIRO and the BoM have regularly reported on climate variability and change in Australia including bushfire weather via the biennial State of the Climate report since 2010.
- Greenhouse gas accounting of forest fires - CSIRO is working closely with the Australian government to develop national greenhouse gas accounting methods for use in the Australian National Greenhouse Gas Inventory. This will lead to improved confidence in estimates of fire impacts on carbon stocks and emissions, and how these vary under differing conditions and forest types. CSIRO, in collaboration with colleagues from the University of Melbourne, are also developing novel modelling approaches to understanding the consequences of both wildfires and prescribed burning on ecosystem-level carbon budgets.

- Resilience - CSIRO was a strategic partner for the Australian Government's National Resilience Taskforce, established in 2018. They designed and led the national engagement process to build a systems understanding of the root causes of disaster vulnerability, articulated in Profiling Australia's Vulnerability. In addition, CSIRO led or collaborated on strategic guidance on how to use scenarios to understand disaster risk, reduce vulnerability by addressing root causes, and deliver better outcomes by focusing on governance and communities.

- Climate Compass **-** CSIRO is an active member of the Commonwealth Government's Disaster and Climate Resilience Reference Group and associated Officer's Group, contributing to whole-of-government collaboration on disaster risk and resilience. In particular, the CSIRO and the Department of the Environment and Energy work together to develop 'Climate Compass: A Climate Risk Management Framework for Commonwealth Agencies'. Climate Compass has been used across the public service and shared with state and local government, as well as being highly commended at the 2019 ComCover Awards for excellence in risk management.

Land Management and wildlife impacts

- Indigenous fire regimes - CSIRO has a growing track record of working in collaborative partnerships with Indigenous groups in the application of traditional knowledge to bushfire management. This includes the development of protocols for indigenous fire management partnerships through the Northern Australia Research Portal.

- Ecology - facilitated by long-term data streams, CSIRO's in-depth research on the dynamics of Australian ecosystems enables impacts of fire on biodiversity and ecosystem processes to be monitored and predicted, contributing to effective design of response and adaptation pathways. By utilising its world-renowned capability in macroecological modelling, CSIRO adds significant value to existing efforts to estimate the impact of the recent fires on biodiversity, and to identify priority areas of habitat to maintain as fire refugia. CSIRO's approach allows estimation of potential extinction levels, and priority habitat mapping, to be extended well beyond better-known vertebrate species, including plants and invertebrates – the so-called "other 99% of biodiversity".

Infrastructure and services

Training - a fire-fighter safety training package was created by Western Australia's Fire and Emergency Services Authority, Department of Conservation and Land Management and CSIRO. CSIRO fire behaviour scientists helped to develop a training course for fire behaviour analysts and provides regular training. These are the fire agency staff responsible for producing fire spread predictions during fire outbreaks, which are used for developing fire suppression strategies and issuing public warnings.

Fire Fighter Health - CSIRO has worked with fire agencies to assess fire fighter smoke and toxic air exposure while conducting for fighting activities. This work has led to changes in the operating procedures and personal protective equipment specifications for fire fighters across the nation.

Crop smoke exposure - CSIRO is working with various horticultural industries to monitor crop exposure to smoke to understand the potential for smoke taint of final products. This allow various industries to ensure product quality and limit the potential financial loss.

Survivability of cars trapped in firestorms - initiated by the NSW RFS and conducted by CSIRO scientists through the BNHCRC, this ground-breaking project evaluated the maximum heat load that a vehicle could face while remaining a safe haven for its occupants, both in terms of the air temperature and the air quality inside the vehicle. This research was used by AFAC to refine their policy documents on guidance for people caught in vehicles during bushfires.

House vulnerability assessment tool - developed for assessing assets in bushfire prone areas. This tool takes account of the building design, planning layout, surrounding elements (both vegetative and other built forms), weather conditions and human behaviour. It then predicts the likelihood of house loss, and the critical failure modes that cause house loss, providing guidance on how to most effectively reduce vulnerability to an acceptable level. The tool has been developed via the BNHCRC.

Revegetation - The ACT government used CSIRO revegetation options for burnt catchments following the 2003 ACT fires to plan rehabilitation efforts. The options drew on previous work on the impacts of bushfire on the long-term quantity of water in rivers and reservoirs, and the impacts following bushfires on water quality, sediment movement and soil erosion, vegetation rehabilitation, and rehabilitation of firebreaks and similar infrastructure. This fire burnt 160 sites in a national park and two nature reserves where CSIRO was already carrying out long term surveys of plant biodiversity. Tracking the recovery of these sites ten years after the bushfire revealed that plants were recovering well, even at sites where the bushfire burnt at high intensity. Species that were killed during the bushfire due to 100 per cent leaf scorch were able to re-establish because their seeds were protected in the soil or held in capsules on the plants.

Fire safe material - a number of materials have been developed including pre-cast concrete panel technology (HySSIL) that is fire resistant for four hours. These new materials can be utilised as fire-proof insulative building materials for constructing fire shelters, bunkers, sheds and panic rooms. Fire resistant coatings based on inorganic polymers have been trialled to provide improved fire protection for timber products used for construction and furniture. Ceramifiable polymers have been developed into cable products which can maintain performance and insulation under fire conditions of 1000°C for two hours, providing a critical increased window of operation in severe fire events.

CSIRO's Data Capabilities

Big Data used to decrease fire risk

Following the 2009 Victorian Bushfires Royal Commission, the State Government established a 10 year, $750 million Powerline Bushfire Safety Program (PBSP) to address two of the recommendations. As putting powerlines underground across the state would cost tens of billions of dollars, CSIRO began work to ensure that available funds would make the maximum impact. Using data on electrical infrastructure and ignitions starting from 2007, CSIRO was able to show that by carefully targeting PBSP investment, a large percentage of the bushfire risk from powerlines could be removed across the state.

Australian Community Climate and Earth System Simulator (ACCESS)

CSIRO and the BoM are contributing the development of a cutting-edge weather and climate modelling capability known as ACCESS. The weather forecasting component of ACCESS has contributed to increasing the accuracy of Australia's weather forecasts. CSIRO's insights into high intensity fire behaviour and technologies to assist in early warning are used by fire and emergency management agencies to reduce the likelihood and impact of catastrophic fires.

Victoria wide evacuability hotspots

Data61 is working with EMV, DELWP and the Vic DPC to develop a tool that will allow state wide assessment of evacuability for given fire weather conditions. Following validation and benchmarking, this tool is expected to be used on an operational basis at the state control centre in Victoria (expected to be ready for trials before the next bushfire season). The methodologies used to develop this capability is location agnostic and scalable so can be deployed nationwide. A range of bushfire evacuation projects have been undertaken in Victoria by Data61 in collaboration with RMIT University. These have contributed towards ongoing understanding of human behaviour and risks under such scenarios thereby leading to simpler and clearer evacuation messaging.

New data integration

Data61 has started developing data assimilation techniques that will allow integration of satellite data with bushfire predictive models such as Spark to create hybrid data driven and model informed predictions.

CSIRO's Bushfire Research Infrastructure

CSIRO Pyrotron

The Pyrotron facility, which opened in 2008, enhances research into bushfire behaviour by enabling observations of flame combustion, propagation and behaviour under controlled conditions. The Pyrotron allow CSIRO scientists to:

- understand the physical processes involved in the behaviour and spread of bushfires under a range of conditions;
- develop better models of fire behaviour to improve effectiveness and safety of fire-fighting;
- improve the design and execution of large-scale field experiments; and
- develop better understanding of likely emissions from bushfires in different fuel and burning conditions.

The facility enables close observation of combustion mechanisms under repeatable conditions not possible in the field, and is used to study:

- the mechanisms by which bushfires spread;
- thermokinetics – the chemistry of combustion in bushfires; and
- fuel consumption, emissions and residues under different burning conditions.

Vertical Wind Tunnel

CSIRO has the world's only 12.5m tunnel, developed to study fire brands in flight. It is used to explore the flight characteristics and combustion characteristics of fire brands that start spot fires.

Fire Testing and Assessment

A large-scale fire testing team at North Ryde use CSIRO's large-scale furnace to expose full scale building elements to BAL FZ conditions to meet testing (required by AS3959 Construction of buildings in bushfire prone areas) for many Australian building product manufacturers. The fire engineering and laboratory teams are also active in setting regulations and standards for fire performance of buildings, including active roles on Standards Australia and Australian Building Codes Board technical committees. This is a longstanding commitment to continuously improve the regulatory environment for building and construction.

CSIRO's Key Partnerships

CSIRO's scientists work with state land management, rural fire agencies and other research agencies to apply knowledge of bushfire dynamics to real events. These partnerships are the primary means that enable CSIRO to disseminate its bushfire research, for example via government departments and agencies for their use in engaging with the community.

Over the past five years CSIRO has worked with a range of government departments, private industry partners and research organisations to conduct bushfire research. These include: the BNHCRC, state fire authorities, local government councils, state department and agencies, federal departments, private companies, and universities.

CSIRO continues to work with state fire authorities to predict, manage and assess the impacts of bushfires. Predictions conducted by agencies using CSIRO's suite of model has enabled timely identification of potential impacts and issue of emergency warnings. For example, CSIRO is currently working with NSW RFS assisting with fire spread predictions and collecting and analysing wildfire data to improve the models for dry eucalypt woodland under a broad range of burning conditions.

CSIRO's Publications

International Journal of Wildland Fire

International Journal of Wildland Fire (IJWF) is the journal of the International Association of Wildland Fire (IAWF). It is published by CSIRO Publishing on the Association's behalf.

IJWF publishes new and significant articles that advance basic and applied research concerning wildland fire. Published papers aim to assist in the understanding of the basic principles of fire as a process, its ecological impact at the stand level and the landscape level, modelling fire and its effects, as well as presenting information on how to effectively and efficiently manage fire. The journal has an international perspective, since wildland fire plays a major social, economic and ecological role around the globe.

The journal's international credentials are reinforced by the diverse editorial team which comprises female and male researchers from Australia Canada, China, France, Italy, Portugal, Turkey, United Kingdom, and the United States.

The IAWF is an independent organisation whose membership includes experts in all aspects of wildland fire management. IAWF independence and breadth of global membership expertise allows it to offer a neutral forum for the consideration of important, at times controversial, wildland fire issues.

Other publications

CSIRO publishing has also published a number of books on the topic of bushfires:

- Community Bushfire Safety: the key social, political and human issues related to Australia's on-going bushfire scenario[10]
- Essential Bushfire Safety Tips[11]
- Landscape and Building Design for Bushfire Areas[12]
- Burning Issues: Sustainability and Management of Australia's Southern Forests[13]
- Flammable Australia: Fire Regimes, Biodiversity and Ecosystems in a Changing World[14].

[10] Handmer, J. & Haynes, K. (2008). "Community Bushfire Safety: the key social, political and human issues related to Australia's on-going scenario". *CSIRO Publishing*.
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[14] Ross, A., Bradstock, A., Gill, M., & Williams, R. (2012) "Flammable Australia: Fire Regimes, Biodiversity and Ecosystems in a Changing World". *CSIRO Publishing*.

Bureau of Meteorology (BoM)

The BoM provides prediction and monitoring services to save lives, protect infrastructure, improve public safety and quality of life, protect the environment, safeguard economic sectors, and increase socio-economic benefits.

The BoM has an in-house capability of around 130 research staff, significant additional expert capability in operational areas, and strong national and international partnerships, particularly the UK Met Office. More than 40 research and development staff work on numerical weather prediction (NWP), making the BoM the Australia's major NWP development agency. The output of the NWP supports many sectors in the Australian community, but particularly the fire agencies who are increasingly making use of large volumes of BoM weather forecast data.

The BoM has also recently developed a Research and Development Plan for 2020-2030. This plan is focused on addressing the evolving needs of Australian society. The BoM plans to:

- provide enhanced decision support and more timely forecast updates prior to and during high impact weather;
- provide more precise, accurate and reliable information, through increased exploitation and increase in the volume of observations;
- enable prediction of multi-hazard- events in a fully consistent manner through the comprehensive weather and climate modelling framework of ACCESS; and
- provide information including a characterisation of uncertainty from minutes to seasons, and for the coming decades, which is consistent across all time scales.

Much of this broader research activity is directly relevant to bushfires, such as better seasonal predictions. BoM staff have engaged closely with fire agencies to provide seasonal predictions prior to the start of, and throughout, the 2019-20 season.

Other research is more subtly related to bushfire, for example better modelling of water in the landscape leads to a better understanding of when vegetation is available to burn. The BoM engages with the broader fire community to ensure understanding of these factors and their efficient application to fire management.

Bushfire Relevant End-User Engagement and Collaboration

The BoM engages widely with fire agencies and with other research bodies to better provide fire-related weather intelligence to the Australian community. The BoM:

- collaborates with all fire agencies through AFAC and the Australia-New Zealand Emergency Management Committee to provide generational upgrades to the Australian Fire Danger Rating System;
- engages with AFAC working groups to direct bushfire weather and climate research and to develop and design services. The working groups include: predictive services; climate change; resilience; rural and land management; national warnings;

- is an active contributor and end-user of research conducted through the BNHCRC. Specific projects which The BoM has contributed to include land surface dryness, coupled fire-atmosphere modelling, severe weather events, and seasonal prediction of fire weather;
- collaborates with CSIRO on climate research (including through the National Environmental Science Program (NESP), smoke management and air quality, and the Spark fire simulator framework (through Data61); and
- engages with the University sector through PhD supervision (e.g. lightning ignition, bushfire mapping, event analysis, radar plume analysis), specific research projects (e.g. atmospheric dynamics research including impacts on fires, future prescribed burning opportunities), and collaborative climate research. The BoM also periodically partners with academic institutions for data collection and analysis of the effectiveness of warnings and the social and economic impact of significant weather events.

Case Studies of Collaborative Activities

The BoM routinely performs post-event reviews of significant events to further understanding of bushfire behaviour and how to best represent it in its modelling and service capabilities. The following are specific case studies of collaborative activities with the BNHCRC and AFAC.

- **Specific bushfire events:** event summaries have been produced for a number of bushfires including: Tathra, State Mine Fire, Margaret River, Waroona, Sir Ivan, Black Saturday, Canberra fires, Bunyip fires;
- **Forecasting Fire Behaviour and Spread:** including development of coupled fire-atmosphere modelling, and its use in analysing and understanding severe fire events; verification and validation of fire spread models; prototype forecasts for sub-seasonal to seasonal fire danger; and upgrading the Australian Fire Danger Rating System;
- **Landscape Modelling for Bushfire Prediction and Management:** soil moisture analysis system case studies for the State Mine Fir and Ballandean Fire, and utilisation of the AQRA for planning activities within the Queensland Fire and Emergency Services;
- **Forecasting Severe Fire Behaviour:** development and operational testing of a technique for forecasting fire generated weather, plume development, ember transport, and spot fire development; and
- **Key Bushfire Related Datasets:** incorporating fire climatology analysis, change in fire weather reports for NSW and QLD, and projected changes in dry lightning and fire danger indices.

Bureau of Meteorology Research Capability

Current bushfire relevant research themes and outcomes

The BoM conducts research in a number of areas with outcomes that are directly relevant to bushfire response, resilience and recovery. These research themes and outcomes include:

Table 2. Bureau of Meteorology Research Themes and Outcomes

Research Theme	Outcomes
Forecasting Fire Behaviour & Spread	• Information on fire behaviour based on environmental conditions. • Improve understanding of atmosphere-fire interactions. • Demonstrate potential for future operational physical modelling.
Forecasting Severe Fire Behaviour	• Provision of guidance on extreme pyro-cumulonimbus and other extreme fire behaviour risks, including in a changing climate.
Smoke and Air Quality Forecasting	• Development of an operational smoke forecast system being trialled in Victoria and NSW.
Landscape Modelling for Bushfire Prediction and Management	• National capability to assess fire danger spanning hours, days, weeks, months, seasonal to decadal.
Improving Decision Support & Impacts	• Small scale prototype for predicting impact of weather on infrastructure.
Impact of Climate Change	• Provision of guidance to operational emergency services agencies on extreme weather in a changing climate. • Monitoring observed changes in bushfire weather conditions over recent decades. • Modelling of future projected changes in extreme bushfire weather conditions. • Research on dry-lightning including based on observations over past decades, as well as future predictions based on modelling.
Effectiveness of public warnings	• Information on best practice fire weather warnings development, construction and dissemination.

The BoM also houses a number of research capabilities, whilst not explicitly bushfire themed, are critical cross-cutting research capabilities important in supporting bushfire response, resilience and recovery. These include:

- **Numerical Environmental Modelling** that covers hours to seasons, and includes atmosphere, hydrology and landscape modelling.
- **Satellite Applications** that derive environmental information from geo-stationary and polar orbiting satellites.
- **Radar Applications** that derive particle characteristic and wind fields from radar data.
- **Heatwave and smoke vulnerability** research which develops vulnerability profiles by modelling impacts from diverse health and related datasets.

Bushfire relevant research infrastructure, datasets, and technology

The BoM maintains major infrastructure and technology platforms and has access to other infrastructure through national and international partnerships.

The BoM maintains a prodigious archive of observations and gridded analyses (see Table 3 below) and forecasts of the environment to support both its research and operations. These data holdings are national assets and are largely shared with the research community through the National Computational Infrastructure (NCI).

Central to the BoM's research and national capability is the continued development and support of the ACCESS. This software is jointly developed by the BoM, CSIRO and the universities, and is built around models developed at the UK Met Office and the US Geophysical Fluid Dynamics Laboratory.

Table 3. Bureau of Meteorology Datasets

Bushfire specific datasets	
Gridded datasets	• Fire danger indices (12km) from 1990, with high resolution (1.5 km) over selected areas • Operational analyses and forecasts of Fire Danger Indices covering hours to seasons. • Fire Danger Indices under future climate scenarios. • Australian Fire Danger Rating System • Daily fire weather data (5km) from 1950 with automatic updates each day • Landscape flammability (fuel moisture) • Smoke analysis and forecasts to 36 hours
Observation datasets	• Satellite derived information on the landscape and smoke plumes. • Wind and smoke plume information from radars • Weather station data
Other datasets with relevance to bushfires	
Operational gridded data sets	• High resolution (1.5 km) analyses and ensemble forecasts to 36-hour lead time forecasts for forested areas of Australia. • National environmental analyses and ensemble forecasts for days to seasons. • Atmospheric analyses and forecast from international weather services. • International atmospheric reanalyses, such as ERA-5.
Operational observation data sets	• Geostationary and polar orbiting satellite data providing atmospheric and landscape information • Radar data • Hydrological station data • Weather • Aircraft and other third party data (including lightning)
Gridded Climate information	• Information from Australian Water Availability Project form 1910 • National, hourly fully atmosphere grids from the BoM Atmospheric Regional Reanalysis for Australia (BARRA) from 1990 • Sub hourly, high resolution (1.5 km) BARRA data for selected regions. • Daily hydrological and landscape information from Australian Water Resources Assessment (AWRA) from 1983.

Geoscience Australia (GA)

Geoscience Australia (GA) is Australia's preeminent public sector geoscience organisation. GA is committed to support Australia's capability to managing the impact of natural hazards, including bushfire. GA:

- develops an understanding of natural hazards and community exposure to support risk mitigation and community resilience;
- provides authoritative, independent information and advice to the Australian Government and other stakeholders to support risk mitigation and community resilience;
- maintains and improves systems for effective natural disaster preparedness, response and recovery;
- contributes to Australia's overseas development program;
- conducts post disaster surveys to understand the impact of an event and the level of recovery and resilience; and
- develops products that support hazard analysis and planning.

GA's Current Bushfire Capabilities

GA supports emergency managers' ability to respond to, and prepare for, bushfires, including providing satellite information to inform emergency managers and the general public of where bushfires have been occurring. GA also develops fundamental datasets and tools to model the potential impact of bushfire. In particular, GA:

- supports EMA to understand what is exposed to bushfires before, during and after events;
- develops and maintains fundamental datasets such as elevation, land cover and wind multiplier factors that help to evaluate the local influences on the speed of the fire front; and
- develops tools to evaluate and map potential exposure of buildings to bushfire, informing construction requirements and land-use planning.

Table 4 provides an overview of GA's specific bushfire related capabilities and technologies.

Table 4. Geoscience Australia Bushfire Research Capabilities

Technology/Tool	Focus
Australian Exposure Information Platform	The platform harnesses information from government agencies to provide an easy-to-see snapshot of what lies exposed in a particular locality, local government area, or other type of geography to assist emergency planners, responders and recovery agencies know who or what is in line of an impending hazard.
EM-LINK	EM-LINK is a catalogue of authoritative datasets available as web services, to provide easy access to relevant data for emergency service responders and recovery agencies.

Elevation Information System (ELVIS)	ELVIS is one of a number of platforms that GA operates for users to directly download topographic information, used by emergency management responders and recovery agencies.
Location Index	The Location Index is an in-development platform to enable policy analysts to more easily join up data that may have been collected using different methods (e.g. survey, earth observation) or on different geographies (local government area, postcode, or as imagery). It is a collaboration between GA, the Australian Bureau of Statistics, the Department of Agriculture, Water and the Environment, the Department of Industry, Science, Energy and Resources, and CSIRO.
Digital Earth Australia (DEA) Hotspots	DEA Hotspots currently provide the public and emergency managers with access to information on the location of hotspots (potential active fires) as detected by satellites. This information is updated every two to six hours, although there is a secure site that is only available to emergency managers that is providing updates every 10 minutes. Since December 2019 over 500,000 unique users have accessed this capability. DEA Hotspots also integrates DEA's 10 metre, daily colour imagery from the Copernicus Sentinel 2 satellites, sourced through the Copernicus Australasia Data Hub managed by DEA.
International Charter 'Space and Major Disasters'	On behalf of the Crisis Coordination Centre, GA manages activation of the International Charter 'Space and Major Disasters', which provides access to commercial and space agency satellite emergency tasking, and the Copernicus Emergency Management Service (EMS) which provides map products such as burnt area extents and input into impact assessments.
ArcGIS Toolbox	GA developed an ArcGIS Toolbox to spatially map the Bushfire Attack Level (BAL) in collaboration with Department of Fire and Emergency Services (WA). The Toolbox uses high-resolution (30-metre) elevation and classified vegetation data to calculate the BAL over large spatial extents. The Toolbox has been published as a free and open-source software project, available through GA's software repository.
Australian National Ground Segment Technical Team	GA, together with the BoM, CSIRO and the Western Australian Land Information Authority (Landgate) form the Australian National Ground Segment Technical Team (ANGSTT). ANGSTT works together to establish, operate and enhance a national network of ground stations that provides access to data generated by Earth observation satellites from a wide variety of government and potentially non-government sources.
Copernicus Australasia Regional Data Hub	GA, together with partner organisations, CSIRO, Queensland Department of Environment and Science, NSW Department of Planning, Industry and Environment, and Landgate (Western Australian Land Information Authority), operates the Copernicus Australasia Regional Data Hub which provides Australia with preferential access to the entire suite of data from the European Copernicus Sentinel satellites.

Australian Nuclear Science and Technology Organisation (ANSTO)

Bushfire Relevant Research Capabilities

ANSTO has a number of bushfire related research capabilities including, fine particle air monitoring, and understanding fire history through cave and lake systems.

Fine particle air pollution monitoring at ANSTO

For over 25 years, ANSTO has played a leading role in measuring and characterising fine particles in the air from a range of locations around Australia and internationally. ANSTO is considered to hold one of the most comprehensive fine particle datasets in the world. The knowledge generated by this work has been used domestically and internationally to improve air quality by guiding environmental protection measures. Measurement undertaken at ANSTO can detect more than 20 different elements, including those found in bushfire smoke.

Using nuclear instruments, such as the high-sensitivity particle accelerators located in ANSTO's Centre for Accelerator Science, scientists can determine elemental air pollution 'fingerprints', quantifying the sources and origin of air pollution with great accuracy. This includes analysis of fine particle pollution, generated naturally (e.g. from fires) or man-made (e.g. fossil fuel combustion), and consequent impacts on the environment and human health. ANSTO is a global leader in this field, and has assisted countries in the region and around the world to build their capabilities.

Understanding Fire History

Cave systems as archives of fire history

ANSTO has the capability to investigate the impact of wildfires and hazard reduction burns on the local environment, particularly the sub-surface hydrology, water quality and water balance (i.e. how much water is going to ground). For over 15 years, ANSTO has led long-term baseline monitoring of cave systems in NSW and Western Australia to investigate the impact of fires on limestone caves and surrounding area. This research project showed that there was no negative impact on the local environment as a result of hazard reduction burns, compared with the much greater impact observed as a result of previous bushfires.

A new study in conjunction with the University of New South Wales is currently being undertaken to assess chemical indicators in caves, which identify traces of previous fires. For instance, this will enable researchers to chart the frequency and intensity of fires that occurred over the last 1,000 years. By understanding the historical impact of bushfires on the environment (e.g. ecosystem resilience, groundwater water levels), these studies can help inform fire and land management practices including in reducing the impact of wildfires.

Lake systems as archives of fire history

ANSTO also undertakes research to understand how to develop realistic predictions of the environmental impact of climate change. The ARC-I project is focussed on how the southern

westerly wind belt (SWW), a dominant feature of the Southern Hemisphere's climate system, is responding to climate change. The SWW, the sole source of rainfall for much of southern Australia, is currently shifting southward. As a result, this region is experiencing below average rainfall and is subsequently prone to an increase in wildfire activity. By analysing lakes in Tasmania, this research seeks to build a historical record of this climate system to understand how it is influencing bushfires in the region.

End-User Engagement and Collaboration

ANSTO develops research projects with other academic institutes, researchers, PFRA's, industry and NGO's. The majority of these research projects and collaborations address both local research questions and national research priorities.

Specific collaborations related to bushfires and their impacts on the community include:

- Aerosol Sampling Program: ANSTO's comprehensive fine particle dataset contains information from a range of locations across Australia, and internationally. This includes data form approximately a dozen monitoring locations from Newcastle to Wollongong working with a number of organisations.[15] Results from ANSTO's Aerosol Sampling Program are used for environmental and regulatory reporting by ANSTO's clients. Thus, project requirements are established by reporting standards and client requirements.
- Collaborative ARC project with University of New South Wales to investigate the impact of bushfires and hazard reduction burns on the local environment by studying cave stalagmites.
- Collaborative ARC project with the University of Melbourne to produce high quality data on how the Southern Westerly Winds (SWW) respond to largescale changes in climate boundary conditions over multiple glacial-interglacial cycles.

ANSTO disseminates its research to the operational sector and policy makers in a number of ways including:

- by working closely with local councils by distributing regular datasets, providing insights into how various weather events impact the air quality and characterises it based on pollutants. These summary sheets are also made available online through ANSTO's data repository and the Australian National Data Service.
- through scientific publications and reports, as well as ongoing engagement with relevant government, industry and academic organisations.

[15] Organisations include: BHP, Alcoa, NSW Environmental Protection Agency, mining companies in the NSW Hunter Valley, Muswellbrook Shire Council, Botany Bay City Council, Newcastle City Council, Orica Australia, Bluescope Steel, and The University of Western Sydney.

Relevant Research Infrastructure and Technology

ANSTO has a range of mature technology platforms and landmark national research infrastructure that have capability to address a wide range of environmental processes, including bushfires. This includes:

- **The Centre for Accelerator Science** (CAS; an NCRIS supported facility). CAS provides users with access to a suite of tools including micro-analytical capabilities in one location that can be used for isotopic dating, air pollution studies, climate science, material science and life sciences studies. The unique aerosol particle characterisation capability at CAS enables ANSTO to undertake quantitative sampling and analysis, which is important in measuring air quality, but also provides an understanding of what is in the air and its sources (further information in the case study below). CAS also has the capability to study individual micron sized particles and undertake isotopic dating that enables researchers to develop historical climate and atmospheric records through the analysis of bedrock surfaces, caves, and sedimentary deposits, for example. ANSTO has used this type of technique to establish an understanding of, bushfire histories.
- **The Australian Synchrotron** located at ANSTO's Clayton campus in Victoria. The Synchrotron is able to support information gathering and crucial analysis on bushfire indicators in stalagmites. This enables us to extract paleoclimate information about changes of seasonal indicators throughout time. Similar to CAS, the Synchrotron also has micro-analytical capabilities to study micron and sub-micron particles.

ANSTO has a number of smaller platforms that can undertake other types of isotopic analysis, which are crucial for climate research, including in the reconstruction of recent fire histories and understanding the impacts of subsequent sediment transportation and soil erosion.

ANSTO's capabilities are available on a fee-for-service basis, and access to ANSTO's facilities is free when undertaken on a competitive basis by academics and research organisations across Australia and the world.

National Measurement Institute (NMI)

The NMI is the Australian Government's national authority on measurement, and plays an important role in the Australian economy by maintaining and regulating Australia's measurement system, developing and maintaining national measurement standards, and delivering world-class measurement products and client services. In addition, NMI regulates the use measurements for legal purposes, including trade.

NMI works with industry, tertiary institutes, researchers and government, as well as international partners to deliver measurement services and expertise to help inform the management of key social and economic needs and challenges. NMI houses specialised measurement capabilities in a number of areas:

- Physical measurement services
- Chemical and biological measurement services
- Testing and analytical services
- National administration of the trade measurement regulatory framework.

These measurement capabilities have been instrumental during the current and previous bushfire seasons. For example NMI is providing regulators and businesses with practical advice on testing approaches, and also providing testing services which may assist in assessing whether regulatory limits for contamination in water and agricultural products are being met, with consequences for meeting export requirements. Activities to date include:

- Conducting urgent testing for PFAS in response to concerns about around the use of fire retardants and potential run-off into drinking water catchments.
- Providing analytical services to state and Australian Government regulators on bushfire-related contamination (for example poly aromatic hydrocarbons; fire retardants; heavy metals) of water and agricultural produce, including meat, seafood, dairy, many agricultural crops, and organic or herbal products.
- This work will include analyses for the Agriculture portfolio's National Residue Survey involve the analysis over 18 months of beef and sheep samples from bushfire affected areas, for export compliance.
- Advising the dairy industry about the testing of dioxins and other contaminants following bushfires.
- Discussing potential collaborative academic research projects related to taint and flavour profiles in food and beverages.
- NMI's trade measurement inspectors are working with servicing licensees and businesses to support the re-establishment of fire affected trade measurement infrastructure, for example shop scales, fuel dispensers and weighbridges.

Defence Science and Technology (DST)

DST adopts a hands on approach to delivering science and technology in support of domestic and regional humanitarian relief as a result of natural and other disasters. This includes contributions to the current national bushfire response, resilience and recovery measures.

Current Bushfire Research Capabilities

DST capabilities currently being leveraged to support the bushfire crisis include:

- **Surveillance and Reconnaissance:** DST maintains a Defence Experimentation Airborne Platform (DEAP) capability for testing of surveillance technologies. This capability is currently being deployed to assist in the mapping of fire fronts and assessing route safety.
- **Operations Analysis:** DST has a large operations analysis and social science capability. This capability is currently being deployed across the bushfire crisis areas to support operational planning and the collection and analysis of observations and lessons.
- **Decisions Support:** DST maintains a significant command and control and decision support capability through the use of artificial intelligence and data fusion. The capability provides near real-time situation awareness for across the crisis areas.
- **International partnerships:** DST, through arrangements managed by the National Security Science and Technology Centre, has engaged with the US Department of Homeland Security to access relevant research and development (R&D) and their cross-agency disaster response systems. DST through Headquarters Joint Operations Command has engaged the US Pacific Command and established a Science and Technology Board to explore potential information and technology exchanges relevant to the current crisis.

Research Capabilities with Potential Applications to Bushfires

In addition, DST has active research programs involving a range of technologies with potential applications to bushfires and natural disasters in the future. These include:

- **Advanced Sensing:** electro-optic, infrared, hyper-spectral and synthetic aperture radar remote sensing that have applications for natural disaster events. DST also has active programs in space borne experimentation capabilities.
- **Computer Vision Processing:** automated processing of imagery and other data to extract objects and information from a wide range of imagery data types.
- **Social Media Analysis:** automated social media analysis that could be applied to the automated monitoring of public social media posts for ‘emergency situations’ and posts about related events of concern (such as fires, floods, storm damage, terrorist attacks).

- **Integrated Situational Awareness:** end-to-end Intelligence, Surveillance & Reconnaissance (ISR) systems that collect, process and disseminate information from airborne platforms to users. These capabilities could be extended to provide an integrated Situational Awareness product that could be made available to mobile users/phones.
- **Decision Support and information fusion:** DST can provide decision support and information fusion at the headquarters level (e.g. HQJOC) to integrate relevant data sources to prototype situational awareness displays to facilitate enhanced decision making. The capabilities which can be integrated include:
    - Blue Force and Incident Tracking – location of blue force platforms, assets and capabilities in relation to the incident sites;
    - Logistics and infrastructure – integration of data from relevant defence logistics information systems including platform [vehicle] availability, fuel, water, medical supplies and personnel, accommodation facilities and relevant infrastructure (e.g. airports, airstrips and heliports);
    - Evacuation and movement planning – analytical functionality to support evacuations and movements of personnel and materials; and
    - Quick integration of open source/unclassified and ad hoc Defence data sources.
- **Fire Protection:** research into materials and systems for protecting naval platforms from fire.

Australian Space Agency (ASA)

The ASA's purpose is to transform and grow a globally-respected Australian space industry that uplifts the broader economy, and inspires and benefits all Australians — underpinned by strong national and international engagement.

The ASA is responsible for whole-of-government coordination of civil space matters and is the primary source of advice to the Australian Government on civil space policy. Under this broad mandate, the Agency has six primary responsibilities:

- Providing national policy and strategic advice on civil space sector.
- Coordinating Australia's domestic civil space sector activities.
- Supporting the growth of Australia's space industry and the use of space across the broader economy.
- Leading international civil space engagement.
- Administering space activities legislation and delivering on our international obligations.
- Inspiring the Australian community and the next generation of space entrepreneurs.

Bushfire Relevant Coordination Activity

The Bushfire Earth Observation Taskforce will coordinate the analysis of the use of earth observation (from space) systems for bushfire risk management. Consultation will be with agencies from all levels of government, industry, and non-government organisations, and seek international input. With this feedback, Taskforce will submit a report to Minister Andrews by 31 March 2020.

National Environmental Science Program (NESP)

NESP is a long-term investment by the Australian Government to support evidence-based environmental management, policy development and decision making through environment and climate research. NESP projects deliver applied research through connecting scientists, policy and decision makers, industry, Indigenous people and communities.

NESP encourages a collaborative, multi-disciplinary approach to environment and climate research. Multiple partners (including research institutions, state agencies and NGOs) in each of the six NESP hubs deliver great depth and breadth of expertise that is available across the program. This includes significant expertise and research capability relevant to bushfire recovery and climate adaptation planning. This is well beyond the program's bushfire-specific projects, which are limited in number as it has not been an identified research priority to date.

NESP is currently contributing three scientists to the Wildlife and Threatened Species Bushfire Recovery Expert Panel that is advising the Minister for the Environment on response to the fire events, including priority emergency actions to support impacted animals, plants, and ecosystems, as well as medium and long term responses required to support the recovery of Australia's environment.

NESP is also supporting analysis of fire impacts and may be engaged to deliver applied science projects to assist recovery efforts. Four of the six NESP Research hubs have conducted research projects with fire-related elements.

Clean Air and Urban Landscape Hub

The Clean Air and Urban Landscapes Hub's research portfolio includes urban air quality. This includes examining the health impacts of pollution from fires, building on research that advanced air quality measurements and models in Western Sydney. It will build a more complete picture of the potentially toxic components of wood smoke.

Threatened Species Recovery Hub

The Threatened Species Recovery Hub research is informing on-ground responses to reduce threats and promote recovery of threatened species; and build a better understanding of their status, threats and management options.

The Hub's research includes many projects that include fire as a disturbance, threat and management tool for threatened species and ecological communities. The Hub has a range of projects nationally that address fire management and fire regimes and their effects on biodiversity.

Three Threatened Species Recovery Hub members, Professor Sarah Legge, Professor John Woinarski and Dr Libby Rumpf are part of the Expert Panel for Wildlife and Threatened Species Bushfire Recovery convened by the Threatened Species Commissioner, Dr Sally Box.

Earth Systems and Climate Change Hub

The Earth Systems and Climate Change Hub conducts research to improve our understanding of extreme weather events, including extreme fire weather. This knowledge is improving projections of how these extreme events will change over time and enabling effective evidence-based planning.

The Hub's brochure about the relationships between climate change and bushfires has been used by governments, the media and community in recent months.

Northern Australia Environmental Resources Hub

The Northern Australia Environmental Resources Hub's research provides practical solutions to support the region's natural and cultural environments.

The Hub's research includes fire management of savanna landscapes, including Indigenous knowledge, and as it relates to feral animals and invasive flora. The Hub's work on fire has a focus on management of savannah landscapes.

Other relevant activity

The vastly interdisciplinary nature of research capability that would be relevant to bushfire response, resilience and recovery makes a comprehensive mapping of all research activities difficult. There will be relevant activities which this mapping exercise has not included.

The following is an initial list of research activities which, although not exclusively committed to bushfire research, should be considered in an overall mapping exercise of Australian research capability in bushfire response, resilience and recovery.

Rural Research and Development Corporation

Australia's Rural Research and Development Corporations (RDCs) have helped drive agricultural innovation since 1989. They allow Australian government and primary producers to co-invest in R&D. This benefits industry and regional communities.

There are currently 15 RDCs including five Commonwealth statutory bodies and ten industry-owned companies (IOCs). All RDCs manage R&D services while most IOCs also provide other industry services, mainly marketing.

The RDCs invest in R&D and innovation to improve the profitability, productivity, competitiveness and long-term sustainability of Australia's primary industries. These include agricultural, fishing and forestry industries.

The Australian Government has developed farmer-oriented priorities to target funding to enable issues of common concern across agriculture, fisheries and forestry industries to be explored in a coordinated manner. The Rural Research, Development and Extension (RD&E) Priorities are: advanced technology, biosecurity, soil, water and managing natural resources, which includes a focus on improving resilience to climate events and impacts; and adoption of R&D.

RDCs are investing funds into climate related research, including projects which relate to climate resilience, adaptation and mitigation. This include topics relating to emissions reduction, seasonal forecasting, cover crops for water infiltration and reduced evaporation, and heat tolerant genes.

SmartSat Cooperative Research Centre

The SmartSat CRC is a consortium of universities and other research organisations, partnered with industry that has been funded by the Australian Government to develop know-how and technologies in advanced telecommunications and Internet of Things (IoT) connectivity, intelligent satellite systems and Earth observation next generation data services. The impact of this research will be to develop intellectual property and specialist industry expertise that will spawn new businesses, create export economic value and generate new high-tech jobs for all Australians.

The SmartSat CRC has three main research themes:

- **Advanced Communication Connectivity and IoT Technologies** to produce new technologies, signal processing algorithms and communications architectures to ensure that Australia meets its needs for universal digital connectivity and help create new commercial opportunities.
- **Advanced Satellite Systems, Sensors and Intelligence to capitalise on** increased opportunities that exist for significant processing and Artificial Intelligence (AI) techniques to be out on-board satellites so that some advanced analytics are carried out on-board satellites to enhance the efficiency and effectiveness of data gathering and analysis.
- **Next Generation Earth Observation Data Services** to use AI, deep learning and other advanced analytics techniques to build analytical models and AI systems that can analyse satellite generated data and provide insights or trigger actions in real time.

Other Cooperative Research Centres (CRCs)

There is a diverse set of CRCs supported by the Australian Government, many of which will have capabilities relevant to bushfire resilience, response, and recovery.

The CRC Program supports industry-led and outcome-focused collaborative research partnerships. There are two streams of funding under the program: CRCs and CRC Projects (CRC-Ps). CRCs are long term collaborations of up to 10 years with no maximum limit to funding. CRC-Ps are short-term collaborations of up to three years with a maximum of $3 million in funding.

CRCs and CRC-Ps commonly collaborate with industry, universities and research institutions; businesses from multinational corporations to small and medium enterprises; governments at all levels; not-for-profit organisations and community associations. The CRC Program has strong international collaborations with many international participants.

University Sector

The Australian university sector has extensive capability in bushfire-related research including disaster and resilience research, research examining the health-related effects of bushfires, and climate change and environmental research.

Key research institutes, centres, and hubs in these fields facilitate the development of a strong evidence-base which enable universities to provide expertise to assist with bushfire resilience, recovery, and response in the short, medium, and long term. A key function of these hubs is their collaboration with end-users responsible for managing bushfires and other disasters, such as firefighters. Analysis, expertise, and innovation drawn from collaboration with key stakeholders in the field is vital to ensuring Australia's bushfire science and research capabilities are current, useful, and applicable to Australia's unique conditions. Experts and researchers from these hubs are also important contributors to Australia's bushfire policy development. For example, select experts from Australian universities were participants at Minister Andrews' Bushfire Science Roundtables in early 2020.

As part of this mapping project, universities were invited to provide input through the five major university peak bodies.[16] The input received from universities about their research hubs, centres, institutes, and groups as it pertains to bushfire resilience, recovery, and response is provided as a complete list in Attachment B. The following sections summarise this appendix. It is beyond the scope of this mapping project to assess the impact or quality of the hubs listed, rather the aim is to provide an overview of Australia's research capability at universities.

In order to map hubs of expertise in Australia, universities were not asked to provide information about specific individual experts researching topics related to bushfires. Such individual experts were advised to ensure their details were up to date on CSIRO's Expert Connect platform, a live beta directory of over 70,000 Australian research academics.

A selection of major interdisciplinary research projects is provided in Attachment B, however it is important to note that most Australian universities have at least one research collaboration with the BNHCRC. The BNHCRC is an important and vital hub for Australian bushfire research, and information on all the various university associated research projects is publicly available on their website. For this reason, and due to the sheer scale of research in Australia, the following section does not examine specific research projects.

[16] Universities Australia, Group of Eight, Regional Universities Network, Innovative Research Universities, and Australian Technology Network.

Bushfire Specific Research Hubs at Australian Universities

There are three bushfire specific institutes or hubs at Australian universities. As is the case in all fields, university research hubs have a role to play in ensuring research is as current and applicable as possible. The knowledge and technology drawn from these hubs has been influential in the current bushfire crisis.

NSW Bushfire Risk Management Research Hub

The NSW Bushfire Risk Management Research Hub (the Hub) is a collaborative venture led by University of Wollongong's Centre for Environmental Risk Management of Bushfires, partnered with the University of Tasmania, Western Sydney University and the University of New South Wales. Funded by the NSW Department of Planning, Industry and Environment (2018-2021), the Hub brings together researchers, NSW fire management agencies, and public land managers in a collaborative research effort to improve fire management strategies and reduce the risk bushfires pose to people, property, and the environment.

The structure of the Hub was set up for policy makers, planners, and managers to work alongside academics, so findings can be shared, and significant outcomes can be applied without delay.

The Hub currently has six major projects:

- dynamic mapping and analysis of fire regimes
- fuel, flammability and carbon dynamics
- emissions and air quality
- fire regime thresholds of potential concern for threatened biodiversity
- health and social benefits of Indigenous fire management
- optimal fire management using past and present knowledge.

Fire Centre Research Hub

Based at the University of Tasmania, the Fire Centre Research Hub is a centralised, transdisciplinary research hub focused on enabling place-based solutions to the fire crisis through community engagement and the creation and dissemination of research, education, outreach, and practitioner tools.

Representing more than 119 members (61 researchers and 58 partners), the Fire Centre integrates knowledge in health, ecology, physics, sociology, geography, computer science, economics, biology, business, law, hydrology, atmospheric science, disaster management and chemistry. The Fire Centre translates research for community outcomes with close stakeholder engagement with NGOs, societies, industry (hydroelectric, tourism, forestry, agriculture and mining), and federal, state and local government.

Darwin Centre for Bushfire Research

Located within the Research Institute for the Environment and Livelihoods at Charles Darwin University, the centre delivers applied fire management research and training opportunities to land managers in northern Australia, South East Asia, Africa and South America. The centre applies field sampling, spatial analysis, and Indigenous knowledge to develop 'savanna burning' methods, including greenhouse gas emissions reduction and carbon sequestration.

Other Relevant Research Capabilities

In addition to these research institutes/hubs, there are also research groups with a focus on bushfires at four Australian universities:

- **Bushfire and Behaviour and Management Group** at the University of Melbourne;
- **Pyrogeography and Fire Science Lab** at the University of Tasmania;
- **Bushfire Research Group** at UNSW Canberra;
- **Bushfire Research Alliance** at Western Sydney University; and
- **Climate Futures Research Group** at the University of Tasmania.

Several universities also offer courses with a focus on bushfire, disaster, or emergency management. These courses range from short courses or modules embedded within broader degrees, to four-year bachelor degrees and highly specialised master degrees. Graduates from these courses enter the workforce equipped with specialised skills to manage emergency cycles, minimise bushfire risk, and maximise bushfire management. Graduates from some of these specialised courses may be eligible to apply for accreditation under the Bushfire Planning and Design (BPAD) scheme[17] administered by the Fire Protection Association Australia.

In addition to the centralised knowledge at bushfire-specific hubs, institutes, and groups, Australian universities have extensive expertise in bushfire-related topics in a range of fields. This is due to the cross-cutting nature of bushfires in the Australian landscape and the interaction between bushfire science and technology with other fields such as health, engineering, agriculture, biology, ecology, and social sciences, among others. The following subsections summarise Australia's university research capabilities in disaster preparation and response, climate and environment, and bushfire health-related research. These areas were selected for analysis due to their close links to bushfire resilience, response, and recovery.

Disaster Preparation and Response Groups

Disaster preparation and response groups at Australian universities have strong multi-disciplinary capabilities in a range of natural disasters fields, including bushfires, earthquakes, tsunamis, droughts, floods, and cyclones, among others. While all these

[17] The BPAD scheme was first developed and implemented in 2006 in response to demands from the community, government and industry to establish a recognition program for bushfire planning and design (BPAD) Accredited Practitioners to assist the community undertaking development on land subject to bushfire impact. The Scheme was designed for individuals (practitioners) delivering bushfire assessment, planning, design and advice services. It accredits practitioners who meet criteria based on specific accreditation and competency requirements, including a detailed knowledge of and ability to practically apply the relevant planning, development and building legislation and policies, the Building Code of Australia and Australian Standard AS3959 Construction of buildings in bushfire prone areas.

hazards are different in nature, lessons learned from elements of their management and response are transferable.

There are a number of key hubs and institutes focused on disaster preparation in Australian universities. Further detail on of the following, including their specialities, is provided in Attachment B:

- **Asia-Pacific Natural Hazards and Disaster Risk Research Group** at the University of Sydney
- **Australasian RISC Research Centre** at Charles Darwin University
- **Centre for Disaster Management and Public Safety** at the University of Melbourne
- **Centre for Disaster Studies** at James Cook University
- **Centre for Social Impact** at Swinburne University
- **Charles Sturt Disaster and Community Resilience Research Group** at Charles Sturt University
- **Disaster Resilience Research Group** at the University of Tasmania
- **Future of Work Institute** at Curtin University
- **Humanitarian Engineering Program** at the University of Sydney
- **Institute for Integrated Research on Disaster Risk Science** at the Australian National University
- **Monash University Disaster Resilience Initiative** at Monash University
- **Disaster Research and Response Network** at RMIT University
- **Risk and Community Safety Research Program**, a collaboration between RMIT University, Australian National University and Emergency Management Australia
- **Tactical Research Unit** at Bond University
- **Thrive Lab, Emergency and Disaster Management** at Charles Darwin University
- **Torrens Resilience Institute** at Flinders University.

Climate and Environment Institutes and Hubs

Considering the myriad of environmental and climate factors which contribute to bushfires in Australia, and the wide impact bushfires have on our environment, research hubs focused on climate and the environment are important actors in the bushfire research space. These research hubs produce research in a wide range of fields including forests and fire, sustainable development, climate change, ecology, species management, biodiversity, human responses to long-term environmental change, geoscience and soil management, agriculture, and earth systems.

National Climate Change Adaptation Research Facility

From 2007 the Government invested $56 million in the National Climate Change Adaptation Research Facility (NCCARF). NCCARF is currently part of Griffith University.

From this investment NCCARF produced an extensive array of adaptation research in many areas such ecosystems, infrastructure and planning. The facility also produced tools such as CoastAdapt, which gives councils and business accessible information on climate risks in the coastal zone.

NCCARF completed a range of research and synthesis materials on bushfires including a synthesis summary on bushfires.[18] The summary includes material on the nature and impacts of bushfire, a synthesis of research findings around the impacts of and adaptation responses to increasing bushfire evens, and a summary of how this new research knowledge might help address key adaptation policy challenges informed by end-user knowledge.

Bushfire Health Related Research Institutes and Hubs

Similarly to climate and environment issues, bushfires have a range of health and medical impacts and consequences. This includes both immediate health issues, such as burns management, as well as longer term impacts of bushfires, such as prolonged smoke exposure. There are a range of research hubs examining the health-related effects of bushfires at Australian universities. These hubs produce research in a wide range of fields including air quality, respiratory illness, mental health, trauma care, and burn injury.

Other Relevant University Institutes and Hubs

As part of the initial request for input, some universities provided information on their capabilities related to wildlife and technology research. Attachment B includes this information, however given the initial request was limited in scope, this list is unlikely to capture all of Australia's university capabilities in this area. Attachment B may be expanded in the future. There are a range of research hubs exploring the impact of bushfire on Australian wildlife and their environments, as well as the treatment and recovery of wildlife species affected by bushfires. Technology-focused research hubs develop tools and technologies that can be employed before, during, and after bushfires to better inform and assist response.

[18] https://www.nccarf.edu.au/sites/default/files/attached_files/Synthesis_Summary_Bushfires_web.pdf

Bushfire Related Competitive Grant Funding

An analysis of Australian grant funding outcomes is one lens to assess the research specialisation and capabilities in a particular area. Based on this premise, an analysis of the funding outcomes from Australia's key grant funding agencies have been conducted by the relevant agencies using a keyword search.

Whilst this type of analysis can provide some insights into the natural prioritisation of bottom-up funding in Australia towards bushfire related research, it is important to note that the results of the analysis depend critically on the choice of keywords used. As such it should be interpreted with care as it is possible that keywords used may not capture all in scope projects. Similarly, it is possible that some projects extracted in the analysis are not truly related to the subjects being investigated.

Australian Research Council (ARC)

The ARC grants are competitively awarded to individuals, research teams and large scale centres through two broad arms under the National Competitive Grants Program:

- **Discovery Program** with a primary focus on supporting individuals and small teams; and
- **Linkage Program** which creates links outside universities, with industry and other partners and stimulates research impact.

As these are competitive investigator-led research grant program, the ARC does not determine the area of research in most cases, except for the smaller schemes such as the Special Research Initiative scheme.

ARC Funded Projects Related to Bushfires

The ARC have undertaken an analysis of ARC-funded projects from 2002 to 2020 (data current as at 17 January 2020). The data were extracted from the ARC database using 'bushfire' and 'forestry fire' as keywords to search project title, abstract (summary), and national benefit text (impact statement) provided in each project application.

ARC have provided the results of their analysis at Attachments E and F. The results include information on Administering Organisation and Partner Organisation (for linkage projects) to provide some insight into universities and partner organisations that undertake bushfire related research. The data are to be interpreted with care as it is possible that the keywords used might not capture all in scope projects.

Since 2002, there have been 111 ARC-funded projects with 'bushfire' or 'forestry fire' keywords. These projects range across a variety of topics and ANZSRC fields of research, including in mathematics, ecology, climate change, artificial intelligence, structural engineering, palaeoecology, communications, fire management, and health. Almost all of the administering organisations are Australian universities.

The projects have been funded under various schemes including the ARC Future Fellowships, Australian Laureate, Discovery Early Career, Discovery Indigenous, Discovery

Projects, Federation Fellowships, Linkage Infrastructure, and Linkage Projects. Funding per project ranges from $14,000 to $5,625,165 with the total funding from 2002-2020 equalling $49,092,021.

Current ARC Projects Relating to Natural Disasters

In addition to an analysis of bushfire related funding outcomes, the ARC has undertaken an analysis of ARC active projects relating to the broader topic of 'Natural Disasters' (data current as at 10 January 2020). This analysis is much broader than bushfire and only includes projects that are currently active.

There are currently 206 active ARC projects related to natural disasters (see full list of results at Attachment F). Projects cover all states and territories and topics include bushfires, droughts, earthquakes, storms, floods, and volcanic eruptions. The earliest of these projects began in 2013 and all projects are administered by an Australian university. Funding allocated ranges from $115,000 to $4,308,668, with the total funding for all active projects equalling $96,256,081.

ARC Centres of Excellence

The ARC Centres of Excellence are prestigious foci of expertise through which high-quality researchers maintain and develop Australia's international standing in research areas of national priority.

Through the ARC Centres of Excellence, significant collaborations occur between universities, publicly funded research organisations, other research bodies, governments, and businesses in Australia and overseas.

The following are descriptions of ARC Centres of Excellence with relevance to bushfires and natural disasters, more broadly. However, it is important to note that other Centres of Excellence are likely to have capability relevant to bushfire resilience, response and recovery.

ARC Centre of Excellence for Climate Extremes

This Centre aims to transform understanding of past and present climate extremes and revolutionise Australia's capability to predict them into the future. Climate extremes cost Australia up to $4 billion a year and will intensify over coming decades. This Centre's blue-sky research will discover processes that explain the behaviour of present and future climate extremes. It will use its researchers, data, modelling, collaboration, graduate program and early career researcher mentoring to transform Australia's capacity to predict climate extremes. This research is expected to make Australia more resilient to climate extremes and minimise risks from climate extremes to the Australian environment, society and economy.

The Centre is funded for $30.05 million over seven years, and is hosted at the University of New South Wales directed by Professor Andrew Pitman.

ARC Centre of Excellence of Australian Biodiversity and Heritage

This Centre will create a world-class interdisciplinary research program to understand Australia's unique biodiversity and heritage. It will track the changes to Australia's environment to examine the processes responsible for the changes and the lessons that can be used to continue to adapt to Australia's changing environment. This Centre will support connections between the sciences and humanities and train future generations of researchers to deal with future global challenges and inform policy in an interdisciplinary context.

The Centre is funded for $33.75 million over seven years, and is hosted at the University of Wollongong directed by Professor Richard Roberts.

ARC Training Centres

The ARC's Industrial Transformation Training Centres scheme fosters close partnerships between university-based researchers and other end users to provide innovative Higher Degree Research (HDR) and postdoctoral training, for end-user focused research industries that are vital to Australia's future.

The objectives of the Industrial Transformation Training Centres scheme are to:

- foster opportunities for Higher Degree by Research candidates and postdoctoral fellows to pursue industrial training;
- drive growth, productivity and competitiveness by linking to key growth sectors;
- enhance competitive research collaboration between universities and organisations outside the Australian higher education sector; and
- strengthen the capabilities of industries and other research end-users in identified Industrial Transformation Priority areas.

The following ARC Training Centres are relevant to bushfires.

ARC Training Centre in Fire Retardant Materials and Safety Technologies

The ARC Training Centre in Fire Retardant Materials and Safety Technologies brings together 39 Chief and Partner Investigators from 27 organisations from Australia, Hong Kong, China, UK and USA to provide high quality training of 19 industry-focused fire researchers. Through joint ARC Discovery, Linkage, and other industry-supported projects, the five Australian universities of this Training Centre[19] have established strong collaborative research track records in flame retardant materials, performance of structures under fire, and modelling of the propagation process of fire.

ARC Training Centre for Forest Value

The ARC Training Centre for Forest Value produces industry-ready graduates and postdoctoral fellows with broad perspectives of the forest industry. Working closely with eight forestry industry and NGO partners, the Centre has research strengths across the full

[19] University of New South Wales, RMIT University, Western Sydney University, University of Southern Queensland, and the University of Adelaide.

forestry value chain from growing trees for production and restoration to producing quality wood products.

The Centre for Forest Value major Research Theme *"Sustainable Forest Production and Certification"* integrates forestry into a wider landscape context by considering ecosystem services, forest certification, business diversification and the role that tree planting can have in agricultural and restored landscapes under changing climates (including in the face of fire risk).

A key strength of the Centre for Forest Value is understanding genetic variation for key tree traits that mitigate against risks (e.g. heat stress and drought) – an important factor in determining eucalypt (and hence forest) adaptation to changing climates; and considering impacts of forestry and fire disturbance on biodiversity and ecosystem function. End-users are intimately involved in designing and conducting research projects through day to day interactions between industry partners and Centre for Forest Value staff and students.

Outcomes are directly disseminated to the operational sector through formal CFV Advisory Committee Meetings (chaired by industry), fortnightly research colloquia with industry partners and annual Centre industry roadshows. Key infrastructure utilised by the Centre for Forest Value includes the TERN Oz Flux Tower at the WARRA field site in Southern Tasmania.

ARC Training Centre Data Analytics for Resources and Environments (DARE)

The ARC Training Centre DARE was launched in 2019 to develop and deliver crucial data science skills and new ways for Australia to become better decision makers of our natural resources.

The centre brings together a diverse field of expertise. Researchers from The University of Sydney will collaborate with colleagues at The University of New South Wales and The University of Western Australia as well as collaborate with a range of other partners from across the sector: the Western Australian Biodiversity Science Institute; GA; IAG Insurance; McKinsey & Company; Natural Resources Commission; Newcrest Mining Ltd; NSW Treasury; Office of Environment and Heritage NSW; Water NSW; The Alan Turing Institute and the University of Leeds, UK.

Impact Studies from the 2018 Engagement and Impact Assessment

In 2018 the ARC conducted a national assessment of Australian university research which assessed how well university researchers engage with the end-users of their research, and how well universities are translating their research into economic, social, environmental, cultural and other impacts.

In the 2018 Engagement and Impact Assessment, there were 637 units assessed for Impact. 18 impact studies had the keyword 'bushfire' in the content of the narrative. Of these, eight received a 'high' rating (see Table 5). 'Bushfires' were most commonly mentioned in the Environmental Sciences discipline.[20]

[20] Full details of these impact studies can be downloaded from the data portal on the ARC website at https://dataportal.arc.gov.au/EI/Web/Impact/ImpactStudies.

Table 1Table 5 shows eight highly rated impact studies from the 2018 Engagement and Impact Assessment.

Table 5. Highly Rated Impact Studies from the 2018 Engagement and Impact Assessment related to 'bushfire' research

Institution	Field of Research	Title of Impact Study
Charles Darwin University	05 Environmental Sciences	Developing better land management systems for northern Australian environments
La Trobe University	05 Environmental Sciences	The burning question: how do we manage fire for biodiversity conservation in Australian landscapes?
Queensland University of Technology	09 Engineering	Aircraft Flight Assist System for the ROAMES network infrastructure management system
Southern Cross University	16 Studies in Human Society	Research into practice: Generating knowledge that supports children, young people and adults to understand and adapt to experiences of loss and grief in their lives
The University of Western Australia	14 Economics	INFFER - applying economics in environmental management
University of Tasmania	05 Environmental Sciences	Protecting People and Nature from Catastrophic Wildfire
University of Tasmania	ID Interdisciplinary	Climate Futures for Tasmania
University of Wollongong	05 Environmental Sciences	Protecting people, property and the environment with research for effective management of bushfire risk

National Health and Medical Research Council (NHMRC)

The NHMRC have undertaken an analysis of NHMRC funded research on the health impacts of bushfire and related topics between 2010 and 2019 (data current as at 22 January 2020). The data were extracted from the NHMRC database using 'bushfire', 'occupational health of firefighters', 'air pollution', and 'burns' as research topic areas of interest.

NHRMC research expenditure on health impacts of bushfires and related topics are shown at Attachment D. Between 2010 and 2019, the NHMRC has invested:

- $12,276,590 on air pollution related research
- $8,018,156 on burn related research
- $4,569,123 on bushfire related research
- $354,728 on research related to the occupational health of firefighters.

Note – Totals for different research topics cannot be added together as individual grants may be allocated to more than one research topic.

Important Considerations

The majority of NHMRC funding is investigator-initiated and is not directed by the NHMRC to any specific disease, health or research topic. The subject matter of the each application is determined by the applicant. A proportion of NHMRC funds is directed to specific topics primarily through the Targeted Calls for Research[21] and International Collaboration schemes,[22] or priorities identified in the NHMRC Corporate Plan.[23]

Funding decisions are the outcome of a competitive process that relies on the collective judgement of independent peer reviewers. There is strong demand for NHMRC funding and the process is very competitive, so not all high quality research proposals are able to be funded.

For reporting purposes, NHMRC classifies applications against disease, health and research topics based on information provided at the time of application including an application's title, keywords, media summaries and other research classifications where appropriate.

This process results in the classification of applications to more than one topic. NHMRC does not apportion funding when more than one topic is indicated and the full value of the grant is attributed.

Relevance to the topic may be either a direct focus or a broader focus such as a longer term potential benefit. The resulting datasets may include a broad range of research from discovery science through to clinical research, health services and public health research.

[21] National Health and Medical Research Council. "Targeted and Urgent Calls for Research". *National Health and Medical Research Council.* Retrieved from: https://www.nhmrc.gov.au/funding/find-funding/targeted-and-urgent-calls-research
[22] National Health and Medical Research Council. "Fund collaborative health research". *National Health and Medical Research Council.* Retrieved from: https://www.nhmrc.gov.au/funding/fund-collaborative-health-research
[23] National Health and Medical Research Council. "NHMRC's strategic priorities". *National Health and Medical Research Council.* Retrieved from: https://www.nhmrc.gov.au/about-us/publications/nhmrc-corporate-plan-2019-20#toc__49

AusIndustry Grants

AusIndustry is the Australian Government's principal agency for delivering assistance, programmes and services which support industry, research, and innovation.

As part of the consultations for this mapping project, AusIndustry has provided a list of departmental customers who have bushfire recovery/defence capabilities that have been referred by the Entrepreneur's Programme (see Table 6).

Table 6. AusIndustry Grants

Company/ Grantee/ Customer	**Product Service**	**Aid Category**
NXT TEC Ltd (NXT Global)	NXT has developed a pre-fabricated building system which is easy to assemble, and aims to deliver large-scale building projects with efficiency. Essentially, they have created flatpacks for large-scale construction e.g. a house you can assemble from a flatpack.	Temporary Shelter
Helitak Fire Fighting Equipment Pty Ltd	Helitak have designed and developed a retractable underbelly water tank for use on the Super Puma model helicopter. The Super Puma has not been equipped for aerial firefighting from the production line, so this technology enables a very common model of helicopter to quickly adapt to the needs of the emergency services in providing additional aerial firefighting capacity where required.	Firefighting
BenchOn	Pro Bono Fire Recovery Business Portal where companies can register to provide their available personnel at no cost to help out in fire recovery projects. This would be completely free with BenchOn taking no commissions or subscriptions. It is based off an IP built BenchOn which can be tailored slightly for the circumstance and provide it to the Recovery Agency to manage.	Rebuilding
Fortitude Frames Pty Ltd	Fortitude Frames provide constructural design solutions to withstand natural disasters, focussing on fire-proof homes. Fortitude manufacture specially designed steel trusses that are used to construct homes that can withstand fires and subsequent radiation of 40kw/sq, and temperatures reaching 1200 degrees.	Rebuilding
Fire Response Pty Ltd	Fire Response are a supplier of industry standard firefighting equipment to emergency services.	Firefighting
Close Comfort Pty Ltd	Close Comfort manufacture and provide their own brand of portable air-conditioning units. They have developed small, portable air-con units that run off very low power, and are quite inexpensive.	Supplies (other)

National Collaborative Research Infrastructure Strategy (NCRIS)

NCRIS supports climate change research by providing observational data and modelling and visualisation tools for researchers to use through a number of research infrastructure investments.

Terrestrial Ecosystem Research Network (TERN) [24]

Collects critical ecosystem observations and makes the resulting data available, with modelling tools, to allow research into how ecosystems are responding to environmental pressures. It provides infrastructure spanning ecosystem science including:

- collection, storage and sharing infrastructure, such as instrumented towers, plot networks for flora and fauna surveys, and real-time environmental sensors and data streams;
- 'soft' infrastructure, such as nationally standardised methods, ways of collecting, managing and discovering data, and capacities for synthesis and policy translation; and
- data for use in bushfire research.

Integrated Marine Observing System

Captures a range of ocean variables and makes it available with modelling tools, including temperature which is important in weather and climate modelling.

Atlas of Living Australia

Collects and makes available biodiversity data to support national and international users demanding timely access to Australian biodiversity data and gives researchers the ability to easily overlay and integrate known species data with other critical data maps types such as current and future climate, habitat, fire, and water availability (both past and present).

National Computational Infrastructure (NCI)

A research supercomputer that supports research in a number of fields, including climate change adaptability and climate modelling.

Bioplatforms Australia

Contributes to understanding species change at the genetic level in areas affected by mining rehabilitation and bushfires. This technology is also likely to be used in captive breeding programs to repopulate native species in the wild.

[24] TERN is investigating damage to its monitoring equipment following the bushfires in Western Australia, South Australia, Victoria, New South Wales and Queensland. The Department of Education, Skills and Training is working with TERN on the restoration of its monitoring network.

Philanthropic Bushfire Capabilities in Australia

Many philanthropic organisations are providing support relevant to bushfires, however this mapping work highlights one planning significant investments directly relevant to research and technology capability.

Minderoo Foundation

The Minderoo Foundation is an Australian philanthropic organisation with a mission to arrest unfairness and create opportunities to better the world. Minderoo Foundation has $1.5 billion committed to a range of global initiatives including the Fire Fund (see below), eliminating cancer, ending modern slavery, and eliminating overfishing and marine pollution.

Fire Fund

Minderoo Foundation's Fire Fund is a $70 million fund for three distinct bushfire areas – response, recovery, and resilience.

As part of the response phase, Fire Fund is mobilising specialised volunteers to support clean up and recovery efforts in NSW, Victoria and South Australia, covering their travel and accommodation expenses. As part of the recovery phase, Fire Fund is focussing on direct, on-the-ground support for affected communities, collaborating with organisations such as the Australian Red Cross, the Salvation Army and Conservation International as well as the Australian Government.

Minderoo Foundation's Wildfire and Disaster Resilience Program (WDRP) was launched in April 2020, assisted by $50 million from the Fire Fund[25]. The WDRP draws on existing research and expertise in Australia and overseas to accelerate innovation, develop new approaches to mitigate bushfires, and improve Australia's ecosystem defences.

University Partnerships

With an existing program of work in the university sector through the Forrest Research Foundation[26] and other initiatives, Minderoo Foundation has many well-established relationships with various universities including Curtin University, Murdoch University, the Australian National University, the University of Melbourne, the University of Sydney, the University of Technology Sydney, and the University of Western Australia. Information on the capabilities of these universities can be found in the *University Sector* section of this report and Attachment B.

[25] Minderoo Foundation. "Wildlife & Disaster Resilience Program". *Minderoo Foundation.* Retrieved from: https://www.minderoo.org/fire-fund/wildfire-and-disaster-resilience-program/

[26] The Forrest Research Foundation was established in 2014 through the Minderoo Foundation. The donation is used to drive research and innovation capacity in Western Australia by awarding Forrest Scholarships to outstanding young intellects from around the world to conduct research at one of Western Australia's five universities.

Bibliometric Analysis of Australia's Bushfire Research Capability

Bibliometric analysis is an evaluation of scientific publications and their influence in the scientific community. Bibliometric analysis is helpful to examine the scope, specialisation, collaboration and impact of the research output of a country, institution or researcher in bushfire related research.

The Department of Industry, Science, Energy and Resources undertook an analysis of bushfire-related research published between 2009 and 2018 using the *Web of Science* data base and the *InCites* analytics tool (both maintained by Clarivate Analytics). *InCites* is built on the selective, structured and complete data provided by *Web of Science*, giving access to comprehensive citation data and metrics. *Web of Science* is a multidisciplinary platform with over 1.7 billion cited references from over 159 million records across 254 subject areas.[27] Attachment C provides the methodology behind the analysis, including the search terms used and key definitions.

Bibliometric Findings

Australia is an International Leader in Bushfire Related Research

When using bibliometrics to analyse a country's research capability in a particular subject area, it is important to consider a number of different performance metrics including: the quantity of publications in that particular field (average number of publications), the impact of the research output in the scientific community (category normalised relative impact, CNRI), and the relative share of publications in that particular research area by a country or organisations (specialisation index). The following findings indicate that Australia performs well internationally in bushfire-related research against all these metrics.

Australia ranks second in the world in bushfire related research output

From the search terms used, 35 countries have published research related to bushfires in the period 2009-2018. The top 10 countries with the highest average publication count are shown in Table 7. In each year across that period, and on average across the period, Australia demonstrated the second highest publication count after the United States. Australia had its largest output in 2016 with 412 publications, and smallest in 2009 with 178 publications. Australia's average impact (CNRI) is well above world average but lower than most other countries in the top 10. It is likely that this is due to Australia's bushfire research having a focus on Australia's unique ecology with limited application to international audiences (the same probably applies to Brazil).

[27] Clarivate, Web of Science Group. (2020). *Web of Science: Confident Research Begins Here.* Retrieved from: https://clarivate.com/webofsciencegroup/solutions/web-of-science/

Table 7. Top 10 countries by average bushfire publications, 2009-2018

Country	Average Publications	Sum of CNRI	Specialisation Index
USA	1023	1.5	1.6
Australia	301	1.4	3.3
Canada	207	1.6	2.0
Spain	184	1.6	2.1
UK	163	1.9	0.9
Germany	128	1.6	0.8
France	113	1.8	1.0
China	111	1.5	0.3
Brazil	106	1.2	1.7
Italy	83	1.8	0.8

Australia is the second most specialised country in terms of bushfire research

The top 10 countries with the highest specialisation index are shown in Table 8. Australia is the second most specialised country when it comes to bushfire research, with an average specialisation index of 3.33, well above the world average of 1.0. The most specialised country is Indonesia, with a specialisation of 6.6 but a far smaller number of publications at 20 per year over the 2009-2018 period.

Table 8. Top 10 countries by average specialisation index, 2009-2018

Country	Average Publications	Sum of CNRI	Specialisation Index
Indonesia	20	1.6	6.6
Australia	301	1.4	3.3
South Africa	59	1.4	3.2
Portugal	60	1.6	2.9
Argentina	34	1.3	2.5
Spain	184	1.5	2.1
Chile	24	1.0	2.1
Greece	35	1.0	2.0
Canada	207	1.6	2.0
Finland	33	2.1	1.7

It is unsurprising that the three countries in the top 10 for both average publications and specialisation scores (Australia, Canada, and Spain) frequently face large bushfire seasons. For example, in 2019 there were extensive bushfires in Alberta, Canada (more than 700,000 hectares of land destroyed),[28] and Spain faced its worst wildfire season in 20 years with heatwave temperatures and forest fires in Tarragona.[29]

[28] Silverman, H. & Sutton, J. (2019). "11,000 people have been forced to evacuate as firefighters battle wildfires in Canada". *CNN*. Retrieved from: https://edition.cnn.com/2019/06/04/world/alberta-wildfires-evacuations/index.html
[29] Henly, J. & Jones, S. (2019). "Spain battles biggest wildfires in 20 years as heatwave grips Europe". *The Guardian.* Retrieved from: https://www.theguardian.com/world/2019/jun/27/hundreds-of-firefighters-tackle-blaze-in-north-east-spain

Australia's Preferred International Collaborators in Bushfire Research

Table 9 shows the top five countries by average co-publication with Australia from 2009-2018. In this analysis, co-authorships on publications are considered as a proxy for collaborations. Australia's top three collaborators in bushfire related research over period analysed were the United States, the United Kingdom and Canada.

Table 9. Top five collaborating countries with Australia by average number of publications, 2009-2018

Country	Average Co-Publications	Sum of Co-CNRI	Collaboration Specialisation Index
USA	46	3.07	1.39
UK	23	2.93	0.94
Canada	14	3.90	1.34
China	10	4.30	0.50
Germany	10	2.71	0.89

Australian Journals for Bushfire Related Research Findings

Australian authored publications on bushfire research can be found in more than 700 journals. Among the top ten journals for Australian authors are publications by CSIRO Publishing and the AIDR.

The **International Journal of Wildland Fire** is the most common journal for Australian authors and second most common journal for publications with authors from the United States of America and Canada. This is a monthly journal from the International Association of Wildland Fire and is published by CSIRO. The journal has an international perspective, since wildland fire plays a major social, economic and ecological role around the globe.

The **Australian Journal of Emergency Management** (AJEM) is a quarterly journal of analysis and insights into current and future issues from researchers and practitioners at all levels of emergency management and is published by the AIDR. AJEM is published as an open access publication under a Creative Commons [CC BY-NC] license. This allows the scientific community, those involved in emergency management and disaster resilience, and the general public to gain unlimited, free and immediate access to scholarly articles and industry news and views.

ATTACHMENTS

ATTACHMENT A – AFAC's Core Membership as of October 2019

Member Name	Council Delegate	
ACT Emergency Services Agency	Ms Georgeina Whelan	Commissioner
ACT Parks and Conservation Service	Mr Neil Cooper	Senior Director, Fire, Forest and Roads
Airservices Australia	Mr Rob Porter	Commissioner, Aviation Rescue Firefighting Services
Bushfires NT	Ms Collene Bremner	Executive Director
Country Fire Authority, Victoria	Mr Steve Warrington	Chief Executive Officer/Chief Officer
Department for Environment and Water, SA (National Parks and Wildlife Service)	Ms Fiona Gill	Director, Fire and Flood Management
Department of Biodiversity, Conservation and Attractions WA, Parks and Wildlife Service	Mr Jason Foster	Acting Executive Director, Regional and Fire Management Services
Department of Fire and Emergency Services, WA	Mr Darren Klemm	Commissioner
Department of Home Affairs, Emergency Management Australia	Mr Rob Cameron	Director-General
Fire and Emergency New Zealand	Mr Rhys Jones	Chief Executive
Fire and Rescue NSW	Mr Paul Baxter	Commissioner
Forest Fire Management Victoria - Department of Environment, Land, Water and Planning	Mr Chris Hardman	Executive Director Forest and Fire Operations Division, Chief Fire Officer FFMV
Forestry Corporation of New South Wales	Mr Ross Dickson	Chief Forester and Company Secretary
ForestrySA	Mr Chris Gibson	Manager Conservation, Fire and Safety
Metropolitan Fire and Emergency Services Board, Melbourne	Mr David Bruce AFSM	Acting Chief Executive Officer/Chief Officer
Northern Territory Fire, Rescue and Emergency Services	Mr David Willing	Executive Director

NSW Rural Fire Service	Mr Shane Fitzsimmons	Commissioner
NSW State Emergency Service	Ms Carlene York	Commissioner
Office of Environment and Heritage, NSW	Ms Naomi Stephens	Director, Fire and Incident Management Branch
Parks & Wildlife Service Tasmania	Mr Jason Jacobi	General Manager
Parks Australia	TBC	Director of National Parks
Parks Victoria	Mr David Nugent	Director, Fire and Emergency Services
Queensland Fire and Emergency Services	Mr Guy Thomas	Director, Operational Support, Park Services
South Australian Country Fire Service	Mr Mark Jones	Chief Officer and Chief Executive
South Australian Metropolitan Fire Service	Mr Michael Morgan	Chief Officer and Chief Executive
South Australian State Emergency Service	Mr Chris Beattie	Chief Officer
Sustainable Timber Tasmania	Mr Andrew Lea	Director
Tasmania State Emergency Service	Mr Andrew Lea	Director
Tasmania Fire Service	Mr Chris Arnol	Chief Officer
Victoria State Emergency Service	Mr Stephen Griffin	Chief Executive Officer

ATTACHMENT B – University Research and Technology Capabilities

As part of this mapping project, universities were invited to provide input through the five major university peak bodies: Universities Australia, Group of Eight, Regional Universities Network, Innovative Research Universities, and Australian Technology Network.

The input received from universities about their research hubs, centres, institutes, and groups as it pertains to bushfire resilience, recovery, and response is provided as a complete table below. The descriptions of each have generally been provided by the relevant university, or their peak body representative.

This table does not include schools or departments within universities that are not specialised institutes, hubs, or groups and each group is only listed once.

Each section is ordered in alphabetical order by university name.

Bushfire specific research institutes/hubs at (or led by) Australian Universities

Universities involved	***Centre Name***	***Focus***
Charles Darwin University	Darwin Centre for Bushfire Research within the Research Institute for the Environment and Livelihoods	The Darwin Centre for Bushfire Research (DCBR) delivers applied fire management research and training opportunities to land managers in northern Australia, South East Asia, Africa and South America. They apply field sampling, spatial analysis and Indigenous knowledge to develop 'savanna burning' methods, including greenhouse gas emissions reduction and carbon sequestration.
University of Tasmania	Fire Centre Research Hub	The Fire Centre was founded in 2018 at UTas to create a centralised, trans-disciplinary research hub in Tasmania. The Fire Centre's mission is to enable place-based solutions to the emerging global landscape fire crisis through community engagement and the creation and dissemination of research, education, outreach, and practitioner tools. The Fire Centre translates transdisciplinary research for community outcomes with close stakeholder engagement with NGOs, Societies, Industry (hydroelectric, tourism, forestry, Agriculture and Mining), and governments (Environment, Health, Disaster and Fire Management, Meteorology). The Fire Centre integrates knowledge in health, ecology, physics, sociology, geography, computer science, economics, biology, business, law, hydrology, atmospheric science, disaster management and chemistry. This centre represents more than 119 members (61 researchers and 58 partners).

University of Wollongong (Lead), University of Tasmania, Western Sydney University and UNSW	NSW Bushfire Risk Management Research Hub led by UOW's Centre for Environmental Risk Management of Bushfires	A collaborative venture (2018-2021) with funding from the NSW Department of Planning, Industry and Environment (DPIE). The hub currently has six key research projects bringing together researchers, fire agencies, and public land managers to inform bushfire risk-reduction strategies.

Bushfire specific research groups at (or led by) Australian Universities

Universities involved	***Centre Name***	***Focus***
University of Melbourne	Bushfire Behaviour and Management Group	A group at UoM working on bushfire related research projects, including BNHCRC funded work.
University of Queensland	Fire Safety Engineering Research Group	The Fire Safety Research Group investigates a wide range of fire topics, from bushfires to fires in buildings, fires in transport infrastructure, and more. The group's combined research expertise covers problems directly or tangentially associated with the bushfires (e.g. initiation and spread of bushfires, performance of structures affected by fires, recovery of affected communities). The Fire Safety Research Group houses the *Cladding Materials Library* designed to help give fire engineers the tools they need to tackle the cladding crisis. The library contains flammability data on a wide range of cladding material and is publicly and freely available. UQ also hosts a *Fire Laboratory* encompassing a suite of state-of-the-art testing equipment designed to permit investigations ranging from small-scale testing to large-scale calorimetry. The Fire Safety Engineering Group is leading the discussion in Australia towards establishing clear guidelines for timber-based construction and achieving true optimisation of tall timber buildings.
University of Tasmania	Pyrogeography and Fire Science Lab	The Pyrogeography and Fire Science Lab targets applied fire research exploring the relationship between fire, landscapes and humans. This group has developed to deployment-ready smartphone applications, AirRater and Tasmanian Fire Service Fire Watch. AirRater helps people with asthma, hay fever or other lung conditions to better manage their symptoms and improve their quality of life by providing air quality information, including smoke, from trusted government sources. Tasmanian Fire Service Fire Watch is a smartphone application that aims to support community access to fire awareness and safety information. In particular, the Fire Watch application's public release will provide accurate fire tracking and advice to multiple smartphone platforms The Pyrogeography and Fire Science Lab uses a range of innovative technological platforms, including high-performance computing infrastructure (NCI), earth-observation platforms, and value-added outputs this group has produced include a global database of extreme fire events based on the satellite fire hotspot records, and multiple outputs derived from meteorological and climate modelling, including an Australia-wide database of Forest Fire Danger Index. The Pyrogeography and Fire Science Lab engages strongly government, industry stakeholders and funders to

Universities involved	*Centre Name*	*Focus*
		address specific research questions and develop collaborative programs. The Pyrogeography and Fire Science Lab has a strong track record in peer-reviewed publications, and reports and frequently runs seminars and engages in outreach and media. Research group members collaborate on research projects with BNHCRC, NSW Bushfire Risk Management Research Hub, Antarctic Climate and Ecosystems-BNHCRC using the research critical mass to propel the Fire Centre.
University of Tasmania	Environmental Health Research Group	The primary focus of the Environmental Health Research group is the wider health impacts from landscape fires, evaluations of interventions for landscape fires, economic evaluation of fire smoke impacts and interventions, Health benefits and risks of fire management strategies. The group works in close partnership with stakeholders including environment agencies, health agencies and stakeholder groups. It has developed co-driven research in partnership with these agencies. It has and is funded by the BNHCRC, the ARC, the Department Environment Lands Water and Planning (Vic), ACT Health, Tasmania Department of Health, Western Australia Department of Health, Northern Territory Environment Protection Authority, Victoria Environment Protection Authority. It collaborates closely with the Fire Centre to support that University cross disciplinary initiative. It has several international collaborations with landscape fire smoke researchers across Australia and in the US, Canada, and Chile.
UNSW Canberra	Bushfire Research Group	Comprises around fifteen academics, research associates and PhD researchers and conducts research with the aim of improving understanding of bushfire and associated processes, and their relation to firefighter and community safety
Western Sydney University	Bushfire Research Alliance	Brings together research expertise in climate change, bushfire prediction, hazard environments, ecological recovery, mental health and social and economic impacts of disasters, and disaster and critical incident perception and preparedness.
University of Western Australia	Bushfire Modelling: The Aurora Bushfire Project	Developed a national system to protect infrastructure, communities and properties by linking wildfire spread prediction, fire management, and alert systems. This simulates bushfires in real time and rapidly communicates the spread predictions via the web, email and the National Telephone Early Warning System (NTEWS). A central component of the system is a website showing real-time fire spread predictions based on satellite hotspot data and current and forecast weather data feeds.

Disaster preparation and response groups at (or led by) Australian Universities

Universities involved	*Centre Name*	*Focus*
Australian National University	ANU Institute for Integrated Research on Disaster Risk Science	The Institute was established to coordinate the ANU's expertise and networks in the disaster domain, including but not limited to bushfire. Internationally connected and supported by an external advisory board, the Institute aims to deliver national and international impact in disaster risk, resilience and effective recovery through research, knowledge transfer, training and education. Their work seeks to provide evidence to improve the implementation of and go beyond the goals of Australia's *National Disaster Resilience Strategy 2011* and *National Disaster Risk Reduction Framework 2018*, in line with the *Sendai Framework for Disaster Risk Reduction 2015-2030*.

Universities involved	*Centre Name*	*Focus*
Bond University	Tactical Research Unit	Provides a range of research support in regard to the armed forces, police and fire and rescue. Their main areas of contribution would be on the physical aspects of firefighting, optimising preparation, recovery, injury mitigation, fatigue, etc.
Charles Darwin University	Thrive Lab, Emergency and Disaster management (EDM) and Northern Institute at College of Indigenous Future, Arts and Society (CIFAS)	EDM at CIFAS delivers research and training on crisis management policy, disaster risk reduction, emergency management and climate change adaptation. They ask key disaster management policy questions such as: 'what are the alternative legal and institutional framework for utilising federal assets to combat disasters including bushfire? How can leaders act in time to mitigate the impact of bushfire? How to measure local and national political commitment on climate related hazards? What kind of emergency management reform is needed in the context of Australia and Asia Pacific? How military and military assets be utilised to strengthen civilian emergency management system?'
Charles Darwin University	Australasian RISC Research Centre	The Australasian RISC Research Centre has some 15 years' experience in bushfire research and research implementation in the following areas: bushfire preparedness (in Australia, New Zealand and Portugal); developing community engagement strategies to develop community bushfire capacity; and bushfire recovery and community capacity building following bushfire disasters.
Charles Sturt University	The Charles Sturt Disaster and Community Resilience Research Group	The Disaster and Community Resilience Research Group advocates that a strongly resourced and acknowledged community sector, whose leaders are appropriately supported, will enhance community resilience. The group investigates disaster preparation and support for local community leaders before, during and after a disaster. They are interested in the extension of current resilience research to examine the role of local community organisations in facilitating general community resilience as a contributing factor to emergency preparedness.
Curtin University	Future of Work Institute	Curtin has researchers and several PhD students across the Schools of Management and Marketing, and their Future of Work Institute works on various projects including: recruitment of volunteers for Department of Fire and Emergency Services (DFES) (funded by the BNHCRC); working with bushfire volunteer brigades and spontaneous volunteers; and challenges facing rural volunteers generally. Curtin is harnessing this expertise to develop a Masters' program in Emergency Management. They held a 'Future of Volunteering' summit with DFES, Volunteering WA, Department of Communities and other stakeholders to identify research needs for the sector.
Flinders University	Torrens Resilience Institute	The Torrens Resilience Institute (TRI) is one of Australia's longest-standing research institutes dedicated to disaster preparedness and management. Its research is advancing the concept of resilience and helping organisations, communities and nations balance disaster preparedness and prevention, response and recovery in the context of interdependent systems, complexity and unexpected cascading consequences arising from these severely disruptive events. TRI research advises and guides government policy, prepares communities and empowers people to minimise the impacts of possible natural hazards, health and security risks or humanitarian and other emergencies in Australia and around the world.

Universities involved	***Centre Name***	***Focus***
James Cook University	The Centre for Disaster Studies	A multi-disciplinary research unit within the College of Science and Engineering at James Cook University, funded by the Queensland Department of Emergency Services.
Led by: RMIT University, Fenner School at ANU and EMA at the Attorney General's Department	Risk and Community Safety research program	Established in 2001 as a collaborative research program to: undertake applied research supporting the achievement of safe, resilient communities, through continuous improvement in emergency management; to help identify and satisfy the strategic research needs of emergency management and to develop appropriate mathematical tools for risk analysis and decision support.
Monash University	Monash University Disaster Resilience Initiative (MUDRI)	MUDRI offers expertise on: • Community-based emergency health, emergency public health and emergency health services • (Lack of) community awareness / (mis)understanding of bushfire messaging • Community development, community resilience, community engagement and recovery, specifically long-term recovery/resilience and sustainability of interventions • Gender issues in bushfire disasters • Australian adoption of lessons learned and EM practice from international humanitarian field • Professionalisation of EM workforce and community leaders, including ability to lead/contribute to national EM tertiary education programs
Swinburne University	Centre for Social Impact (CSI)	Has expertise in sensemaking, learning and change in emergency management organisations. For example, CSI has done work on the commemoration of the Black Saturday bushfires, and its impact of practitioners. Researchers at CSI have also been educating the public on the most effective ways to donate to bushfire relief efforts.
Swinburne University	Centre for Smart Infrastructure and Digital Construction	Expertise in structural safety and civil engineering for disaster resilience. For example, following the Black Saturday bushfires, a team of researchers worked with Frankston Concrete Products to design, build and test an above ground bushfire shelter. The Smart Structures Laboratory conducts research over a broad range of infrastructure related areas, including large-scale testing of new engineering materials and components leading to the development of more efficient infrastructure systems and safer buildings, bridges, offshore structures and mining structures including those relevant in bushfire-affected environments.
TAFE NSW	National Centre for Emergency Management	The National Centre for Emergency Management Studies (NCEMS) provides a professional development space for emergency services personnel. Their training promotes strong performance, based on practical exercises, and provides a solid foundation for leadership roles.

Universities involved	***Centre Name***	***Focus***
University of Adelaide	The Stretton Institute	The Institute intends to explore areas such as Australia's housing system, accommodation approaches in disaster relief and recovery, economics of bushfires etc. to turn science into policy and community awareness. Areas for exploration include: • The adequacy of Australia's housing system to cope with re-housing needs triggered by emergency events • A comparative international review of emergency and short-term accommodation approaches in disaster relief and recovery • Social policy responses to those who have suffered direct and indirect loss • Consideration of whether Australians have a 'right' to be re-housed following bushfire losses, and under what conditions • The economics of bushfires, costs and opportunities • Insurance affordability, policy terms, conditions, exclusions and fairness • Planning regulations and rationale • How to assess and spread risk? • Are stock losses an opportunity to re-assess appropriate stock for threatened areas? • Harnessing volunteer capacity in an emergency – requirements, risks, training needs • The role of the NGO sector in long-term capacity building, landcare, wildlife regeneration etc. • Building social capital in a diverse and competitive society. This might also include community provision of emergency housing, food, and clothing.
University of Melbourne	Melbourne School of Engineering	Researchers are engaged in many aspects of fire safety and resilience as it relates to physical infrastructure, water management and remediation post-disaster. Under the Universities 21 umbrella, some key researchers are part of an International Fire Safety Consortium.
University of Melbourne	Centre for Disaster Management & Public Safety	This Centre is a hub for global expertise, analysis and innovation on emergency and disaster management. It provides analytic tools and visualisation and modelling platforms and has engaged with current and previous bushfire emergencies. It has developed the Intelligent Disaster Decision Support System (IDDSS) and contributes to the UN Sustainable Development Goals. One major project in collaboration with the Centre for Spatial Data Infrastructures and Land Administration at the University of Melbourne is the development of a bushfire situation awareness application which aggregates live and near real-time information from multiple trusted sources for Australia.
University of Melbourne	Centre for Spatial Data Infrastructure and Land Administration	The Centre undertakes research on various topics including spatial data infrastructures spatial enablement and land administration in order to support sustainable development goals.

University of Melbourne	Faculty of Architecture, Building and Planning	The Faculty has a number of experts on urban planning and fire vulnerability, bushfire prevention and affordable housing options, including in response to disasters such as bushfires.
University of Newcastle	Research Centre for Gender, Leadership and Sustainability (GLASS)	Has a core focus on gender and climate change in particular Professor of Social Work Margaret Alston, whose work on rurality and gender has considered how disasters impact women, men and children differently. Professor Alston's work has also included the role of social workers in disaster work, including in disaster-preparedness, during the disaster and in post-disaster practice.
University of Queensland	Fire Safety Engineering Research Group	Leading fire safety engineering research and education through developing sustainable innovations and design approaches (not focused on bushfires).
University of Sydney	Asia-Pacific Natural Hazards and Disaster Risk Research Group	Focus on a wide variety of hazard and disaster risk related issues including: bushfires, heatwaves, droughts and dust storms; and climate change, climate impacts, adaptation and management.
University of Sydney	Centre for Disability Research and Policy	Experts in disability inclusive disaster risk reduction research.
University of Sydney	Humanitarian Engineering Program	The Humanitarian Engineering program includes research into disaster recovery and response; remote areas and Indigenous communities; role of built environment in contributing to resilience of communities & links between infrastructure, public health, education and livelihoods.
University of Tasmania	Disaster Resilience Research Group	The Disaster Resilience Research Group produces research that strengthens disaster risk governance to manage disaster risks. In doing this, they support the Sendai Framework for Disaster Risk Reduction and the Australian National Disaster Risk Reduction Framework. The research group focusses on all-hazards in the Australian context, but recent research has collaborated with end-users responsible for managing bushfires, floods, man-made hazards and severe weather events. A current research project with the BNHCRC is working with the emergency services, state and local governments', not-for-profit organisations and the infrastructure sector to investigate how and where people need to be creative when planning and managing the consequences of unprecedented disasters. Other projects include working with a range of private organisations on training and exercising, investigating human factors issues in night-time aviation firefighting, and efforts to enhance Urban Resilience for the Government of Bangladesh (via the World Bank).
University of Technology Sydney	Centre for Advanced Modelling and Geospatial	The Centre conducts research in spatial information systems focused in various applications and software for use particularly in the predictive systems and mapping applications. This research activity includes developing systems such as bushfire risk assessment, coastal sensitivity index ranking systems, flood warning systems, oil-spill trajectory systems, soil erosion assessment systems, landslide early warning systems, spatial based earthquake risk assessment systems; noise and

	Information Systems	propagation modelling, carbon monoxide (Co) propagation modelling, location-based services and others. The Centre uses latest imaging technologies and state-of-the-art sensors (e.g. Unmanned Aerial Vehicles (UAVs), Laser Scanning Systems such as Light Detection and Ranging (LiDAR), Terrestrial Laser Scanning Systems (TLS), Global Positioning Systems (GPS), Drone-based remote sensors (optical, infrared, thermal, hyper-spectral and LiDAR etc.) for various Earth observation applications and monitoring of environmental phenomenon.
Western Sydney University	School of Business	WSU's researchers in Economics and Finance, and Accounting have expertise in insurance, financial planning, and economic and environmental impact of bushfire emergencies. Researchers have been working with Fire & Rescue NSW for the past six years and have developed a research program examining community safety and individual's responses to structural fires. There is currently a five year study into the health and economic cost of structural fires in NSW using administrative data, Fire & Rescue NSW incident data, Ambulance data, Emergency Department data, Hospital Admission data, Mortality data (registry of deaths data), and outpatient data from burns units. There is also a current PhD student using this data. Research collaborators are: Neuroscience Australia, The Children's Hospital at Westmead and Australian Clinical Innovation. The Cost Benefit Research Group can assess the economic and environmental impact of bush fire volunteer and permanent firefighters regarding their responses in comparison to the wider first responders. This is in terms of their material provision as well as financial compensation.

Climate and environment research institutes/hubs at (or led by) Australian Universities

Universities involved	***Centre Name***	***Focus***
Australian National University	Fenner School of Environment & Society	One focus area of the Fenner School is forests and fire where research focuses on management of critically important native forests and woodlands, including forest ecology, landscape restoration, wildlife conservation, ecologically sustainable forestry, and the effects of fire and climate. The School currently has 12 active projects.
Australian National University	Climate Change Institute	The Climate Change Institute provides authoritative leadership climate change research across a broad range of research themes.
Australian National University	Energy Change Institute	The ANU Energy Change Institute combines leading research and teaching on the technologies, efficiency, policy, law, sociology and economics of moving to a sustainable and predominantly renewable energy future.
Australian National University	Institute for Water Futures	This new National Institutes Grant funded institute is one in its formative stage, and supports capability that will prove useful in the recovery stage: • Hydrological modelling and forecasting – predicting changes in runoff, river flow, and catchment behaviour in response to bushfires • Water quality modelling – effect of bushfires on quality of urban water supply • Water supply planning and resilience – evaluation of water supply planning in the face of deep uncertainty, and development of robust and adaptive plans in the face of uncertain futures • Futures – building capacity to conceive of and plan for the future in a way that takes climate and other drivers

Universities involved	*Centre Name*	*Focus*
		• Politics of innovation – understanding the process of radical change, and how it can be facilitated, particularly in the context of specific windows of opportunity.
Charles Sturt University	Institute for Land, Water and Society	In partnership with government and others, the Institute undertakes biophysical, social and economic research to address local, regional, national and global issues. Research is undertaken within four thematic (not mutually exclusive) areas: biodiversity conservation, environmental water, rural and regional communities and international sustainable development.
Curtin University	ARC Industrial Transformation Training Centre for Mine Site Restoration	Five of the themes of the CMSR are applicable to landscapes affected by bushfires: restoration genetics, seed technology and enablement, rare species management, restoration ecophysiology, restoration trajectory.
Curtin University	Curtin Urban Sustainability Policy Institute	A research institute concerned with sustainability, and coordinators of the Environment and Climate Emergency coursework. Strong engagement, science outreach, and citizen science presence.
Deakin University	Centre for Energy, the Environment and Natural Disasters	Provides high-quality, interdisciplinary research and policy input on energy, environmental and natural disasters-related issues.
Edith Cowan University	Centre for Ecosystem Management	The Centre for Ecosystem Management is a school-based centre located within ECU's School of Science. Research within the Centre contributes to a diverse range of topics including fire ecology and fire management, freshwater ecosystems, ecological water requirements, resolving problems of habitat degradation, mine site rehabilitation, pollution, the ecology of forests and woodlands, conservation and cultural perceptions of (valuing) the environment. Fire-related research includes the impact of wildfire on water quality and aquatic ecosystems, and fire ecology in the rangelands and peri-urban settings.
Flinders University	National Centre for Groundwater Research and Teaching	A national and international centre of excellence in groundwater research. Bushfire and natural disasters can have long lasting impact on the environment including catchment health, local water supplies, soil properties, alteration of evaporation and transpiration and hence runoff (quantity and quality) in catchments and subsequent infiltration/recharge to groundwater (and groundwater levels). The NCGRT, with other key research groups in environmental health at Flinders University, provides critical expertise in catchment management and remediation, modelling and analysis of quality/quantity of water dynamic and flows via field and laboratory investigations, and environmental water quality assessments and management.
Griffith University	Griffith Climate Change Response Program	The Griffith Climate Change Response Program leads transdisciplinary research into climate change adaptation and mitigation. The program is primarily focussed on the challenges of adapting to a rapidly changing climate. They are also involved in greenhouse gas mitigation research and where this intersects with adaptation issues – the so called 'adaptation-mitigation nexus'. The Program has a strong track record of successful partnerships with Governments, industry and communities to address the complex and unique requirements of both climate change adaptation and mitigation and

Universities involved	*Centre Name*	*Focus*
		delivered more than 30 climate change projects in Australia and internationally. Director Professor Mackey is currently the Coordinating Lead Author for the Australasian Chapter of the IPCC 6th Assessment Report.
Host: Griffith University with mandate to operate nationally.	The National Climate Change Adaptation Research Facility (NCCARF)	The NCCARF supports decision makers throughout Australia as they prepare for and manage the risks of climate change and sea-level rise. In its first phase of operation (2008-2013) NCCARF delivered a suite of research projects aimed at providing information needed to adapt to climate change. In Phase 2 NCCARF developed a synthesis and communication program to condense and translate technical research information developed in its first phase into communication products for end-users.
Griffith University	Australian Rivers Institute	The Australian Rivers Institute (ARI) research focuses on a source-to-sea philosophy, providing the knowledge to underpin the sustainable management of aquatic ecosystems. They support governments, resource managers, the water industry and the community with informed research relating to the preservation and management of catchment, river, estuarine and coastal ecosystems including environmental economics. ARI's researchers have initiated a series of interdisciplinary research projects and creative collaborations that have been recognised internationally. The four grand challenges to be addressed are: • Balancing water needs for humans and nature. • Arresting aquatic biodiversity decline. • Tackling land-based waterways pollution. • Making catchments more resilient to climate change.
Hosts: University of New South Wales, University of Technology Sydney, and Macquarie University (as well as CSIRO and the Sydney Institute of Marine Science)	NSW Climate Adaptation Research Hub	A five year research collaboration between the Department of Planning, Industry and Environment and research institutions on climate change and adaptation science. Key priority research areas are: biodiversity; coastal processes and responses; and adaptive communities.
James Cook University	The Centre for Disaster Studies	A multi-disciplinary research unit within the College of Science and Engineering at James Cook University, funded by the Queensland Department of Emergency Services.
La Trobe University	Centre for the Study of the Inland	The Centre for the Study of the Inland (CSI)'s expertise in the Humanities and Social Sciences focuses on how people have lived with and are living with fire, how it is remembered and how we can value different cultural perspectives to meet the needs of people and nature in an era of climate change. CSI provides a multi-disciplinary platform for interconnecting

Universities involved	*Centre Name*	*Focus*
		themes of water, landscapes and land use (including indigenous land use), agricultural and pastoral history, resource extraction and human responses to long-term environmental change.
La Trobe University	Centre for Future Landscapes	Multi-disciplinary environmental research centre addressing the outcomes of landscape change and ecological function in modified landscapes. They have several major projects on effects of fire on flora and fauna - *Box-Ironbark Experimental Mosaic Burning, Foothills Fire and Biota*, *Mallee Fire and Biodiversity*, *Mallee Hawkeye, Scientifically-based monitoring* and *Ecosystem Resilience*. They undertake field-based empirical research, spatial analysis and ecological modelling to inform effective bushfire management in south-eastern Australia. They have a track record of working with government departments and parks agencies to provide scientific knowledge to underpin ecological fire management.
La Trobe University	Centre for Freshwater Ecosystems	The Centre for Freshwater Ecosystems directly supports decision making regarding maintenance and restoration of the long-term health of rivers, catchments, floodplains and wetlands. The Centre operates from La Trobe's Albury-Wodonga campus which provides unique access to field sites and connection with local communities. The Centre hosts a number of equipment and laboratory capabilities, incl. an analytical chemistry laboratory for water quality and nutrient testing and resources to support biogeochemical analysis and regional ecosystem surveys.
La Trobe University	Research Centre for Applied Alpine Ecology	Supported by a strong multidisciplinary research and cross-institutions membership, the Centre's work ranges from ecological processes, to rare and endangered species conservation, effects of large bushfires in the Alps, human activities, and the management of these ecosystems in response to climate change. The Centre is custodian of critical long-term databases of national significance with ecological monitoring (on animals, threatened species, weeds, pests) as a key resource to understand long-term change in alpine ecosystems.
Monash University	Department of Civil Engineering	Conducts air quality monitoring and exposure assessment including the following three major areas: 1. Personal exposure monitoring via portable and/or wearable air quality monitoring devices using IoT for real-time monitoring purpose. 2. Detailed stationary air quality monitoring 3. Building indoor and outdoor ventilation system: Building envelop and indoor environmental quality monitoring and analysis to understand how the outdoor air pollutants affect the indoor environments, which is important for sensitive groups such as senior citizens and young kids (i.e. age-care centres, schools/classrooms, and hospitals)
Monash University	Monash Sustainable Development Institute (MSDI)	For longer-term policy and solutions to limit global warming and reduce future fire risk, the MSDI offers expertise, research and engagement into emissions reduction, public health and climate change, behaviour change and sustainability, water, and transitions to economic sustainability.
Monash University	Monash Climate Change Communication Research Hub	Monash Climate Change Communication Research Hub conducts social research and leads projects to build media/policy infrastructure that adequately addresses climate change in Australia. • Broker between media outlets and experts - Partners with ABC and Channel 7 • Expertise on communicating and educating severity of disaster to regional communities. • Research to make accessible climate related analysis on fires.

Universities involved	*Centre Name*	*Focus*
		• Weatherzone/Weatherpulse app
Monash University	Monash Indigenous Studies Centre	Conducts their research on Gunaikurnai Country (Gippsland) through Indigenous Studies Centre. They have close communication with Gunaikurnai Land and Waters Aboriginal Corporation and assessment of cultural heritage sites after fires, and planning for their future management. The Centre contains expertise on indigenous land management practices/cultural burning.
Murdoch University	Terrestrial Ecology Research Group	Areas of research include fire impact on shrublands and climate change impact on biodiversity, including impact of shortened fire intervals in Western Australia, impacts of high-severity fire and post-fire management on forest development and wildlife.
RMIT University	Centre for Environmental Sustainability and Environmental Remediation	Focused on issues of urban pollution, methods of pollution degradation and use risk assessments to contextualise exposure into sustainable solutions for managing environmental problems and pollution. Undertaking Environmental and human-health risk assessments, Environmental decision-making, Natural resource management, Environmental economics
RMIT University	Climate Change Exchange	A collaborative climate change research-practice network to meet the knowledge sharing, capacity building, and research needs of various government and policy stakeholders including local governments, Catchment Management Authorities and Water Authorities, State Government departments, and other bodies such as Primary Care Partnerships, The Victorian Council of Social Services, and Jesuit Social Services.
RMIT University	Climate Change Transformations Program	Focuses on adaptation governance and practice, sustainable and just transitions, disaster, development and resilience, and the rejuvenation of sociol-ecological systems.
Southern Cross University	Forest Research Centre	Supports a variety of research projects relating to forested landscapes primarily in the tropics and subtropics of Australia, with an emphasis on recovery. The fields of study include ecology of forests, forested landscape recovery, forest flora and fauna surveys, forest resource inventory and integrated agriculture and forestry. Current activities among others, focus on the fate of various animal populations occupying wet forests of eastern Australia and recovery of subtropical open wooded pastures following fires of variable intensity.
Southern Cross University	Environmental Geochemistry & Mineralogy Group and Landscape Hydrogeochemistry Group	Groups at SCU investigating the effects of bushfires on soil properties, sediment geochemistry, toxic trace element behaviour (specifically Chromium and Arsenic) and the implications for post-fire water quality.
University of Adelaide	Law – reforms, expertise and advice - The	Adelaide Law School offers a range of expertise specifically linked to the bushfire crisis, including: • The legal framework for the deployment of the Australian Defence Force (ADF) to assist in national disaster relief in Australia - critical legal and policy issues relating to ADF natural disaster support within Australia

Universities involved	*Centre Name*	*Focus*
	Research Unit on Military Law and Ethics (RUMLAE)	• Property law research explicitly exploring the challenge posed by climate change and environmental harm generally, to the future of property law. • Water allocation law. • Land use planning law, vegetation clearance laws and reservation of land for conservation purposes. • Civil liability advice on broader issues of negligence in relation to failure to respond to known risks, the connection between ecology and law, the impact of land use and management policy on present disasters.
University of Adelaide	Environment Institute	The Environment Institute (EI) brings together research expertise from across the University. They coordinate such diverse areas as the recovery of plant and animal species post-fire using on-ground research, and drone and GIS approaches, the social and economic impacts of fires on the communities affected (both short and long term), the mental and physical health of people who live in areas impacted by fires and those who fight the fires, planning for long term approaches to decrease the risk of severe wildfire, and collaborating with relevant State Government agencies in developing new programs to deal with the future impact of fire. The EI also has strong research groups who will consider the impacts of fires on the quality of freshwater in the affected regions and marine scientists who will examine the impact of ash on coastal marine environments.
University of Adelaide	Waite Research Institute	Works on understanding the effects of bushfire on soil chemistry and biology and their implications for successful re-establishment of productive vineyards, orchards, pastures and broad acre cropping together with the effects of fire on pollinators and insect pests, pathogen infections, weed management. This includes: • Assessing the extent of heat and fire-damage to perennial woody crops to enable growers to make rapid estimations of the future options for bushfire-affected orchards. • Assessing and predicting the extent of smoke taint of fruits, nuts and their products and advising on amelioration strategies. • Understanding the effects of bushfire on soil chemistry and biology and their implications for successful re-establishment of productive vineyards, orchards, pastures and broad acre cropping. • Understanding the effects of fire on pollinators and insect pests, pathogen infections, weed management. • Establishment of sensor network, early warning, prediction and amelioration/protection systems in high-value crops to reduce the effects of smoke and heat damage (with engineering, computing disciplines).
University of Adelaide	Australian Institute for Machine Learning	Understanding of the drivers for Australian bushfire and assessing risk requires analysis of a wide range of climate variables. There is an urgent need for scientific research that integrates climate and fire data over time and from multiple sources. Data can also be applied to predict the severity and probable pathway of a bushfire. Deep Learning has been tested in natural hazard and fire management in the USA and Australia. Current examples of potential applications might include: • Navigational systems for automated vehicles that can operate in low visibility, high fire intensity environments and identify priority assets to protect

Universities involved	*Centre Name*	*Focus*
		• Fire-fighting equipment attached to these vehicles that can make automated decisions about where and how to engage with a fire. For example, prioritising which assets to protect and directing hoses to the highest priorities sites • Automated vehicles to remove burning timber from roads. • Improving fire risk and spread models using machine learning, in partnership with the CRC, BoM and CSIRO.
University of Canberra	Institute of Applied Ecology	A key research focus is the environmental impacts of bushfires on water quality and aquatic ecosystems including fish communities, and assessing the resilience of ecosystems after bush fires.
University of Melbourne	School of Ecosystem and Forest Sciences	A number of specific research groups with expertise on many aspects of bushfire behaviour and management, forest and land management, fire ecology and biodiversity, and forest hydrology.
University of Melbourne	School of Biosciences	Experts on wildlife biodiversity, ecology and environmental decision making, including potential role of indigenous knowledge.
University of Melbourne	School of Geography	Researchers in environmental geography examining the impact of fires.
University of Melbourne	Melbourne Sustainable Society Institute	One of the Melbourne Interdisciplinary Research Institutes that emphasises the contribution of the social sciences and humanities to understanding and addressing sustainability and resilience challenges. One of their research projects examines Australian bushfire prevention.
University of New South Wales	UNSW Climate Change Research Centre	Multi-disciplinary research centre housing research expertise in the key areas of Earth's climate: atmospheric, oceanic and terrestrial processes. They apply basic scientific principles to pressing questions on climate dynamics, global climate change, and extremes of weather and climate.
University of Newcastle	Priority Research Centre for Frontier Energy Technologies and Utilisation hosted by the Newcastle Institute for Energy and Resources	Leads national and international work in fire science, fire suppression, and fire chemistry, abatement technologies, developing optimised energy solutions for gas, water, and mineral industries. Key projects include the Hydro Harvester; an apparatus which absorbs water from the atmosphere using silica gel that can be used for drinking, irrigation or firefighting.
University of Newcastle	Centre for Water, Climate and Land	Provides access to world-renowned expertise in understanding and addressing the impacts of hydroclimatic extremes (like droughts, bushfires, and floods) across Australia. Specific skills include characterising these impacts, forecasting, extreme event risk analysis, water resources management, and climate-smart agriculture. A current project is working with Australian insurers to understand the full potential of future climate risk.

Universities involved	*Centre Name*	*Focus*
University of Newcastle	Conservation Biology Research Group	Consists of a team of internationally recognised experts in biodiversity conservation with project experience in the natural environment and biodiversity, environmental monitoring and restoration ecology.
University of Newcastle	Centre International de Formation des Autorités et Leaders (CIFAL)	Newcastle serves as a capacity building centre to equip and empower communities and organisations with skills and resources to action Sustainable Development Goals and address global challenges, such as risk reduction of natural disasters. All CIFAL Newcastle disaster related activities are certified by the UN through the United Nations Institute for Training and Research (UNITAR) and/or the United Nations Office for Disaster and Risk Reduction. CIFAL Newcastle also acts as UNITAR's hub in the Pacific region for disaster risk reduction. CIFAL Newcastle is a unique mechanism to build capacity by working with government agencies, planners, emergency services and international and community representatives. The UON Disaster and Development Research Group offers education and training in disaster preparedness and reconstruction and sustainable development and risk reduction.
University of Queensland	School of Earth and Environmental Sciences	Research groups in the school such as the Remote Sensing Research Centre use remotely sensed data, fieldwork and spatial models to measure, map and monitor biophysical properties in terrestrial, atmospheric and aquatic environments to better understand and manage the Earth's environments and resources.
University of Technology Sydney	UTS Climate Change Cluster	The Climate Change Cluster undertakes integrated and interdisciplinary research at the intersection of the Physical and Life Sciences. The research serves to address the biggest environmental and societal issues facing Australia and other countries in a changing climate: food and energy security; sustainability and ecological resilience; and global health.
University of Southern Queensland	Forest Industries Research Centre	Focused on issues as they relate to the forestry value chain, thus the economic and environmental sustainability of forest industries. They have led a bushfire risk national trial and conduct other bushfire related research.
University of Southern Queensland	Institute for Life Sciences and the Environment	The Institute includes the Centre for Applied Climate Science, which has core capability in global climate science/climate change science and meteorological science associated with weather extremes and disaster response communication and community engagement for disaster preparedness and recovery.
University of Southern Queensland	Institute for Resilient Regions	The Institute includes the Rural Economies Centre of Excellence (RECoE), which collaborates with the Clean Growth Choices Consortium to conduct research focused on how communities respond to unprecedented change, such as climate variability, droughts and fires; and examines traditional land management practices, including law and policy.
University of Sydney	Australian Centre for Climate and Environmental Law	The Australian Centre for Climate and Environmental Law is world renowned for interdisciplinary research, education and public engagement in these areas of law.
University of Sydney	Sydney Environment Institute	The Institute has very strong research capacity on climate change adaption, community engagement, transition to low carbon economy etc. Serves as a general convenor of climate change expertise across the University.

Universities involved	*Centre Name*	*Focus*
University of Sydney	Sydney Institute of Agriculture	The Institute is leading basic and applied research in soil, carbon, water, climate and agriculture, drought and risk management, ag tech. Research capabilities are detailed here.
University of Sydney	Climate Change, Human Health and Social Impacts Research Node	The Node is a partnership between the NSW Office of Environment and Heritage, NSW Health and The University of Sydney. The goal of the research Node is to inform adaptation programs that seek to protect and promote health in NSW, in the face of a changing climate. Led by the University of Sydney's Planetary Health Initiative, with support from NSW Health and Edge Environment, this Node will focus on the relationship between climate change and health, with research themes addressing urban design and the built environment; vulnerable populations; physical and mental health; and health assets and services.
University of Tasmania	Climate Futures Group	Climate Futures bridges the gap between fundamental climate science and the local planning and adaptation needs of Australian industries (e.g. hydroelectric, agribusiness producers, tourism, and forestry), government agencies (e.g. emergency services) and communities. Climate Futures provides localised climate information, producing fine-scale climate change projections that allow for the analysis of localised climate impacts, changes to seasonality and extreme events. The targeted projections are optimised to support operational decision-making. Climate Futures uses the high-performance computing infrastructure (NCI), the Tasmanian Partnership for Advanced Computing at University of Tasmania and the output from CSIRO's regional climate model (Conformal Cubic Atmospheric Model). One of the major strengths of this centre has been the generation of technical reports addressing some of the key questions for extreme weather events and fire danger. Research is co-designed with stakeholders, technical reports, workshops and peer reviewed publications. Current collaborations include projects with BNHCRC, University of Tasmania Fire Centre, Tasmanian Institute of Agriculture, Hobart City Council, Launceston City Council, Greening Australia, Tasmanian Fire Service, Tasmanian Parks and Wildlife, Hydro Tasmania, TasNetworks, Department of Primary Industries, Parks, Water and Environment, Department of Premier and Cabinet.
University of Tasmania	ARC Training Centre for Forest Value	The ARC Training Centre for Forest Value produces industry-ready graduates and postdoctoral fellows with broad perspectives of the forest industry. Working closely with eight forestry industry and NGO partners, the Centre has research strengths across the full forestry value chain from growing trees for production and restoration to producing quality wood products. The Centre for Forest Value major Research Theme *"Sustainable Forest Production and Certification"* integrates forestry into a wider landscape context by considering ecosystem services, forest certification, business diversification and the role that tree planting can have in agricultural and restored landscapes under changing climates (including in the face of fire risk). A key strength of the Centre for Forest Value is understanding genetic variation for key tree traits that mitigate against risks (e.g. heat stress and drought) – an important factor in determining eucalypt (and hence forest) adaptation to changing climates; and considering impacts of forestry and fire disturbance on biodiversity and ecosystem function. Key infrastructure utilised by the Centre for Forest Value includes the TERN Oz Flux Tower at the WARRA field site in Southern Tasmania.
University of Tasmania	Tasmanian Institute of Agriculture	The Tasmanian Institute of Agriculture supports sustainable agriculture and food sectors through high-impact research, development, extension and education. As part of its extensive portfolio, this centre is world-leading in smoke taint

Universities involved	*Centre Name*	*Focus*
		research. The ability to discriminate between the affected and unaffected vineyards will be of significant value to the grape and wine industry in mitigating smoke taint. This group has strong connections with LaTrobe University.
University of Tasmania, CSIRO, BoM, UNSW, ANU, Monash University, University of Melbourne	Earth Systems and Climate Change Hub	The Earth Systems and Climate Change Hub aims to build world-leading climate and Earth systems science capability and using our understanding of Australia's past, present and future climate to supply useful and accessible climate information for Australia. Their role is to deliver research, data, tools and services for a range of end users including government, private sector, NGOs and Australian communities, to ensure that Australia's policies and management decisions are effectively informed by Earth systems and climate change science. The Earth Systems and Climate Change Hub is a national partnership, with world-leading capability in multi-disciplinary Earth system science and modelling that provides Earth system and climate information in support of a productive and resilient Australia. The hub focuses on three research priorities: improving understanding of past and current climate, improving understanding of how the climate may change in the future, and building the utility of climate change information.
University of Western Australia	Centre for Environmental Economics and Policy (CEEP)	One focus area of CEEP is the economics of bushfire-risk mitigation. Over multiple projects across four Australian states, the Centre has investigated whether and when the benefits of strategies such as prescribed burning are sufficient to outweigh their costs and any extra risks they involve.
University of Western Australia	West Australian Biogeochemistry Centre (WABC)	WABC is a centralised, stable isotope facility housed at UWA. The WABC examines ecological sustainability of natural ecosystems and their response to disturbance and environmental change.
University of Western Australia	Ecosystem Restoration and Intervention Ecology Research Group	The Ecosystem Restoration & Intervention Ecology Research Group works in a range of fields from urban ecology and green infrastructure to the management and restoration of changing ecosystems which includes species conservation and management.
University of Wollongong	Centre for Atmospheric Chemistry	Research at the Centre for Atmospheric Chemistry advances understanding of atmospheric trace gas and aerosol chemistry, atmosphere and biosphere exchange of trace gases, and long term changes in atmospheric composition and chemistry - from the laboratory to the field and at local to global scales. Over more than 20 years, they have established the most intensive atmospheric composition and chemistry research and training program in Australian universities. They collaborate widely in Australian and international atmospheric science communities including other universities, CSIRO, ANSTO, BoM, federal and state government departments and international networks.
University of Wollongong	Australian Centre for Culture, Environment, Society and Space (ACCESS)	ACCESS research integrates analysis of environment, culture, society and space to: • identify and analyse the place-based, multi-dimensional challenges and opportunities that emerge as environments, cities, economies and communities are differentially transformed across space and place; • explore how decision-making and action to address these challenges and opportunities can be imagined and enacted at multiple scales and across institutions and communities.

Universities involved	*Centre Name*	*Focus*
University of Wollongong	Centre for Sustainable Ecosystem Solutions	The Centre for Sustainable Ecosystem Solutions (CSES) aims to be a nationally and internationally significant centre for innovative research into the way that threatening processes affect the structure, function and composition of ecosystems. CSES uses a cross-disciplinary focus to create a collaborative research environment targeted at ecosystem management. With a proven track record of translating research into policy development and ecosystem management, CSES provides innovative solutions to major societal challenges that fall under the National Strategic Research Priorities: Living in a Changing Environment and Managing Our Food & Water Resources.
University of Wollongong	GeoQuEST Research Centre	The GeoQuEST Research Centre represents an interdisciplinary team from the Faculty of Science, Medicine and Health and the Faculty of Engineering and Information Sciences that have a focus on environmental and climate change research under the overall theme of Earth System Science and Technology. The centre brings together outstanding researchers studying the atmosphere, earth and water within the broad disciplines of geography, geology, environmental science and environmental engineering who share interests in environmental processes and climate change.
University of Wollongong	Sustainable Buildings Research Centre	The Sustainable Buildings Research Centre is a multi-disciplinary facility that aims to be a leader in ideas and solutions that address the challenge of transforming buildings and the built environment into sustainable, resilient and effective places in which people live and work. Their themes and areas of research are diverse, all focused on making buildings more liveable, more sustainable, more cost-effective, and kinder to our environment.
Victoria University	Institute for Sustainable Industries and Liveable Cities	A major research theme of the Institute is climate change with a focus on: impact analysis; mitigation and adaptation; Infrastructure and planning; and risk analysis and management. Supporting this area is a Group dedicated to fire research. The Institute has significant fire testing infrastructure including a unique large scale structural fire test furnace capable of testing structures under combined structural and fire loading.
Western Sydney University	Hawkesbury Institute for the Environment	Conducts research across the full spectrum of life from genetic level to ecosystem level tackling urgent environmental issues. These include the impact of rising CO_2 levels and CO_2 prediction models; the impact of environmental change on plant, animal and microbial communities; using technology to understand and better manage our most important natural and managed ecosystems in a changing world. Research in bushfires includes extreme weather conditions and early warning systems that predict bushfire events.

Bushfire health related research hubs/centres at Australian Universities

Universities involved	***Centre Name***	***Focus***
Centre partners: University of Sydney, UNSW, Monash, UWA, UTas, QUT, University of Melbourne	Centre for Air Pollution, Energy and Health Research (CAR), an NHMRC CRE	Based at the Woolcock Institute of Medical Research at The University of Sydney, CAR is the largest mass of environmental epidemiologists in the country working on air pollution, bushfires and related issues, harnessing a wealth of expertise on how air pollution and new forms of energy affect our health.
Flinders University	Órama: Institute for Mental Health, Wellbeing and Neuroscience	Órama is a multi-disciplinary research institute representing a unique blend of research capabilities centred on the disciplines of basic and applied neuroscience, psychiatry, psychology, allied health, engineering, social science, education and public health. Bushfire disasters have both immediate and longer term impact on the mental health, resilience and wellbeing of individuals. The Institute has expertise in the research and treatment of individuals exposed to traumatic events in bushfire affected communities. In collaboration with the SAHMRI Wellbeing and Resilience Centre, the Órama Institute is able to measure baseline wellbeing and provide ongoing interventions to increase resilience.
Monash University	School of Rural Health	The School of Rural Health is leading the Hazelwood Health Study, a 20 year, $30 million community health project investigating long term health impacts on surrounding communities of the 2014 Hazelwood Mine Fire in the Latrobe Valley (Gippsland), the longest running and most complex fire in Victoria's history.
Monash University	Monash University Accident Research Centre (MUARC)	The MUARC is working with the VicCFA and Metropolitan Fire Brigade to develop Australia's first national incident and injury data management. This will be a highly valuable resource for understanding risk factors and prevention.
Monash University	Turner Institute for Brain and Mental Health	Provides post-traumatic stress disorder (PTSD) support for firefighters through the Turner Institute for Brain and Mental Health School of Psychological Sciences Trauma Clinic.
Monash University	Climate, Air Quality Research (CARE) Unit	The CARE Unit contains expertise on chronic respiratory diseases health impacts of bushfire smoke in the air.
Queensland University of Technology	International Laboratory for Air Quality and Health (ILAQH)	Part of the Institute for Health and Biomedical Innovation and the Institute for Future Environments, ILAQH has been a Collaborating Centre of the World Health Organization on Research and Training in the field of Air Quality and Health since 2004. ILAQH undertakes research, postgraduate training and consultancy in the complex, interdisciplinary field of air quality and its impact on human health, with a specific focus on ultrafine and nanoparticles.

Universities involved	*Centre Name*	*Focus*
Swinburne University	Centre for Transformative Innovation (CTI)	The CTI contains relevant expertise in bushfire preparedness, response and recovery. Their Social Network Research Lab has led work on social connectedness and mental health in bushfires in response to the Black Saturday bushfires, in collaboration with members of the Beyond Bushfires team. As an active participant of Beyond Bushfires, the group has experience with managing community stakeholders such as the Australian Red Cross, schools, and various federal and state agencies involved in the bushfires.
Swinburne University	Social Innovation Research Institute (SIRI)	SIRI has been researching rural mental health, wellbeing and resilience in Europe, Australia and North America since 1998. Their researchers have key expertise in rural community participation and empowerment, and experience supporting communities to find their own resilience and empowering them to improve their mental health, in recent partnership with Beyond Blue, SANE and Patient Opinion. SIRI, through the Social Data Analytics (SoDA) Lab, is also leading the "Data Co-Op Platform for Social Impact and Wellbeing", a Rural Mental Health Data Collaborative. With additions of other data, including open data, analyses will consider relationships between climate change and mental health, community infrastructure and mental health.
Swinburne University	Centre for Mental Health (CMH)	The CMH contains relevant expertise in designing and delivering interventions (including the federally-funded Mental Health Online (MHO) centre for online delivery), and providing support/training for local professionals. Their researchers have expertise in understanding and navigating the network of services (federal, state, non-government) and modalities (self-help, online, peer support, clinical) that could be useful for people affected by bushfires. MHO has a self-help program for PTSD, and expertise in the skill of video-based delivery of psychological services, which could be of use to local practitioners working with affected populations. Their Social Health and Wellbeing (SHAW) Laboratory also has key expertise in how loneliness can negatively impact social functioning and exacerbate mental health symptoms.
Swinburne University	Iverson Health Innovation Research Institute	The Institute contains significant expertise in assessing the physiological mechanisms underpinning stress related or respiratory related illnesses. Understanding these mechanisms provides direction towards appropriate therapies for prevention and management.
Swinburne University	Centre for Forensic and Behavioural Science (CFBS)	Australia's leading centre for excellence in forensic mental health and forensic behavioural science research, teaching and practice development. CFBS has key expertise in bushfire arson prevention and the psychology of bushfire setting and criminal psychology. It has a long term partnership with the Victorian Government's Forensicare, and shares joint facilities.
University of Melbourne	Phoenix Australia	Affiliated with the University and closely linked with the Department of Psychiatry, Phoenix Australia (Centre for Posttraumatic Mental Health) are the developers of the NHMRC guidelines for the prevention and treatment of PTSD. They work with governments, organisations, agencies and the community to conduct research and develop and implement policy and practice initiatives for the understanding and delivery of innovative science and best practice care in trauma and disaster. They also work closely with Centre for Health Equity on bushfire responses.
University of Melbourne	Lung Health Research Centre	This Centre consists of experts on the effects of air quality on lung health.

Universities involved	***Centre Name***	***Focus***
University of Melbourne	Centre for Health Equity	Researchers from this Centre have considerable expertise on factors influencing community resilience following bushfires. Specific projects include: • Beyond Bushfires was an ARC Linkage project and provided important insights into factors influencing mental health and wellbeing up to five years after the Black Saturday bushfires. • 10 Years Beyond Bushfires involved a to return to the same communities to provide insights into how people were managing 10 years on from the 2009 bushfires and build an understanding of the long term experiences of those affected by disasters. • Funded by the BNHCRC, ReCap (or Recovery Capitals) aims to support wellbeing after disasters by aligning disaster recovery evidence with a framework of community capitals (social, human, cultural, natural, financial, built & political) to guide development of recovery strategies adapted to community contexts. Children & Disasters is a series of research and translation projects to promote understanding of the impacts of disasters on children, teenagers and school communities, and to develop and test resources and strategies to promote positive outcomes.
University of Newcastle	Priority Research Centre for Healthy Lungs	The Centre contains expertise in the development and implementation of advanced models for diagnosis and treatment of asthma and chronic obstructive pulmonary disease. The Centre hosts the NHMRC Centre for Severe Asthma which is an international collaboration developing innovative approaches to detect, prevent, and reduce severe asthma. Tools, education, training, and programs are available to communities, services, and clinicians to improve asthma disease management and access to new asthma therapies.
University of Newcastle	Priority Research Centre for Brain and Mental Health	The Centre is a nationally recognised hub for world-leading mental health research across the spectrum of discovery, prevention, early intervention, treatment, and implementation.
University of Newcastle	Centre for Rural and Remote Mental Health	The Centre provides leadership in rural and remote mental health research and program delivery, working closely with rural communities to support the mental health and wellbeing of rural and regional communities. The Centre has pioneered innovative evidence-informed programs, including the Rural Adversity Mental Health Program (RAMHP), which is currently working in bushfire zones to identify people in need of extra support and to link them with appropriate and available services. Research capability focuses on providing evidence-based solutions to improve the mental health, wellbeing and resilience of rural and remote residents during adverse circumstances. The Centre is actively engaged in considering how best to support rural and remote communities to stay well (see Community Wellbeing Collaboratives), to improve the mental health and wellbeing outcomes for rural and remote communities (see the Orange Declaration on rural and remote mental health), as well as to understand, respond to and prevent rural suicide. This work has been built on a foundation of understanding mental health and wellbeing in rural communities (e.g. see the Australian Rural Mental Health Study).

Universities involved	*Centre Name*	*Focus*
University of Southern Queensland	Institute for Resilient Regions	The Institute includes the Centre for Health, Informatics, and Economic Research, a multi-disciplinary centre committed to research advancing understanding of issues of greatest potential benefit to the health and welfare of our community; and the Innovative Mental Health Solutions Research Program focuses on projects that develop innovative (often technology-based) approaches to understand and cultivate growth within a range of mental health and wellbeing domains. Specifically, research program aims to bridge gaps in quality and access to appropriate mental health resources for all Australians.
University of Sydney	Climate Adaptation and Health Research Node	The Climate Adaptation and Health research node focuses on understanding the risk climate change poses to our health. Their work develops sustainable and effective measures to combat health issues that are aggravated by climate change, such as heat stress in the workplace.
University of Sydney	Brain and Mind Centre	Their focus on public mental health in the workplace includes first responders and frontline service personnel. The Centre focuses on sleep, function, stress, disadvantage; assessment and design of national mental health service developments; and 'climate change anxiety'.
University of Sydney	Matilda Centre	The Matilda Centre team are experts in mental health and substance use, as well as implementing resources and interventions to improve mental health and address substance use. Their expertise in research in trauma and post-traumatic mental health is especially relevant. The Centre's well-established collaborations nationally provide an effective framework for the consideration of the mental health and substance use impacts of the bushfire crisis, and the exploration of mechanisms to deal with these.
University of Western Australia	Burn Injury Research Unit UWA	The burn injury research unit is focused on translational and basic research into burn injury, wound repair, scarring, fibrosis and long-term outcomes for paediatric and adult burn patients.
University of Western Australia	Institute for Respiratory Health	The Institute for Respiratory Health has been researching respiratory conditions for 20 years including environmental causes of chronic illness and long term exposure to air pollution.

Wildlife and bushfire related research hubs/centres at Australian Universities

Universities involved	*Centre Name*	*Focus*
Host Organisation: by University of Queensland	NESP Threatened Species Recovery Hub	Threatened Species Recovery Hub research is informing on-ground responses to reduce threats and promote recovery of threatened species; and build a better understanding of their status, threats and management options. The Centre for Biodiversity and Conservation Science (CBCS) are undertaking a national analysis on the implications of these fires for Australia's threatened species and also those species that are not threatened but may become endangered due to the fires. This proactive work is part of the wider NESP threatened species hub work led by UQ. Hub partners include ANU, University

Universities involved	*Centre Name*	*Focus*
		of Sydney, UNSW, Charles Darwin University, University of Tasmania, RMIT University, Monash University, University of Melbourne, University of Western Australia, and Australian Wildlife Conservancy.
Griffith University	Environmental Futures Research Institute	Environmental Futures Research Institute (EFRI) is a global leader in environmental research with state-of-the-art facilities used to develop solutions that facilitate clean, resilient and sustainable futures for both fauna and flora of terrestrial and aquatic ecosystems. EFRI supports four strategic research platforms: • Centre for clean environment. • Australian research centre for human evolution. • Planetary health. • Food Futures. Their research addresses key environmental priorities that reflect critical global issues and identifies niche markets and research gaps in the current marketplace.
University of Adelaide	School of Animal and Veterinary Sciences	Following the 2015 Pinery fires in South Australia, veterinary clinical teams from the University of Adelaide developed additional expertise in the management of severe burns and critical care of affected animals. Staff have been volunteering their time to treat animals injured in the current bushfires, such as through Vets Beyond Borders and Koala Rescue. The knowledge and experience in these areas could contribute to a community of improved practice for managing burnt and heat-affected animals.
University of Queensland	Centre for Biodiversity and Conservation Science	The Centre for Biodiversity and Conservation Science (CBCS) are undertaking a national analysis on the implications of these fires for Australia's threatened species and also those species that are not threatened but may become endangered due to the fires. This proactive work is part of the wider NESP Threatened Species Recovery Hub work led by UQ.
University of New South Wales	Centre for Ecosystem Science	The Centre for Ecosystem Science provides advice on the effects bushfires have on native animals, as well as terrestrial ecology, ecosystem restoration, management of invasive species, and predators.
University of Sydney	Australian Wildlife Genomics group	The Australian Wildlife Genomics group has expertise in genetic management of Australian wildlife populations. They are assisting the federal government, as well as some of the states, with providing genetic and small population management expertise as they develop their action plans for how to deal with the catastrophic fires and their long-term impacts on Australia's wildlife.
University of Sydney	Multispecies Justice research group	The group is reconceptualising justice to address the impacts of our era's most pressing problems, such as climate change, Indigenous rights throughout the world, resource depletion and industrial farming for a multispecies world.
University of Sydney	Koala Health Hub	The Koala Health Hub contributes to the generation of new knowledge on koala health management and actively promotes translation of that knowledge through engagement across research, government and rehabilitation sectors.

Universities involved	*Centre Name*	*Focus*
University of Technology Sydney	UTS Centre for Compassionate Conservation	The centre focuses on on critical conservation challenges such as stemming extinction, resolving human-wildlife conflict, ending wildlife trade, enhancing the welfare of wild animals, and promoting coexistence.

Technology and bushfire related research hubs/centres at Australian Universities

Universities involved	*Centre Name*	*Focus*
Curtin University	Innovation Central Perth	Curtin has the enabling platform Innovation Central Perth located on its campus, part of its partnership with Cisco. Cisco's technologies and scale hold promise for advanced near real-time bushfire monitoring and response; and crisis response.
Curtin University	Curtin Institute of Computation	CIC assists in applying computational methods across the sciences, engineering, social sciences, health science, business, and the humanities to provide innovative solutions to complex problems. The CIC initiates and fosters collaborative, interdisciplinary research and education programs with researchers.
Curtin University	The Curtin Hub of Immersive Visualisation and eResearch (HIVE)	The HIVE is an advanced facility established by Curtin University to serve the growing demands of researchers and industry for visualisation, virtualisation and simulation capabilities in Australia. There are a range of visualisation platforms, including a hologram table and 180 degree 3D Visualisation Platform that can be used to for research, science communication, and outreach.
Curtin University	Remote Sensing and Satellite Research Group	This group is part of a national and international network of scientists that undertake quantitative research in the field of Earth observations from space.
Federation University	The Centre for e-Research and Digital Innovation and The Centre for Informatics and Applied Optimisation	The key research themes for the Centres include: 1. Statistical analyses and modelling to predict extreme weather systems and events 2. Digital portals for federation and management of big data for informed decision making including: Grampians Natural Disaster Research; Victorian Ground Water Mapping; AgriFed data portal for informed decision making in farming.
Monash University	Drone Discovery Platform	The Drone Discovery Platform brings drones together with advanced sensing technologies and smart analytics. The state-of-the-art sensors and innovative data handling pipelines provide unique interdisciplinary opportunities across sectors including the STEM disciplines and the Arts. The platform has a national scope to meet the emerging needs of federal and state agencies, to enable industry partnerships and maximise the impact of University research and education.
RMIT University	Centre for Remote Sensing	The Centre has capability in the development and application of remote sensing technologies, including: satellite earth observation, aerial and UAV (RPAS) based hyperspectral and thermal observations, LiDAR, in situ observation systems and

Universities involved	*Centre Name*	*Focus*
		associated modelling to measure, map and monitor the biophysical attributes of terrestrial environments. Key partners include Victoria's Department of Environment, Land, Water and Planning.
RMIT University	Centre for Information Discovery and Data Analytics	The Centre has capability and expertise in developing new approaches to find relevant information in massive data collections, particularly bringing together data, users and systems to build a holistic situational analysis. They also have specific internationally recognised capability in Spatial information, Modelling and Analytics.
RMIT University	SPACE Research Centre	The Centre has capability and expertise in the development of platform technologies to support satellite positioning and tracking, GPS meteorology, atmospheric studies, geodesy and surveying.
Swinburne University	Centre for Design Innovation	The Centre has capability and expertise in designing for bushfire resilience and expertise in programs required for providing essential infrastructure following a disaster. Their work provides important insights into building design for harm minimisation in bushfire-affected regions. For example, their researchers have collaboratively developed the Good Design Award winning Atlite bushfire skylight, the only Australian-designed and made roof window that is bushfire, hail, cyclone and leak resistant.
Swinburne University	Centre for Urban Transitions	The Centre has capability in policy analysis of current dynamics and drivers of urban change, urban modelling and policy scenario analysis using GIS and building and policy performance data, and economic, business-case and investment analysis in low-carbon urban development. Of most relevance is their experience in housing and disaster preparation.
University of Adelaide	School of Biological Sciences	The Spatial Sciences Group has considerable expertise and track record in remote sensing and geospatial analysis, to improve the understanding, management and monitoring of the environment at landscape scales. This includes the Unmanned Remote Aircraft Facility and near real-time satellite imagery analysis.
University of Newcastle	i3 Lab	The UON i3 Lab is currently working with the Department of Defence and Joint & Operations Analysis Division at Edinburgh (SA) in the evaluation of different information delivery modalities for command and control operations. Within the Defence environment, which has similarities with government disaster operations, simultaneous control of entities during logistics and operations tasks creates complex environments that place high information processing demands on operators. The i3 Lab creates virtual environments and platforms for operators to enable understanding of how to optimise performance under these conditions, to improve situational awareness and reduce cognitive load. These operations and tools have direct applicability to bushfire command and control operations, evacuation activities, and using simulation to train personnel in response to disasters.
University of Southern Queensland	Institute for Advanced Engineering and Space Sciences	Within this institute: • The Centre for Astrophysics have developed an advanced fire detection and management system using remote sensing and machine learning from astronomical research into exploding stars;. • The Centre for Future Materials have been developing ways to enhance the resilience of road structures to natural hazards such as flood, bushfire and earthquakes; Other expertise within the Institute includes, water quality and management, GIS surveying of damage, and management of catastrophic failure on energy reticulation networks.

Universities involved	*Centre Name*	*Focus*
University of Sydney	Communications and Technology for Society Research Group	The Communications and Technology for Society Research Group works closely with practitioners focussing on systems interoperability and communications (including social media) in extreme events such as bushfires, floods, epidemics, terrorist attacks etc. Their research supports practitioners with their systems for extreme event management and co-ordination, as well as with the management of communications with the general public and volunteers (including digital volunteers).
University of Sydney	Sydney Institute of Robotics and Intelligent Systems	The Sydney Institute for Robotics and Intelligent Systems (SIRIS), incorporating the Australian Centre for Field Robotics (ACFR), is one of the largest robotics research institutes in the world. SIRIS is uniquely at the forefront of advancements in robotics and intelligent systems, while also being able to address the role of this technology in society by bringing together robotics researchers with experts in design, business, medicine, arts and social sciences from across the University.

University courses specifically related to bushfires and/or disasters

University	*Course Name*
Australian National University	Graduate Certificate of Disaster Risk Science and Sustainability
Charles Darwin University	Master of Emergency and Disaster Management
Charles Darwin University	Graduate Certificate of Emergency and Disaster Management
Charles Darwin University	Graduate Diploma of Emergency and Disaster Management
Charles Darwin University	Graduate Certificate in Leadership (Police, Fire and Emergency Services)
Charles Sturt University	Bachelor of Emergency Management
Charles Sturt University	Master of Emergency Management
Charles Sturt University	Doctor of Public Safety
Charles Sturt University	Graduate Certificate in Fire Investigation
Charles Sturt University	Graduate Certificate in Community Leadership and Resilience
Curtin University	Masters of Environment and Climate Emergency
Curtin University	Graduate Certificate in Environment and Climate Emergency
Curtin University	Graduate Diploma in Environment and Climate Emergency
Federation University	Certificate III Conservation and Land Management
Federation University	Diploma in Conservation and Land Management (as a pathway to)
Federation University	Bachelor of Environmental and Conservation Sciences (including the online module – SCENV3110 “Fire Ecology: Burning Issues in Science and Management)
James Cook University	Graduate Certificate of Disaster Health and Humanitarian Assistance
Queensland University of Technology	Master of Health Management (Emergency and Disaster Management)
Queensland University of Technology	Graduate Certificate in Emergency and Disaster Management

University	*Course Name*
Queensland University of Technology	Short Course: Introduction to Disaster Risk Management
Queensland University of Technology	Short Course: Leadership in Disaster Management
Queensland University of Technology	Short Course: Disaster planning and preparedness
RMIT University	Master of Disaster, Design and Development
Southern Cross University	Course: Fire Ecology and Management
James Cook University	Graduate Certificate of Disaster Management
James Cook University	Graduate Certificate of Disaster Health and Humanitarian Assistance
University of Melbourne	Course: Bushfire Planning and Management
University of Melbourne	Course: Bushfire and Climate
University of Newcastle	Master of Disaster Resilience and Sustainable Development
University of Newcastle	Graduate Certificate in Disaster Risk Reduction
University of Newcastle	Master of Environmental Law
University of Queensland	Master of Engineering Science (MEngSc) in Fire Safety Engineering
University of Queensland	International Master of Science for Fire Safety Engineering (IMFSE)
University of Queensland	Graduate Certificate in Fire Safety (GCFS)
University of Queensland	Bachelor (Honours) and Master of Engineering (BE(Hons)/ME) in Civil Engineering and Fire Safety Engineering
University of Tasmania	Bachelor of Applied Science (Professional Honours in Environmental Management)
University of Tasmania	Bachelor of Justice Studies (includes minor in Emergency Management)
University of Tasmania	Bachelor of Natural Environment and Wilderness Studies (includes minor in Emergency Management)
University of Tasmania	Bachelor of Social Sciences (Police Studies) (includes minor in Emergency Management)
University of Tasmania	Master of Applied Science (Environmental Management and Spatial Sciences)
University of Tasmania	Master of Protected Area Governance and Management
University of Technology, Sydney	Short Course: Planning for Bushfire Prone Areas
Victoria University	Graduate Certificate in Performance Based Building and Fire Codes
Western Sydney University	Master of Bushfire Protection
Western Sydney University	Graduate Certificate in Bushfire Protection

ATTACHMENT C – Bibliometric Analysis Methodology

Search Terms

A group of select search terms (see Table 10) were used to identify bushfire-related publications in the Web of Science database, including those in the Emerging Sources Citation Index (ESCI).

Table 10. Bushfire Search Terms

prescribed fire*	forest AND fire*
fuel-reduction AND fire*	fire AND rainforest
bushfire*	post-fire*
wildfire*	landscape fire*
fire* AND regime*	fire* AND ecology

* = allows for plural forms of the word.
AND = both words may be present in the title, abstract or keywords.

Publications were included in the analysis if any of the search terms appear in the publication's title, abstract, or keywords. As such, analysis is highly contingent on what search terms are used. Search terms which are too broad will capture unrelated publications whereas search terms which are too specific will discount publications which may be relevant. Emphasis should be placed on trends rather than exact numbers of publications.

Average Publications

The average publications is the average annual number of Web of Science documents over a selected time period. Full counting is used, whereby each publication with at least one co-author is counted once towards each country and affiliated organisation. Only publications which are classified as articles, notes, or reviews were counted towards this publication count.

Category Normalised Relative Impact (CNRI)

The Category Normalised Relative Impact (CNRI) of a document is a measure of its citation impact, therefore its academic impact. It is calculated by dividing the actual count of citing items by the expected citation rate for documents with the same document type (article, review), year of publication, and subject area. When a document is assigned to more than one subject area, an average of the ratios of the actual to expected citations is used. A score above 1.2 indicates stronger impact than the world average and below 0.8 is below world average.

Specialisation Index

The Specialisation Index is a measure of scientific output which takes into account both the relative size of a country and the relative size of a research area (Equation 1). The Specialisation Index normalises a country's output in a research field with its output overall and compares this to the average world output in this research field. A Specialisation Index above 1.0 indicates a focus above world average, whereas below 1.0 is below world average.

Equation 1: Calculation of the Specialisation Index

$$Specialisation\ Index\ = \frac{\%\ of\ Australian\ publications\ in\ research\ area\ X}{\%\ of\ world\ publications\ in\ research\ area\ X}$$

ATTACHMENT D – NHMRC Research Expenditure

NHMRC Research expenditure on the health impacts of bushfires and related topics between 2010 and 2019

Research Area	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Bushfires	$228,452	$263,665	$706,671	$466,020	$516,308	$569,420	$533,703	$252,611	$512,294	$519,979	$4,569,123
Occupational health of firefighters					$165,871	$188,857					$354,728
Air pollution	$970,849	$1,047,179	$866,442	$778,190	$1,062,309	$1,132,569	$929,473	$1,057,160	$2,242,620	$2,189,798	$12,276,590
Burns	$1,826,480	$937,430	$511,769	$453,778	$674,792	$661,368	$568,009	$818,974	$795,584	$769,972	$8,018,156

Attachment E - ARC projects relating to bushfire, funded since 2002

16/01/2020

Note 1 - Project data was extracted from the ARC database using 'bushfire', 'forestry fire' as keywords to search project title, abstract (summary) and national benefit text (impact statement) provided in each project application. For this dataset only Project Title and Project Summary text is shown.

Note 2 - The data are to be interpreted with care as it is possible that the keywords used might not capture all in scope projects. It is also possible that some applications extracted are not truly related to the subjects being interested.

Note 3 - All data is limited to the information provided within the application and does not include any variations that have been made to the project after approval.

Note 4 - A Partner Organisation is an Australian or overseas organisation, other than the Administering Organisation, which provides cash and/or in-kind contributions to the research project. Partner Organisations are required in funding certain ARC schemes and may be categorised to different sectors (e.g. Australian, international, government, non-profit, industry or overseas higher education organisations).

Note 5 - FoR refers to Field of Research codes, SEO to Socio-Economics Objectives codes, assigned to a project. Research applicants are invited to classify their applications with up to three 6-digit FoR and SEO codes, and to indicate the proportion of the research content attributable to each code. The information might be helpful in vetting projects for relevance to specific research subject.

Note 6 - Outcomes for some schemes for funding commencing in 2020 have not yet been finalised.

Note 7 - The data are provided for the intended use only (as described in the request in accompanying email) and should not be re-used for any other purpose.

ProjectCode	Scheme Name	Project Title	Project Summary	Admin Organisation Name	Partner Organisation	Funding Commencement Year	Funding Completion Year	Funding Amount	FoR 6-digit level code	SEO 6-digit level code
CE0348177	ARC Centres of Excellence	ARC Centre for Perceptive & Intelligent Machines in Complex Environments	ARC Centre for Perceptive & Intelligent Machines in Complex Environments. The Centre for Perceptive and Intelligent Machines in Complex Environments will perform fundamental research into and construct reliable large-scale systems of networked sensors, computational intelligence, mobile robots, and knowledge sources to support a large variety of critical human tasks, including surveillance/ security (eg. borders/airports/homes), health care support (eg. smart houses/ health condition monitoring, semi autonomous wheelchairs), and civil disaster support (eg. fighting bushfires, looking for people in rubble) always keeping people in the loop so that strong human/ machine cooperative ventures can achieve what neither human or machines could accomplish independently.	Monash University		2003	2007	$5,625,165	280209 - Intelligent Robotics; 280109 - Decision Support and Group Support Systems; 280207 - Pattern Recognition	671499 - Instrumentation not elsewhere classified; 671299 - Computer hardware and electronic equipment not elsewhere classified
DE130100434	Discovery Early Career Researcher Award	What fire regimes can maintain biodiversity in northern Australia's savannah landscapes, and how do we implement them?	Inappropriate fire regimes (the frequency, intensity and size of bushfires) are causing ongoing declines in Australia's biodiversity, yet we have little understanding of the fire regimes that should be implemented. Focussing on Kakadu National Park in northern Australia, this project will develop optimal fire management strategies for conserving biodiversity.	The University of Melbourne		2013	2015	$371,114	060202 - Community Ecology (excl. Invasive Species Ecology); 050211 - Wildlife and Habitat Management; 050104 - Landscape Ecology	960805 - Flora, Fauna and Biodiversity at Regional or Larger Scales; 960906 - Forest and Woodlands Land Management
DE130100924	Discovery Early Career Researcher Award	Living with bushfires: generating essential evidence for sustainable fire management	Planned burning is a crucial tool for bushfire management yet a side effect is smoke pollution. This research will use ambulance data to assess the acute community health impacts of smoke from wild and planned fires to provide essential evidence for increasing the safety and acceptability of planned burning operations in Australia.	University of Tasmania		2013	2015	$375,000	111705 - Environmental and Occupational Health and Safety; 050205 - Environmental Management	920405 - Environmental Health; 960705 - Rural Land Policy; 961004 - Natural Hazards in Forest and Woodlands Environments
DE130101436	Discovery Early Career Researcher Award	Experiments in space: geospatial information technologies for cultural environmental research	By harnessing the power of emerging digital mapping technologies, this research will extend how we understand the relationship between humans and the environment. Specifically it will use maps to generate new knowledge across two important yet everyday problems: bushfire management and urban quality of life.	University of Wollongong		2013	2015	$297,010	200299 - Cultural Studies not elsewhere classified; 160403 - Social and Cultural Geography; 200199 - Communication and Media Studies not elsewhere classified	970116 - Expanding Knowledge through Studies of Human Society; 950205 - Visual Communication; 961099 - Natural Hazards not elsewhere classified
DE130101734	Discovery Early Career Researcher Award	Should I stay or should I go? Increasing natural disaster preparedness and survival through animal attachment	This project will determine the extent to which people's willingness to risk their lives to save animals during natural disasters could be reinterpreted as a protective factor by motivating preparedness. This information will be used to create effective public health campaigns designed to increase natural disaster preparedness and save lives.	Central Queensland University		2013	2015	$371,622	111712 - Health Promotion; 160104 - Social and Cultural Anthropology; 170113 - Social and Community Psychology	920407 - Health Protection and/or Disaster Response; 970117 - Expanding Knowledge in Psychology and Cognitive Sciences; 961099 - Natural Hazards not elsewhere classified
DE140100200	Discovery Early Career Researcher Award	Characterising changes in Australia's vegetation for biomass monitoring, carbon accounting and fire hazard mapping	To reduce the uncertainties in estimating and predicting vegetation biomass and to aid in the development of climate change strategies, this project will formulate and explore the first detailed long term aboveground vegetation biomass carbon record for Australia using a series of satellite passive microwave instruments. The spatiotemporal variation in biomass carbon over past decades will be investigated to better understand how it responds to changing climate and human activities. Such information will allow more accurate estimation of future vegetation dynamics and carbon storage. Moreover, an enhanced bushfire danger index that incorporates aboveground biomass information will be developed to more precisely predict the potential damage.	The University of New South Wales		2014	2016	$385,279	050101 - Ecological Impacts of Climate Change; 090905 - Photogrammetry and Remote Sensing; 040699 - Physical Geography and Environmental Geoscience not elsewhere classified	960501 - Ecosystem Assessment and Management at Regional or Larger Scales; 961004 - Natural Hazards in Forest and Woodlands Environments; 960307 - Effects of Climate Change and Variability on Australia (excl. Social Impacts)
DE150100242	Discovery Early Career Researcher Award	Bushfires, faith and community cohesion: building a resilient Australia	Bushfire emergencies in Australia have social, ethical and political, as well as biophysical causes. Hidden in embedded vulnerability, social norms and institutional structures, these causes are often critical obstacles to building resilient communities. This project aims to identify key ways to heighten resilience by examining how sacred and secular faith affects the ability of individuals and communities to prepare for, respond to and recover from bushfires. Using ethnographic methods, this project will critically examine evidence of bushfire vulnerability, resilience and adaptation strategies driven by, retained in, or promoted through faith and ethics.	University of Wollongong		2015	2017	$353,773	160403 - Social and Cultural Geography; 160499 - Human Geography not elsewhere classified	970116 - Expanding Knowledge through Studies of Human Society; 961099 - Natural Hazards not elsewhere classified
DE150100985	Discovery Early Career Researcher Award	Entrainment and interface dynamics of turbulent flows	Patches of turbulent flow such as in clouds, volcanic or bushfire plumes grow with time because they draw or entrain non-turbulent fluid through their boundaries. The quantity of fluid entrained, and why it entrains this amount, is poorly understood. This is a major bottleneck in our ability to predict how these natural phenomena evolve in time. This project aims to employ idealised laboratory models of these natural phenomena, and utilise high quality measurement techniques and theoretical tools to quantify and understand the physical basis of the entrainment mechanism. The project aims to create better climate models and more accurate predictions of natural disasters associated with bushfires and volcanos.	The University of Melbourne		2015	2017	$390,000	091508 - Turbulent Flows	960202 - Atmospheric Processes and Dynamics; 960303 - Climate Change Models
DE170100367	Discovery Early Career Researcher Award	Decadal climate variability: Mechanisms, interactions and effects	This project aims to study the processes underlying decadal climate variability, through increasingly complex models, underpinned by observations. Climate variations on time scales of years, decades and longer affect Australia, with potentially devastating effects on agriculture, water supply, bushfires and health. Improved climate prediction on decadal time scales is urgently needed, but limited understanding of the system's natural variability hampers progress. This knowledge will reduce uncertainty in near term climate projections, allowing more informed decision making about adaptation on the regional scale, particularly for sectors such as agriculture, health, water and ecosystem management (including bushfire control).	The University of New South Wales		2017	2019	$342,924	040503 - Physical Oceanography; 040105 - Climatology (excl. Climate Change Processes); 040104 - Climate Change Processes	960304 - Climate Variability (excl. Social Impacts); 960310 - Global Effects of Climate Change and Variability (excl. Australia, New Zealand, Antarctica and the South Pacific) (excl. Social Impacts); 960303 - Climate Change Models
DE170100572	Discovery Early Career Researcher Award	Collaborative information seeking and its application in tourism	The project aims to better understand group behaviour of information seeking. Collaboration is an essential aspect of modern life; collaborative work, including tourism, encompasses obtaining and using information. However, most information behaviour models focus on the individual seeker of information, rather than on improving collaboration and team performance. The project builds models and develops guidelines for understanding and supporting collaborative information seeking behaviour in the context of tourism. Making it easier for tourists to find information is expected to benefit the Australian tourism industry.	University of South Australia		2017	2019	$360,000	080703 - Human Information Behaviour	970108 - Expanding Knowledge in the Information and Computing Sciences

ProjectCode	Scheme Name	Project Title	Project Summary	Admin Organisation Name	Partner Organisation	Funding Commencement Year	Funding Completion Year	Funding Amount	FoR 6-digit level code	SEO 6-digit level code
DE180101598	Discovery Early Career Researcher Award	Fire resistant and lightweight wall systems using innovative blocks	This project aims to develop an innovative block with lightweight and fire resistant characteristics by using Pumice and Perlite materials, followed by wall systems using the blocks. For this purpose, it will use material and thermal characterization studies, thermal and structural numerical models and fire tests of the new blocks, wall panels and a compartment. This project will generate new knowledge on lightweight blocks and fire safety, and develops cost-effective fire safe solutions for mid-rise buildings and bushfire safe rooms.	Queensland University of Technology		2018	2020	$357,446	090506 - Structural Engineering	870399 - Construction Materials Performance and Processes not elsewhere classified; 870202 - Commercial Construction Design; 870204 - Residential Construction Design
DE190100233	Discovery Early Career Researcher Award	Pyrosecurity: understanding and managing bushfires in a changing climate	This project aims to examine cultural and political factors that have shaped bushfire management in Australasia during the past two decades and identify how practices might better adapt to a changing world. Bushfires are a serious natural hazard with major social, economic, and environmental impacts. Social and climatic changes are altering the intensity, frequency, and consequences of bushfires, creating significant uncertainties in how we anticipate them. This project will examine how bushfire management practitioners and institutions manage diverse uncertainties, leading to new theoretical insights and strategic policy advice. Expected benefits include better prediction and management of bushfire impacts and improved education and training of bushfire practitioners.	Deakin University		2019	2021	$372,574	160403 - Social and Cultural Geography; 200204 - Cultural Theory	970116 - Expanding Knowledge through Studies of Human Society; 961099 - Natural Hazards not elsewhere classified
DE190100379	Discovery Early Career Researcher Award	Curvature flow of clusters: optimal partitioning and merging fire fronts	This project aims to develop the curvature flow of clusters, a new mathematical innovation that builds on methods with proven success in making new progress on difficult problems in geometry and topology. The curvature flow of clusters will allow foams - partitions of space - to be viewed dynamically. This allows long-standing problems on their structure, a key mathematical challenge in material science, to be studied in a natural context. The project is expected to produce a software suite capable of simulating the movement of merging fire fronts with better accuracy than ever before. The mathematical tools developed by the project will have broad applicability, not only to space partitioning but also notably to bushfires, especially on the dynamics of merging fire fronts.	University of Wollongong		2019	2021	$360,000	010110 - Partial Differential Equations; 010102 - Algebraic and Differential Geometry	970101 - Expanding Knowledge in the Mathematical Sciences
DE200100157	Discovery Early Career Researcher Award	Breaking the link between predators and bushfire for fauna conservation	This project aims to quantify how bushfires amplify the impacts of invasive predators (feral cats and foxes) on native fauna. Through innovative field experiments and empirical modelling, this project expects to generate new knowledge in the key areas of wildlife conservation, fire ecology and invasive species management. Expected outcomes of this project include transformative insights into how threats interact to influence biodiversity and greatly enhanced capacity to manage bushfires and invasive predators. These advances should provide significant benefits, including improved conservation of threatened species, advances in ecological theory and improved capacity to predict and respond to environmental change.	The University of Sydney		2020	2022	$426,343	050202 - Conservation and Biodiversity; 050211 - Wildlife and Habitat Management	960811 - Sparseland, Permanent Grassland and Arid Zone Flora, Fauna and Biodiversity; 960910 - Sparseland, Permanent Grassland and Arid Zone Land and Water Management
DP0452487	Discovery Projects	Infrared optoelectronic sensors based on p-type molecular beam epitaxy grown HgCdTe	The ability of infrared detectors to directly sense the thermal output of an object has applications in medicine, search and rescue, bushfire detection and in the defence and surveillance industries. The highest performing infrared detectors are photon detectors based molecular beam epitaxy (MBE) grown HgCdTe. The primary aims of this project relate to the fundamental understanding of p-type doping in MBE grown HgCdTe, a current and major difficulty in HgCdTe technology, and the use of such p-type MBE grown layers in conjunction with a newly developed plasma process based n-p junction formation technology to realise novel and innovative infrared detector structures. Such structures would have the ability to revolutionise the use of HgCdTe in infrared detectors and focal plane array applications.	The University of Western Australia		2004	2006	$350,000	291702 - Optical and Photonic Systems; 290902 - Integrated Circuits; 240203 - Condensed Matter Physics - Electronic and Magnetic Properties; Superconductivity	671201 - Integrated circuits and devices
DP0556412	Discovery Projects	Nonlocal Statistical Mechanics and Logarithmic Conformal Field Theory	Australia has an enviable track record as an innovator and developer of advanced materials. This project in strategic basic research consists of theoretical work within the disciplines of statistical mechanics and conformal field theory to determine the profound role of nonlocal interactions, such as connectivities, in determining the critical physical properties of materials. Connectivities play a significant role in diverse applications such as the gelation of polymers, random fuse networks, the spatial spread of epidemics and bushfires and the tertiary recovery of oil. This research will be practically useful in engineering the physical properties of advanced materials such as liquid crystals, gels, polymers and other materials.	The University of Melbourne		2005	2007	$201,000	230199 - Mathematics not elsewhere classified; 240201 - Theoretical Physics	780101 - Mathematical sciences; 780102 - Physical sciences; 680399 - Other
DP0556939	Discovery Projects	Australian climate extremes and predictability in a changing CO2 world: the unique role of the Southern Hemisphere extratropical ocean-atmosphere	Australia's climate is extreme, with harsh droughts, severe bushfire seasons, climate change, soil loss, and salinity all posing potentially enormous socio-economic challenges over the next fifty years. Research into climate variability, extremes, and predictability is thus highly significant for Australia, and will underpin efforts to protect our biodiversity and ensure the nation's environmental sustainability. We propose to launch a major new initiative in extratropical climate analysis. This work will have significant benefits for the many sectors of society reliant on interseasonal-interannual climate prediction. Prominent examples include agriculture, energy, freshwater supply, bushfire control, air quality, health, and tourism.	The University of New South Wales		2005	2007	$225,000	260602 - Climatology (incl. Palaeoclimatology); 260403 - Physical Oceanography	770102 - Climate variability; 770101 - Climate change; 770103 - Weather
DP0557638	Discovery Projects	The role of bush fires in the formation and fate of dioxin like chemicals in Australia	A global (POPs) treaty signed by more than 100 nations targets the reduction and elimination of dioxins, which are persistent, bioaccumlative and highly toxic to humans. Bushfires have been suggested as the major source of dioxins in Australia. Experimental data indicate bushfires may not represent the actual sources of dioxin. Our aim is to experimentally establish the levels of dioxins formed and re-emitted from bushfires in Australia. The results will assist to make informed decisions that lead to effective action for reducing dioxin contamination in Australia, fulfilling the treaty requirements and protecting the population and environment.	The University of Queensland		2005	2007	$178,000	259902 - Environmental Chemistry (incl. Atmospheric Chemistry); 300899 - Environmental Sciences not elsewhere classified; 300605 - Fire Management	769999 - Other Environmental aspects; 770799 - Other; 730299 - Public health not elsewhere classified
DP0558468	Discovery Projects	Integrating human operators into large-scale sensor networks	Information awareness is critical in many applications of national importance: from bush fire fighting and defence to transportation and health care. These applications involve tasks in which timely delivery and fusion of heterogeneous information streams is of critical importance. They can all benefit from the use of robotic and embedded sensor networks considered in this project. Human operators, acting as users or supervisors, will remain at the centre of these systems. The technology and algorithms developed in this project will efficiently structure information exchange between humans and sensor networks. Establishing Australian leadership in this fast-evolving high-technology field will spur growth and job creation.	The University of Sydney		2005	2007	$235,000	280104 - Computer-Human Interaction; 280209 - Intelligent Robotics	620399 - Forestry not elsewhere classified; 610104 - Combined Operations
DP0558499	Discovery Projects	Australia's exceptional Palaeozoic fossil fishes, and a Gondwana origin for land vertebrates	The 370 million-year-old Gogo deposit in WA has produced the World's best-preserved fossil fishes of Devonian age. New discoveries of related forms in eastern and central Australia document the deep history of Australia's unique vertebrate fauna, and provide new evidence on the evolution of the first jaws and limbs in vertebrates. They indicate that the first land animals may have evolved on the Australian landmass. These remarkably preserved, information-rich skulls and braincases of some of the oldest known vertebrate fossils provide unique data on early evolution of the head and brain; they are held in national collections as a significant contribution to both National and World Heritage.	The Australian National University		2005	2007	$280,000	260112 - Palaeontology; 270501 - Animal Systematics, Taxonomy and Phylogeny; 270799 - Ecology and Evolution not elsewhere classified	780104 - Earth sciences; 750802 - Preserving movable cultural heritage; 780105 - Biological sciences

Attachment E

ProjectCode	Scheme Name	Project Title	Project Summary	Admin Organisation Name	Partner Organisation	Funding Commencement Year	Funding Completion Year	Funding Amount	FoR 6-digit level code	SEO 6-digit level code
DP0559769	Discovery Projects	A Spatially-Aware RFID-enhanced Sensor Network	Using radio frequency identity (RFID) tags to revolutionise sensor network technologies has the potential to have wide ranging impacts on many of Australia's key industries, including precision agriculture, health care and habitat monitoring (e.g., bush fires). This fundamental research will create a new type of communication network that will have tremendous impact by allowing monitoring and tracking technologies to be deployed over large, infrastructure-free areas at nominal cost. By contributing to the solution of the cost and complexity problems that limit practical deployment of sensor networks, we hope help Australia become a global leader in realizing real-world benefits from information communication technologies.	University of Wollongong		2005	2007	$207,888	291704 - Computer Communications Networks	671399 - Communication equipment not elsewhere classified
DP0666122	Discovery Projects	Coupled Atmosphere-Bushfire Modelling with Application to Canberra 2003	Large bushfires are by far the largest contributor to property losses in Australia. Prescribed fire is an important land management tool for farmers, foresters and park managers among others. There is a need to develop practical and accurate tools for predicting the behaviour and spread of both prescribed and uncontrolled fires. Australian bushfire research and land management would benefit greatly from the application of modern, advanced computational methods. The time is ripe for the huge advances in computer technology and numerical modelling to be applied directly to fire problems, benefiting public safety and the safety of fire-fighting volunteers.	Monash University		2006	2008	$309,000	300605 - Fire Management; 280210 - Simulation and Modelling; 260601 - Meteorology	770502 - Land and water management; 730299 - Public health not elsewhere classified; 770202 - Atmospheric processes
DP0667075	Discovery Projects	Abrupt Southern Hemisphere Climate Change: The Role Of The Southern Ocean Thermohaline Circulation	Australia's climate is extreme, with harsh droughts, severe bushfire seasons, climate change, soil loss, and salinity all posing potentially enormous socio-economic challenges over the next ten-fifty years. Research into climate change and climate variability is thus highly significant for Australia, and will underpin efforts to protect our biodiversity and ensure the nation's environmental sustainability. We propose to launch a major new study of the stability of the Southern Ocean's thermohaline circulation and its role in global climate. This work could have significant long-term benefits for those sectors of society sensitive to shifts in climate; including agriculture, energy, freshwater supply, health, and tourism.	The University of New South Wales		2006	2008	$270,000	260602 - Climatology (incl. Palaeoclimatology); 260403 - Physical Oceanography	770101 - Climate change; 770102 - Climate variability
DP0667123	Discovery Projects	Defence and Security Risk Assessment using Agent Based Distillations	Today's society continues to be occupied with the idea of risk. The recent events of September 11th, the Bali bombing, SARS, the bush fires in Canberra, and the Tsunami are examples of human-made and natural disasters. These events had dramatic consequences on the social, economic, and political environment and numerous industries. This project offers an innovative methodological paradigm for assessing risk through the transfer of technologies drawn from defence simulations to the safety and security areas. The success of this project will mark a paradigm shift in the area of risk assessment and management.	The University of New South Wales		2006	2008	$306,000	280110 - Systems Theory; 280210 - Simulation and Modelling; 280109 - Decision Support and Group Support Systems	610104 - Combined Operations; 700101 - Application packages
DP0667181	Discovery Projects	Nodal Power Saving for Disconnected Ad Hoc Sensor Networks	Bushfire, age care and farming is Australia's today and tomorrow. A key aspect in bushfire control is early detection of ignitions by spreading miniature low power sensors in a large potential area in an ad hoc fashion and localizing. Response to panic alarm buttons by retirees in a retirement village where they are free to walk around while their location is monitored in real time using a wireless tag they carry to transmit data relating to their physical health(i.e blood pressure, ECG etc). Locating live stocks roaming around in the dairy industry using sensory transmission used for monitoring their statues is vitals for the farmer for improving efficiency.	Deakin University		2006	2008	$250,000	291704 - Computer Communications Networks; 280110 - Systems Theory; 280209 - Intelligent Robotics	671399 - Communication equipment not elsewhere classified; 750304 - The aged; 620305 - Integration of farm and forestry
DP0773532	Discovery Projects	Constrained numerical optimisation techniques for automatic graph drawing	Network visualisation (graph drawing) is an enabling technology that is valuable to many important Australian interests. This project aims to develop new techniques that are more easily adapted to specific applications than current methods. There are a range of benefits in developing this technology including but not limited to: improved mapping of terrorist networks that can aid early identification of security threats; improved design and analysis of communication networks, either for the telecommunications industry or for emergency and disaster management scenarios such as bushfires; improved access to biological network databases used in the study of metabolic processes critical to drug development and genetic research.	Monash University		2007	2009	$176,184	280105 - Interfaces and Presentation (excl. Computer-Human Interaction); 280399 - Computer Software not elsewhere classified; 280499 - Computation Theory and Mathematics not elsewhere classified	700199 - Computer software and services not elsewhere classified; 700299 - Information services not elsewhere classified; 729901 - Technological and organisational innovation
DP0877064	Discovery Projects	Plant ecological strategies across species and an evolutionary-ecology vegetation model	This proposal is aimed at fundamental science about plant traits and water use and flammability. These vegetation processes underpin management of bushfires, water, salinity and carbon storage, which are national priorities for An Environmentally Sustainable Australia. The proposal pursues cost-benefit understanding of stem-leaf relations and of flammability, and aims also to develop an evolutionary-ecology vegetation model (EEVM). An EEVM will encapsulate the next generation of fundamental ecological science, with direct application for global change scenarios and for ecosystem management. This proposal forms a network among outstanding laboratories internationally for the purpose, and gives Australia a lead role.	Macquarie University		2008	2010	$690,000	270703 - Terrestrial Ecology; 270706 - Life Histories (incl. Population Ecology); 270799 - Ecology and Evolution not elsewhere classified	760299 - Environmental and resource evaluation not elsewhere classified; 770902 - Land and water management; 770702 - Land and water management
DP0877432	Discovery Projects	Innovations in Bayesian inference with applications to climate extremes	Climate extremes have immense impacts on Australia and society, affecting agriculture, water supply and management, bushfire control, utilities, power, insurance, the economy and many other sectors. This project will examine possible changes in the frequency and intensity of Australian extreme rainfall, droughts, flooding and tropical cyclones using innovative Bayesian statistical methods. The project will provide valuable training to Australian graduates in Bayesian computation and the statistical modelling of climate extremes. It will enhance Australia's reputation as a strong contributor to the development of Bayesian methodologies and climate research, and help foster collaborations between climate and mathematical scientists.	The University of New South Wales		2008	2010	$210,000	230203 - Statistical Theory; 230204 - Applied Statistics; 260602 - Climatology (incl. Palaeoclimatology)	780101 - Mathematical sciences; 770102 - Climate variability
DP0877454	Discovery Projects	Exact solution of generalized models of polymers and percolation in two dimensions	Originating with the work of Rodney Baxter, Australia is the world leader in exactly solvable lattice models in two dimensions. This project, in strategic basic research, aims to continue this tradition and extend it by solving exactly new classes of two-dimensional lattice models involving nonlocal degrees of freedom. Since this will lead to new universal classes of thermodynamic behaviours for a diverse range of polymer-like systems, the potential for exploitation and commercialization is almost limitless. Potential applications include percolation of contaminants through aquifers, the spatial spread of epidemics and bushfires, the tertiary recovery of oil and filtering drinking water.	The University of Melbourne		2008	2011	$365,000	230199 - Mathematics not elsewhere classified; 240201 - Theoretical Physics	780101 - Mathematical sciences; 780102 - Physical sciences; 680399 - Other
DP0878146	Discovery Projects	Analysing Instabilities in Complex Combustion Models for Different Geometrical Configurations	Anyone who has gazed into a fire will appreciate the complexity of combustion. To date only the simplest of models have been comprehensively analysed. This project, which aims to analyse more complex combustion models, will address some of the fundamental issues of combustion theory. Results from this project will lead to a better understanding of combustion processes, with the potential to prevent explosions in reactors and storage tanks. Other potential applications range from bushfires to the manufacture of exotic materials. Furthermore, the novel mathematical techniques developed in this project can be easily adapted to other types of systems such as those used in biology (eg. epidemiology and tumour growth), economics, physics etc.	The University of New South Wales		2008	2011	$301,118	230199 - Mathematics not elsewhere classified; 290699 - Chemical Engineering not elsewhere classified	780101 - Mathematical sciences; 659999 - Other (e.g. safety); 669999 - Other

Attachment E

ProjectCode	Scheme Name	Project Title	Project Summary	Admin Organisation Name	Partner Organisation	Funding Commencement Year	Funding Completion Year	Funding Amount	FoR 6-digit level code	SEO 6-digit level code
DP0878744	Discovery Projects	Reconstructing the historical frequency and intensity of Australian droughts: A multi-species dendrochronological approach	Drought directly and indirectly impacts every Australian. Severe droughts devastate rural communities, lead to increased water restrictions and bushfire activity, slows the national economy and threatens diverse ecosystems. Our research will improve understanding of where, when, and how intensely droughts have occurred across eastern Australia in the past. The results will provide unique insights into the processes that generate Australian droughts and how future droughts might be anticipated. The results will provide farmers, hydrologists, and policy-makers with better data on long-term variability in water supplies to improve local, regional, and national water planning initiatives and infrastructure development.	Monash University		2008	2010	$463,500	270705 - Palaeoecology; 300199 - Soil and Water Sciences not elsewhere classified	770802 - Land and water management; 770102 - Climate variability
DP0879110	Discovery Projects	Categorization and Working Memory: Bridging two Pillars of Cognition	Categorization is a fundamental cognitive skill that underlies much expert behavior, including medical diagnosis. A given task often gives rise to widely divergent strategies across individuals, and flawed strategies have been implicated in prediction errors of experts (e.g., bush fire fighters). This project seeks to identify the underlying variables that determine an individual's strategy acquisition by relating working memory performance to categorization. Working memory is a core cognitive construct that is quite well understood, but its relationship to category learning has so far remained unexplored. Being able to predict the development of categorization strategies can help maximize expert performance.	The University of Western Australia		2008	2011	$244,000	380102 - Learning, Memory, Cognition and Language; 380109 - Psychological Methodology, Design and Analysis	780108 - Behavioural and cognitive sciences
DP0880770	Discovery Projects	Novel Partial Discharge Detection Technique based on an Overhead Transmission Line Sensing Architecture	Overhead power transmission systems are a common instigator of fires through the production of sparks from faulty insulators. Australia is experiencing extended hot and dry conditions that amplify the risk of these events becoming large scale bushfires, causing millions of dollars of damage and destroying immeasurable amounts of native flora and fauna. The overhead transmission line sensing system proposed in this research will provide power companies with a cost effective insulator condition monitoring tool to continually survey Australia's aging electrical infrastructure. This ensures a reliable electricity supply to consumers, while also protecting the ecosystems of Australia's bushland.	RMIT University		2008	2010	$205,000	290901 - Electrical Engineering; 290903 - Other Electronic Engineering	660301 - Electricity transmission; 660399 - Energy distribution not elsewhere classified
DP0985828	Discovery Projects	A unified reinforced concrete model for flexure and shear	The catastrophic Minnesota River Bridge collapse in the USA in 2007 highlighted the importance of accurately assessing, maintaining, upgrading and prolonging the design life of our aging infrastructure. The problem, which is just as severe in Australia, is further exacerbated by increasing man-made (terrorist) hazards and natural hazards such as earthquake, tsunami, flood and bushfire. Reinforced concrete and composite steel-concrete structures comprise a very large part of Australia's bridge and building infrastructure. This project will provide a safe and more economical tool for engineers to both extend the working-life of existing infrastructure and design new infrastructure.	The University of Adelaide		2009	2011	$400,000	290801 - Structural Engineering	680503 - Civil; 680102 - Commercial; 680203 - Civil
DP1093114	Discovery Projects	Optimising Cooperation in Multiterminal Wireless Networks	With more and more of our communications networks becoming wireless, new technologies are required to ensure optimal use of limited resources. This project develops and optimises cooperation for multiterminal wireless networks to increase the transmission rate and / or lower the power consumption of wireless networks. Benefits of this research are efficient deployment and operation of high-speed wireless networks such as broadband Internet and digital television, and improved lower-power wireless sensor networks for applications such as remote monitoring bushfire early warning systems.	The University of Newcastle		2010	2012	$150,000	280506 - Coding and Information Theory	700302 - Telecommunications
DP1093148	Discovery Projects	The dynamics and predictability of fire weather over southern Australia	As illustrated by the recent Victorian bushfires, Australia has one of the most severe fire climates in the world. Fires play a major role in modifying our landscape, affecting native flora and fauna, and damaging infrastructure and property. Effective fire fighting and fire management relies heavily on the prediction of fire weather and the impact of atmospheric conditions on fire behaviour. This project investigates some of the key processes that cause local enhancements in fire weather in regions of complex terrain like southern Australia.	The University of Melbourne		2010	2012	$210,000	260601 - Meteorology; 300605 - Fire Management; 260699 - Atmospheric Sciences not elsewhere classified	770103 - Weather; 770799 - Other; 770202 - Atmospheric processes
DP1093952	Discovery Projects	Advanced Nanostructured Ceramic Composites for Ultracapacitors	The global climate changes and the related disastrous events such as heat flows, bushfires, and flooding will endanger the Australian population and our natural environment. The implementation of effective devices and technologies to reduce our carbon footprint is a priority task. The project addresses the issue by development of new ultracapacitor materials for next generation green energy storage devices through engineering and implementation of advanced nanoceramics and nanocomposites created by innovative nanotechnologies. The project will also contribute to other national research priorities such as materials and frontier technologies, reduction of atmospheric pollution, and decrease in the energy dependence of our country on oil.	University of Wollongong		2010	2012	$280,000	291404 - Ceramics; 291804 - Nanotechnology; 291402 - Composite Materials	660303 - Energy storage; 660502 - Renewable energy; 660503 - Energy storage and distribution
DP1094676	Discovery Projects	Relative income, social preferences, and charitable giving: An experimental analysis	Understanding people's incentives to give to others (i.e., what motivates private donations) is important in regulating social interactions, achieving fair outcomes, and designing optimal responses to natural disasters like floods and bushfires. Australia's social and economic fabric is strengthened by good public polices relating to redistribution and taxation. The cross-cultural aspect of our study will increase awareness about differing beliefs across countries about the determinants of income and how policy makers can use this information to design appropriate policies to help people in need. This research project will also increase the level of academic interactions between Australian and foreign universities.	The University of Melbourne		2010	2012	$183,281	349999 - Economics not elsewhere classified; 340101 - Microeconomic Theory	720299 - Microeconomic issues not elsewhere classified; 720201 - Microeconomic effects of taxation
DP1094784	Discovery Projects	Modes of Pacific Ocean variability and their relationship to regional Southern Hemisphere climate	This project will provide a thorough examination of the role of the major Pacific Ocean modes in forcing variability in Australian climate. Enhancing our knowledge of the mechanisms driving natural modes of variability and how they affect Australian rainfall is fundamental for improving seasonal forecasting and long-term climate prediction. Results from this research can contribute to the underpinning sciences that inform on the risks associated with climate extremes and climate change. This is extremely beneficial to Australia, as it can have implications for adaptation strategies, assisting the socio-economic sectors dependant on climate forecasting, including agriculture, natural resources, bushfire control and water management.	The University of New South Wales		2010	2013	$264,237	260403 - Physical Oceanography; 260602 - Climatology (incl. Palaeoclimatology)	770102 - Climate variability; 770101 - Climate change
DP1095972	Discovery Projects	Insect herbivore and plant responses in eucalypt forests under climate change at physiological, species and community scales	Understanding the drivers for insect populations and vulnerabilities to climate change are the first steps to predicting adaptation and mitigation strategies to minimise impacts of climate change on forest biodiversity. Our research will quantify the outcome of climate change on the still neglected but important insect community associated with eucalypts in Australian forests. These insect communities are widespread, diverse and quintessential for the Australian economy and ecology. Apparent climate change is expected to cause biodiversity shifts, leading to outbreaks and extinctions of insects in eucalypt forests. Negative outcomes of impacts could also include the accumulation of leaf litter, increasing bush fire activity in the future.	Western Sydney University		2010	2012	$305,000	300603 - Pests, Health and Diseases; 300604 - Management and Environment; 279901 - Global Change Biology	770704 - Control of pests and exotic species; 770705 - Integrated (ecosystem) assessment and management; 620301 - Native forests

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ProjectCode	Scheme Name	Project Title	Project Summary	Admin Organisation Name	Partner Organisation	Funding Commencement Year	Funding Completion Year	Funding Amount	FoR 6-digit level code	SEO 6-digit level code
DP1096276	Discovery Projects	Eco-NextNet: An Ecologically-Inspired Adaptive Network Resource Management Framework for a Sustainable Next Generation Mobile Network for Ubiquitous Services	Ubiquitous communications service is the most important element of today's societies. In urban and rural areas of the country as well as at the time of natural disasters such as bushfires, floods, cyclones, it is vital to devise alternative schemes to create and sustain on-demand telecommunications services. In most cases it is not the lack of technology that hinders the implementation of a reliable communications service, but it is the resource allocation. In this project we propose a novel sustainable resource management framework inspired by natural ecological systems to solve the above problem. Upon completion, Australia will be in forefront of technologies related to the management of complex networks.	The University of Sydney		2010	2013	$285,000	291799 - Communications Technologies not elsewhere classified; 291704 - Computer Communications Networks; 291706 - Broadband Network Technology	700302 - Telecommunications
DP1096456	Discovery Projects	Development of Leakage Resistant Well-Cements for Geo-Sequestration of Carbon Dioxide Application using Alkali Activated Slag and Geopolymer Cements	The biggest threat facing life now is climate change due to carbon dioxide (CO2) emissions. Extreme weathers are increasing in frequency and intensity, as evidenced by recent bushfires, and it is predicted to get worse unless carbon mitigation strategies are quickly implemented. Geo-sequestration is the technology of capturing and storing of the CO2 deep below ground for long time (>1000 years). It offers the best hope for large reductions of CO2 emissions. However, CO2-brine stored under pressure is acidic and has the risk of leaking in the long term by dissolving the cement used to seal the pipe wells. This project will develop alternative novel cements which are acid resistant and will not allow CO2 to leak through the sealed wells.	Monash University		2010	2013	$530,000	290801 - Structural Engineering; 290704 - Geomechanics; 290805 - Geotechnical Engineering	770101 - Climate change; 700401 - Prevention and treatment of pollution; 680302 - Cement and concrete materials
DP1097075	Discovery Projects	The Objects of Probabilities	Probabilities impact almost every aspect of our lives. Actuaries calculate probabilities of property loss due to bushfires, while climatologists warn that such probabilities will increase alarmingly. Probabilities abound in engineering, medicine, the law, the sciences and social sciences, and much philosophy. Yet we lack a proper understanding of the kinds of things that receive probabilities: the objects of probabilities. This project will provide such understanding. It will rethink the foundations of probability and decision theory, with potential ramifications for the philosophy, science, and public policy that are based on these theories. It thus aims to strengthen Australia's research profile and international standing in these areas.	The Australian National University		2010	2012	$283,000	440107 - Metaphysics; 440106 - Logic; 440102 - Epistemology	780199 - Other; 780101 - Mathematical sciences
DP110101950	Discovery Projects	How has bushfire activity varied around the Southern Hemisphere over the last 10,000 years?	We will determine the relative contribution of climate and human ignitions in driving bushfire activity around the Southern Hemisphere over the last 10,000 years. Such knowledge is crucial for ecologically sustainable fire management, resolving debates about past Aboriginal environmental impacts and understanding the risk posed by climate change.	University of Tasmania		2011	2015	$560,000	060206 - Palaeoecology; 060208 - Terrestrial Ecology; 050104 - Landscape Ecology; 040605 - Palaeoclimatology	960307 - Effects of Climate Change and Variability on Australia (excl. Social Impacts); 961004 - Natural Hazards in Forest and Woodlands Environments; 960806 - Forest and Woodlands Flora, Fauna and Biodiversity
DP110105376	Discovery Projects	Tree water use, bushfires, and the implications for urban and rural water supplies	After bushfires, regrowing trees in catchments may use water much faster than before the fire. This project will develop simple tests for whether this is the case for a particular area of forest, and why, and how such effects can be incorporated in planning for rural and urban water supplies.	The Australian National University		2011	2013	$340,000	060705 - Plant Physiology; 040608 - Surfacewater Hydrology	960913 - Water Allocation and Quantification
DP120100153	Discovery Projects	Methodologies for resolving high Rayleigh number transitions in convection and elucidating instabilities in polar vortices	This project will develop new methods for modeling complex rotating convection flows such as polar vortices found in the Antarctic atmosphere. This work has the potential to provide insight into important physical processes impacting Australian and global weather patterns, which is crucial for understanding the evolution of our climate.	Monash University		2012	2014	$320,000	091504 - Fluidisation and Fluid Mechanics; 091501 - Computational Fluid Dynamics	970109 - Expanding Knowledge in Engineering; 960307 - Effects of Climate Change and Variability on Australia (excl. Social Impacts)
DP120100727	Discovery Projects	Propagation and free boundary problems in nonlinear partial differential equations	Understanding the propagation of invasive species, flames and disadvantageous genes is a challenging problem in many areas of modern science. This project develops a new mathematical approach to better understand such propagation problems, where the mathematical model predicts a precise location of the propagating front for future time.	The University of New England		2012	2014	$255,000	010110 - Partial Differential Equations	970101 - Expanding Knowledge in the Mathematical Sciences
DP120102123	Discovery Projects	Compression of distributed data: bridging the gap between theory and practice	In bushfire and tsunami early warning systems, environmental monitoring and healthcare applications, distributed sensors collect and transmit correlated data. This project will design novel data compression algorithms that exploit this correlation to dramatically increase the performance of existing networks and enable new applications.	University of South Australia		2012	2014	$320,000	080401 - Coding and Information Theory; 100510 - Wireless Communications	970110 - Expanding Knowledge in Technology; 890103 - Mobile Data Networks and Services
DP120103758	Discovery Projects	Artificial intelligence meets wireless sensor networks: filling the gaps between sensors using spatial reasoning	Monitoring potential disaster regions and integrating available information with expert knowledge can prevent disasters and save many lives. The outcome of our project is one of the key components for intelligent systems that can autonomously monitor the environment, make the correct inferences and issue appropriate warnings and recommendations.	The Australian National University		2012	2014	$320,000	080199 - Artificial Intelligence and Image Processing not elsewhere classified; 080203 - Computational Logic and Formal Languages; 090903 - Geospatial Information Systems	961099 - Natural Hazards not elsewhere classified; 970108 - Expanding Knowledge in the Information and Computing Sciences; 890205 - Information Processing Services (incl. Data Entry and Capture); 810105 - Intelligence
DP120103950	Discovery Projects	Links between bushfires in Victoria and floods in Queensland	This project will investigate connections between bushfires in Victoria and floods in Queensland under the framework that atmospheric blocking can be thought of as a common link. High resolution runs using the Intergovernmental Panel on Climate Change future projections of the energetics of high impact weather will improve climate forecasts in sensitive coastal areas of the country.	The University of Melbourne		2012	2014	$310,000	040104 - Climate Change Processes; 040102 - Atmospheric Dynamics; 040107 - Meteorology	960202 - Atmospheric Processes and Dynamics; 960304 - Climate Variability (excl. Social Impacts); 960303 - Climate Change Models
DP120104159	Discovery Projects	Approximate reasoning with qualitative spatial constraints involving landmarks	Applications like emergency management of bushfires, floods, or earthquake require spatial information systems to integrate multiple kinds of information and make intelligent responses in a very limited time. This project will make breakthroughs in developing efficient methods to reason about complex spatial situations.	University of Technology Sydney		2012	2014	$150,000	080199 - Artificial Intelligence and Image Processing not elsewhere classified; 080201 - Analysis of Algorithms and Complexity	970108 - Expanding Knowledge in the Information and Computing Sciences; 970101 - Expanding Knowledge in the Mathematical Sciences
DP130101866	Discovery Projects	Numerical prediction of bushfire behaviour and bushfire weather	Bushfires are a threat to Australia’s population and infrastructure, but there are many aspects of fire behaviour that are poorly understood. This project will examine how bushfires interact with the atmosphere and how these interactions influence fire spread. This research will underpin the development of new systems for fire weather prediction.	The University of Melbourne		2013	2015	$370,000	040107 - Meteorology; 040102 - Atmospheric Dynamics; 070503 - Forestry Fire Management	960203 - Weather; 961008 - Natural Hazards in Mountain and High Country Environments; 961004 - Natural Hazards in Forest and Woodlands Environments
DP130103646	Discovery Projects	Discovering the molecular mechanisms and origins of karrikin and strigolactone signalling in plants	Understanding how hormones control plant growth has transformed plant biology and driven major advances in crop production. This project will study genes responsible for the action of two new growth regulators, strigolactones and karrikins, and, by uncovering their action mechanisms, will obtain crucial knowledge to stimulate yet further advances in plant science.	The University of Western Australia		2013	2015	$505,000	060702 - Plant Cell and Molecular Biology; 060305 - Evolution of Developmental Systems; 030502 - Natural Products Chemistry	970106 - Expanding Knowledge in the Biological Sciences; 970103 - Expanding Knowledge in the Chemical Sciences; 829999 - Plant Production and Plant Primary Products not elsewhere classified
DP140104567	Discovery Projects	Understanding the biological functions of the karrikin-responsive signaling system of plants in growth, development and responses to the environment	A new signalling system in plants, related to that of strigolactone hormones but evolutionarily more ancient and functionally distinct, has been discovered. It is defined by the Karrkin-Insensitive-2 (KAI2) protein discovered by its ability to confer responsiveness to karrikins from bushfires. The KAI2 system influences seed germination, and development of seedlings, leaves and potentially roots. This project will use KAI2 mutants and transgenic plants to define the biological functions of KAI2 signalling, and its interactions with other signalling systems. New genes central to KAI2 signalling and responses will be identified for functional analysis. The research will reveal the significance of this new signalling system in plant biology.	The University of Western Australia		2014	2016	$395,000	060705 - Plant Physiology; 060703 - Plant Developmental and Reproductive Biology; 060702 - Plant Cell and Molecular Biology	970106 - Expanding Knowledge in the Biological Sciences; 829999 - Plant Production and Plant Primary Products not elsewhere classified; 961203 - Rehabilitation of Degraded Forest and Woodlands Environments

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DP150100299	Discovery Projects	Enabling social innovation for local climate adaptability	Climate variability and change is likely to be felt most acutely at the local scale in Australia. This is where inter/national and State policies are translated into practices to prepare for, and adapt to, anticipated impacts of heatwaves, bushfires and floods. This project will investigate tensions and potentialities between risk-based assessments by local governance agencies and innovations by local groups and Non-Government Organisations. The research will utilise an innovative mixed-methods approach to investigate and to analyse the strategies and experiments of adaptation practices. It aims to develop new ways of identifying and implementing practical, local, adaptive responses that are contextually relevant, socially innovative and capacity building.	RMIT University		2015	2017	$172,500	160403 - Social and Cultural Geography; 160514 - Urban Policy; 120502 - History and Theory of the Built Environment (excl. Architecture)	960301 - Climate Change Adaptation Measures; 960311 - Social Impacts of Climate Change and Variability; 940204 - Public Services Policy Advice and Analysis
DP150100878	Discovery Projects	Managing Australian landscapes to reduce house loss during bushfires	The number of houses destroyed by bushfires in Australia is increasing. This project aims to undertake the first comprehensive analysis of links between land management practices and house loss during bushfires across Australia. Results from this research are expected to improve the ability of authorities, industry and individual home owners to quantify risk from bushfires, and to identify ways that Australian landscapes can be managed to reduce house losses during bushfires. Results from this research will be communicated directly to key stakeholders including government agencies, industry and home owners.	The Australian National University		2015	2017	$217,500	120504 - Land Use and Environmental Planning; 050205 - Environmental Management	961004 - Natural Hazards in Forest and Woodlands Environments; 961010 - Natural Hazards in Urban and Industrial Environments; 960708 - Urban Land Policy
DP150101777	Discovery Projects	Aboriginal patch burning and the quest for sustainable fire management	This project aims to document historical changes in the spatial grain of the patch burning mosaic in an Arnhem Land savannah with an unbroken history of management by Aboriginal people, and in adjacent areas where traditional management has ceased. The mosaic's spatial grain will be inferred by mapping the individual ages of the long-lived conifer Callitris intratropica. Prior research has shown that Callitris individuals can be reliably aged, and population structures are very sensitive to fire regimes: saplings only establish if unburnt for 10 years. This research is expected to provide the first direct test of the hypothesis that Aboriginal people maintained fine-grained fire mosaics in savannas, and inform bushfire policy debates.	University of Tasmania		2015	2017	$276,363	050104 - Landscape Ecology; 050202 - Conservation and Biodiversity	960906 - Forest and Woodlands Land Management; 960806 - Forest and Woodlands Flora, Fauna and Biodiversity
DP160103248	Discovery Projects	Bushfire-enhanced wind and its effects on buildings	This project seeks to advance our understanding of bushfire–wind interaction to improve current design standards for buildings against bushfire-enhanced winds. Bushfire-enhanced winds have caused considerable property damage and loss of lives. The project aims to identify the mechanisms governing bushfire–wind interaction and determine the wind load effects on buildings due to bushfire-enhanced wind. It aims to do so by using advanced computation techniques and unique fire-wind tunnel test facility. This knowledge is designed to guide the development of improved building construction standards for bushfire-prone regions to facilitate the design and construction of a new generation of bushfire-resistant buildings that safeguard lives and properties against the increasing threat of bushfire due to climate change.	Western Sydney University		2016	2018	$330,000	120202 - Building Science and Techniques; 091503 - Engineering Practice; 090502 - Construction Engineering	870204 - Residential Construction Design; 961004 - Natural Hazards in Forest and Woodlands Environments; 970112 - Expanding Knowledge in Built Environment and Design
DP170100177	Discovery Projects	Microeconomic effects of Australian natural disasters	This project aims to describe and identify the effects of Australian natural disasters – such as the Black Saturday bushfires and the Brisbane floods – on important microeconomic outcomes, including health, education and employment. Natural disasters have profound economic and social effects on individuals and communities. This project intends to bring evidence on how disasters affect individuals and how the effects can be lessened. The project expects to inform policy-makers on these critical issues by analysing field, survey and administrative data on individuals before and after past disasters.	Monash University		2017	2019	$403,500	140208 - Health Economics; 140211 - Labour Economics	910202 - Human Capital Issues; 920407 - Health Protection and/or Disaster Response
DP180102250	Discovery Projects	Navigating under the forest canopy and in the urban jungle	This project aims to develop a framework for unmanned aerial vehicles (UAV), which optimally balances localisation, mapping and other objectives in order to solve sequential decision tasks under map and pose uncertainty. This project expects to generate new knowledge in UAV navigation using an innovative approach by combining simultaneous localisation and mapping algorithms with partially observable markov decision processes. The project's expected outcomes will enable UAVs to solve multiple objectives under map and pose uncertainty in GPS-denied environments. This will provide significant benefits, such as more responsive disaster management, bushfire monitoring and biosecurity, and improved environmental monitoring.	Queensland University of Technology		2018	2020	$362,734	090104 - Aircraft Performance and Flight Control Systems; 090602 - Control Systems, Robotics and Automation; 050202 - Conservation and Biodiversity	880303 - Air Safety; 960511 - Ecosystem Assessment and Management of Urban and Industrial Environments; 960501 - Ecosystem Assessment and Management at Regional or Larger Scales
DP190101733	Discovery Projects	Drift learning for decision-making in dynamic multi-stream environments	This project aims to provide application-ready real-time decision support systems for big data situations. Real-time support for organisational decisions is crucial in fast-changing environments that are highly dependent on data from multiple large streams. Unforeseen changes in data distribution (drift) are inevitable. The ability to learn drift in dynamic environments with multiple large data streams will benefit innovation and decision quality in challenging data situations. The project will have wide applications, such as in cybersecurity, telecommunications, bushfire control and logistics. The project will advance machine learning knowledge, providing a foundation and technologies to support real-time decision-making in big data environments.	University of Technology Sydney		2019	2021	$467,000	080605 - Decision Support and Group Support Systems; 080109 - Pattern Recognition and Data Mining; 080108 - Neural, Evolutionary and Fuzzy Computation	890205 - Information Processing Services (incl. Data Entry and Capture); 890201 - Application Software Packages (excl. Computer Games); 970108 - Expanding Knowledge in the Information and Computing Sciences
DP200101123	Discovery Projects	Shaping a sunburnt country: fire, climate and the Australian landscape	Fire shapes Australia's landscape, biodiversity and resources. This project aims to quantify the recent history of fire intensity and severity using several novel proxies in the fire-prone landscapes of south-eastern Australia. Calibration of these new proxies to recent wildfires will be used for a better characterisation of fire regimes. This research will be applied to sedimentary archives to investigate how fire regimes have evolved over the past 100 years. The outcomes will inform debates about the relationship between climatic variability and fire severity, and this will contribute to increase the preparedness of natural resource management to potential future climate and land-use scenarios.	University of Wollongong		2020	2022	$379,000	040604 - Natural Hazards; 050209 - Natural Resource Management	960307 - Effects of Climate Change and Variability on Australia (excl. Social Impacts)
DP200101311	Discovery Projects	Unraveling hexavalent chromium formation and fate in fire-impacted soil	Hexavalent chromium is a cancer-causing toxin. It can form via heating of natural (unpolluted) soil during bushfires. However, little is known of the processes and factors which govern its formation and behavior in fire-impacted soil. Using a combination of field-based investigations, innovative experiments and cutting edge analytical approaches, this project aims to systematically explore hexavalent chromium formation via fire-induced heating of soil and to examine its post-fire fate in soil systems. The results will transform our understanding of the chromium cycle at the Earth's surface, and will facilitate accurate assessment and mitigation of the risks posed by hexavalent chromium formation in fire-impacted soil.	Southern Cross University		2020	2022	$390,000	040202 - Inorganic Geochemistry; 050304 - Soil Chemistry (excl. Carbon Sequestration Science)	961204 - Rehabilitation of Degraded Fresh, Ground and Surface Water Environments; 960906 - Forest and Woodlands Land Management
DP200101627	Discovery Projects	Airborne Base Station Communication Systems: Capacity and Optimization	This project will fundamentally characterise and optimize information gathering, dissemination, and communication capacities of airborne base stations to enable low latency communications in rural and remote areas. New technologies such as precision farming, safe remote equipment operation in mining, and wide area surveillance and security, require low latency communications that are an order of magnitude beyond what is currently available from satellite links. The expected outcome will be radically new base station deployment and flight path planning, and data transmission technologies. These will unlock new application technologies by enabling secure wide-spread communications coverage, delivering economic benefits to remote Australia.	Macquarie University		2020	2022	$405,000	100510 - Wireless Communications	890103 - Mobile Data Networks and Services

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DP200101640	Discovery Projects	When every second counts: Multi-drone navigation in GPS-denied environments	The aim of this research is to develop a framework for multiple Unmanned Aerial Vehicles (UAV), that balances information sharing, exploration, localization, mapping, and other planning objectives thus allowing a team of UAVs to navigate in complex environments in time critical situations. This project expects to generate new knowledge in UAV navigation using an innovative approach by combining Simultaneous Localization and Mapping (SLAM) algorithms with Partially Observable Markov Decision Processes (POMDP) and Deep Reinforcement learning. This should provide significant benefits, such as more responsive search and rescue inside collapsed buildings or underground mines, as well as fast target detection and mapping under the tree canopy.	Queensland University of Technology		2020	2022	$360,000	090104 - Aircraft Performance and Flight Control Systems; 090602 - Control Systems, Robotics and Automation; 050202 - Conservation and Biodiversity	880303 - Air Safety; 960511 - Ecosystem Assessment and Management of Urban and Industrial Environments; 960501 - Ecosystem Assessment and Management at Regional or Larger Scales
DP200101859	Discovery Projects	Extreme Value Theory Approaches to Insurance in a Catastrophic Environment	Recent decades are marked by numerous significant natural (climate change) or man-made (financial crises) catastrophes, which have significantly altered the landscape of the insurance industry. These have potentially significant negative impacts on the availability and affordability of insurance, and hence on the capability and capacity of households and businesses to take risks and be competitive. This project endeavours to establish progressive approaches (using extreme value theory) to the challenges faced by insurance in such a catastrophic environment. They will enhance the financial stability and competitivity of the Australian economy, and further establish its global leadership in dealing with climate changes and catastrophes.	The University of New South Wales		2020	2022	$310,000	150205 - Investment and Risk Management	900103 - Superannuation and Insurance Services
DP200102704	Discovery Projects	Light steel roof and wall systems under combined wind and bushfire actions	The project aims to investigate the complex behaviour of light cold-formed-steel roof and wall systems involving localized failures under the combined action of wind and bushfire using wind suction tests at elevated temperatures combined with advanced numerical modelling. It will generate new knowledge of the behaviour and strength of cold-formed-steel roof and wall systems under bushfire conditions. Expected outcomes include new design models for wind, bushfire and cold-formed-steel Standards. This will significantly improve the bushfire safety of buildings, since non-combustible steel roof and wall systems are used as building envelopes in bushfire prone areas, but are not designed to withstand recently discovered bushfire-enhanced winds.	Queensland University of Technology		2020	2022	$277,000	090506 - Structural Engineering	861205 - Sheet Metal Products; 861206 - Structural Metal Products; 870204 - Residential Construction Design
FF0561734	Federation Fellowships	Genesis of Australian Climate Extremes in the Southern Hemisphere Extratropical Ocean-Atmosphere	Australia's climate is extreme, with harsh droughts, severe bushfire seasons, climate change, soil loss, and salinity all posing potentially enormous socio-economic challenges over the next fifty years. Research into climate variability, extremes, and predictability is thus highly significant for Australia, and will underpin efforts to protect our biodiversity and ensure the nation's environmental sustainability. I propose to launch a major new initiative in extratropical climate analysis. This work will have significant benefits for the many sectors of society reliant on interseasonal-interannual climate prediction. Prominent examples include agriculture, energy, freshwater supply, bushfire control, air quality, health, and tourism.	The University of New South Wales		2005	2010	$1,551,625	260602 - Climatology (incl. Palaeoclimatology); 260403 - Physical Oceanography	770102 - Climate variability; 770101 - Climate change; 770103 - Weather
FF0668718	Federation Fellowships	Adaptive and Integrated Resource Allocation	By leveraging progress in communication technologies, adaptive and integrated optimization systems will open innovative application areas critical to Australia, yet outside the scope of existing optimization technology. For instance, they will dispatch and reallocate ambulances in real time, help contain pandemics, allocate resources dynamically to extinguish bushfires, and assist in failure recovery of energy infrastrutures. These systems will also solve existing logistics and manufacturing applications better, making these industries more effective and reactive. The project also aims at establishing a center of excellence in optimization in Melbourne with an international reputation in research, teaching, and industrial collaboration.	Monash University		2006	2011	$1,581,110	230117 - Operations Research; 280301 - Programming Techniques; 280303 - Programming Languages	700102 - Application tools and system utilities; 730399 - Health and support services not elsewhere classified; 710101 - Electricity services and utilities
FL100100214	Australian Laureate Fellowships	Future risks associated with ocean surface warming: impacts on climate, rainfall, carbon, and circulation	Climate change is already affecting Australia, with harsh drought, more intense bushfire seasons, increased monsoon rains, heatwaves, and warmer temperatures all a feature of the past few decades. Climate change is expected to accelerate in the future, warming the oceans at an increased rate. This will affect ocean circulation, carbon uptake and ocean-atmosphere modes, such as El Nino, with unknown intensity. This project will improve our preparedness for climate change by better quantifying the risks that ocean warming will transform Australia's climate, rainfall, and sea level; as well as the ocean's uptake of carbon and the global ocean circulation. This will benefit sectors including agriculture, water management, fisheries, and tourism.	The University of New South Wales		2010	2015	$2,918,382	040503 - Physical Oceanography; 040104 - Climate Change Processes; 040102 - Atmospheric Dynamics	960307 - Effects of Climate Change and Variability on Australia (excl. Social Impacts); 960303 - Climate Change Models; 960304 - Climate Variability (excl. Social Impacts)
FS100100081	Super Science Fellowships	The dynamics of subtropical anticyclones and the connection to drought, heatwaves and bushfires in southern Australia	The aim of the project is to understand the dynamics of anticyclones (high pressure systems) in the region of southern Australia. The study of anticyclones in the region is important because of their very strong connection to rainfall in the winter, and heatwaves and bushfires in the summer, and because so little work has been done on understanding what is the defining feature of the climate of southern Australia. Understanding what controls the location and strength of these features will go a long way to explaining how the climate of southern Australia will change in a warmer world.	Monash University		2010	2013	$556,800	040104 - Climate Change Processes; 040102 - Atmospheric Dynamics	960202 - Atmospheric Processes and Dynamics; 960303 - Climate Change Models
FT100100108	ARC Future Fellowships	DNA and the missing: ancient DNA and advanced forensic identification	Identifying the remains of missing persons, disaster victims and war dead is of major social and cultural importance and has significant implications for national and international justice systems. This project will apply expertise in analysis of ancient DNA to build capacity and expertise within Australia to identify highly degraded human remains.	The University of Adelaide		2010	2014	$693,272	069901 - Forensic Biology; 060411 - Population, Ecological and Evolutionary Genetics	810107 - National Security; 940402 - Crime Prevention; 940302 - International Aid and Development
FT100100774	ARC Future Fellowships	Representation theory of diagram algebras and logarithmic conformal field theory	Generalized models of polymers and percolation are notoriously difficult to handle mathematically, but can be described and solved using diagram algebras and logarithmic conformal field theory. Potential applications include polymer-like materials, filtering of drinking water, spatial spread of epidemics and bushfires, and tertiary recovery of oil.	The University of Melbourne		2010	2014	$682,909	010505 - Mathematical Aspects of Quantum and Conformal Field Theory, Quantum Gravity and String Theory; 010501 - Algebraic Structures in Mathematical Physics; 010502 - Integrable Systems (Classical and Quantum); 010506 - Statistical Mechanics, Physical Combinatorics and Mathematical Aspects of Condensed Matter	970101 - Expanding Knowledge in the Mathematical Sciences
FT120100715	ARC Future Fellowships	Climate-proofing southeastern Australia's native forests: where, when, and how?	Changing environmental conditions and forest fragmentation threaten the ability of native forest species to regenerate or migrate. Using unique long–term datasets and novel statistical analyses, this project will assess future risks to forest regeneration after logging, bushfires, and land abandonment.	The University of Melbourne		2012	2016	$683,974	070504 - Forestry Management and Environment; 050101 - Ecological Impacts of Climate Change	820104 - Native Forests; 960301 - Climate Change Adaptation Measures; 960505 - Ecosystem Assessment and Management of Forest and Woodlands Environments
FT130100043	ARC Future Fellowships	How does ecological disturbance shape the genetic diversity of natural populations?	Environmental disturbances shape the dynamics of the world's ecosystems. However, we do not understand how they influence biodiversity at its most fundamental level, genetic diversity. This is important, because genetic diversity affects the fitness of individuals, the viability of populations and the adaptability of species. This project will study fire in the Australian environment to discover how disturbance affects genetic diversity. By integrating landscape genomics and computational modelling with long-term field studies, the research will significantly advance our understanding of how genetic diversity is distributed, and improve our ability to predict the responses of natural populations to changes in the frequency and severity of wildfire.	The Australian National University		2013	2017	$735,320	060411 - Population, Ecological and Evolutionary Genetics; 060208 - Terrestrial Ecology; 050211 - Wildlife and Habitat Management	961004 - Natural Hazards in Forest and Woodlands Environments; 960806 - Forest and Woodlands Flora, Fauna and Biodiversity; 960305 - Ecosystem Adaptation to Climate Change

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ProjectCode	Scheme Name	Project Title	Project Summary	Admin Organisation Name	Partner Organisation	Funding Commencement Year	Funding Completion Year	Funding Amount	FoR 6-digit level code	SEO 6-digit level code
IN130100038	Discovery Indigenous	Investigation of atypical bushfire spread driven by the interaction of wind, terrain and fire	Large bushfires continue to pose a significant risk to communities in south-eastern Australia. Despite this, there is still very little known about the processes driving the development of large bushfires. This project aims to improve understanding of extreme fire processes and thus improve mitigation planning, community safety and environmental outcomes.	The University of New South Wales		2013	2015	$460,000	040604 - Natural Hazards; 090702 - Environmental Engineering Modelling; 070503 - Forestry Fire Management	970105 - Expanding Knowledge in the Environmental Sciences; 961008 - Natural Hazards in Mountain and High Country Environments; 961004 - Natural Hazards in Forest and Woodlands Environments
IN140100011	Discovery Indigenous	Understanding the role of terrain geometry in eruptive bushfire behaviour	This project aims to improve understanding of the physical processes that cause eruptive bushfire behaviour, otherwise known as fire blow-up. Eruptive fire behaviour, characterised by rapid and unexpected escalation in fire intensity and rate of spread, is a global phenomenon that poses a major threat to fire-fighter safety and can seriously compromise bushfire suppression efforts. This project will address the role that terrain geometry plays in the incidence of fire eruption, through consideration of its effect on the attachment of flames to a surface. Expected outcomes include a dynamic fire spread modelling framework and the provision of better advice to bushfire authorities concerning fire blow-up.	The University of New South Wales		2014	2016	$370,000	090702 - Environmental Engineering Modelling; 040604 - Natural Hazards; 010299 - Applied Mathematics not elsewhere classified	970105 - Expanding Knowledge in the Environmental Sciences; 961008 - Natural Hazards in Mountain and High Country Environments; 970109 - Expanding Knowledge in Engineering
IN160100029	Discovery Indigenous	Understanding the role of deep flaming in violent pyroconvective events	This project aims to improve the prediction of firestorms by combining state-of-the-art knowledge of dynamic bushfire behaviour with atmospheric models to provide a comprehensive understanding of how the heat and moisture released by a bushfire interacts with ambient atmospheric instability to produce extreme fire events. Firestorms represent the most extreme and catastrophic phase of development of a bushfire. They often cause broad-scale loss of property, environmental damage and human fatalities. Firestorms cannot be suppressed, and so accurate and timely warnings of their occurrence, combined with appropriate community responses, are the only way of mitigating their effects. Better understanding of extreme fire processes may improve mitigation planning, community safety, environmental outcomes and emergency response measures.	The University of New South Wales		2016	2018	$404,000	040604 - Natural Hazards; 040102 - Atmospheric Dynamics; 090702 - Environmental Engineering Modelling	970105 - Expanding Knowledge in the Environmental Sciences; 961004 - Natural Hazards in Forest and Woodlands Environments; 960202 - Atmospheric Processes and Dynamics
LE0560940	Linkage Infrastructure, Equipment and Facilities	Stable Isotope Ratio Mass Spectrometry Facility	This application for a Stable Isotope Ratio Mass Spectrometer Facility provides a focus for research collaboration and training in northern Australia. The Facility will enhance strong collaboration between organisations committed to increasing understanding of unique northern environments, and will include the Arafura Timor Research Facility, a Major National Research Facility. The Facility will contribute to studies of conservation biology, natural resource management, environmental and marine science and resource development in the tropical north. It will help develop knowledge bases, innovative approaches to environmental management and sustainable development and high levels of research and research training for regional development.	Charles Darwin University		2005	2005	$229,326	259902 - Environmental Chemistry (incl. Atmospheric Chemistry); 300803 - Natural Resource Management; 300802 - Wildlife and Habitat Management	780103 - Chemical sciences; 770304 - Physical and chemical conditions; 780105 - Biological sciences
LE0775666	Linkage Infrastructure, Equipment and Facilities	Flora and Fauna Research Facility	Our ability to make informed decisions regarding conservation and management of unique Australian ecosytems depends greatly on our understanding of the organisms inhabiting them. Researchers at the University of Wollongong are addressing this need through a wide range of studies including the: effects of climate change on plants, biology of invasive species, possible causes for declining frog populations, role of the immune system in aging and natural selection, effects of maternal hormones on offspring, effects of pesticides on native vertebrates, and impacts of bushfires on ecosystems. The infrastructure requested will enable research in these and other important areas.	University of Wollongong		2007	2007	$200,000	270703 - Terrestrial Ecology; 270604 - Comparative Physiology; 270706 - Life Histories (incl. Population Ecology)	780105 - Biological sciences; 770704 - Control of pests and exotic species; 771103 - Living resources (flora and fauna)
LE100100141	Linkage Infrastructure, Equipment and Facilities	High-resolution ITRAX XRF core scanning facility for global change research	This facility will enable researchers to obtain high-resolution geochemical profiles in the study of environmental change and climate variability. It will provide archive data on the variation of density and chemical element composition along sediment and soil cores, rock cores, wood samples, speleothems and corals. These archives contain important information such as human activity, climate variability, water quality changes, pollution histories, recent geomorphological change, land-use change, introduction of invasive species and the occurrence of bushfires. A better understanding of the occurrence and timing of these major environmental issues is of national and regional importance.	AINSE Limited	Australian Nuclear Science and Technology Organisation (PO)	2010	2010	$420,000	040310 - Sedimentology; 040311 - Stratigraphy (incl. Biostratigraphy and Sequence Stratigraphy); 040606 - Quaternary Environments; 040605 - Palaeoclimatology; 040202 - Inorganic Geochemistry; 040601 - Geomorphology and Regolith and Landscape Evolution; 060206 - Palaeoecology; 210102 - Archaeological Science; 040607 - Surface Processes; 050206 - Environmental Monitoring; 050205 - Environmental Management; 050204 - Environmental Impact Assessment	770102 - Climate variability; 770705 - Integrated (ecosystem) assessment and management; 750901 - Understanding Australia's past; 780104 - Earth sciences; 750902 - Understanding the pasts of other societies; 770304 - Physical and chemical conditions; 770402 - Land and water management; 770409 - Estuarine and lagoon areas; 770101 - Climate change
LP0348543	Linkage Projects	Bushfire smoke and the relationship between human and landscape health	A team of landscape ecologists, environmental chemists and public health specialists will determine the ecological causes and adverse health effects of different levels of bushfire smoke in Darwin. Darwin is an ideal setting for this research because the only source of air pollution is the high incidence of controlled and uncontrolled bushfires during the dry season causing variable air quality: a preliminary study found a link between smoke pollution levels and asthma. The findings of the proposed research will contribute to improved fire management practices to reduce injurious smoke pollution events and contribute to setting appropriate national air quality standards.	Charles Darwin University	NT Department of Business, Industry and Resource Development (PO); Department of Infrastructure Planning and Environment (PO); Department of Health and Community Services (PO); Bureau of Meteorology (PO)	2003	2006	$395,000	300605 - Fire Management; 259902 - Environmental Chemistry (incl. Atmospheric Chemistry); 321202 - Epidemiology	770701 - Air quality; 730210 - Environmental health; 770702 - Land and water management
LP0455679	Linkage Projects	Robotic Vehicles for Fire Fighting and Emergency Services Support	The use of robots to support humans in bushfire fighting, search and rescue missions, civil disaster operations and terrorist apprehension (including hostage rescue) can save lives, minimise injury and improve security. This project aims at providing such capabilities and to deploy them in modes from direct teleoperation to fully autonomous operation as the situation dictates, in full partnership with the Victorian Country Fire Authority.	Monash University	Country Fire Authority (PO)	2004	2009	$495,950	280209 - Intelligent Robotics	671499 - Instrumentation not elsewhere classified; 671299 - Computer hardware and electronic equipment not elsewhere classified
LP0561200	Linkage Projects	Design of Wireless sensor and communication networks with fixed and mobile nodes.	Wireless sensor and communication networks with fixed and mobile nodes are rapidly becoming essential technologies for hostile environmental monitoring, battlefield surveillance and precision agriculture. However, due to the complexities associated with interconnected design issues involving sensors, autonomous vehicles and communication protocols, even very simple networks have proven to be difficult to design. This project proposes to intelligently employ higher capabilities of mobile nodes and develop methods for rapid deployment, maintenance and routing that are aware of location, energy, and security. The outcomes of this project will form the basis for design of intelligent wireless networks for defence and civilian applications.	University of Technology Sydney	ADI Limited (PO)	2005	2007	$180,000	291704 - Computer Communications Networks; 280110 - Systems Theory; 280204 - Signal Processing	610104 - Combined Operations; 700302 - Telecommunications; 729901 - Technological and organisational innovation
LP0562568	Linkage Projects	Developing a Smart Monitoring System for Leakage Currents from Insulators on Wooden Poles	Numerous wooden poles are used for electricity power transmission in urban and rural areas of Australia. Insulators suspended on poles are subject to contamination and moisture that cause partial discharge currents to flow through the wooden poles, resulting in pole fires leading to loss of power to customers and possible bush fires. This project aims at studying the characteristics of leakage currents from insulators on wooden poles in Australian conditions and developing a smart monitoring system to detect and prevent pole fires caused by leakage currents. The outcomes will reduce the risk of pole fires, hence improving public safety, reliability of power supply and sustainability of the Australian power industry.	RMIT University	Alinta Network Services (PO); Powercor Australia (PO)	2005	2008	$144,888	290901 - Electrical Engineering; 280204 - Signal Processing; 280201 - Expert Systems	660301 - Electricity transmission; 671403 - Industrial instrumentation; 700103 - Information processing services

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LP0776483	Linkage Projects	Assisted GPS and Advanced Positioning For Emergency Services	Many volunteers have lost their lives fighting bushfires in Australia. Fires are becoming more numerous and more fierce. Some of those firemen could have been saved if better information was available: where they were, where the firefront was and how it was progressing. This project aims to save lives by solving part of this problem: locating and reporting the position of the remote firefighter by making GPS work reliably under trees. This will also make search and rescue operations safer and more efficient. The technology can transfer readily into the location-based services market which is set to boom in the next decade. This project helps maintain momentum in Australia's world-class but small positioning industry.	The University of New South Wales	Signav Pty Ltd (PO)	2007	2010	$153,762	291005 - Navigation and Position Fixing; 291710 - Radio Communications and Broadcasting not elsewhere classified	671399 - Communication equipment not elsewhere classified; 770799 - Other
LP0776604	Linkage Projects	Spatial-dynamic models to identify optimal fire mosaics, based on demography, dispersal and fire responses of plants, birds and reptiles	Inappropriate fire regimes threaten native species with extinction. The threat is higher in cleared landscapes where habitat is isolated and recolonisation unlikely. Furthermore, climate change is predicted to increase the frequency of intense bushfires. To meet the priority goals Sustainable Use of Biodiversity, and Responding to Climate Change, landscape-scale fire management is essential. We will use simulation models based on detailed biological data and fire-behaviour to explore large-scale and long-term consequences of alternate fire management policies. Our project will enable fire mosaics to be implemented that maintain biodiversity and will identify effective fire management responses to climate change, and habitat fragmentation.	Flinders University	Department for Environment & Heritage (PO); South Australian Museum (PO); Native Vegetation Council (PO); Department of Environment and Conservation NSW (PO)	2007	2011	$431,052	270708 - Conservation and Biodiversity; 300803 - Natural Resource Management; 300902 - Land and Parks Management	770705 - Integrated (ecosystem) assessment and management; 770805 - Integrated (ecosystem) assessment and management; 770703 - Living resources (flora and fauna)
LP0881993	Linkage Projects	Developing a decision support system for the management of road runoff for water quality protection	Multiple stakeholders share a vested and often significant financial commitment to ensure water quality standards. These industries, in turn, are vital to the social and economic sustainability of many rural communities in Australia. Recent climatic trends of increasing drought episodes and related natural disasters such as bushfires are expected to increase the delivery of sediments and associated pollutants to streams. The proposed DSS will allow testing of various management scenarios with respect to road position and layout, thereby providing a planning and management tool, and a method to educate the practitioners involved in environmental management in Australia.	The University of New South Wales	Forests NSW (PO); Parks, Conservation & Lands Branch, Dept. of Territory and Municipal Services (PO); Department of Sustainability and Environment (PO); Department of Environment and Conservation (PO); Southern Rivers Catchment Management Authority (PO); Eurobodalla Shire Council (PO)	2008	2010	$290,000	260502 - Surfacewater Hydrology; 260114 - Geomorphology; 300105 - Applied Hydrology (Drainage, Flooding, Irrigation, Quality, etc.)	770702 - Land and water management; 770402 - Land and water management; 770802 - Land and water management
LP0882048	Linkage Projects	Understanding the health effects of landscape burning and biomass smoke in Australian towns and cities	Bushfires are increasingly affecting Australian towns and cities directly and indirectly from episodes of severe air pollution. An approach to manage bushfires is to reduce fuel loads by setting planned fires under stable weather conditions, yet this strategy is controversial because of community concerns about ecological sustainability and negative health impacts from smoke. The relative importance of air pollution from planned and unplanned bushfires vs. wood heaters, agricultural burning and other sources of air pollution will be determined. Our study will enable evidence-based bushfire smoke management, help formulate national air quality standards and shape policies regarding biomass smoke and bushfire management.	University of Tasmania	Department of Health & Human Services (PO); Department of Tourism, Arts and the Environment (PO); Tasmania Fire Service (PO); NSW Department of Health (PO); Department of Health, Western Australia (PO); Department of Environment and Conservation (PO)	2008	2011	$440,000	300605 - Fire Management; 270704 - Landscape Ecology; 321202 - Epidemiology	770701 - Air quality; 730210 - Environmental health; 770702 - Land and water management
LP0882579	Linkage Projects	Fire management of complex rehabilitated forests - quantifying and understanding spatial variability of forest structure and fuels	Up to 5 million ha of forest is burnt by bushfire in Australia in severe fire years. The cost of fire suppression in 2002/3 in WA was in excess of 12 million dollars. Consequently, development and application of technologies and knowledge for enhancing fire management and reducing wildfire risk is of high priority and substantial economic, social and environmental benefit. The opportunity to conduct experimental fires across a complex landscape will enable calibration and development of technologies not previously possible. This research will define the way prescribed fire is used to integrate young rehabilitated forest into management of the broader landscape and develop more cost-effective tools for fire management.	The University of Western Australia	Worsley Alumina Pty Ltd (PO); Department of Environment & Conservation, WA (PO)	2008	2010	$465,000	300605 - Fire Management; 270704 - Landscape Ecology; 270703 - Terrestrial Ecology	770707 - Rehabilitation/reafforestation; 770705 - Integrated (ecosystem) assessment and management; 640102 - Aluminium ores
LP0883287	Linkage Projects	An Integrated Assessment of the Impacts of Climate Change on Victorian Alpine Ecosystems: Detecting and Managing Ecological Change	Climate change threatens biodiversity in alpine areas of Australia. This project seeks to predict how plants, soils and small animals will respond to warming and the associated increased risk of bushfire. Our project uses chambers placed out in the field to simulate warming conditions, and measures plant growth and development, and small animal community structure within the chambers. We also assess the effects of climate change on soil processes. The information is used to evaluate the ability of alpine plants and animals to deal with climate change and to identify ways managers can help maintain biodiversity in this fragile ecosystem.	The University of Melbourne	Department of Sustainability and Environment (PO); Parks Victoria (PO)	2008	2012	$596,250	270203 - Population and Ecological Genetics; 300199 - Soil and Water Sciences not elsewhere classified; 279901 - Global Change Biology	770603 - Living resources (flora and fauna); 770602 - Land and water management; 760101 - Global climate change adaptation measures
LP0884116	Linkage Projects	Assessing the adaptive capacity of hospital facilities to cope with climate-related extreme weather events: A risk management approach	Given Australia's and New Zealand's relatively high exposure to climate extremes, the social, economic and health benefits of better managed hospital facilities are significant. Floods, bushfires, heatwaves and cyclones cost Australia over $1.4bn/year and New Zealand over NZ$43m/yr in disruption to communities, business productivity and damage to infrastructure. This research will help to mitigate these costs by protecting populations from the health risks associated with such events. The potential benefits will be most significant for those vulnerable communities at high risk such as the aged, the obese, the ill and those geographically exposed to more extreme weather events.	The University of New South Wales	NSW Department of Health (PO); Queensland Health (PO); Government of South Australia, Department of Health (PO); NZ Ministry of Health (PO)	2008	2011	$435,000	310202 - Building Construction Management; 350208 - Organisational Planning and Management	680599 - Other; 760101 - Global climate change adaptation measures
LP0989138	Linkage Projects	The impact of vineyard exposure to smoke on vine physiology and the composition of grapes and wine	Taint in grapes and wine as a consequence of vineyard exposure to smoke has resulted in a decline in product quality and significant financial losses for grape and wine producers throughout Australia. Given the close proximity of many Australian wine regions to areas of bush and forest and the predicted continuation of warm, dry climatic conditions, the incidences of vineyard smoke exposure is expected to increase in the future. The project aims to establish grape and wine production methods which can be employed by industry to counter the effects of smoke on grape and wine composition, and to minimise smoke taint in finished wine; with clear economic benefits for grape-growers and wine producers.	The University of Adelaide	The Yalumba Wine Company (PO); Primary Industries and Resources SA (PO); Brown Brothers (PO); Fosters Group Ltd. (PO)	2009	2011	$247,662	300305 - Oenology and Viticulture; 250499 - Analytical Chemistry not elsewhere classified; 300201 - Plant Biochemistry and Physiology	620204 - Grapes; 670108 - Beverages (e.g. alcohol, wines, soft drinks, excl. fruit juices)
LP0989892	Linkage Projects	Towards Distributed Phased Array Radar for High Resolution Weather Monitoring	Several recent reports on climate change by leading international and national bodies forecast that the rate of weather hazards such as storms and wind-shear, and of weather-associated phenomena such as bush fires will increase over the next 40 years. The current technology for monitoring weather events, and effects like wind-shift, which has a serious impact on dangers associated with bush fires, has significant weaknesses. We will deliver considerable improvements in monitoring capability by developing the technology for using a network of small phased array radars. We aim to place monitoring resources where end-user needs are greatest.	The University of Melbourne	Raytheon Australia (PO)	2009	2011	$720,000	290901 - Electrical Engineering; 280204 - Signal Processing; 260601 - Meteorology	770103 - Weather; 770101 - Climate change; 610199 - Other
LP0992107	Linkage Projects	Simulation Technology for Modelling Extreme Bushfire Behaviour	Extreme fires cause immeasurable damage to communities through destruction of homes and damage to infrastructure. Large, highly intense fires reduce biodiversity, take decades for recovery, increase greenhouse gas emissions and reduce carbon storage capacity. Climate change is likely to increase the frequency of extreme fire weather increasing the need for reliable fire spread prediction under extreme conditions and to reduce impact by preparedness and suppression. Incorporating an evidence-based fire spread model into a fire location forecasting system will give fire agencies early warning of potentially disastrous fires, enable early response to prevent fires and mitigate the consequence to life, property and the environment.	The University of Western Australia	Department of Fire and Emergency Services (PO); Landgate (PO)	2009	2013	$220,000	280210 - Simulation and Modelling; 230118 - Optimisation; 300605 - Fire Management	770902 - Land and water management; 770702 - Land and water management; 770101 - Climate change

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LP100200158	Linkage Projects	The impact of severe bushfires on the ecology, demography and genetics of frogs in the Victorian Kinglake region	The February 2009 bushfires in Victoria devastated many communities, and also had a profound impact on wildlife species. This research is aimed at measuring the impact of these fires on frogs in the Kinglake region. It will provide a range of national benefits, including a better understanding of the effects of wildfire on native species and their habitats, information to help plan conservation efforts for frogs, and a vital connection with local landowners; some of whom lost their homes in the fires but were still concerned about the wellbeing of frogs in the area. Australia is a fire-prone country, and this project will help develop responses to the threats posed by the expected increase in the frequency and intensity of fires in southern Australia.	The University of Melbourne	Museum Victoria (PO); Melbourne Water (PO); Goulburn Broken Catchment Management (PO)	2010	2013	$210,000	060207 - Population Ecology; 050104 - Landscape Ecology; 060411 - Population, Ecological and Evolutionary Genetics	960805 - Flora, Fauna and Biodiversity at Regional or Larger Scales; 961003 - Natural Hazards in Farmland, Arable Cropland and Permanent Cropland Environments; 961004 - Natural Hazards in Forest and Woodlands Environments
LP100200164	Linkage Projects	Bushfires, social connectedness and mental health	The 2009 Victorian bushfires caused much loss of life, property destruction, and community disturbance. It is important for Promoting Better Health and Strengthening the Social and Economic Fabric that an accurate understanding is achieved of the factors that contribute to optimal recovery from natural disasters. This project will survey people affected by the fires over 5 years to both profile adaptation after the fires and to identify the individual and community processes that influence outcome. This project being undertaken in partnership by academic, disaster management, health and community organisations will provide crucial information for shaping policy for disaster management in the years ahead.	The University of Melbourne	Australian Red Cross (PO); Centrelink (PO); Victorian Department of Health (PO); Australian Rotary Health (PO); Central Hume Primary Care Partnership (PO); Bendigo Loddon Primary Care Partnership (PO); Banyule Community Health Service (PO); Outer East Health and Community Support Alliance (PO); Central West Gippsland Primary Care Partnership (PO); Lower Hume Primary Care Partnership (PO)	2010	2015	$1,285,047	111708 - Health and Community Services; 111714 - Mental Health; 170110 - Psychological Methodology, Design and Analysis	920410 - Mental Health; 920413 - Social Structure and Health; 920506 - Rural Health; 920408 - Health Status (e.g. Indicators of Well-Being)
LP100200825	Linkage Projects	Fires, black carbon, greenhouse gas emissions and the carbon balance of southern sclerophyll forests	Ecologically sustainable forest management requires an understanding of the role of fire in the carbon balance of native forests, and in Australia's overall carbon balance. Fires are crucial to both this carbon balance and to the ecology of the forests. This project will help forest managers make decisions about using prescribed fire to manage fuels while at the same time managing carbon. An aim of management is to identify fire regimes that will optimise the carbon outcome as well as provide protection to life and property. This project will help managers meet that aim by developing a quantitative understanding of how much stable, black carbon (charcoal) is produced and how it affects other soil processes.	The University of Sydney	Department of Sustainability and Environment, Victoria (PO)	2010	2014	$520,000	050301 - Carbon Sequestration Science; 070503 - Forestry Fire Management; 060208 - Terrestrial Ecology	961403 - Forest and Woodlands Soils; 960305 - Ecosystem Adaptation to Climate Change; 960301 - Climate Change Adaptation Measures
LP110200006	Linkage Projects	Is a grass-fire cycle reducing biodiversity in the stone country of Kakadu National Park?	There is concern that bushfires in northern Australia are causing biodiversity loss. The project will compare fire regimes and populations of a fire-sensitive tree, Callitris intratropica, in Kakadu to similar areas in central Arnhem Land, to see how fire management can be optimised to prevent further biodiversity loss on the Arnhem Plateau.	University of Tasmania	Kakadu National Park (PO)	2011	2013	$60,094	050104 - Landscape Ecology; 060202 - Community Ecology (excl. Invasive Species Ecology); 050202 - Conservation and Biodiversity	960806 - Forest and Woodlands Flora, Fauna and Biodiversity; 960805 - Flora, Fauna and Biodiversity at Regional or Larger Scales
LP110200020	Linkage Projects	Using community engagement and enhanced visual information to promote FireWatch satellite communication as a support for collaborative decision-making	Using continuously updated satellite data, FireWatch will repurpose its professional service for use by the wider public, informing community-based decision-making and action. Communication flows and community decision-making will promote informed action at times of fire stress. Complex visual data will be communicated in clear and compelling ways.	Edith Cowan University	Landgate (PO)	2011	2014	$179,982	200102 - Communication Technology and Digital Media Studies; 120304 - Digital and Interaction Design; 200212 - Screen and Media Culture	970120 - Expanding Knowledge in Language, Communication and Culture
LP110200313	Linkage Projects	Incendiary cultures: co-constructing resilience to engage with fire and risk in landscape management	Effective communication and management of bushfire risk can be hindered by wide divergence between expert views and community understandings. Building on resilience theory, this project will draw together experts from fire agencies and local communities to rethink fire from modelling to combat, and from resisting to engaging in response activities.	The University of Melbourne	Victorian Department of Sustainability and Environment (PO); Office of the Emergency Services Commissioner (PO)	2011	2014	$260,845	160802 - Environmental Sociology; 050205 - Environmental Management; 160808 - Sociology and Social Studies of Science and Technology	960311 - Social Impacts of Climate Change and Variability; 960699 - Environmental and Natural Resource Evaluation not elsewhere classified; 950299 - Communication not elsewhere classified
LP120100704	Linkage Projects	Improving grid performance: detection of arc faults and determination of energy losses in electricity distribution networks	This project will develop a monitoring system to address the critical need to ensure safe operations of overhead power lines, particularly in rural areas, and prevent bushfires caused by electrical faults. The research also enables monitoring of power losses in electricity distribution networks and improving the energy efficiency of the supply system.	The University of New South Wales	Australian Strategic Technology Program (PO)	2012	2014	$140,000	090607 - Power and Energy Systems Engineering (excl. Renewable Power); 090608 - Renewable Power and Energy Systems Engineering (excl. Solar Cells)	850604 - Energy Transmission and Distribution (excl. Hydrogen); 850703 - Industrial Energy Conservation and Efficiency
LP130100146	Linkage Projects	Bushfires, smoke, and people: assessing the risks and benefits from planned burning on the urban-rural interface	A key strategy to protect people from wildfire is the use of planned burns to reduce fire hazards. The exposure of communities to smoke pollution is a serious side-effect of this intervention. This project will be critical in enabling authorities to protect public health by determining acceptable levels of smoke originating from planned burns.	University of Tasmania	Victorian Department of Sustainability and Environment (PO); British Columbia Centre for Disease Control (PO); NSW Environment Protection Authority (PO); Vicrorian Environment Protection Authority (PO)	2013	2016	$559,330	050205 - Environmental Management; 160404 - Urban and Regional Studies (excl. Planning); 111705 - Environmental and Occupational Health and Safety	960705 - Rural Land Policy; 961004 - Natural Hazards in Forest and Woodlands Environments; 920405 - Environmental Health
LP130100406	Linkage Projects	Bushfires and biodiversity: optimising conservation outcomes in peri-urban areas at risk	Risks of dangerous bushfires in the urban fringe have the potential to restrict conservation policy. This project will examine community attitudes and concerns to provide recommendations that ensure future native vegetation management balances fire-risk perceptions against biodiversity value.	University of South Australia	SA Department of Environment, Water and Natural Resources (PO); Eyre Peninsula Natural Resource Management (PO); Adelaide Mount Lofty Ranges Natural Resource Management Board (PO)	2013	2016	$236,486	160403 - Social and Cultural Geography; 050202 - Conservation and Biodiversity; 050205 - Environmental Management	970116 - Expanding Knowledge through Studies of Human Society; 940204 - Public Services Policy Advice and Analysis; 960799 - Environmental Policy, Legislation and Standards not elsewhere classified
LP130100645	Linkage Projects	Bushfire safety improvements for rural electricity networks using hybrid fault detection incorporating distributed observations of travelling waves	Electrical faults in distribution networks can result in catastrophic bush fires. The existing fault detection methods are known to be incapable of detecting many faults. This project will develop improved protection methods that detect travelling waves produced by dangerous faults such as fallen lines and vegetation contacts.	Central Queensland University	Western Power (PO)	2013	2016	$195,000	090607 - Power and Energy Systems Engineering (excl. Renewable Power)	850604 - Energy Transmission and Distribution (excl. Hydrogen)
LP140100489	Linkage Projects	Software Defined Networking: Transforming Emergency Operations	The project aims to improve the effectiveness and efficiency of Australia's emergency operations, for example, bushfire and rescue missions, by providing robust and integrated communications systems for police and the emergency services. Emergency communications systems are currently fragmented by the different technologies, creating disconnected islands of information. The project aims to provide techniques that allow multiple wireless technologies to communicate seamlessly using modern software-defined networking solutions.	The University of Adelaide	QSPectral Systems Pty Ltd (PO)	2014	2017	$194,873	100503 - Computer Communications Networks; 100504 - Data Communications	890104 - Mobile Telephone Networks and Services; 890103 - Mobile Data Networks and Services; 890199 - Communication Networks and Services not elsewhere classified

Attachment E

ProjectCode	Scheme Name	Project Title	Project Summary	Admin Organisation Name	Partner Organisation	Funding Commencement Year	Funding Completion Year	Funding Amount	FoR 6-digit level code	SEO 6-digit level code
LP150100654	Linkage Projects	Mitigating extreme water supply contamination in bushfire burned catchments	This project involves Melbourne Water, the Department of Environment and Primary Industries, and East Gippsland Water in developing tools to evaluate mitigation options that will protect our water supplies and increase the resilience of Australian communities to bushfire. Major bushfires in south-east Australia in 2003, 2007, 2009 and 2013 were followed by storms that triggered extreme soil erosion events in catchments, contaminating water supplies and damaging critical infrastructure. The capacity to mitigate the risk of interruption to the water supplies of our cities and towns in a more fire-prone future is currently limited by our knowledge of where, why, and how often these post-fire contamination events will occur. This project aims to address these knowledge gaps.	The University of Melbourne	MELBOURNE WATER CORPORATION/MELBOURNE WATER (PO); DEPARTMENT OF ENVIRONMENT AND PRIMARY INDUSTRIES/Department of Sustainability and Environment (PO); EAST GIPPSLAND REGION WATER CORPORATION/EAST GIPPSLAND WATER (PO)	2015	2018	$310,000	040608 - Surfacewater Hydrology; 070504 - Forestry Management and Environment; 040607 - Surface Processes	960909 - Mountain and High Country Land and Water Management; 960907 - Forest and Woodlands Water Management; 961008 - Natural Hazards in Mountain and High Country Environments
LP160100661	Linkage Projects	Building an integrated system for Australian bushfire prevention	This project aims to develop a comprehensive approach to prevent arson. Bushfires are a serious issue in Australia, made worse by climate change; since most of these fires are started by people, it is important to prevent arson. Building on previous work, this project intends to improve community responses, and build a model to predict risk and improve data sharing. The intended outcome is an all-risks approach to arson prevention and community engagement. This research should reduce the incidence of arson in Australia, and also be useful overseas.	The University of Melbourne	CRIME STOPPERS VICTORIA LIMITED (PO)	2016	2018	$115,000	160201 - Causes and Prevention of Crime; 120504 - Land Use and Environmental Planning; 120501 - Community Planning	940402 - Crime Prevention; 960301 - Climate Change Adaptation Measures
LP170100152	Linkage Projects	Fauna, fuel and fire: effects of animals on bushfire risk	This project aims to determine the extent that animals influence fire regimes through effects on fuel load and characteristics. Minimising the risk of large, severe bushfires, while conserving native species is one of the greatest challenges facing managers of fire-prone ecosystems globally. Using a powerful combination of landscape-scale field observations, experimental manipulations of animal densities, and modelling, the project expects to quantify interactions between animals, bushfire fuel and fire regimes in south eastern Australian forests, woodlands and scrublands. This evidence should benefit the design of integrated, efficient, and complementary strategies for fire and fauna management in Australia's extensive fire-prone ecosystems.	The Australian National University	Department of Defence (PO); PARKS AUSTRALIA (PO)	2018	2021	$645,000	050205 - Environmental Management; 050102 - Ecosystem Function; 060202 - Community Ecology (excl. Invasive Species Ecology)	961004 - Natural Hazards in Forest and Woodlands Environments; 970105 - Expanding Knowledge in the Environmental Sciences; 960806 - Forest and Woodlands Flora, Fauna and Biodiversity
LP190100436	Linkage Projects	Forecasting live fuel moisture content, the on/off switch for forest fire	Dry forest fuels are a precursor of large bushfires. This research aims to develop, for the first time, a model to reliably forecast the moisture content of live fuels (e.g. the foliage and fine branches of shrubs and trees). This will be achieved by combining (i) satellite-derived estimates of live fuel moisture content, (ii) forecasts of soil moisture, and (iii) plant physiological responses to soil dryness. Forecasts of live fuel moisture content will deliver an early warning system of the risk of bushfires. These forecasts will also facilitate improved planning of prescribed burns: if fuels are too dry there is a risk of burns escaping, conversely, if fuels are too wet there is a risk that burns will fail to meet objectives.	Western Sydney University	NSW RURAL FIRE SERVICE (PO); Office of Environment and Heritage NSW (PO); Environment, Planning and Sustainable Development Directorate - Departmental (PO)	2020	2022	$524,027	050102 - Ecosystem Function; 060203 - Ecological Physiology; 090905 - Photogrammetry and Remote Sensing	961004 - Natural Hazards in Forest and Woodlands Environments; 960505 - Ecosystem Assessment and Management of Forest and Woodlands Environments; 960307 - Effects of Climate Change and Variability on Australia (excl. Social Impacts)
LX0665810	Linkage International	Eddy mixing and water mass formation in the Southern Ocean in a global 1/4 degree model	The next generation of ocean climate models will rely on linkages between experts in large-scale oceanography, mesoscale ocean physics and computational techniques. This project brings together such expertise. It will result in the development of better ocean models for use in climate prediction by improving the representation of eddy contributions to air/sea interactions. Australia's climate is extreme, with harsh droughts, severe bushfire seasons, soil loss, and salinity all posing potentially enormous socio-economic challenges over the next fifty years. Improving climate models is thus highly significant for Australia, as mitigating the effects of climate change depend on reliable climate prediction systems.	The University of New South Wales		2006	2007	$14,000	260403 - Physical Oceanography; 260602 - Climatology (incl. Palaeoclimatology)	770305 - Oceanic processes (excl. climate related); 770102 - Climate variability

Attachment F - ARC projects funded for natural disasters to January 2020

10/01/2020

Note 1 - Project data was extracted from the ARC database using keywords to search project title, abstract (summary) and national benefit text (impact statement) provided in each project application. Keywords used for data extraction include those listed on 'keywords' sheet.

Note 2 - The project listing has not been vetted for relevance. Data are to be interpreted with care as it is possible that the keywords used might not capture all in scope projects. It is also possible that some applications extracted are not truly related to the subjects being interested.

Note 3 - The 'active' status of a project is defined as the stage of a project where the project has not yet provided a Final Report to the ARC, and the project may have a commencement year early but delayed for completion. As such, the 'active' status could change on a daily basis.

Note 4 - The project data is correct on the day the extraction is made.

Note 5 - All data is limited to the information provided within the application or approved by the Minister, and does not include any variations that have been made to the project after approval.

Note 6 - The data are provided for the intended use only (as described in the request in accompanying email) and should not be re-used for any other purpose.

Project Status	ProjectID	Number of Keyword	keywords	Admin Organisation Name	Admin Organisation State Name	Investigator List	Scheme Name	StartYr	Project Title	Project Summary	Funding Amount	FOR Classification Code List	Primary 4-digit Field of Research
Active	DE130100295	3	drought; flood; natural disaster	James Cook University	Queensland	Nathan English	Discovery Early Career Researcher Award	2013	Forecasting the future of flood and drought in Australia using multi-century tree-ring and isotope chronologies from the tropics	The effects of El Nino on Australian floods and droughts in a globally changing climate is unclear because we lack long climate records from the past. This project will measure tree-ring and isotope records using kauri pine to advance our understanding of El Nino's effects on the frequency and intensity of drought and floods in Australia.	$373,679	04 Earth Sciences 05 Environmental Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0501 ECOLOGICAL APPLICATIONS 0402 GEOCHEMISTRY 040606 - Quaternary Environments; 040203 - Isotope Geochemistry; 050101 - Ecological Impacts of Climate Change	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DE140100283	1	flood	The University of Melbourne	Victoria	Narrelle Morris	Discovery Early Career Researcher Award	2014	From War Crimes Investigator to War Crimes Jurist: Sir William Flood Webb KBE and his impact on international criminal law in the twentieth century	Sir William Flood Webb KBE (1887-1972) is little known but was Australia's most prominent jurist on war crimes in the mid-twentieth century. This project is a legal-historical study that investigates and examines Webb's extraordinary impact on the development and transformation of international criminal law through his roles as a war crimes investigator, consultant and jurist and, in particular, as President of the International Military Tribunal for the Far East. The project will shed light on historical views of war crimes, the legal actions taken and institutions created in response and the judicial and procedural precedents that were established, not only within Australia but internationally.	$356,247	21 History and Archaeology 18 Law and Legal Studies 2103 HISTORICAL STUDIES 1801 LAW 180116 - International Law (excl. International Trade Law); 210303 - Australian History (excl. Aboriginal and Torres Strait Islander History)	1801 - LAW
Active	DE150100242	1	bushfire	University of Wollongong	New South Wales	Christine Eriksen	Discovery Early Career Researcher Award	2015	Bushfires, faith and community cohesion: building a resilient Australia	Bushfire emergencies in Australia have social, ethical and political, as well as biophysical causes. Hidden in embedded vulnerability, social norms and institutional structures, these causes are often critical obstacles to building resilient communities. This project aims to identify key ways to heighten resilience by examining how sacred and secular faith affects the ability of individuals and communities to prepare for, respond to and recover from bushfires. Using ethnographic methods, this project will critically examine evidence of bushfire vulnerability, resilience and adaptation strategies driven by, retained in, or promoted through faith and ethics.	$353,773	16 Studies in Human Society 1604 HUMAN GEOGRAPHY 160403 - Social and Cultural Geography; 160499 - Human Geography not elsewhere classified	1604 - HUMAN GEOGRAPHY
Active	DE150100302	1	storm	Flinders University	South Australia	Margaret Shanafield	Discovery Early Career Researcher Award	2015	Predicting groundwater replenishment in arid catchments	Australia is the world's driest continent, and reliant on groundwater for survival and livelihood. A clear understanding of how our groundwater is replenished is therefore imperative. Groundwater recharge is difficult to quantify because it occurs as infiltration beneath streambeds in response to rain events. This project aims to combine field data from fibre optic temperature sensing, radio-isotopes, and remote sensing into streamflow and catchment scale models to characterise connections between infiltration and recharge in an Australian catchment. The project aims to produce easily applicable tools to predict aquifer replenishment after storm events and predictions of groundwater availability under future climate conditions.	$357,170	04 Earth Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040603 - Hydrogeology; 040608 - Surfacewater Hydrology	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DE150101104	3	cyclone; earthquake; natural disaster	Queensland University of Technology	Queensland	Keerthan Poologanathan	Discovery Early Career Researcher Award	2015	Novel Shelters Using Sheathed Cold–formed Steel Framing Systems	Safe shelters are needed within residential, school and commercial building systems to prevent the loss of lives during natural disasters. This project aims to understand how the fire, cyclone and earthquake resistance of shelters can be increased by using a new cold-formed and rivet fastened hollow flange section as studs and joists within the lightweight steel frame wall, and floor systems with superior configurations that are lined with thin steel sheet and thermally superior boards. Experimental and numerical studies will be used to enhance our understanding of these novel and more complex systems and develop safer shelter systems at low cost. They can also be used in many other applications based on the emerging modular building concept.	$330,000	09 Engineering 0905 CIVIL ENGINEERING 090506 - Structural Engineering	0905 - CIVIL ENGINEERING
Active	DE150101297	1	drought	Monash University	Victoria	Ailie Gallant	Discovery Early Career Researcher Award	2015	Rethinking Australian drought risk, its long-term variability and processes	Drought risk describes the likelihood that damage will result from exposure to drought. This project aims to fundamentally reshape how we define, characterise and understand drought risk in Australia. A framework for drought risk will be applied that includes the complete range of characteristics that modulate the impacts of drought, which are the frequency of recurrence, duration, severity, seasonality and spatial extent. Long-term changes in drought risk will be examined and the process-based climatic risk factors will be identified. Advancing knowledge on the nature and causes of the long-term changes in drought risk is crucial to improving risk management of drought in the agricultural and water resource sectors.	$320,094	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040105 - Climatology (excl. Climate Change Processes); 040102 - Atmospheric Dynamics; 040607 - Surface Processes	0401 - ATMOSPHERIC SCIENCES

Project Status	ProjectID	Number of Keyword	keywords	Admin Organisation Name	Admin Organisation State Name	Investigator List	Scheme Name	StartYr	Project Title	Project Summary	Funding Amount	FOR Classification Code List	Primary 4-digit Field of Research
Active	DE150101347	1	storm	Queensland University of Technology	Queensland	Matthew Mason	Discovery Early Career Researcher Award	2015	Characterising the hazard, structure and impacts of convective wind storms	This project aims to characterise probabilistically the severe convective wind storm risk (thunderstorm and tornado) to Australia under current and future climates. This will be achieved using a new coupled analysis-simulation based approach to wind hazard analysis. It will also characterise the complex wind structure within these wind storms by integrating three-dimensional data from novel high-resolution observation networks into a unifying wind field model. The project aims to generate the requisite information that allows convective wind storms to be explicitly accounted for in national and international wind-resistant design standards, thus acting to mitigate the devastating impacts of future events.	$375,000	04 Earth Sciences 09 Engineering 0401 ATMOSPHERIC SCIENCES 0915 INTERDISCIPLINARY ENGINEERING 0905 CIVIL ENGINEERING 091507 - Risk Engineering (excl. Earthquake Engineering); 040105 - Climatology (excl. Climate Change Processes); 090506 - Structural Engineering	0915 - INTERDISCIPLINARY ENGINEERING
Active	DE160100092	2	drought; flood	The Australian National University	Australian Capital Territory	Sophie Lewis	Discovery Early Career Researcher Award	2016	What is extreme? Advancing insights into Australia's variable rainfall	This project aims to address fundamental questions about the causes of Australia's rainfall variability, providing crucial information about how changing climates affect the water cycle. Bringing together earth system data from ground-based and satellite observations, palaeoclimate reconstructions and climate model simulations, it plans to analyse the processes that cause change in Australia's rainfall. The project aims to integrate these datasets using the novel analysis of water isotopes, an important diagnostic of the water cycle. This approach is expected to help evaluate how Australia's rainfall responds to natural and anthropogenic drivers and identify the processes behind recently observed rainfall extremes.	$389,742	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040605 - Palaeoclimatology; 040104 - Climate Change Processes; 040105 - Climatology (excl. Climate Change Processes)	0401 - ATMOSPHERIC SCIENCES
Active	DE160100128	2	earthquake; tsunami	The Australian National University	Australian Capital Territory	Jonathan Pownall	Discovery Early Career Researcher Award	2016	Tectonic drivers of extreme metamorphism in Eastern Indonesia	This project intends to investigate the tectonic drivers of (ultra-)high temperature metamorphism in eastern Indonesia. Subduction zones – where one of Earth's plates collapses beneath another – drive the formation of mountain belts and produce high pressure and high temperature metamorphic rocks. However, it is typically very difficult when investigating mature mountain belts to interpret how subduction was exactly involved. Eastern Indonesia is one of the few places where active subduction can be linked directly to recent mountain building. Better understanding of how complex subduction dynamics and how mountain belts form is intended to assist natural hazard assessment in earthquake-prone areas.	$368,131	04 Earth Sciences 0403 GEOLOGY 040313 - Tectonics; 040304 - Igneous and Metamorphic Petrology; 040303 - Geochronology	0403 - GEOLOGY
Active	DE160100213	2	drought; flood	The University of Queensland	Queensland	David Adamson	Discovery Early Career Researcher Award	2016	Optimising the National Benefits From Restoring Environmental Water Flows	The project plans to evaluate strategies that may maximise the national benefits from restoring environmental flows in Australia's Murray–Darling Basin (MDB). MDB water supply is characterised by prolonged droughts and flood events, and future climatic projections anticipate that these water supply events will intensify. As the uncertainty of future water supply increases, it is important that the volume of water provided by the portfolio of water rights is known. By examining how decision-makers adapt to water supply uncertainty, optimal management strategies could be determined for watering key ecological assets, trading water between irrigators and the government; and private and public investments.	$335,000	14 Economics 1402 APPLIED ECONOMICS 140201 - Agricultural Economics	1402 - APPLIED ECONOMICS
Active	DE160100289	1	natural disaster	The University of Queensland	Queensland	Joseph Gattas	Discovery Early Career Researcher Award	2016	Structural design and distributed fabrication of folded sandwich structures	This project intends to develop a new type of modular structural form that retains the streamlined construction of existing prefabricated systems, but can be rapidly fabricated in non-specialist and low-cost manufacturing plants. 'Folded sandwich structures' are part of the emerging field of origami-inspired engineering design. This project intends to conduct numerical, experimental and theoretical structural analysis and optimisation on plate and shell building components. Such a system would enable the establishment of a distributed local manufacturing network, for example to provide the short-term infrastructure needs of regions affected by natural disaster.	$375,000	09 Engineering 0905 CIVIL ENGINEERING 0910 MANUFACTURING ENGINEERING 090506 - Structural Engineering; 091006 - Manufacturing Processes and Technologies (excl. Textiles); 090503 - Construction Materials	0905 - CIVIL ENGINEERING
Active	DE160101020	1	flood	The University of Sydney	New South Wales	Nicolas Flament	Discovery Early Career Researcher Award	2016	The geodynamics of past sea level changes	This project is designed to quantify the effect of flow deep within Earth's interior on past sea-level changes and on the flooding history of Australia over the last 550 million years. The rise and fall of sea level has shaped our planet over time. This project plans to combine recent advances in tectonic reconstructions and dynamic Earth models with the global and Australian rock record. The intended outcome is to understand how the Earth's surface is shaped by flow within its interior, and how these processes explain the sedimentary record. Project results have the potential to be used as an exploration tool to maximise Australia's competitive advantage in exploring onshore sedimentary basins.	$350,821	04 Earth Sciences 0403 GEOLOGY 0404 GEOPHYSICS 040402 - Geodynamics; 040311 - Stratigraphy (incl. Biostratigraphy and Sequence Stratigraphy); 040301 - Basin Analysis	0404 - GEOPHYSICS

Project Status	ProjectID	Number of Keyword	keywords	Admin Organisation Name	Admin Organisation State Name	Investigator List	Scheme Name	StartYr	Project Title	Project Summary	Funding Amount	FOR Classification Code List	Primary 4-digit Field of Research
Active	DE170100329	1	earthquake	The Australian National University	Australian Capital Territory	Lauren Waszek	Discovery Early Career Researcher Award	2017	Linking seismic structure to geodynamic processes beneath Australasia	This project aims to understand the relationship of mantle discontinuities beneath the Australian tectonic plate to mantle convection processes. Subducting slabs stagnate at different depths in the mantle, but the reason is not known. The Australian plate has complex boundaries which exhibit a range of subduction behaviours, making it an ideal location to study convection mechanisms. The project will use specialised seismic stations for detailed studies beneath New Zealand and Indonesia. The goal is to determine the relationship between seismic observations and geodynamical processes beneath Australasia, and understand how deeper mechanisms influence seismic activity and earthquake hazard at Earth's surface. Such detailed observations will help us to understand processes at the Earth's surface, with implications for earthquake hazard.	$360,000	04 Earth Sciences 0404 GEOPHYSICS 040407 - Seismology and Seismic Exploration	0404 - GEOPHYSICS
Active	DE170100367	1	bushfire	The University of New South Wales	New South Wales	Leela Frankcombe	Discovery Early Career Researcher Award	2017	Decadal climate variability: Mechanisms, interactions and effects	This project aims to study the processes underlying decadal climate variability, through increasingly complex models, underpinned by observations. Climate variations on time scales of years, decades and longer affect Australia, with potentially devastating effects on agriculture, water supply, bushfires and health. Improved climate prediction on decadal time scales is urgently needed, but limited understanding of the system's natural variability hampers progress. This knowledge will reduce uncertainty in near term climate projections, allowing more informed decision making about adaptation on the regional scale, particularly for sectors such as agriculture, health, water and ecosystem management (including bushfire control).	$342,924	04 Earth Sciences 0405 OCEANOGRAPHY 0401 ATMOSPHERIC SCIENCES 040503 - Physical Oceanography; 040105 - Climatology (excl. Climate Change Processes); 040104 - Climate Change Processes	0401 - ATMOSPHERIC SCIENCES
Active	DE170100572	1	bushfire	University of South Australia	South Australia	Jia Tina Du	Discovery Early Career Researcher Award	2017	Collaborative information seeking and its application in tourism	The project aims to better understand group behaviour of information seeking. Collaboration is an essential aspect of modern life; collaborative work, including tourism, encompasses obtaining and using information. However, most information behaviour models focus on the individual seeker of information, rather than on improving collaboration and team performance. The project builds models and develops guidelines for understanding and supporting collaborative information seeking behaviour in the context of tourism. Making it easier for tourists to find information is expected to benefit the Australian tourism industry.	$360,000	08 Information and Computing Sciences 0807 LIBRARY AND INFORMATION STUDIES 080703 - Human Information Behaviour	0807 - LIBRARY AND INFORMATION STUDIES
Active	DE170100578	1	natural disaster	The Australian National University	Australian Capital Territory	Alison Behie	Discovery Early Career Researcher Award	2017	The effect of environmental disasters on primate behaviour and distribution	This project aims to study how natural disasters affect animal distribution and behaviour and to predict effects of future disasters. Despite recent increases in environmental disasters, no research has considered their effect on wildlife behaviour and distribution using quantitative methods. This project will create quantitative, multilayered models of climate tolerances and in relation to the effects of natural disasters and behavioural adaptations of affected animals. Anticipated outcomes include improved conservation programmes that reduce the effect of severe weather on wildlife when formulating conservation policy in the face of increasing environmental disasters.	$364,257	16 Studies in Human Society 1601 ANTHROPOLOGY 160102 - Biological (Physical) Anthropology	1601 - ANTHROPOLOGY
Active	DE170101191	1	flood	The University of New South Wales	New South Wales	Alejandro Di Luca	Discovery Early Career Researcher Award	2017	The future intensity of extreme East Coast Lows	This project aims to determine the environmental factors controlling the intensity of extreme East Coast Lows and how their intensity responds to global warming conditions. East Coast Lows are responsible for much of the high-impact weather affecting the east coast of Australia. Understanding the causes behind future climate changes is critical to provide confidence in future projections. This project will use high-resolution climate models that can realistically simulate all the key dynamic processes including atmosphere-ocean interactions. Expected outcomes are adaptation strategies to mitigate the future effect of East Coast Lows on coastal fresh water resources, flooding and erosion.	$360,000	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 040104 - Climate Change Processes; 040105 - Climatology (excl. Climate Change Processes); 040102 - Atmospheric Dynamics	0401 - ATMOSPHERIC SCIENCES
Active	DE170101296	1	drought	The University of Queensland	Queensland	Lee Hickey	Discovery Early Career Researcher Award	2017	Accelerated genomic selection to speed up genetic gain in wheat	This project aims to design drought-resistant crops. Since the Green Revolution, rates of genetic gain for wheat yield have begun to plateau, while climate change threatens productivity and global food security. Numerous breeding technologies have emerged, including genomic selection, speed breeding, high-throughput phenotyping and crop modelling. This project will develop and validate crop improvement protocols by fusing these four technologies. More efficient breeding techniques could accelerate genetic gain in wheat beyond what is expected in ongoing breeding programs, and enable breeders to develop robust cereal varieties in the face of climate change.	$372,000	07 Agricultural and Veterinary Sciences 0703 CROP AND PASTURE PRODUCTION 070305 - Crop and Pasture Improvement (Selection and Breeding); 070303 - Crop and Pasture Biochemistry and Physiology	0703 - CROP AND PASTURE PRODUCTION
Active	DE180100040	2	earthquake; tsunami	The Australian National University	Australian Capital Territory	Andrew Valentine	Discovery Early Career Researcher Award	2018	Enabling next-generation earthquake and tsunami early warning	This project aims to develop a new approach for earthquake and tsunami early warning, avoiding many of the limitations currently present in such systems. The project will combine machine learning and artificial intelligence with state-of-the-art geophysical modelling, allowing high-quality real-time prediction of seismic hazards with full uncertainty information. Highlighting opportunities at the interface between geoscience and data science, the project will stimulate novel approaches, and build Australian research capacity in this area. Expected benefits include improved techniques for geophysical imaging and real-time data analysis, in addition to enhanced capabilities for mitigating the costs associated with seismic activity.	$337,300	08 Information and Computing Sciences 04 Earth Sciences 0801 ARTIFICIAL INTELLIGENCE AND IMAGE PROCESSING 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0404 GEOPHYSICS 040407 - Seismology and Seismic Exploration; 080109 - Pattern Recognition and Data Mining; 040604 - Natural Hazards	0404 - GEOPHYSICS

Project Status	ProjectID	Number of Keyword	keywords	Admin Organisation Name	Admin Organisation State Name	Investigator List	Scheme Name	StartYr	Project Title	Project Summary	Funding Amount	FOR Classification Code List	Primary 4-digit Field of Research
Active	DE180100157	1	forest fire	The University of Adelaide	South Australia	Cheng (Rey) Chin	Discovery Early Career Researcher Award	2018	Impact of spatially uniform and irregular rough surfaces on drag reduction	This project aims to understand the turbulent transport mechanism for fluid flow over spatially uniform and irregular rough walls. It will provide accurate modelling of irregular roughness and high fidelity simulations. The intended outcomes are physical understanding of the turbulence phenomenon in these flows, and novel flow control of irregular rough wall flows leading to significant drag reduction for transport industries in Australia. Benefits are relevant to both engineering applications involving rough walls and to environmental applications enabling better prediction of particulate matter dispersion	$366,446	09 Engineering 0915 INTERDISCIPLINARY ENGINEERING 091504 - Fluidisation and Fluid Mechanics	0915 - INTERDISCIPLINARY ENGINEERING
Active	DE180100391	2	cyclone; storm	Curtin University	Western Australia	Nicola Browne	Discovery Early Career Researcher Award	2018	Island resilience to tropical cyclones and rising sea levels	This project aims to produce a dynamic model to address the global problem of low-lying island inundation following high-energy events, such as tropical cyclones and storm surges. These events threaten coastal habitats and biodiversity, and in worst cases, displace human populations. The model will identify islands at risk to inundation thereby enabling governments to adopt appropriate mitigation and/or adaptation strategies to improve outcomes for island economic, societal and biological values.	$386,500	06 Biological Sciences 04 Earth Sciences 0602 ECOLOGY 0403 GEOLOGY 040310 - Sedimentology; 060206 - Palaeoecology; 060205 - Marine and Estuarine Ecology (incl. Marine Ichthyology)	0403 - GEOLOGY
Active	DE180101593	1	earthquake	The University of Adelaide	South Australia	Hossein Derakhshan	Discovery Early Career Researcher Award	2018	Seismic evaluation of non-structural unreinforced masonry components	This project aims to reduce earthquake risk posed by unreinforced masonry buildings. The project will use integrated experimental and numerical research to understand the dynamic interaction between timber floors, roofs and walls. New knowledge about this interaction will enable economical and safe earthquake design methods to be used for unreinforced masonry buildings.	$359,446	09 Engineering 0905 CIVIL ENGINEERING 090506 - Structural Engineering; 090504 - Earthquake Engineering	0905 - CIVIL ENGINEERING
Active	DE180101598	1	bushfire	Queensland University of Technology	Queensland	Anthony Ariyanayagam	Discovery Early Career Researcher Award	2018	Fire resistant and lightweight wall systems using innovative blocks	This project aims to develop an innovative block with lightweight and fire resistant characteristics by using Pumice and Perlite materials, followed by wall systems using the blocks. For this purpose, it will use material and thermal characterization studies, thermal and structural numerical models and fire tests of the new blocks, wall panels and a compartment. This project will generate new knowledge on lightweight blocks and fire safety, and develops cost-effective fire safe solutions for mid-rise buildings and bushfire safe rooms.	$357,446	09 Engineering 0905 CIVIL ENGINEERING 090506 - Structural Engineering	0905 - CIVIL ENGINEERING
Active	DE190100042	1	drought	The Australian National University	Australian Capital Territory	Katharine Grant	Discovery Early Career Researcher Award	2019	Long-term variability of the Australian monsoon	This project aims to address large uncertainties in Australia's hydroclimate projections, by reconstructing Australian monsoon variability over the past three million years. The project expects to generate new knowledge to quantify the frequency and amplitudes of extreme rainfall and drought in Northwest Australia. By providing essential new information about the timing, frequency, and intensity of past drought and extreme rainfall, the project is expected to enable more accurate climate projections required for effective adaptation and mitigation. This project will also benefit the Australian archaeology community, by providing a much-needed environmental context for mapping Australian pre-history.	$350,000	04 Earth Sciences 0403 GEOLOGY 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040605 - Palaeoclimatology; 040606 - Quaternary Environments; 040305 - Marine Geoscience	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DE190100062	1	earthquake	The Australian National University	Australian Capital Territory	Caroline Eakin	Discovery Early Career Researcher Award	2019	What's shaking down under?	This project aims to determine the underlying cause of recent earthquake activity in central Australia. Of all the stable continents, Australia is surprisingly seismically active, with intra-plate earthquakes occurring relatively frequently. However, these are unpredictable, placing lives and infrastructure at risk. This project offers the opportunity to use a new seismic experiment to improve detection of small events that may warn of a more dangerous earthquake to come, and provide sub-surface imaging of the hidden crustal boundaries and faults that are ultimately responsible. Benefits will include improved hazard assessment, and a new predictive model for exploration that relates regional seismicity, crustal faults, and mineral systems.	$404,000	04 Earth Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0403 GEOLOGY 0404 GEOPHYSICS 040407 - Seismology and Seismic Exploration; 040604 - Natural Hazards; 040313 - Tectonics	0404 - GEOPHYSICS
Active	DE190100233	1	bushfire	Deakin University	Victoria	Timothy Neale	Discovery Early Career Researcher Award	2019	Pyrosecurity: understanding and managing bushfires in a changing climate	This project aims to examine cultural and political factors that have shaped bushfire management in Australasia during the past two decades and identify how practices might better adapt to a changing world. Bushfires are a serious natural hazard with major social, economic, and environmental impacts. Social and climatic changes are altering the intensity, frequency, and consequences of bushfires, creating significant uncertainties in how we anticipate them. This project will examine how bushfire management practitioners and institutions manage diverse uncertainties, leading to new theoretical insights and strategic policy advice. Expected benefits include better prediction and management of bushfire impacts and improved education and training of bushfire practitioners.	$372,574	20 Language, Communication and Culture 16 Studies in Human Society 2002 CULTURAL STUDIES 1604 HUMAN GEOGRAPHY 160403 - Social and Cultural Geography; 200204 - Cultural Theory	1604 - HUMAN GEOGRAPHY
Active	DE190100326	1	drought	The Australian National University	Australian Capital Territory	Helen Bothwell	Discovery Early Career Researcher Award	2019	Genomics of drought adaptation in endangered Eucalyptus woodlands	This project aims to investigate divergence in drought response strategies among foundation Eucalyptus species, using the latest genomic advances. The project expects to contribute new knowledge of drought adaptation in trees, specifically identifying above and below ground interactions that may constrain evolutionary responses to climate change by assessing genotype-trait associations in an integrated, whole plant research model. Expected outcomes include enhanced capacity to design agroforestry and restoration breeding programs to increase tree productivity and resilience under increasing aridity. This will benefit the conservation of endangered Australian woodlands, restoration of degraded landscapes, and production forestry.	$419,406	06 Biological Sciences 05 Environmental Sciences 0603 EVOLUTIONARY BIOLOGY 0604 GENETICS 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 060411 - Population, Ecological and Evolutionary Genetics; 060306 - Evolutionary Impacts of Climate Change; 050202 - Conservation and Biodiversity	0604 - GENETICS

Attachment F

Project Status	ProjectID	Number of Keyword	keywords	Admin Organisation Name	Admin Organisation State Name	Investigator List	Scheme Name	StartYr	Project Title	Project Summary	Funding Amount	FOR Classification Code List	Primary 4-digit Field of Research
Active	DE190100379	1	bushfire	University of Wollongong	New South Wales	Valentina-Mira Wheeler	Discovery Early Career Researcher Award	2019	Curvature flow of clusters: optimal partitioning and merging fire fronts	This project aims to develop the curvature flow of clusters, a new mathematical innovation that builds on methods with proven success in making new progress on difficult problems in geometry and topology. The curvature flow of clusters will allow foams - partitions of space - to be viewed dynamically. This allows long-standing problems on their structure, a key mathematical challenge in material science, to be studied in a natural context. The project is expected to produce a software suite capable of simulating the movement of merging fire fronts with better accuracy than ever before. The mathematical tools developed by the project will have broad applicability, not only to space partitioning but also notably to bushfires, especially on the dynamics of merging fire fronts.	$360,000	01 Mathematical Sciences 0101 PURE MATHEMATICS 010110 - Partial Differential Equations; 010102 - Algebraic and Differential Geometry	0101 - PURE MATHEMATICS
Active	DE190100866	1	storm	Monash University	Victoria	Martin Singh	Discovery Early Career Researcher Award	2019	Intense thunderstorms in the tropics and subtropics under global warming	This project aims to determine how the frequency of intense tropical and subtropical thunderstorms will change as a result of future global warming. Climate models project that the energy available to such storms will increase in the future, but the reasons for this increase in available energy, and the implications for thunderstorm activity, remain uncertain. Using observations and high-resolution models, the project expects to generate new knowledge of the mechanisms driving changes in intense thunderstorm activity under climate change, and to provide more accurate projections of the frequency of intense thunderstorms in a warmer climate. This project should deliver benefits to sectors of the economy such as agriculture and transportation, which are significantly exposed to such hazards.	$325,000	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 040104 - Climate Change Processes; 040108 - Tropospheric and Stratospheric Physics; 040102 - Atmospheric Dynamics	0401 - ATMOSPHERIC SCIENCES
Active	DE190101268	1	natural disaster	The University of Melbourne	Victoria	Tobias Ide	Discovery Early Career Researcher Award	2019	The impact of disasters on armed conflicts	This project aims to conduct a comprehensive, cross-case study on the effect of major disasters on the intensity of ongoing armed conflicts. The numbers of natural disasters and of armed conflicts are on the rise, yet little is known about the interactions between both phenomena. This project will study 36 cases of disaster striking armed conflict zones to generate new knowledge natural disaster-related risks. The project will enable more targeted on the ground practices and policy measures in the domains of climate change adaptation, foreign policy, peace building and disaster risk reduction.	$352,000	16 Studies in Human Society 1606 POLITICAL SCIENCE 1604 HUMAN GEOGRAPHY 160499 - Human Geography not elsewhere classified; 160607 - International Relations	1604 - HUMAN GEOGRAPHY
Active	DE190101389	2	earthquake; landslide	Curtin University	Western Australia	Amy Parker	Discovery Early Career Researcher Award	2019	Imaging, analysing and forecasting Australian hazards with satellites	This project aims to improve Australia's ability to anticipate geophysical hazards. It will generate a new national capability in the use of satellite radar imagery to monitor and manage geohazards, benefiting all communities. By producing high-resolution maps of ground displacements, the project will assess the controls upon where and why these events occur, and whether they exhibit precursory behaviour. This is the first step towards accurate hazard forecasting and in building Australia's capability for near-real-time geophysical hazard monitoring on a national scale. The outputs will impact upon future recommendations for national earthquake and landslide monitoring and deliver new tools to underpin regulation of resource extraction and inform construction codes.	$325,000	04 Earth Sciences 09 Engineering 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0909 GEOMATIC ENGINEERING 090902 - Geodesy; 040604 - Natural Hazards	0909 - GEOMATIC ENGINEERING
Active	DE200100086	1	drought	The University of New South Wales	New South Wales	Anna Ukkola	Discovery Early Career Researcher Award	2020	Will an improved land surface model enhance seasonal prediction of drought?	This project aims to increase the predictability of seasonal droughts that cause major socio-economic losses in rural Australia. The capacity to predict drought, and in particular its impacts on the land, is currently limited by the low skill of forecast models. Using novel observations, the project expects to quantify the vulnerability of Australian agricultural lands to seasonal droughts. The new knowledge will then be used to modify land processes in the Bureau of Meteorology's seasonal prediction system to better reflect Australian conditions. This project is expected to improve forecasts of high impact droughts, crucial to mitigate socio-economic risks, and should benefit decision-making in agriculture and other industries.	$357,203	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 040104 - Climate Change Processes; 040105 - Climatology (excl. Climate Change Processes)	0401 - ATMOSPHERIC SCIENCES
Active	DE200100157	1	bushfire	The University of Sydney	New South Wales	Tim Doherty	Discovery Early Career Researcher Award	2020	Breaking the link between predators and bushfire for fauna conservation	This project aims to quantify how bushfires amplify the impacts of invasive predators (feral cats and foxes) on native fauna. Through innovative field experiments and empirical modelling, this project expects to generate new knowledge in the key areas of wildlife conservation, fire ecology and invasive species management. Expected outcomes of this project include transformative insights into how threats interact to influence biodiversity and greatly enhanced capacity to manage bushfires and invasive predators. These advances should provide significant benefits, including improved conservation of threatened species, advances in ecological theory and improved capacity to predict and respond to environmental change.	$426,343	05 Environmental Sciences 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 050202 - Conservation and Biodiversity; 050211 - Wildlife and Habitat Management	0502 - ENVIRONMENTAL SCIENCE AND MANAGEMENT

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Active	DE200100649	1	heatwave	Western Sydney University	New South Wales	Renee Prokopavicius	Discovery Early Career Researcher Award	2020	Green or crispy: Which plants use transpiration to survive heatwaves?	Heatwaves are increasing in frequency and intensity, and extreme heat poses a significant threat to tree growth and survival. This project aims to investigate how different Australian tree species respond to extreme heat by tracking dynamic changes in water use during both natural and experimental heatwaves, representing current and future stress levels. Identification of a predictable response among plant functional types could be used to better forecast the potential effects of climate change on forest ecosystems. This project also expects to identify heat-tolerant tree species and their relevant physiological traits, which can improve the success of urban tree plantings to help create cooler, greener cities throughout Australia.	$415,416	06 Biological Sciences 07 Agricultural and Veterinary Sciences 05 Environmental Sciences 0602 ECOLOGY 0706 HORTICULTURAL PRODUCTION 0501 ECOLOGICAL APPLICATIONS 060203 - Ecological Physiology; 050101 - Ecological Impacts of Climate Change; 070601 - Horticultural Crop Growth and Development	0602 - ECOLOGY
Active	DE200101116	1	flood	The University of Sydney	New South Wales	James Baker	Discovery Early Career Researcher Award	2020	Bringing granular mechanics to prevent fluid-driven soil erosion problems	This project aims to investigate the erosive behaviour of soils by exploring the interaction between evolving topography and overland water flow. It expects to generate new knowledge about the dominant granular mechanisms under different flow conditions using innovative high-speed X-ray imaging and detailed numerical simulations. Anticipated outcomes include a simple mathematical framework that takes these important factors into account, which will bridge geomechanics and fluid mechanics to provide valuable insight into long-term erosion and deposition rates. This should provide significant benefit by enhancing our ability to predict, and therefore prevent, intense soil loss or problematic build-up of sediment.	$378,616	09 Engineering 0905 CIVIL ENGINEERING 0914 RESOURCES ENGINEERING AND EXTRACTIVE METALLURGY 091402 - Geomechanics and Resources Geotechnical Engineering; 090501 - Civil Geotechnical Engineering	0914 - RESOURCES ENGINEERING AND EXTRACTIVE METALLURGY
Active	DE200101133	1	drought	University of Tasmania	Tasmania	Frances Sussmilch	Discovery Early Career Researcher Award	2020	The quick and the dead: identifying mechanisms for plant drought survival	This project aims to identify genes that control plant responses to low air humidity, which enhance drought survival by restricting water loss. Most plant water loss occurs through pores called stomata. This project expects to identify the genes that close stomata within minutes of decreased humidity by determining the molecular changes that occur over this timeframe and testing candidate genes for a critical role. Diverse land plant models will be examined to ensure broad applicability of results. A major expected outcome is new knowledge of genes that minimise plant water loss, which would ultimately benefit plant-based industries through new targets for breeding improved, drought-adapted varieties for food security in a drying climate.	$427,067	06 Biological Sciences 0603 EVOLUTIONARY BIOLOGY 0607 PLANT BIOLOGY 060702 - Plant Cell and Molecular Biology; 060303 - Biological Adaptation; 060705 - Plant Physiology	0607 - PLANT BIOLOGY
Active	DE200101293	1	earthquake	Monash University	Victoria	Qianbing Zhang	Discovery Early Career Researcher Award	2020	Dynamic Fracturing and Energy Release Mechanisms in Heterogeneous Materials	The prediction of fracturing behaviour in geomaterials (i.e. rock, soil and concrete) under dynamic/impact loads is essential in dealing with a wide range of engineering problems including excavation and mining, blasting and fragmentation, earthquake engineering, impact cratering, and protective structure design However, current knowledge and modelling capabilities of these applications remains empirically based. This project aims to investigate fundamental issues governing the dynamic fracturing of geomaterials and apply this knowledge to advance the understanding and modelling capacity of dynamic fractures in geomaterials.	$426,717	09 Engineering 0914 RESOURCES ENGINEERING AND EXTRACTIVE METALLURGY 0905 CIVIL ENGINEERING 090501 - Civil Geotechnical Engineering; 091402 - Geomechanics and Resources Geotechnical Engineering	0905 - CIVIL ENGINEERING
Active	DE200101361	1	earthquake	The University of Queensland	Queensland	Mojtaba Rajabi	Discovery Early Career Researcher Award	2020	The Australian tectonic stress state: Far-field forces and local impacts	This project aims to investigate the present-day tectonic stress field of Australia using detailed analysis of stress magnitude data and state-of-the-art 3D geomechanical-numerical modelling across spatial scales. Tectonic stresses control the Earth's deformation and are a primary cause of collapse of subsurface structures. This project expects to improve our knowledge of the causes of the tectonic stress field of Australia and its consequences for earthquake risk assessment, safe and sustainable usage of underground environments for groundwater exploration and production, CO2 sequestration, waste disposal, mine stability, exploration and production of hydrocarbon and geothermal resources.	$403,866	09 Engineering 04 Earth Sciences 0914 RESOURCES ENGINEERING AND EXTRACTIVE METALLURGY 0403 GEOLOGY 040313 - Tectonics; 091402 - Geomechanics and Resources Geotechnical Engineering	0403 - GEOLOGY
Active	DE200101435	1	cyclone	The University of New South Wales	New South Wales	Difei Deng	Discovery Early Career Researcher Award	2020	Rainfall Enhancement Following Landfalling Tropical Cyclone over Australia	Australia has one of the highest incidents of tropical cyclone-related rainfall in the world. Although these events have considerable socio-economic impacts on population centres and industries, the rainfall processes following the landfalling tropical cyclones have received limited attention from the research community. This project aims to improve fundamental understanding of the high-risk locations, spatial-temporal characteristics, thermodynamic-dynamic mechanism on enhanced rainfall following the landfall of tropical cyclones over Australia. Expected outcomes include: (a) scientific support for weather forecasting; and (b) improved knowledge of extreme rainfall following tropical cyclone landfall in the context of warming climate.	$364,932	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 040107 - Meteorology	0401 - ATMOSPHERIC SCIENCES
Active	DP130102035	1	earthquake	The University of Melbourne	Victoria	Carolyn Stevens; Tamara Kohn; Richard Chenhall; Theodore Bestor; Shuhei Hosokawa; Joseph Hankins	Discovery Projects	2013	Sonic practice in Japan: sound in everyday life	This anthropological project focuses on 'sonic practice' - a way of understanding how sound is made significant to people in their everyday life - and its impact on social relations in Japan.	$178,000	20 Language, Communication and Culture 16 Studies in Human Society 2002 CULTURAL STUDIES 1601 ANTHROPOLOGY 160104 - Social and Cultural Anthropology; 200202 - Asian Cultural Studies	1601 - ANTHROPOLOGY

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Active	DP140103090	1	drought	Flinders University	South Australia	Kathleen Soole; David Day; Colin Jenkins; Lee Sweetlove	Discovery Projects	2014	Engineering the plant mitochondrial electron transport chain for tolerance of environmental stress	Plants often face hostile environments that place them under stress. Reactive oxygen molecules produced under these conditions act as signals to activate defense mechanisms, but also cause cell damage. Mitochondria are subcellular compartments involved in energy production and are essential for plant growth and development, but they have also been implicated in the response of plants to environmental stress, and in production of reactive oxygen molecules. This project will investigate special features of plant mitochondria that ameliorate oxidative stress. Potential outcomes include crops better able to cope with environmental stress.	$387,095	06 Biological Sciences 07 Agricultural and Veterinary Sciences 0607 PLANT BIOLOGY 0703 CROP AND PASTURE PRODUCTION 060702 - Plant Cell and Molecular Biology; 070303 - Crop and Pasture Biochemistry and Physiology	0607 - PLANT BIOLOGY
Active	DP140103535	1	storm	Monash University	Victoria	Xiwang Zhang; Ana Deletic; David McCarthy	Discovery Projects	2014	Development of Solar-induced, Dark-active Photocatalytic Membranes for Water Disinfection	Stormwater is one of the last freshwater resources that has not been utilised to its full potential. However, large amount of faecal pathogens in stormwater limit its harvesting practice.This project aims at addressing this significant problem by developing the next generation of photocatalytic membranes for stormwater disinfection. The proposed membranes not only are passive water treatment technology which only utilises solar energy, but also are operated regardless of weather, even at night. The results will provide new insights on development of future water treatment technologies. This project will also raise Australia's credibility and competitiveness in the water and membrane industries.	$390,000	09 Engineering 0912 MATERIALS ENGINEERING 0904 CHEMICAL ENGINEERING 091205 - Functional Materials; 090404 - Membrane and Separation Technologies; 090410 - Water Treatment Processes	0904 - CHEMICAL ENGINEERING
Active	DP150100299	3	bushfire; flood; heatwave	RMIT University	Victoria	Jean Hillier; Wendy Steele; Susan MacCallum; Jason Byrne; Donna Houston	Discovery Projects	2015	Enabling social innovation for local climate adaptability	Climate variability and change is likely to be felt most acutely at the local scale in Australia. This is where inter/national and State policies are translated into practices to prepare for, and adapt to, anticipated impacts of heatwaves, bushfires and floods. This project will investigate tensions and potentialities between risk-based assessments by local governance agencies and innovations by local groups and Non-Government Organisations. The research will utilise an innovative mixed-methods approach to investigate and to analyse the strategies and experiments of adaptation practices. It aims to develop new ways of identifying and implementing practical, local, adaptive responses that are contextually relevant, socially innovative and capacity building.	$172,500	16 Studies in Human Society 12 Built Environment and Design 1604 HUMAN GEOGRAPHY 1605 POLICY AND ADMINISTRATION 1205 URBAN AND REGIONAL PLANNING 160403 - Social and Cultural Geography; 160514 - Urban Policy; 120502 - History and Theory of the Built Environment (excl. Architecture)	1604 - HUMAN GEOGRAPHY
Active	DP150100328	1	volcanic eruption	Macquarie University	New South Wales	Heather Handley; Simon Turner; Mark Reagan; Jennifer Barclay	Discovery Projects	2015	Timescales of mixing and volatile transfer leading to volcanic eruptions	The short-lived lead isotope, 210Pb, has the unique ability to place timescale constraints on volcanic processes, such as the input, mixing and degassing of magma. These processes are believed to be of fundamental importance in the triggering of volcanic eruptions. This project will measure 210Pb isotopic compositions and elemental diffusion profiles in crystals of volcanic rocks that represent the end members of mixed magmas to constrain the volume and timescale of volatile transfer from magmatic recharge and also the time between magma mixing events and eruptions. The project aims to test the paradigm that magma recharge triggers volcanic eruptions and aims to yield significant outcomes for understanding eruption triggers at hazardous volcanoes.	$340,500	04 Earth Sciences 0403 GEOLOGY 0402 GEOCHEMISTRY 040303 - Geochronology; 040203 - Isotope Geochemistry; 040314 - Volcanology	0403 - GEOLOGY
Active	DP150100442	1	earthquake	Monash University	Victoria	Xiao-Ling Zhao; Amin Heidarpour; Riadh Al-Mahaidi; Lin-Hai Han	Discovery Projects	2015	Behaviour of ultra-high strength double-skin composite tubular construction	Ultra-high strength (UHS) steel tubes are currently used mainly in the vehicle industry due to their high strength and light weight. This project aims to enable the building of more resilient and sustainable infrastructure by utilising these UHS steel tubes in double-skin composite tubular construction. To date there has been little work to understand the effects of fire, earthquake and impact related incidents on these structures. This project aims to access unique testing facilities for full size impact and fire testing and the state-of-the-art hybrid testing simulation. It is expected to increase the competitiveness of the Australian manufacturing industry by overcoming the bottleneck in the manufacture of steel sections.	$415,500	09 Engineering 0905 CIVIL ENGINEERING 090506 - Structural Engineering; 090502 - Construction Engineering; 090503 - Construction Materials	0905 - CIVIL ENGINEERING
Active	DP150100878	1	bushfire	The Australian National University	Australian Capital Territory	Philip Gibbons; Geoffrey Cary; Arthur Gill; Stephen Dovers; Max Moritz	Discovery Projects	2015	Managing Australian landscapes to reduce house loss during bushfires	The number of houses destroyed by bushfires in Australia is increasing. This project aims to undertake the first comprehensive analysis of links between land management practices and house loss during bushfires across Australia. Results from this research are expected to improve the ability of authorities, industry and individual home owners to quantify risk from bushfires, and to identify ways that Australian landscapes can be managed to reduce house losses during bushfires. Results from this research will be communicated directly to key stakeholders including government agencies, industry and home owners.	$217,500	12 Built Environment and Design 05 Environmental Sciences 1205 URBAN AND REGIONAL PLANNING 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 120504 - Land Use and Environmental Planning; 050205 - Environmental Management	1205 - URBAN AND REGIONAL PLANNING
Active	DP150100912	1	drought	The University of Sydney	New South Wales	Michael Kirkpatrick; Nicholas Williamson; Wenxian Lin; Steven Armfield	Discovery Projects	2015	Thermal stratification, overturning and mixing in riverine environments	Thermal stratification is common in Australia's rivers due to our hot, drought-prone climate and high human demands relative to available supply, which has led to a significant reduction in flows relative to natural levels. Thermal stratification inhibits mixing, creating stagnant conditions characterised by low oxygen levels and increased concentrations of contaminants, leading to algal blooms, fish kills and systemic damage to ecosystems. The aim of this project is to develop predictive models for the effects of physical processes such as night-time cooling, wind, turbulence and currents on riverine thermal stratification. This is expected to enable a more accurate determination of the flow rates required to maintain the health of our river systems.	$335,100	09 Engineering 0915 INTERDISCIPLINARY ENGINEERING 091508 - Turbulent Flows; 091504 - Fluidisation and Fluid Mechanics; 091501 - Computational Fluid Dynamics	0915 - INTERDISCIPLINARY ENGINEERING

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Active	DP150101339	1	storm	The University of New South Wales	New South Wales	Ian Turner; Jason Middleton; Kristen Splinter; Ad Reniers; Mark Davidson; Chris Blenkinsopp	Discovery Projects	2015	Beach Erosion and Recovery: Quantifying the Hazard	Coastal erosion is confronting societies and the natural environment. The economic value in Australia of built assets at risk includes roads ($60 billion), commercial buildings ($81 billion) and homes ($63 billion). Hard engineering entire coastlines is rarely feasible, with beaches providing the best coastal defence along the great majority of sandy coastlines. But how wide should a buffer zone be to provide adequate protection from storms? And critically, how reliable are the present modelling tools used to predict this, and can they be improved? Underpinned by innovative field observations to fill fundamental knowledge gaps, this project aims to deliver advanced understanding and the best available solution to storm erosion prediction.	$423,200	04 Earth Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0403 GEOLOGY 0405 OCEANOGRAPHY 040305 - Marine Geoscience; 040604 - Natural Hazards; 040503 - Physical Oceanography	0403 - GEOLOGY
Active	DP150103038	1	heatwave	Queensland University of Technology	Queensland	Shilu Tong; Gerard FitzGerald; Yuming Guo; Bin Jalaludin	Discovery Projects	2015	Development of a heatwave definition using the health risk-based metrics	Climate change is increasingly recognised as this century's biggest global health threat, but the health consequences of climate change remain to be quantified. A typical example is health risks from heatwaves which kill more people than any other natural hazard in Australia, but few comprehensive datasets are available on what affects heatwaves can have on population health and well-being, and how such evidence can be translated into policy. This project aims to understand the health risks associated with heatwaves, to develop health risk-based metrics to define a heatwave across different areas, and to evaluate its implications for the development of social and health policies within an Australian context.	$291,168	11 Medical and Health Sciences 1117 PUBLIC HEALTH AND HEALTH SERVICES 111705 - Environmental and Occupational Health and Safety; 111706 - Epidemiology	1117 - PUBLIC HEALTH AND HEALTH SERVICES
Active	DP150104006	1	flood	Griffith University	Queensland	Brian Fry; Jonathon Olley; Michele Burford	Discovery Projects	2015	New tracer methods for revealing the hidden connections between ecosystems	As humans modify the biosphere, many complex landscape-level problems are emerging. New methods are required to work on these large-scale problems. The aim of this project is to develop novel methods involving trace elements and isotopes, opening up new ways to explore the large-scale connections between terrestrial ecosystems and downstream estuaries. It is planned to use these new methods to test for unexpected positive benefits of floods for estuarine fisheries. The project is significant and innovative because it develops two fundamentally new types of tracer work, one at the sediment-animal level and one at the within-molecule level. The expected outcomes include a new toolkit for tracing the hidden connections between terrestrial and aquatic ecosystems.	$500,700	05 Environmental Sciences 06 Biological Sciences 0501 ECOLOGICAL APPLICATIONS 0602 ECOLOGY 050102 - Ecosystem Function; 050104 - Landscape Ecology; 060205 - Marine and Estuarine Ecology (incl. Marine Ichthyology)	0501 - ECOLOGICAL APPLICATIONS
Active	DP150104346	1	earthquake	Curtin University	Western Australia	Hong Hao	Discovery Projects	2015	Development of Precast Concrete Segmental Columns to Resist Dynamic Loads	Using precast segmental concrete columns in structures improves the construction efficiency and site safety, leads to better construction quality control, and reduces the construction cost, site disruption and environmental impacts. The performance of segmental columns to resist earthquake and blast loads is not well studied yet. As a structure might be subject to such loads during its service life, understanding its resistance capacities is essential for structural safety. This project aims to perform experimental and numerical investigations to study the performance of precast segmental concrete columns under earthquake and blast loads, and develop analytical and design methods for applications of such columns in building and bridge structures.	$593,400	09 Engineering 0905 CIVIL ENGINEERING 090506 - Structural Engineering	0905 - CIVIL ENGINEERING
Active	DP160100746	1	storm	Monash University	Victoria	Paul Cally; Hans De Sterck; Sergiy Shelyag	Discovery Projects	2016	Advanced simulation methods for the coupled solar interior and atmosphere	This project aims to develop numerical methods for complex magnetohydrodynamic simulations able to handle sharp and dynamically evolving inhomogeneities, spherical geometries, and dramatic variations in density and wave speed across the simulation domain. The project plans to develop these methods within the context of solar wave processes, which are fundamental to the transfer of energy from the sun’s interior to its outer atmosphere, to the acceleration of the solar wind that rushes past the Earth continually, and to solar activity in general. This would provide the best available modelling of how the sun's atmosphere works, with direct implications for how the Earth's space environment is determined by solar storms and eruptions.	$403,100	01 Mathematical Sciences 02 Physical Sciences 0103 NUMERICAL AND COMPUTATIONAL MATHEMATICS 0201 ASTRONOMICAL AND SPACE SCIENCES 010302 - Numerical Solution of Differential and Integral Equations; 020109 - Space and Solar Physics	0103 - NUMERICAL AND COMPUTATIONAL MATHEMATICS
Active	DP160101058	1	drought	The University of Newcastle	New South Wales	Silvia Frisia; John Hellstrom; David Mattey	Discovery Projects	2016	Hydrological changes in Australia and the South Pacific	This project plans to use stalagmites from the South–West Pacific to generate continuous rainfall records for the last 2000 years. Stalagmites contain uncorrupted data that are not available in other archives, and provide unparalleled accurate chronologies. The spatial and temporal variations of the data may highlight the interplay of climate drivers, such as El Niño Southern Oscillation, and how they change the distribution of rainfall in the Pacific. This knowledge would increase our scientific understanding and enable better predictions of the recurrence of droughts and wet events in Australia.	$448,062	04 Earth Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0403 GEOLOGY 040605 - Palaeoclimatology; 040310 - Sedimentology; 040306 - Mineralogy and Crystallography	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE

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Active	DP160101158	1	earthquake	The University of Adelaide	South Australia	Rosalind King; Simon Holford; Khalid Amrouch; Dave Healy; Richard Hillis	Discovery Projects	2016	Subsurface fluid flow through fractures in sedimentary basins	This project aims to improve understanding of subsurface fluid transport through fractures. Fractures in rock provide interconnected, hydraulically conductive networks enabling large-volume fluid transport through sedimentary basins. The ability of a fracture to transmit fluid is primarily controlled by the in situ stress field, but also by rock strength, fracture plane orientation and roughness and pore-fluid pressure. We have a good understanding of in situ stress within many sedimentary basins, but know very little about the nature and origin of natural fractures. This project aims to provide a detailed, quantitative understanding of the nature and origin of natural fractures in the subsurface, which is critical for predicting fluid migration within aquifers, carbon dioxide storage sites, and geothermal and hydrocarbon reservoirs.	$230,000	04 Earth Sciences 0403 GEOLOGY 040312 - Structural Geology; 040313 - Tectonics; 040309 - Petroleum and Coal Geology	0403 - GEOLOGY
Active	DP160101377	1	flood	Monash University	Victoria	Jeffrey Walker; Remko Uijlenhoet; Alan Seed	Discovery Projects	2016	Improved rainfall measurement using mobile phone tower link attenuation	The project aims to use the microwave link data between mobile phone towers to complement the sparse rain gauge network in urban areas, to allow more accurate near-real-time monitoring of rainfall. Accurate near-real-time precipitation data at high resolution are critical to flash flood forecasting in and around Australia's capital cities. Current estimates suffer from the limited availability of rain gauge data in urban areas. However, mobile phone towers abound and the microwave links between them can provide information on rainfall intensity, meaning that these data could be used to supplement the rain gauge data. This project plans to develop the technology to generate precipitation maps using mobile phone network link, rain gauge and weather radar data.	$539,500	09 Engineering 04 Earth Sciences 0905 CIVIL ENGINEERING 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 090509 - Water Resources Engineering; 040608 - Surfacewater Hydrology	0905 - CIVIL ENGINEERING
Active	DP160102070	1	earthquake	The University of Adelaide	South Australia	Michael Griffith; Mark Masia; Jason Ingham	Discovery Projects	2016	Safeguarding Australia's heritage masonry buildings from earthquake attack	The project aims to improve the guidance provided in Australian and New Zealand design codes for the seismic capacity assessment of heritage masonry buildings. The majority of culturally significant heritage buildings in Australia are constructed of unreinforced masonry, and all of these buildings were erected before seismic design guidelines or requirements existed. The risk posed by earthquakes to these important buildings is significant – as highlighted by the 2011 Christchurch earthquake where both major cathedrals in the city were heavily damaged. The project aims to develop an analysis and design method that accounts for the material properties and non-typical structural layouts used in heritage stone and clay brick masonry buildings that are most relevant to seismic response.	$380,000	09 Engineering 0905 CIVIL ENGINEERING 090504 - Earthquake Engineering; 090506 - Structural Engineering; 090503 - Construction Materials	0905 - CIVIL ENGINEERING
Active	DP160102134	1	volcanic eruption	The University of Sydney	New South Wales	Steven Armfield; Nicholas Williamson; Wenxian Lin; Michael Kirkpatrick	Discovery Projects	2016	Entrainment and Mixing in Turbulent Negatively Buoyant Jets and Fountains	The project intends to develop tools to accurate predict fountain flows. Volcanic eruptions, building ventilation and brine discharge from desalination plants are all examples of turbulent fountains and negatively buoyant jets. The project aims to conduct an investigation into the turbulent structure of fountains and negatively buoyant jets using numerical simulation and laboratory experiments, and to assess the accuracy of the commonly used integral models and test the effect of the use of more accurate entrainment relations. This may have a range of applications – enabling better prediction of environmental impacts, reduction of the adverse effects of the discharge of pollutants, and reduction in energy consumption in building ventilation and other industrial applications.	$300,000	09 Engineering 0915 INTERDISCIPLINARY ENGINEERING 091504 - Fluidisation and Fluid Mechanics; 091501 - Computational Fluid Dynamics; 091508 - Turbulent Flows	0915 - INTERDISCIPLINARY ENGINEERING
Active	DP160102427	1	volcanic eruption	Curtin University	Western Australia	Martin Danisik; Noreen Evans; Axel Schmitt; Phil Shane; Takehiko Suzuki; Shanaka de Silva	Discovery Projects	2016	Developing and testing a new dating tool for Quaternary science	This project plans to use cutting-edge instrumentation to develop a novel method for dating geological materials formed in a critical time window for which no dating technique currently exists. The last million years of Earth's history has seen dramatic changes in global climate and environment, with catastrophic volcanic eruptions and numerous other natural processes shaping landforms and ecosystems. A major challenge for studying these phenomena and their impacts is the dating of geological archives in the time window between 50 000 and 1 000 000 years. This project aims to develop a method for dating young volcanic rocks that can close this critical gap. The result would be a new dating tool with broad implications for the Quaternary sciences globally, including paleoclimate and paleoenvironmental reconstructions, natural hazards assessment, hominin evolution and archaeology.	$289,500	04 Earth Sciences 0403 GEOLOGY 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040303 - Geochronology; 040314 - Volcanology; 040604 - Natural Hazards	0403 - GEOLOGY
Active	DP160102612	2	natural disaster; tsunami	Swinburne University of Technology	Victoria	Guoxing Lu; Zhong You	Discovery Projects	2016	Sandwich Structures with Folded Core under Impact and Blast Loading	This project aims to support the development of new materials resistant to impacts. Novel sandwich panels making use of Miura-ori folded cores have superior performance relative to monolithic solid plates, in terms of stiffness and strength. They have great potential to be used in commercial and military vehicles as well as protective structures, which can be subjected to impact and blast loading. This project aims to systematically investigate the impact and blast response of such sandwich panels by establishing theoretical models and conducting experiments and advanced simulations. The findings may provide an insight into the fundamental mechanics of sandwich panels with folded cores under impact and blast loading, as well as guidelines for optimum design of these novel structures.	$440,000	09 Engineering 0913 MECHANICAL ENGINEERING 0905 CIVIL ENGINEERING 090506 - Structural Engineering; 091308 - Solid Mechanics	0905 - CIVIL ENGINEERING

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Active	DP160103248	2	bushfire; storm	Western Sydney University	New South Wales	Kenny Kwok; Yaping He	Discovery Projects	2016	Bushfire-enhanced wind and its effects on buildings	This project seeks to advance our understanding of bushfire–wind interaction to improve current design standards for buildings against bushfire-enhanced winds. Bushfire-enhanced winds have caused considerable property damage and loss of lives. The project aims to identify the mechanisms governing bushfire–wind interaction and determine the wind load effects on buildings due to bushfire-enhanced wind. It aims to do so by using advanced computation techniques and unique fire-wind tunnel test facility. This knowledge is designed to guide the development of improved building construction standards for bushfire-prone regions to facilitate the design and construction of a new generation of bushfire-resistant buildings that safeguard lives and properties against the increasing threat of bushfire due to climate change.	$330,000	09 Engineering 12 Built Environment and Design 0905 CIVIL ENGINEERING 0915 INTERDISCIPLINARY ENGINEERING 1202 BUILDING 120202 - Building Science and Techniques; 091503 - Engineering Practice; 090502 - Construction Engineering	1202 - BUILDING
Active	DP160103436	1	drought	Western Sydney University	New South Wales	Belinda Medlyn; Remko Duursma; Roderick Dewar; Mathew Williams	Discovery Projects	2016	To grow or to store: Do plants hedge their bets?	This project aims to resolve a long-standing question about the function of perennial plants: how much of the carbon taken up by photosynthesis is used immediately for growth, and how much is kept in reserve as insurance against future stress? This question is important to our understanding of how plants respond to stresses such as severe drought, and yet lack of data and theoretical modelling currently hampers our ability to answer it. By applying novel data analysis and modelling tools to recent experimental results, the project plans to test hypotheses for how plants allocate carbon between growth and storage in response to stress. Insights from the project may underpin better management of Australia's vulnerable ecosystems.	$428,100	05 Environmental Sciences 06 Biological Sciences 0501 ECOLOGICAL APPLICATIONS 0699 OTHER BIOLOGICAL SCIENCES 0602 ECOLOGY 060203 - Ecological Physiology; 050102 - Ecosystem Function; 069902 - Global Change Biology	0602 - ECOLOGY
Active	DP160103439	1	flood	The University of New South Wales	New South Wales	Lisa Alexander	Discovery Projects	2016	Has rainfall become more variable or extreme?	The trends and variability of global daily rainfall are uncertain. By tackling data shortcomings and the scaling issues that exist between observations and models, this project aims to produce the first well-constrained long-term assessment of the variability and trends in daily rainfall over land. Using extreme value analysis on the resulting data would allow the exploration of the sensitivity of rainfall extremes to grid resolution, interpolation method and order of operation on an unprecedented grand scale. Ultimately, this means that improved return period estimates could be calculated for the types of events that could lead to flooding. Understanding how, where and why it rains is vital for enabling sound decisions to be made by our planners and policy-makers.	$339,000	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 040105 - Climatology (excl. Climate Change Processes); 040107 - Meteorology; 040104 - Climate Change Processes	0401 - ATMOSPHERIC SCIENCES
Active	DP160103915	1	drought	The Australian National University	Australian Capital Territory	Lindell Bromham; Marcel Cardillo	Discovery Projects	2016	Evolution at extremes: Macroevolutionary responses to harsh environments	The project seeks to investigate the capacity of iconic Australian plant groups (Eucalyptus, Acacia, Banksia, Grevillea, Hakea) to adapt to increases in extreme conditions. Australia presents many extreme conditions for plant survival, such as drought, heat, or salt-affected soils. Are some lineages better able to adapt and diversify in these conditions? This project aims to develop new methods to identify lineages most tolerant of extreme environments, detect enabling traits that contribute to stress resistance, and test whether plant assemblages in extreme environments are formed from colonisation by specialist tolerators, or by local species adapting. These methods may allow the prediction of species or communities best able to adapt to conditions expected under global environmental change.	$378,700	06 Biological Sciences 0603 EVOLUTIONARY BIOLOGY 0602 ECOLOGY 060309 - Phylogeny and Comparative Analysis; 060202 - Community Ecology (excl. Invasive Species Ecology); 060306 - Evolutionary Impacts of Climate Change	0603 - EVOLUTIONARY BIOLOGY
Active	DP160103961	1	wildfire	Monash University	Victoria	Hugh Blackburn; Alexander Smits; Juan Lopez	Discovery Projects	2016	Dynamics of fire whirls and dust devils	The project aims to develop fundamental understanding and models to inform the development of more accurate computer models of fire front propagation. Fire whirls and dust devils are strongly swirling localised vortex flows that result from an interplay of circulation and buoyancy, may extend hundreds of metres into the air. By projecting firebrands well away from the ground strike, fire whirls can initiate spot fires well beyond a fire front, advancing fronts at much higher speeds than most fire spread models predict. The project aims to improve understanding of the sets of local conditions that produce and stabilise these flows, using computational fluid dynamics matched to laboratory experiments and dimensional analysis of results.	$310,000	04 Earth Sciences 01 Mathematical Sciences 09 Engineering 0404 GEOPHYSICS 0102 APPLIED MATHEMATICS 0915 INTERDISCIPLINARY ENGINEERING 091508 - Turbulent Flows; 040403 - Geophysical Fluid Dynamics; 010207 - Theoretical and Applied Mechanics	0915 - INTERDISCIPLINARY ENGINEERING
Active	DP160104233	1	flood	Monash University	Victoria	Nemai Karmakar; Christoph Rüdiger	Discovery Projects	2016	Airborne passive radiometer for high resolution soil moisture monitoring	The project proposes to create a novel technology to measure soil moisture. Accurate knowledge of soil moisture profiles at high resolution is important for sustainable land and water management including efficient irrigation scheduling and cropping practices. A passive multi-band soil moisture-measuring radiometer at L-, Ku- and Ka-bands is proposed. The radiometer comprises a three-band shared aperture antenna array, a receiving electronics, a digital controller and a data logger. The array antenna comprises dual polarised stacked patch elements. Beamforming networks form agile beams to scan the ground. Sensitive radiometer receivers apply brightness temperature downscaling for high resolution. The high-resolution passive radiometer would revolutionise airborne soil moisture monitoring by removing the mechanically steerable bulky and heavy scanheads.	$660,000	10 Technology 09 Engineering 1005 COMMUNICATIONS TECHNOLOGIES 0909 GEOMATIC ENGINEERING 100501 - Antennas and Propagation; 100505 - Microwave and Millimetrewave Theory and Technology; 090905 - Photogrammetry and Remote Sensing	1005 - COMMUNICATIONS TECHNOLOGIES

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Active	DP160104564	1	natural disaster	The University of Sydney	New South Wales	Jane Lê; Christopher Wright; Paula Jarzabkowski	Discovery Projects	2016	The human side of energy security	This project plans to develop a decision enactment model to guide industry and policy makers in producing more effective energy decisions. Managing our energy supply to ensure access to reliable, affordable and sustainable energy is vital to Australian economic growth and quality of life. However, energy security is continually under threat from manipulation of supply, ageing infrastructure and natural disasters. Solutions from economic and engineering perspectives only partially address these issues because they overlook critical human factors that underpin energy security. The project plans to use a practice-based approach to examine energy-related firms and agencies to explain how decisions and actions that take place within these contexts shape our energy future.	$228,000	15 Commerce, Management, Tourism and Services 1503 BUSINESS AND MANAGEMENT 150310 - Organisation and Management Theory; 150312 - Organisational Planning and Management	1503 - BUSINESS AND MANAGEMENT
Active	DP170100023	1	heatwave	The University of Western Australia	Western Australia	Thomas Wernberg; Adriana Verges; Peter Steinberg	Discovery Projects	2017	Global threats to kelp forests from heatwaves, herbivores and diseases	This project aims to understand the mechanisms behind climate-mediated declines in kelp. Ocean warming causes the collapse of valuable temperate kelp forests globally and on both sides of Australia, but it is unknown if this is because of direct physiological effects from temperature or the indirect effects of changes in species interactions. This project will compare the direct effects of marine heatwaves to the indirect effects of range-shifting tropical herbivores and pathogens for the kelp forests of the Great Southern Reef, one of Australia's largest coastal ecosystems. This project will generate knowledge underpinning adaptation strategies for these critical ecosystems, and could enhance the capacity to respond to degradation of these natural assets.	$385,000	06 Biological Sciences 0602 ECOLOGY 0699 OTHER BIOLOGICAL SCIENCES 0607 PLANT BIOLOGY 060205 - Marine and Estuarine Ecology (incl. Marine Ichthyology); 060701 - Phycology (incl. Marine Grasses); 069902 - Global Change Biology	0602 - ECOLOGY
Active	DP170100096	1	natural disaster	University of Tasmania	Tasmania	Kate Booth; Bruce Tranter; Christine Eriksen; Shaun French	Discovery Projects	2017	Geographies of house and contents under-insurance	This project aims to analyse house and contents insurance to advance strategic disaster management. When natural disasters strike, house and contents insurance provides a safety net, but many households are under-insured or not insured at all. Governments and communities tend to bear the costs, but the geographies of inadequate insurance, including any crucial post-disaster effects, are unknown. This research is expected to strategically improve disaster policy and practice, and reduce the financial and social costs of disasters to governments, communities and householders.	$327,451	16 Studies in Human Society 1604 HUMAN GEOGRAPHY 160403 - Social and Cultural Geography	1604 - HUMAN GEOGRAPHY
Active	DP170100177	3	bushfire; flood; natural disaster	Monash University	Victoria	David Johnston; Benno Torgler; Peter Siminski; Silvia Mendolia; David Savage	Discovery Projects	2017	Microeconomic effects of Australian natural disasters	This project aims to describe and identify the effects of Australian natural disasters – such as the Black Saturday bushfires and the Brisbane floods – on important microeconomic outcomes, including health, education and employment. Natural disasters have profound economic and social effects on individuals and communities. This project intends to bring evidence on how disasters affect individuals and how the effects can be lessened. The project expects to inform policy-makers on these critical issues by analysing field, survey and administrative data on individuals before and after past disasters.	$403,500	14 Economics 1402 APPLIED ECONOMICS 140208 - Health Economics; 140211 - Labour Economics	1402 - APPLIED ECONOMICS
Active	DP170100224	1	earthquake	University of Tasmania	Tasmania	Matt King; Shin-Chan Han; Pippa Whitehouse; Wouter van der Wal	Discovery Projects	2017	Earthquake biases in measurements of Antarctica's sea-level contribution	This project aims to accurately determine Antarctica's contribution to present-day sea-level. Large technique-specific systematic errors make this uncertain and controversial with the sign of change not agreed. Three of four measurement techniques rely on knowing the solid earth's changing shape or gravity field. Studies have not considered post-seismic deformation, but GPS data show that Antarctica has deformed since the 1998 Magnitude-8.2 Antarctic Plate Earthquake. This project will develop a model of these earthquakes constrained by geodetic data and use the model to estimate Antarctica's contribution to sea-level change. This should enable more confident local, national and international planning. This will benefit society through reducing the sea-level projection uncertainty.	$439,500	09 Engineering 04 Earth Sciences 0909 GEOMATIC ENGINEERING 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0404 GEOPHYSICS 040402 - Geodynamics; 090902 - Geodesy; 040602 - Glaciology	0404 - GEOPHYSICS
Active	DP170100430	1	drought	University of Tasmania	Tasmania	Sergey Shabala; Rainer Hedrich	Discovery Projects	2017	Stomata functioning in halophytes for improved plant stress tolerance	This project aims to determine how halophytes balance photosynthesis and water loss under extreme soil conditions. Salinity and drought affect crop production. Plants' ability to balance carbon dioxide uptake and water loss through stomata determines how they cope with stressors. Halophytes can achieve this balance at conditions that normally kill 99% of crops, but how they do so is unknown. This project will characterise the transport systems mediating stomata function in halophytes and contribute to understanding the molecular and physiological basis of their operation. This should allow breeders to use this trait to improve crop performance under conditions of extreme salinity and drought.	$446,500	06 Biological Sciences 07 Agricultural and Veterinary Sciences 0607 PLANT BIOLOGY 0703 CROP AND PASTURE PRODUCTION 060705 - Plant Physiology; 060702 - Plant Cell and Molecular Biology; 070305 - Crop and Pasture Improvement (Selection and Breeding)	0607 - PLANT BIOLOGY
Active	DP170100761	1	drought	University of Tasmania	Tasmania	Timothy Brodribb; Brendan Choat; Herve Cochard; Philippe Marmottant; Sylvain Delzon	Discovery Projects	2017	The failure-threshold of leaves in drought	This project aims to reveal how specific water-stress thresholds damage the leaves of Australian crop and forest species during drought. Water stress affects agricultural productivity and plant survival in drought-prone regions such as Australia. Using optical and X-ray techniques, this project seeks to visualise and quantify the dynamic processes of damage and repair in leaves under stress. Anticipated outputs include a practical basis to predict drought-induced canopy death; identification of threats to ecologically sensitive plants; and selection and screening tools to improve the drought resilience of agriculturally important crop species.	$375,500	07 Agricultural and Veterinary Sciences 06 Biological Sciences 0703 CROP AND PASTURE PRODUCTION 0602 ECOLOGY 0603 EVOLUTIONARY BIOLOGY 060203 - Ecological Physiology; 060303 - Biological Adaptation; 070303 - Crop and Pasture Biochemistry and Physiology	0602 - ECOLOGY

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Active	DP170101033	1	drought	The University of Western Australia	Western Australia	Pauline Grierson; Edward Cook; Grzegorz Skrzypek	Discovery Projects	2017	Annual rainfall variability and extreme drought over the late Holocene	This project aims to understand long-term rainfall variability for Australia by developing a network of extended, high resolution rainfall records from tree rings. How anthropogenic changes to the atmosphere have influenced changing rainfall patterns across Australia is unclear. By extracting climatic information from tree growth rings across a latitudinal gradient from the subtropical north to the south coast of western Australia, the project will extend hydroclimatic records by several centuries, to identify the frequency and extent of extreme droughts across the continent. Outcomes are expected to provide appropriate context for evaluating and adapting to climate change, allowing climate modellers, agricultural producers and other industries to improve forecasts of likely change for risk management.	$485,000	05 Environmental Sciences 04 Earth Sciences 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 0501 ECOLOGICAL APPLICATIONS 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 050101 - Ecological Impacts of Climate Change; 040605 - Palaeoclimatology; 050202 - Conservation and Biodiversity	0501 - ECOLOGICAL APPLICATIONS
Active	DP170101108	1	flood	The University of Western Australia	Western Australia	Michael Johns; Eric May; Paul Stanwix	Discovery Projects	2017	Carbon dioxide-methane exchange in porous media for carbon-neutral energy production	This project aims to incorporate carbon capture and storage into natural gas production from energy reserves. Carbon sequestration could assist in achieving the goals of the Paris Climate Agreement. Injecting carbon dioxide into natural gas reservoirs or methane hydrate sands would be a nearly carbon-neutral means of energy production. However, this exchange of carbon dioxide for methane is poorly understood in both reservoirs and sands because multiple phases like water and sand affect mixing and recovery. This project will combine spatially-resolved Magnetic Resonance Imaging of high-pressure flooding and exchange experiments with multi-scale modelling. The expected outcome is simultaneous carbon dioxide sequestration with enhanced energy production.	$391,000	05 Environmental Sciences 09 Engineering 0503 SOIL SCIENCES 0914 RESOURCES ENGINEERING AND EXTRACTIVE METALLURGY 0915 INTERDISCIPLINARY ENGINEERING 050301 - Carbon Sequestration Science; 091505 - Heat and Mass Transfer Operations; 091406 - Petroleum and Reservoir Engineering	0503 - SOIL SCIENCES
Active	DP170102278	1	drought	Western Sydney University	New South Wales	Scott Johnson; Sue Hartley; David Tissue	Discovery Projects	2017	Silicon defences for plant protection	This project aims to study how silicon uptake in grasses affects plant susceptibility aboveground. Grasses contain more silicon than nearly any other plant, which they acquire entirely from the soil. Silicon increases plant resistance to herbivores, disease and drought, but up to 25 per cent of grass productivity is lost to root herbivores, a situation compounded by water stress. Silicon uptake is poorly understood, but root herbivory and changing rainfall patterns can either impair uptake or induce the plant to take up more silicon. The goal of this project is to optimise silicon-based resistance in grasses and exploit this for plant protection from invasive pests and drought.	$338,000	06 Biological Sciences 05 Environmental Sciences 0602 ECOLOGY 0608 ZOOLOGY 0501 ECOLOGICAL APPLICATIONS 060808 - Invertebrate Biology; 050101 - Ecological Impacts of Climate Change; 060203 - Ecological Physiology	0608 - ZOOLOGY
Active	DP170102766	1	drought	Western Sydney University	New South Wales	Elise Pendall; Stefan Arndt; Mark Tjoelker; Eva van Gorsel; Eric Davidson; Vanessa Haverd	Discovery Projects	2017	Temperature sensitivity of soil respiration and its components	This project aims to demonstrate how temperate evergreen forests could buffer against climate change. Soil respiration returns around half the carbon taken up by forests to the atmosphere. This project will characterise and quantify how microbes and roots in soils depend on temperature and substrate supply, and so predict how rising temperatures and drought will affect forests as natural carbon sequestration sinks. This project will resolve the roles of environmental drivers of soil respiration across forests; integrate mechanistic understanding of differing plant and microbial responses to temperature within a common modelling framework; and evaluate the implications of this knowledge in predictions of climatic impacts on terrestrial carbon cycling.	$405,500	06 Biological Sciences 05 Environmental Sciences 0699 OTHER BIOLOGICAL SCIENCES 0602 ECOLOGY 0501 ECOLOGICAL APPLICATIONS 050102 - Ecosystem Function; 060203 - Ecological Physiology; 069902 - Global Change Biology	0501 - ECOLOGICAL APPLICATIONS
Active	DP170102870	1	storm	The University of Melbourne	Victoria	Timothy Fletcher; Andrew Western; Meenakshi Arora	Discovery Projects	2017	Urban subsurface flow pathways from stormwater infiltration	This project aims to understand how water (and associated pollutants) move through the urban landscape. Urban stormwater runoff degrades streams, causing erosion, pollution and loss of biodiversity. Stormwater infiltration can reduce runoff volumes and pollutant loads and could restore stream baseflows, lost through creation of impervious areas. In reality, however, the fate of infiltrated stormwater in the urban landscape is unknown. This project is expected to predict where infiltration may damage waterway health, saving money on repairs.	$527,000	04 Earth Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040608 - Surfacewater Hydrology	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DP170103067	1	storm	The Australian National University	Australian Capital Territory	Stephen Eggins; Michael Ellwood; Christopher Cornwall; William Maher; Andrea Dutton	Discovery Projects	2017	Holding coral reefs together with soluble cement	This project aims to characterise and understand cement formation in coral reefs. Coral reefs are constructed by cementing together aragonite building blocks made by corals. The main cementing agent is high-magnesium calcite, the most soluble carbonate mineral and susceptible to ocean acidification. High-magnesium calcite cements are best developed on the high energy margins of coral reefs. This project will quantify how crustose coralline algae produces high-magnesium calcite and controls the dissolution and reprecipitation of high-magnesium cements. This project intends to quantify rates of reef cementation, susceptibility to ocean acidification and warming, and possible mitigating effects of alkalinity addition.	$393,000	04 Earth Sciences 0403 GEOLOGY 0402 GEOCHEMISTRY 0405 OCEANOGRAPHY 040502 - Chemical Oceanography; 040305 - Marine Geoscience; 040203 - Isotope Geochemistry	0405 - OCEANOGRAPHY
Active	DP170103350	1	earthquake	The University of Melbourne	Victoria	Mark Quigley; Louis Moresi; Sandy Steacy; Seth Stein	Discovery Projects	2017	Origins and distributions of intraplate earthquakes	This project aims to investigate the behaviour and origin of intraplate earthquakes in Australia by developing a multi-million-year record of earthquakes using geological, geochronological, geospatial, seismological, statistical and numerical modelling data. It will use maximum credible magnitudes, maximum shaking intensities of intraplate earthquakes and spatiotemporal relationships between large prehistoric and contemporary earthquakes to improve models of future seismic hazard in Australia and globally. This will lead to improved predictions of future earthquake impacts in urban and natural environments and development of new paleoseismic techniques.	$345,000	04 Earth Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0404 GEOPHYSICS 040604 - Natural Hazards; 040402 - Geodynamics; 040607 - Surface Processes	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE

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Active	DP170103793	1	landslide	The University of Adelaide	South Australia	Giang Nguyen; Ha Bui; Jose Andrade	Discovery Projects	2017	Liquefaction of silty soils: Micromechanics, modelling and prediction	The project aims to develop a numerical approach to understand liquefaction in silty soils. Liquefaction of silty soils in submarine landslides, mine tailings dam failures and cargo liquefaction in vessels carrying iron/nickel ores can cause property loss and be fatal. This project will bridge the behaviours across the scales and deliver constitutive models that possess grain scale mechanisms for better prediction of liquefaction induced failure at the large scales. The expected outcomes are liquefaction criteria for silty soils with different silt contents and numerical tools to predict the onset of liquefaction and flow of liquefied soils.	$277,000	09 Engineering 0905 CIVIL ENGINEERING 0914 RESOURCES ENGINEERING AND EXTRACTIVE METALLURGY 091402 - Geomechanics and Resources Geotechnical Engineering; 090501 - Civil Geotechnical Engineering	0914 - RESOURCES ENGINEERING AND EXTRACTIVE METALLURGY
Active	DP170104091	1	drought	The Australian National University	Australian Capital Territory	Patrick Meir; Lucas Cernusak; Rafael Oliveira; Maurizio Mencuccini; David Galbraith; Emanuel Gloor	Discovery Projects	2017	Hydraulic control on water use, growth and survival in tropical rainforest	This project aims to measure drought-related limits to water transport in the woody xylem tissue of trees in Australian tropical rainforests, to understand how this influences tree water use, photosynthesis, health and mortality risk. Tropical rainforests are sensitive to climate variability, especially drought, but this sensitivity is poorly understood, despite large effects regionally and globally. This project will compare forests that contrast strongly in seasonal drought stress, and use the information to develop a model designed for species-diverse forest, with subsequent potential global application. The understanding gained will enable widely applicable advances designed to feed through rapidly to regional- and global-scale models that inform land use, economic and social policy-making.	$448,000	06 Biological Sciences 05 Environmental Sciences 0602 ECOLOGY 0501 ECOLOGICAL APPLICATIONS 050102 - Ecosystem Function; 050101 - Ecological Impacts of Climate Change; 060203 - Ecological Physiology	0501 - ECOLOGICAL APPLICATIONS
Active	DP170104384	2	drought; flood	The University of Adelaide	South Australia	Matthew Gilliham; Rainer Hedrich	Discovery Projects	2017	A signalling pathway for future crop improvement	This project aims to decipher a mechanism that controls plant gas exchange – the process that emits oxygen, loses water, absorbs carbon dioxide and is essential for plant growth for food, fibre and fuel production. When plants encounter stressful conditions such as drought, high temperatures or flooding, they adapt their physiology to maintain viability and re-establish growth. This project will manipulate stress-induced gamma-aminobutyric acid's capacity to control plant gas exchange to help secure future food production, through improving crop tolerance to stresses such as low water availability and high temperatures – conditions associated with a changing Australian climate.	$375,000	07 Agricultural and Veterinary Sciences 06 Biological Sciences 0703 CROP AND PASTURE PRODUCTION 0607 PLANT BIOLOGY 060702 - Plant Cell and Molecular Biology; 060705 - Plant Physiology; 070303 - Crop and Pasture Biochemistry and Physiology	0607 - PLANT BIOLOGY
Active	DP170104541	1	drought	The University of Adelaide	South Australia	Robert Fitzpatrick; Michael McLaughlin; Freeman Cook; Diederik Jacques	Discovery Projects	2017	Extreme soil acidification and metal release risks from increasing drought	The project aims to study the effects of drought on pH and metal speciation in soils, and develop tools to assess current and future risks. Social and economic well-being depends on good soil and water quality. Climate change makes droughts more frequent and severe, which could cause soil acidification (pH<4) and metal release in many regions. The project will integrate experimental data on the effects of drought on soil geochemistry with hydro-geochemical models, and apply these to national-scale predictions. The intended outcomes are improved management and preparedness for droughts and new research directions for geochemistry.	$502,000	05 Environmental Sciences 04 Earth Sciences 01 Mathematical Sciences 0503 SOIL SCIENCES 0402 GEOCHEMISTRY 0102 APPLIED MATHEMATICS 050304 - Soil Chemistry (excl. Carbon Sequestration Science); 040299 - Geochemistry not elsewhere classified; 010299 - Applied Mathematics not elsewhere classified	0503 - SOIL SCIENCES
Active	DP170104550	1	earthquake	The University of New South Wales	New South Wales	Klaus Regenauer-Lieb; Christoph Schrank; Emmanouil Veveakis; Thomas Poulet; Benjamin Marks; Sotirios Alevizos	Discovery Projects	2017	Pressure waves on the mechanics of earthquakes and faulting	This project aims to decipher the physics of faulting and earthquakes from damage zones around seismogenic faults. It will examine a mechanism for instability in solids: volumetric collapse due to a dissipative pressure wave. This pressure wave may control damage-zone geometry and relate to earthquake stress and rock material properties. The project will research the instability through theoretical, laboratory and field studies. Anticipated outcomes include advances in earthquake and fault prediction, tools to determine the stress state and material properties of Earth's crust, and knowledge of a class of solid instabilities.	$438,000	04 Earth Sciences 0404 GEOPHYSICS 0403 GEOLOGY 040312 - Structural Geology; 040407 - Seismology and Seismic Exploration; 040402 - Geodynamics	0403 - GEOLOGY
Active	DP180100771	1	natural disaster	The University of Melbourne	Victoria	Paul Ali; Ian Ramsay	Discovery Projects	2018	Financial exclusion, poor insurer practices and consumer protection	This project aims to study financial exclusion and variations in access to general insurance, as well as insurer practices in selling insurance and handling claims. Through surveys, focus groups and interviews, the project also aims to evaluate the effectiveness of the legal protections for consumers of general insurance. The expected project outcomes include law and policy reform proposals to improve the effectiveness of these protections and maximise access to general insurance, particularly for socio-economically disadvantaged consumers. This should have benefits such as an increased uptake of general insurance and improved community resilience to natural disasters and other unforeseen events.	$358,916	18 Law and Legal Studies 1801 LAW 180105 - Commercial and Contract Law; 180109 - Corporations and Associations Law	1801 - LAW
Active	DP180100854	1	drought	University of Technology Sydney	New South Wales	Derek Eamus	Discovery Projects	2018	Drought-induced mortality in arid-zone tree species: a mechanistic study	This project aims to determine the relative importance of elevated temperature and increased vapour pressure deficit during drought in causing drought induced mortality (DIM). The outcomes of this project will be an enhanced ability to predict future mortality in response to a warmer and atmospherically drier climate. This will benefit the development of future management strategies and our ability to predict drought impacts on landscape function and productivity.	$412,872	05 Environmental Sciences 0501 ECOLOGICAL APPLICATIONS 050101 - Ecological Impacts of Climate Change	0501 - ECOLOGICAL APPLICATIONS

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Active	DP180101593	1	earthquake	Swinburne University of Technology	Victoria	John Wilson; Nelson Lam; Emad Gad	Discovery Projects	2018	Seismic performance of precast concrete buildings for lower seismic regions	This project aims to develop a displacement-based method of assessing precast concrete buildings in regions of lower seismicity for risk of collapse and seismic performance. The project will investigate the system behaviour and vulnerability of buildings laterally supported by precast concrete geometric walls, which are currently poorly understood but dominate Australian construction. The modelling produced is expected to allow such buildings to be simply checked for seismic compliance using displacement principles, rather than the more complex force based methods with direct benefits for building costs and community safety.	$256,903	09 Engineering 0905 CIVIL ENGINEERING 090504 - Earthquake Engineering	0905 - CIVIL ENGINEERING
Active	DP180101986	1	drought	The University of Sydney	New South Wales	Dan Penny; Duncan Cook; Timothy Beach; Sheryl Beach; Elizabeth Graham; David McGee; Quan Hua	Discovery Projects	2018	Resolving the Maya climate-collapse hypothesis	This project aims to test the climate-collapse theory by developing detailed records of climate and social change from Maya cities that did not collapse, and in doing so identify why some cities were more resilient to the impact of climatic variability than others. Catastrophic climate variability is often invoked to explain the historic collapse of large low-density urban centres in the global tropics. The collapse of the Maya civilisation of Central America after the 8th century AD is the archetypal social collapse yet, despite robust evidence for drought across Central America, archaeological evidence suggests a heterogenous social response. This project will reveal what social, material, or environmental properties facilitated resiliency in historic urban centres confronting climatic variability.	$208,846	21 History and Archaeology 04 Earth Sciences 2101 ARCHAEOLOGY 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 210103 - Archaeology of Asia, Africa and the Americas; 040605 - Palaeoclimatology	2101 - ARCHAEOLOGY
Active	DP180102062	1	storm	Monash University	Victoria	Xiwang Zhang; Ana Deletic; David McCarthy; Jiaguo Yu	Discovery Projects	2018	All-solid-state Z-scheme photocatalysts for water treatment	The project aims to develop high-performance Z-scheme photocatalysts by using two-dimensional (2D) semiconductors as building blocks for low-cost, highly-efficient pathogen inactivation and emerging pollutant degradation in stormwater treatment. The project expects to generate new fundamental knowledge in the area of photocatalyst design and Z-scheme photocatalytic system, and advance the application of photocatalytic oxidation in water treatment. The expected outcomes of the project include novel 2D Z-scheme photocatalysts and enhanced capacity in stormwater management.	$437,100	09 Engineering 0904 CHEMICAL ENGINEERING 0912 MATERIALS ENGINEERING 091205 - Functional Materials; 090402 - Catalytic Process Engineering; 090410 - Water Treatment Processes	0904 - CHEMICAL ENGINEERING
Active	DP180102203	1	drought	Western Sydney University	New South Wales	Belinda Medlyn; Sally Power; Elise Pendall; David Tissue; Alan Knapp; Melinda Smith	Discovery Projects	2018	Brown is the new green: grassland responses to drought and heat	This project aims to improve accuracy and precision in predicting the impact of water availability and heat stress on grassland function. Grassland ecosystems are important reservoirs of global biodiversity and carbon storage. Grasslands are highly sensitive to drought and heat stress, but studies recently showed that current grassland models cannot predict these responses because they do not adequately represent the key processes of physiological drought tolerance, leaf browning, and species traits. This project will collect targeted data sets in order to develop and test model representations of these key processes. This will provide significant benefits, such as greatly increasing capacity to predict the impact of drought and heat stress on grasslands, at scales ranging from field to globe.	$485,949	06 Biological Sciences 05 Environmental Sciences 0699 OTHER BIOLOGICAL SCIENCES 0602 ECOLOGY 0501 ECOLOGICAL APPLICATIONS 069902 - Global Change Biology; 050101 - Ecological Impacts of Climate Change; 060203 - Ecological Physiology	0699 - OTHER BIOLOGICAL SCIENCES
Active	DP180102250	1	bushfire	Queensland University of Technology	Queensland	Luis Gonzalez; Jonathan Roberts; Kevin Gaston; Nicholas Roy	Discovery Projects	2018	Navigating under the forest canopy and in the urban jungle	This project aims to develop a framework for unmanned aerial vehicles (UAV), which optimally balances localisation, mapping and other objectives in order to solve sequential decision tasks under map and pose uncertainty. This project expects to generate new knowledge in UAV navigation using an innovative approach by combining simultaneous localisation and mapping algorithms with partially observable markov decision processes. The project's expected outcomes will enable UAVs to solve multiple objectives under map and pose uncertainty in GPS-denied environments. This will provide significant benefits, such as more responsive disaster management, bushfire monitoring and biosecurity, and improved environmental monitoring.	$362,734	05 Environmental Sciences 09 Engineering 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 0906 ELECTRICAL AND ELECTRONIC ENGINEERING 0901 AEROSPACE ENGINEERING 090104 - Aircraft Performance and Flight Control Systems; 090602 - Control Systems, Robotics and Automation; 050202 - Conservation and Biodiversity	0901 - AEROSPACE ENGINEERING
Active	DP180102408	1	storm	The University of Sydney	New South Wales	Michael Wheatland; KD Leka	Discovery Projects	2018	Magnetic skeletons, solar flares, and space weather	This project aims to investigate how magnetic reconnection occurs during solar flares through accurate reconstruction of coronal magnetic fields from solar data before and after flares, and by reliable determination of field skeletons. Solar flares are dynamic events in the Sun's corona which cause local space weather storms. Magnetic reconnection is the accepted mechanism for flares but conventional models neglect the three-dimensional (3D) nature of the process. The project will improve 3D reconnection models for flares, and advance the ability to predict large events and hence space weather storms.	$357,031	02 Physical Sciences 0202 ATOMIC, MOLECULAR, NUCLEAR, PARTICLE AND PLASMA PHYSICS 0201 ASTRONOMICAL AND SPACE SCIENCES 020109 - Space and Solar Physics; 020204 - Plasma Physics; Fusion Plasmas; Electrical Discharges; 020106 - High Energy Astrophysics; Cosmic Rays	0201 - ASTRONOMICAL AND SPACE SCIENCES
Active	DP180102522	1	flood	The University of Newcastle	New South Wales	Anthony Kiem; Tessa Vance; George Kuczera; Jason Roberts	Discovery Projects	2018	Flooding in Australia – are we properly prepared for how bad it can get?	This project aims to investigate how floods have varied over the past 2000 years. Floods are a recurrent and natural part of Australia's hydroclimate and are influenced strongly by climate variability. However, these influences are not yet completely understood or accounted for. This project will use novel insights from 2000 years of climate reconstructions to generate new knowledge about how bad flooding can get and what causes flood frequency to change over time. A decision-making framework that allows for all the uncertainties associated with managing floods will also be developed. This will provide a critical evaluation of the accuracy of existing flood estimates, and also the reliability of infrastructure and policy based on those estimates.	$333,267	09 Engineering 04 Earth Sciences 0905 CIVIL ENGINEERING 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 090509 - Water Resources Engineering; 040605 - Palaeoclimatology; 040608 - Surfacewater Hydrology	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE

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Active	DP180102724	1	drought	Monash University	Victoria	Ian McNiven	Discovery Projects	2018	Archaeology of a Torres Strait reef island community	This archaeology project aims to document the long-term development of socioeconomic strategies by Indigenous Australians to live sustainably on small, drought-prone, tropical reef islands. It uses Tudu in central Torres Strait as a case study. This project will produce new and innovative insights into how Torres Strait Islander reef island communities built cultural and community resilience to environmental stress. It will broaden Australian archaeological knowledge of continental rocky islands to include recently formed reef islands.	$291,745	21 History and Archaeology 16 Studies in Human Society 2101 ARCHAEOLOGY 1699 OTHER STUDIES IN HUMAN SOCIETY 210101 - Aboriginal and Torres Strait Islander Archaeology; 169902 - Studies of Aboriginal and Torres Strait Islander Society	2101 - ARCHAEOLOGY
Active	DP180102737	2	drought; flood	The University of New South Wales	New South Wales	Ashish Sharma	Discovery Projects	2018	A Fourier approach to address low-frequency variability bias in hydrology	This project aims to develop a mathematical framework to better simulate the occurrence of sustained anomalies, such as droughts and long periods of flooding, into the future. These events increase water insecurity and result in loss of revenue, livelihoods and lives. Hydrological planning requires knowledge of how such sustained extremes will change in the future. Current alternatives for simulating such changes for future climates are inadequate for catchment-scale planning to proceed. The project proposes a strategy for post-processing hydrological simulations of the future using an elegant frequency-domain approach. It expects to provide the tools needed to develop hydrologic infrastructure, such as water supply reservoirs, that secure our water resources for the generations to come.	$327,316	04 Earth Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0401 ATMOSPHERIC SCIENCES 040608 - Surfacewater Hydrology; 040104 - Climate Change Processes	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DP180102969	1	drought	The Australian National University	Australian Capital Territory	Marilyn Ball; Maurizio Mencuccini; Rafael Oliveira; Lawren Sack	Discovery Projects	2018	Role of top-down-rehydration in drought tolerance of mangroves	This project aims to understand the role of absorption and storage of atmospheric water (vapour, mist, rain, dew) by shoots in survival of mangroves where high soil salinity limits root water uptake, particularly during hot, dry conditions. This research will advance understanding of drought and salinity tolerance. The project outcomes will include identification of environmental conditions that limit drought survival and functional plant traits that enhance drought survival. These outcomes are fundamental to interpreting mechanisms underlying mangrove dieback under drought and will benefit the development of process-based models for better prediction of mangrove responses to climate change.	$368,400	06 Biological Sciences 0607 PLANT BIOLOGY 0602 ECOLOGY 060705 - Plant Physiology; 060203 - Ecological Physiology	0607 - PLANT BIOLOGY
Active	DP180103314	1	cyclone	The University of Western Australia	Western Australia	Yinghui Tian; Christophe Gaudin; Lizhong Wang	Discovery Projects	2018	Improving the security of anchoring systems under extreme cyclones	This project aims to investigate the behaviour of anchoring systems under cyclonic loading and to innovate anchor designs to improve their security during extreme cyclones. Anchoring systems are increasingly playing the vital role of securing floating structures to extract ocean energies, but the current empirical knowledge and design method hinder confidence in engineering application. This project expects to advance the fundamental scientific understanding of the geotechnical mechanism of anchors under cyclonic loading using innovative experimental and advanced numerical modelling. Outcomes will include quality first-hand data contributing to the knowledge base, innovative anchor designs and new scientific based design guidelines.	$359,400	09 Engineering 0905 CIVIL ENGINEERING 090501 - Civil Geotechnical Engineering	0905 - CIVIL ENGINEERING
Active	DP180103444	1	storm	Monash University	Victoria	Ruth Reef; David Kennedy; Vanessa Wong; Tom SPENCER; Susan Brooks; Iris Moeller	Discovery Projects	2018	The role of vegetated foreshores in stabilising Australia's shorelines	This project aims to improve Australia's capacity to predict shoreline position with sea level rise, identify the role of vegetation in foreshore stabilisation and determine thresholds for shoreline retreat by quantifying the links between biological, geomorphological and sedimentary processes and shoreline position. Sea level rise and potential increases in storminess are predicted to lead to severe impacts and there is an immediate and critical need to understand and accurately predict the functioning, dynamics, and distribution of Australia's coastal zones. Expected outcomes of this interdisciplinary project include an integrated modelling framework crucial for planning and management of sea level rise responses in Australia.	$323,415	04 Earth Sciences 05 Environmental Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0501 ECOLOGICAL APPLICATIONS 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 050101 - Ecological Impacts of Climate Change; 040607 - Surface Processes; 050205 - Environmental Management	0501 - ECOLOGICAL APPLICATIONS
Active	DP180103611	1	heatwave	The University of New South Wales	New South Wales	Angela Moles	Discovery Projects	2018	How does climate affect regeneration and distribution of Australian plants?	This project aims to quantify the degree to which Australian plant species have responded to changes in climate over the last few decades, and to build understanding of the mechanisms that underpin responses to climate change. It seeks to fill critical knowledge gaps about the way heatwaves, freezing temperatures and temperature variability affect plants. The project aims to introduce a novel approach that will allow assessment of physiological and morphological change in response to recent climate change in the absence of historic data. Improved accuracy in identifying species that will have trouble responding to climate change would allow managers to more effectively target their resources to maximise biodiversity and ecosystem function.	$217,096	05 Environmental Sciences 06 Biological Sciences 0501 ECOLOGICAL APPLICATIONS 0603 EVOLUTIONARY BIOLOGY 060303 - Biological Adaptation; 050101 - Ecological Impacts of Climate Change; 060302 - Biogeography and Phylogeography	0603 - EVOLUTIONARY BIOLOGY
Active	DP180103700	2	drought; flood	The University of Western Australia	Western Australia	Petra Tschakert; Paul Plummer; Carmen Lawrence; Pierre Horwitz; Chantal Bourgault du Coudray	Discovery Projects	2018	Locating loss from climate change in everyday places	This project aims to investigate loss within the contexts of fire, drought and flooding in Western Australia. The project's innovative approach will reveal how community members in rural and urban places make value trade-offs and decisions over desirable futures. The project's expected outcomes will provide insights into acceptable and intolerable losses, and grief and hope, in familiar places. The findings will contribute an analysis of community resilience in the face of socio-economic and environmental threats, and inclusive planning for place-based adaptation.	$353,050	16 Studies in Human Society 17 Psychology and Cognitive Sciences 1604 HUMAN GEOGRAPHY 1701 PSYCHOLOGY 160403 - Social and Cultural Geography; 170113 - Social and Community Psychology; 160404 - Urban and Regional Studies (excl. Planning)	1604 - HUMAN GEOGRAPHY

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Active	DP180103748	1	landslide	The University of Newcastle	New South Wales	Daichao Sheng; Jinsong Huang; DV Griffiths	Discovery Projects	2018	Quantitative risk assessment of unsaturated soil slopes	This project aims to develop a novel quantitative risk assessment tool for slope failures or landslides by integrating cutting-edge methods in statistics, unsaturated soil mechanics and large deformation mechanics. The project will quantify various uncertainties in risk analysis of a landslide, rationally estimate its consequences, and improve understanding of its failure mechanisms. Expected outcomes include a reduction of societal and economic costs due to landslides, achieved through better engineering guidelines and government regulations for landslide risk management.	$400,901	09 Engineering 0905 CIVIL ENGINEERING 090501 - Civil Geotechnical Engineering	0905 - CIVIL ENGINEERING
Active	DP180103762	1	earthquake	The Australian National University	Australian Capital Territory	Michael Gagan	Discovery Projects	2018	Exploring past climates, volcanic disasters and earthquakes in Australasia	This project aims to combine cutting-edge geochemical microanalysis of precisely dated cave deposits and corals to generate fundamental knowledge of Australasian earth hazards and environmental turning points over the past 500,000 years. These novel long-term perspectives of society's most challenging environmental threats will provide the scientific basis required for informed decision-making and sustainable development in Australasia.	$458,418	21 History and Archaeology 04 Earth Sciences 2101 ARCHAEOLOGY 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040605 - Palaeoclimatology; 210103 - Archaeology of Asia, Africa and the Americas; 040604 - Natural Hazards	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DP190100376	1	storm	The University of Sydney	New South Wales	Daniela Traini; Patrick Spicer; Janet Davies; Stuart Prescott; Hui Xin Ong; Patrick Cullen	Discovery Projects	2019	Cause and effect: new mechanisms of particles formation in thunderstorms	This project aims to identify meaningful and specific indicators for predicting particle formation and alteration during thunderstorms. How thunderstorms develop is well-understood. However, identifying meaningful and specific indicators for predicting particle alteration during a thunderstorm is still not clear. This project will practically contribute to the evidence of the impact of air particulates, thereby having direct implications for meteorological, and air pollution policy in Australia and worldwide. This project will allow researchers to understand the impact of these factors on the escalation of the causative effects, and to find a way to prevent unnecessary fatal outcomes.	$550,000	04 Earth Sciences 03 Chemical Sciences 0401 ATMOSPHERIC SCIENCES 0306 PHYSICAL CHEMISTRY (INCL. STRUCTURAL) 030603 - Colloid and Surface Chemistry; 040101 - Atmospheric Aerosols	0306 - PHYSICAL CHEMISTRY (INCL. STRUCTURAL)
Active	DP190100797	1	earthquake	The University of Adelaide	South Australia	Michael Griffith; Phillip Visintin; Abdul Sheikh; Jason Ingham	Discovery Projects	2019	Improved seismic resilience against life-safety hazard of masonry buildings	This project aims to develop a cost-effective technique to mitigate the safety risk posed by the many unreinforced brick masonry parapets and walls which are vulnerable to seismic shock. Every Australian city has many streets lined with older unreinforced brick masonry buildings (now cafes, pubs, boutique shops) which feature parapets. The project will provide benefits to society by reducing the potential for parapet collapse and therefore reduce the total number of fatalities in an earthquake. Building owners and engineers will be benefit from the design guidance provided by this project, which will lead to a suite of fully-tested and low-cost retrofit techniques.	$320,000	09 Engineering 0905 CIVIL ENGINEERING 090506 - Structural Engineering	0905 - CIVIL ENGINEERING
Active	DP190101171	1	natural disaster	Flinders University	South Australia	Melanie Oppenheimer; Susanne Schech; Romain Fathi; Rosemary Wall; Russell Wylie	Discovery Projects	2019	Resilient humanitarianism: the League of Red Cross Societies, 1919-1991	This project aims to advance the concept of resilient humanitarianism through a historical investigation of one humanitarian body, the League of Red Cross Societies, from its inception to the end of the Cold War. Global humanitarian crises abound due to ongoing conflict and natural disasters but nation states, bodies such as the United Nations and humanitarian organisations seem incapable of offering lasting solutions to intractable situations. This project will use rarely accessed archives and an interdisciplinary approach to investigate the evolution of humanitarianism, voluntary action and global civil society during the 20th century. This historical analysis can inform humanitarian policy, debates and practice of the present and future.	$330,912	21 History and Archaeology 2103 HISTORICAL STUDIES 210303 - Australian History (excl. Aboriginal and Torres Strait Islander History); 210399 - Historical Studies not elsewhere classified; 210307 - European History (excl. British, Classical Greek and Roman)	2103 - HISTORICAL STUDIES
Active	DP190101259	1	flood	The Australian National University	Australian Capital Territory	Mark Krumholz	Discovery Projects	2019	The cosmic distribution of metals	This project aims to understand how the elements forged in stars flow through space and find their way into new stars and planets. The history of these elements, and how they came to be in planets like ours, is one of the most basic questions remaining in astrophysics. The expected outcome is to provide a model for the history of the elements that can provide a theoretical basis and a vital set of statistical tools to interpret the flood of data that will arrive from Australian and international telescopes over the next five years. The results will significantly benefit astronomical fields from cosmology to chemical evolution, and the machine learning methods developed will have applications well beyond astronomy. The end result will be a new and deeper insight into our cosmic origins.	$390,000	02 Physical Sciences 0201 ASTRONOMICAL AND SPACE SCIENCES 020103 - Cosmology and Extragalactic Astronomy; 020104 - Galactic Astronomy	0201 - ASTRONOMICAL AND SPACE SCIENCES
Active	DP190101552	1	drought	University of Tasmania	Tasmania	Timothy Brodribb; Noel Holbrook; Jennifer Powers; Patrick Mitchell	Discovery Projects	2019	The future of forests under climatic stress	This project aims to measure the vulnerability of forest trees to more extreme drought as global temperatures inevitably rise. Australian forests face the immediate threat of increased mortality associated with intensifying drought stress in the future. Understanding the magnitude of this threat is of the utmost urgency. This project aims to predict future mortality of forest communities in Australia and worldwide using recent breakthroughs enabling the rapid quantification of lethal stress in trees. This new understanding will provide a basis upon which to make far-reaching decisions about land management, conservation and restoration.	$459,000	06 Biological Sciences 07 Agricultural and Veterinary Sciences 0602 ECOLOGY 0705 FORESTRY SCIENCES 0607 PLANT BIOLOGY 060203 - Ecological Physiology; 070504 - Forestry Management and Environment; 060705 - Plant Physiology	0602 - ECOLOGY

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Active	DP190101733	1	bushfire	University of Technology Sydney	New South Wales	Jie Lu; Guangquan Zhang; Junyu Xuan; Witold Pedrycz	Discovery Projects	2019	Drift learning for decision-making in dynamic multi-stream environments	This project aims to provide application-ready real-time decision support systems for big data situations. Real-time support for organisational decisions is crucial in fast-changing environments that are highly dependent on data from multiple large streams. Unforeseen changes in data distribution (drift) are inevitable. The ability to learn drift in dynamic environments with multiple large data streams will benefit innovation and decision quality in challenging data situations. The project will have wide applications, such as in cybersecurity, telecommunications, bushfire control and logistics. The project will advance machine learning knowledge, providing a foundation and technologies to support real-time decision-making in big data environments.	$467,000	08 Information and Computing Sciences 0801 ARTIFICIAL INTELLIGENCE AND IMAGE PROCESSING 0806 INFORMATION SYSTEMS 080605 - Decision Support and Group Support Systems; 080109 - Pattern Recognition and Data Mining; 080108 - Neural, Evolutionary and Fuzzy Computation	0801 - ARTIFICIAL INTELLIGENCE AND IMAGE PROCESSING
Active	DP190101823	1	drought	The University of New South Wales	New South Wales	Martin De Kauwe; Patrick Meir; Lucas Cernusak; Andrew Pitman; Vanessa Haverd	Discovery Projects	2019	Resilience of eucalypts to future droughts	This project aims to examine how resilient Eucalyptus species are to future droughts by combining data synthesis, manipulative experiments and modelling. Climate change is expected to increase the frequency, magnitude and duration of future droughts, with major environmental and socio-economic consequences for Australia. Current predictive capacity is extremely limited: experiments are limited in scale and cannot capture important global change interactions, whilst models do not represent the functional characteristics and adaptions of eucalypts. This project will develop a strong evidence- and process-based understanding to quantify the functional behaviour of drought-adapted Eucalyptus species and leverage this insight to make future model projections.	$430,000	05 Environmental Sciences 04 Earth Sciences 06 Biological Sciences 0501 ECOLOGICAL APPLICATIONS 0401 ATMOSPHERIC SCIENCES 0699 OTHER BIOLOGICAL SCIENCES 050101 - Ecological Impacts of Climate Change; 069902 - Global Change Biology; 040104 - Climate Change Processes	0501 - ECOLOGICAL APPLICATIONS
Active	DP190101968	1	drought	Western Sydney University	New South Wales	Uffe Nielsen; Thomas Jeffries; Feike Dijkstra; Osvaldo Sala; Yolima Carrillo	Discovery Projects	2019	Causes and consequences of biogeochemical mismatches during drought	This project aims to provide improved understanding of biogeochemical cycling. Drought is one of the main threats to Earth's ecosystems, but our ability to predict the consequences of drought remain limited. There is strong evidence that drought impacts critical carbon and nutrient cycles, with substantial impacts on ecosystem functioning. This project will provide insights into carbon, nitrogen and phosphorous cycles essential to generalise patterns of biogeochemical cycling under current and future conditions. The project will assist scientists, policymakers and landholders make better-informed management decisions to reduce the risks of drought impacts on ecosystem functioning.	$421,500	05 Environmental Sciences 06 Biological Sciences 0501 ECOLOGICAL APPLICATIONS 0503 SOIL SCIENCES 0602 ECOLOGY 050101 - Ecological Impacts of Climate Change; 050303 - Soil Biology; 060208 - Terrestrial Ecology	0501 - ECOLOGICAL APPLICATIONS
Active	DP190102138	2	drought; flood	The University of Adelaide	South Australia	Mark Thyer; Dmitri Kavetski; Holger Maier; Seth Westra; Craig Simmons; Anthony Jakeman; Barry Croke; Hoshin Gupta	Discovery Projects	2019	Delivering robust hydrological predictions for Australia's water challenges	This project aims to build a virtual hydrological laboratory to identify the best hydrological models that maximise predictive performance in a range of catchments, accounting for their dominant hydrological processes and data availability. New process-informed hydrological model structures will be developed using this virtual laboratory to embody our best understanding of hydrological processes and data from real catchments. The expected outcomes include major improvements in hydrological predictions for Australian catchments. This project will provide major benefits to irrigators, water authorities and engineers, who rely on hydrological predictions for sustainable water management in the highly-variable, semi-arid Australian climate.	$381,000	09 Engineering 04 Earth Sciences 0905 CIVIL ENGINEERING 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040608 - Surfacewater Hydrology; 090509 - Water Resources Engineering	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DP190102185	1	drought	The University of Queensland	Queensland	Andrew Borrell; Ian Godwin; Lee Hickey; Ben Trevaskis; Rod Snowdon	Discovery Projects	2019	Cereal blueprints for a water-limited world	This project aims to demonstrate that key developmental genes in cereals can be manipulated to design plant architecture for specific resource-limited environments. Producing more food with less water is one of the greatest challenges facing humanity today. This project expects to increase understanding of how shoot and root systems can be uncoupled to enhance crop adaptation in water-limited environments using an accelerated genome editing approach. An expected outcome of the project is enhanced drought adaptation for cereals in a dry world. This should provide significant benefits to farmers and consumers in Australia and worldwide.	$590,000	07 Agricultural and Veterinary Sciences 06 Biological Sciences 0703 CROP AND PASTURE PRODUCTION 0607 PLANT BIOLOGY 060702 - Plant Cell and Molecular Biology; 070303 - Crop and Pasture Biochemistry and Physiology; 070305 - Crop and Pasture Improvement (Selection and Breeding)	0703 - CROP AND PASTURE PRODUCTION
Active	DP190102782	1	drought	The University of Adelaide	South Australia	John Tibby; Jonathan Tyler; Melanie Leng; Jonathan Overpeck	Discovery Projects	2019	East Australian climate extremes through the Holocene	The project aims to document climate variability in eastern Australia over the Holocene, the last 11,500 years. It seeks to develop Australia's two highest-resolution Holocene climate records using novel techniques to infer past rainfall, temperature and evaporation. The project will combine the expertise of international drought and climate specialists with novel techniques developed by the Australian investigators to derive an unparalleled record of drought duration, frequency and intensity. In particular, the project aims to determine the frequency, duration and causes of mega-droughts in eastern Australia, of which little is known. Expected project outcomes include improved decision making capacity for natural resource management, and planning.	$465,534	04 Earth Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040605 - Palaeoclimatology; 040606 - Quaternary Environments	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DP190102940	1	earthquake	Macquarie University	New South Wales	Yingjie Yang; Juan Afonso; Nicholas Rawlinson; Michael Ritzwoller; Fenglin Niu	Discovery Projects	2019	Unveiling the fine structure of the Australian continent using ocean waves	This project aims to develop new methods to better image lithospheric and upper-mantle structures by using noise from ubiquitous ocean waves, and then use these methods to illuminate fine-scale lithospheric-asthenospheric structures in Australia, from the surface to the upper mantle. Imaging the Earth's structure using seismic tomography is one of the most fundamental tasks of geoscience. Conventional earthquake-based seismic tomography has difficulties in deciphering fine-scale lithospheric structures. The images from this project will provide a better understanding of the nature of intraplate earthquakes and volcanoes, and improve the assessment of intraplate seismic and volcanic hazards in Australia.	$370,000	04 Earth Sciences 0403 GEOLOGY 0404 GEOPHYSICS 040407 - Seismology and Seismic Exploration; 040313 - Tectonics	0404 - GEOPHYSICS

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Active	DP190103315	1	storm	The University of Western Australia	Western Australia	Yinghui Tian; Mark Cassidy	Discovery Projects	2019	Lifting objects off the seabed	This project aims to investigate the process of lifting objects off the seabed. Understanding this breakout process is the scientific basis for a variety of offshore applications such as oil and gas decommissioning, marine salvage and securing foundations under extreme storms. This project expects to advance the understanding of soil-fluid-structure interactions of this problem using innovative high-speed photography observations and advanced numerical coupled analyses. Outcomes will include a numerical tool, verified against a high quality experimental database, to predict the breakout process and uplift required for pressing offshore challenges. The ability for Australia's engineers to predict lift procedures more accurately will contribute to safer operations in Australian waters and to the more economic harnessing of ocean resources.	$320,000	09 Engineering 0905 CIVIL ENGINEERING 090501 - Civil Geotechnical Engineering	0905 - CIVIL ENGINEERING
Active	DP190103645	1	earthquake	The University of Sydney	New South Wales	David Airey	Discovery Projects	2019	The effects of cyclic loading on partially saturated soils	This project aims to predict the settlement and strength of the upper, partially saturated layer of the ground when it is subjected to cyclic loading. Most of our critical infrastructure is built on or in this layer, but currently we cannot reliably predict the ground response of partially saturated soils to the cyclic loads that arise from earthquakes, traffic and construction processes. The project is expected to develop a new numerical model that can predict the effects of cyclic loads, and provide updated engineering guidance to ensure the integrity of infrastructure dependent on partially-saturated soils. Improved predictions of the processes involved resulting from this project will have significant economic benefits, as well as ensuring the safety and security of infrastructure and reduced maintenance costs.	$360,000	09 Engineering 0905 CIVIL ENGINEERING 090501 - Civil Geotechnical Engineering; 090507 - Transport Engineering; 090504 - Earthquake Engineering	0905 - CIVIL ENGINEERING
Active	DP200100201	1	heatwave	The University of Western Australia	Western Australia	Thomas Wernberg; Melinda Coleman	Discovery Projects	2020	Marine heatwaves drive loss of genetic diversity and selection in kelps	This project aims to unravel where and when marine heatwaves drive loss of genetic diversity and rapid directional selection in kelp forests. Although the devastating ecological impacts of marine heatwaves are well studied, empirical understanding of how marine heatwaves impact underlying evolutionary processes including adaptive capacity and resilience is lacking. This research will use a powerful combination of innovative heatwave analyses, cutting-edge genomics and physiological experiments to fill these knowledge gaps and represents a step change in our understanding of how kelp respond and adapt in multi-stressor seascapes. Results will pave the way for development of novel mitigation strategies to future-proof marine management.	$526,573	06 Biological Sciences 0607 PLANT BIOLOGY 0699 OTHER BIOLOGICAL SCIENCES 0602 ECOLOGY 060205 - Marine and Estuarine Ecology (incl. Marine Ichthyology); 060701 - Phycology (incl. Marine Grasses); 069902 - Global Change Biology	0602 - ECOLOGY
Active	DP200100203	1	wildfire	The University of New South Wales	New South Wales	Andrew Baker; Pauline Treble	Discovery Projects	2020	Reconstructing Australia's fire history from cave stalagmites	Fire represents a major natural hazard, and its impact on Australian communities and ecosystems is increasing. Representing a world first, this project aims to calibrate the paleofire signal from stalagmites in shallow caves, and to construct annually resolved stalagmite records of paleofire frequency and intensity for the last millennia. The project aims to use stalagmites from south west Australia to determine the relationship between fire and climate and assess the robustness of stalagmite hydroclimate proxies in fire-prone regions. This project expects to establish a new research field for speleothem science, enhancing capacity for the Australian Quaternary and speleothem research communities, as well as benefits to land managers.	$472,000	04 Earth Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040606 - Quaternary Environments	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DP200100206	1	drought	University of Wollongong	New South Wales	Helen McGregor; Jody Webster; Janice Lough; Sophie Lewis; Benjamin Henley; Thomas Felis; Yusuke Yokoyama; Tara Clark	Discovery Projects	2020	Past climate and environmental impacts on Great Barrier Reef paleoecology	This project aims to investigate the interconnected processes that led to past reef growth and demise. The iconic Great Barrier Reef and reefs globally are under threat. Yet reefs appear to have undergone cycles of death and recovery, though the causes are poorly understood. This project will reconstruct past climate, rainfall, water quality, coral bleaching and reef ecology feedbacks across Great Barrier Reef death events to establish which environmental stressors and paleoclimate variations are most critical for reef health. The outcomes will better constrain long term coral reef dynamics and provide significant benefits to those who manage reefs globally, since the Great Barrier Reef covers the full range of reef environments.	$418,000	06 Biological Sciences 04 Earth Sciences 0602 ECOLOGY 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0401 ATMOSPHERIC SCIENCES 040605 - Palaeoclimatology; 060206 - Palaeoecology; 040104 - Climate Change Processes	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DP200100225	1	drought	Monash University	Victoria	John Bowman	Discovery Projects	2020	The origin and evolution of the land plant meristem	This project aims to identify the extent of overlap between the genetic determinants of the gametophyte and sporophyte shoot meristems. The project expects to generate new knowledge of the evolution and development of land plants by applying comparative genomics and new technologies to a novel model genetic system. Expected outcomes include an elucidation of the genetic basis for one of the key morphological adaptations for life on land. The ability to manipulate the growth and development of plants via the activity of meristems based on fundamental principles has broad agricultural implications.	$540,000	06 Biological Sciences 0603 EVOLUTIONARY BIOLOGY 0604 GENETICS 0607 PLANT BIOLOGY 060305 - Evolution of Developmental Systems; 060703 - Plant Developmental and Reproductive Biology; 060403 - Developmental Genetics (incl. Sex Determination)	0603 - EVOLUTIONARY BIOLOGY

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Active	DP200100347	1	drought	Monash University	Victoria	Michael Lazarou	Discovery Projects	2020	Understanding how cells regulate self eating during starvation and stress	This project aims to investigate how autophagosomes are built during autophagy by using advanced multi-modal imaging and unique gene-edited human cell lines. This project expects to generate new knowledge on how a family of evolutionary conserved proteins regulate autophagosome formation during starvation and stress conditions. Expected outcomes include the development of frontier imaging technologies that can be subsequently utilised for the advancement of any field of cell biology. This should provide significant benefits by placing Australia at the forefront of cell biology technologies and increasing our understanding of how plant and human cells can protect themselves during starvation and stress.	$450,000	06 Biological Sciences 0601 BIOCHEMISTRY AND CELL BIOLOGY 060108 - Protein Trafficking; 060110 - Receptors and Membrane Biology; 060199 - Biochemistry and Cell Biology not elsewhere classified	0601 - BIOCHEMISTRY AND CELL BIOLOGY
Active	DP200100482	2	earthquake; volcanic eruption	Macquarie University	New South Wales	Nathan Daczko; Stephen Foley; Heather Handley; Thomas Raimondo	Discovery Projects	2020	Plumbing the gap: a mantle solution to the enigma of bimodal arc volcanism	Subduction zones and volcanic arcs are the most tectonically active regions on Earth and are crucial to understanding, geochemical cycles, tectonic-climate coupling, ore genesis and natural hazards. Bimodal volcanism is a long-recognised characteristic of arc crust that has never been satisfactorily explained, yet, it controls many of these processes. This project will test a new hypothesis that the two types of magmas originate from distinct mantle sources. It integrates novel high-pressure experiments with database analysis of natural volcanic rocks, covering magmatic systems from mantle source to volcano. This project will improve our understanding of arc processes, including the association of economic metals with bimodal arc volcanism.	$222,301	04 Earth Sciences 0403 GEOLOGY 040304 - Igneous and Metamorphic Petrology	0403 - GEOLOGY
Active	DP200100615	1	flood	The University of New South Wales	New South Wales	Jae Kyung Woo; Chi Kin Eric Cheung; Hansjoerg Albrecher; Gordon Willmot	Discovery Projects	2020	Shock model-based framework for modelling correlated large losses	This project aims to develop aggregate risk models by utilizing shock models in reliability theory. It intends to provide a new alternative approach which is more realistic and also mathematically tractable in order to estimate various types of quantities in (re)insurance and operational risk management. The expected outcome includes enhanced capacity by advanced analytical tools to assess correlated and large risks, thus assisting in the management of key risks and improving the effectiveness of risk management. This should benefit the stability of the financial and regulatory systems where large and dependent risks are concerned.	$334,000	01 Mathematical Sciences 15 Commerce, Management, Tourism and Services 0104 STATISTICS 1502 BANKING, FINANCE AND INVESTMENT 010406 - Stochastic Analysis and Modelling; 150204 - Insurance Studies; 150205 - Investment and Risk Management	1502 - BANKING, FINANCE AND INVESTMENT
Active	DP200100966	2	tsunami; volcanic eruption	The University of Sydney	New South Wales	Maria Seton; Rebecca Carey; Simon Williams; Nicolas Coltice; Robert Duncan	Discovery Projects	2020	Eruption and disruption: how Earth's deep interior and surface communicate	Massive volcanic eruptions are a fundamental part of the Earth System, responsible for globally disruptive events, from airspace disturbance, to extinction of the dinosaurs. This project will reveal relationships between hot, deep sources of volcanic material, and the tectonic processes at the Earth's surface. Expected outcomes of this project include assembling an unprecedented set of new observations from underwater volcanoes offshore Eastern Australia, and the development of innovative geodynamic models of how the deep Earth interacts with the surface to form these volcanoes. This will provide significant benefits by advancing our understanding of the deep Earth, and its impact on Earth's surface, natural hazards, and mineral systems.	$549,000	04 Earth Sciences 0403 GEOLOGY 0404 GEOPHYSICS 040402 - Geodynamics; 040305 - Marine Geoscience	0404 - GEOPHYSICS
Active	DP200101123	2	bushfire; wildfire	University of Wollongong	New South Wales	Anthony Dosseto; Scott Mooney; Ross Bradstock; Damien Lemarchand; Nathalie Vigier	Discovery Projects	2020	Shaping a sunburnt country: fire, climate and the Australian landscape	Fire shapes Australia's landscape, biodiversity and resources. This project aims to quantify the recent history of fire intensity and severity using several novel proxies in the fire-prone landscapes of south-eastern Australia. Calibration of these new proxies to recent wildfires will be used for a better characterisation of fire regimes. This research will be applied to sedimentary archives to investigate how fire regimes have evolved over the past 100 years. The outcomes will inform debates about the relationship between climatic variability and fire severity, and this will contribute to increase the preparedness of natural resource management to potential future climate and land-use scenarios.	$379,000	05 Environmental Sciences 04 Earth Sciences 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040604 - Natural Hazards; 050209 - Natural Resource Management	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DP200101157	1	storm	The Australian National University	Australian Capital Territory	Eelco Rohling; Gavin Foster	Discovery Projects	2020	Understanding total long-term sea-level consequences	This project addresses the urgency in long-term infrastructure planning to understand the long-term "equilibrium" sea-level-change consequences from today's exceptionally rapid climate change. Understanding this requires detailed sea-level reconstructions back to warm periods with similar CO2 levels to today (~3.5 million years ago), but these remain insufficiently defined. To advance, the project will deliver a next-generation, multi-million-year sea-level reconstruction that includes dynamically evolving (time-dependent) interactions between critical climate factors. This will then be applied with other palaeoclimate data to reconstruct equilibrium relationships between sea level, temperature, and CO2 at currently unattainable precision.	$449,000	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040605 - Palaeoclimatology; 040104 - Climate Change Processes; 040606 - Quaternary Environments	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DP200101191	1	drought	The University of Adelaide	South Australia	Sarah Wheeler; Celine Nauges; Rupert Grafton	Discovery Projects	2020	Consequences of water reform and changing farm adaptation in the Basin	This project aims to evaluate the consequences of, and lessons learned from, the past two decades of water reform in the Murray-Darling Basin (MDB). In particular, it will examine the recent economic and farm consequences of water recovery. Australia is over halfway through implementation of the MDB Plan, and has spent over $6 billion in water recovery to achieve basin-wide resilience, with billions more still committed. Project expected outcomes include pioneering new methods to track how MDB irrigation efficiency, productivity and other farm outcomes have changed as a response to water reform. It will also draw lessons from both national and international case studies to consequently inform more effective water management.	$157,699	14 Economics 1499 OTHER ECONOMICS 149902 - Ecological Economics	1499 - OTHER ECONOMICS

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Active	DP200101311	1	bushfire	Southern Cross University	New South Wales	Edward Burton; Scott Fendorf	Discovery Projects	2020	Unraveling hexavalent chromium formation and fate in fire-impacted soil	Hexavalent chromium is a cancer-causing toxin. It can form via heating of natural (unpolluted) soil during bushfires. However, little is known of the processes and factors which govern its formation and behavior in fire-impacted soil. Using a combination of field-based investigations, innovative experiments and cutting edge analytical approaches, this project aims to systematically explore hexavalent chromium formation via fire-induced heating of soil and to examine its post-fire fate in soil systems. The results will transform our understanding of the chromium cycle at the Earth's surface, and will facilitate accurate assessment and mitigation of the risks posed by hexavalent chromium formation in fire-impacted soil.	$390,000	05 Environmental Sciences 04 Earth Sciences 0503 SOIL SCIENCES 0402 GEOCHEMISTRY 040202 - Inorganic Geochemistry; 050304 - Soil Chemistry (excl. Carbon Sequestration Science)	0402 - GEOCHEMISTRY
Active	DP200101467	1	storm	University of Tasmania	Tasmania	Catriona Hurd; John Beardall; Andrew Bridle; Juan Gaitan-Espitia; John Raven	Discovery Projects	2020	Seaweed forests of the future: responses to ocean acidification and warming	The aim is to discover if rising levels of oceanic carbon dioxide will offset negative effects of ocean warming on seaweeds, using targeted physiological experiments together with novel molecular diagnostics. Seaweeds create habitats and food for shellfish and fish, and play a crucial role in long term 'blue carbon' storage. They are predicted to benefit from future carbon dioxide enrichment, but to test this forecast requires a detailed understanding of the mechanisms used by seaweeds to acquire dissolved inorganic carbon. The expected outcome is robust predictions of how the primary productivity of coastal waters will respond to future high carbon dioxide conditions, enabling human adaptation to environmental change.	$350,000	06 Biological Sciences 0607 PLANT BIOLOGY 0699 OTHER BIOLOGICAL SCIENCES 060705 - Plant Physiology; 060701 - Phycology (incl. Marine Grasses); 069902 - Global Change Biology	0607 - PLANT BIOLOGY
Active	DP200101545	1	flood	The University of Western Australia	Western Australia	Ryan Lowe; Marco Ghisalberti; Heidi Nepf; Albertus Van Dongeren; Robert McCall	Discovery Projects	2020	Advancing predictions of ecosystem-based coastal flood defence	This project aims to develop a new framework to accurately predict how a diverse range of coastal ecosystems (seagrasses, corals, mangroves) act to reduce coastal flooding. The project aspires to develop novel theory and models to quantify how the large, complex roughness of these ecosystems interacts with coastal flows to attenuate extreme water levels at coastlines. Expected outcomes include new predictive models and guidelines that can be immediately incorporated into coastal hazard forecasts and engineering practice. This will allow greatly-improved predictions of how coastal ecosystems support the safety and resilience of coastal communities worldwide, and new design guidelines to boost nature-based coastal defence projects.	$564,507	04 Earth Sciences 09 Engineering 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0911 MARITIME ENGINEERING 0915 INTERDISCIPLINARY ENGINEERING 091103 - Ocean Engineering; 091504 - Fluidisation and Fluid Mechanics; 040604 - Natural Hazards	0911 - MARITIME ENGINEERING
Active	DP200101573	2	drought; flood	The Australian National University	Australian Capital Territory	Luigi Renzullo; Albert van Dijk	Discovery Projects	2020	Ecohydrological forecasting: the pivotal role of root-zone soil moisture	This project aims to overcome the scientific and technological challenges preventing soil water and vegetation forecasting at useful land management scales (eg. 25 m). The significance is in enabling an unprecedented hyperresolution modelling capability for Australia through the integration of new ecohydrological theory with a range of satellite observations. Outcomes include more accurate, spatially-detailed information of current soil water amounts, and reliable forecasts of vegetation condition several months into the future. This will greatly enhance timely decision making and forward planning by farmers, fire agencies, and other land and water managers, with corresponding increases in productivity, sustainability and community safety.	$361,000	04 Earth Sciences 01 Mathematical Sciences 05 Environmental Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0104 STATISTICS 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 040608 - Surfacewater Hydrology; 050206 - Environmental Monitoring; 010401 - Applied Statistics	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DP200101627	1	bushfire	Macquarie University	New South Wales	Stephen Hanly; Iain Collings; Hazer Inaltekin; David Gesbert	Discovery Projects	2020	Airborne Base Station Communication Systems: Capacity and Optimization	This project will fundamentally characterise and optimize information gathering, dissemination, and communication capacities of airborne base stations to enable low latency communications in rural and remote areas. New technologies such as precision farming, safe remote equipment operation in mining, and wide area surveillance and security, require low latency communications that are an order of magnitude beyond what is currently available from satellite links. The expected outcome will be radically new base station deployment and flight path planning, and data transmission technologies. These will unlock new application technologies by enabling secure wide-spread communications coverage, delivering economic benefits to remote Australia.	$405,000	10 Technology 1005 COMMUNICATIONS TECHNOLOGIES 100510 - Wireless Communications	1005 - COMMUNICATIONS TECHNOLOGIES
Active	DP200101640	1	bushfire	Queensland University of Technology	Queensland	Luis Gonzalez; Jonghyuk Kim; Sven Koenig; Kevin Gaston	Discovery Projects	2020	When every second counts: Multi-drone navigation in GPS-denied environments	The aim of this research is to develop a framework for multiple Unmanned Aerial Vehicles (UAV), that balances information sharing, exploration, localization, mapping, and other planning objectives thus allowing a team of UAVs to navigate in complex environments in time critical situations. This project expects to generate new knowledge in UAV navigation using an innovative approach by combining Simultaneous Localization and Mapping (SLAM) algorithms with Partially Observable Markov Decision Processes (POMDP) and Deep Reinforcement learning. This should provide significant benefits, such as more responsive search and rescue inside collapsed buildings or underground mines, as well as fast target detection and mapping under the tree canopy.	$360,000	05 Environmental Sciences 09 Engineering 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 0906 ELECTRICAL AND ELECTRONIC ENGINEERING 0901 AEROSPACE ENGINEERING 090104 - Aircraft Performance and Flight Control Systems; 050202 - Conservation and Biodiversity; 090602 - Control Systems, Robotics and Automation	0901 - AEROSPACE ENGINEERING

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Active	DP200101764	1	hurricane	The University of Adelaide	South Australia	Sanjeeva Balasuriya; Nicholas Ouellette	Discovery Projects	2020	Uncertainties in coherent transport of particles and intrinsic properties	This Project aims to quantify the uncertainty of a model output in terms of uncertainties in modelling assumptions, by developing new mathematical techniques and applying them to real-world data. This will be in the context of assessing the accuracy of tracking coherently moving structures (e.g., hurricanes, oceanic biodiversity hotspots, pollutant patches, insect swarms) from experimental/observational data sets. Novel, data-tested, mathematical methods for uncertainty quantification of coherent structures will be developed as Project outcomes. Project benefits include new insights into protecting the environment, improved uncertainty quantification in climate modelling, and the generation of interdisciplinary knowledge and training.	$450,000	01 Mathematical Sciences 04 Earth Sciences 0104 STATISTICS 0102 APPLIED MATHEMATICS 0404 GEOPHYSICS 010204 - Dynamical Systems in Applications; 040403 - Geophysical Fluid Dynamics; 010406 - Stochastic Analysis and Modelling	0102 - APPLIED MATHEMATICS
Active	DP200101768	2	drought; flood	The University of Adelaide	South Australia	Jonathan Tyler; John Tibby; Takeshi NAKAGAWA; Melanie Leng; Yusuke Yokoyama	Discovery Projects	2020	East Asian Monsoon response to periods of abrupt global change	This proposal aims to investigate the response of the East Asian Monsoon to abrupt climatic change, under baseline states of both warm and cool climate. The research is significant as it utilises unique, precisely dated sediments from Japan, and novel approaches to quantifying spatial and temporal climate patterns. The research will improve understanding of the nature and causes of decadal-scale changes in monsoon precipitation, with relevance for constraining the trajectory of the future monsoon, and the risks of prolonged drought and flood. The findings will benefit the Asian people, for whom the monsoon has major economic, social and environmental importance. In turn, this will benefit Australia, via economic and climatic ties to Asia.	$464,000	04 Earth Sciences 0402 GEOCHEMISTRY 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040606 - Quaternary Environments; 040605 - Palaeoclimatology; 040203 - Isotope Geochemistry	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	DP200101854	2	earthquake; tsunami	The Australian National University	Australian Capital Territory	Hrvoje Tkalcic; Caroline Eakin; Millard Coffin; Nicholas Rawlinson; Joann Stock	Discovery Projects	2020	Probing the Australian-Pacific plate boundary: Macquarie Ridge in 3-D	This project aims to advance understanding of the Australia-Pacific plate boundary - the Macquarie Ridge Complex - in the Southern Ocean. It will be the first study to elucidate the processes generating the world's largest submarine earthquakes not associated with active subduction, which may lead to understanding of how subduction initiates, the mechanism of earthquakes occurring at convergent margins, and more accurate estimates of earthquake and tsunami potential. This study will put Australia at the forefront of Earth Science research into the evolution of tectonic plates and has the potential to better inform hazard assessment efforts in the region, benefiting policy-makers and at–risk communities along the Australia coastline.	$626,000	09 Engineering 04 Earth Sciences 0911 MARITIME ENGINEERING 0403 GEOLOGY 0404 GEOPHYSICS 040407 - Seismology and Seismic Exploration; 040305 - Marine Geoscience; 091103 - Ocean Engineering	0404 - GEOPHYSICS
Active	DP200101859	10	bushfire; cyclone; drought; earthquake; flood; heatwave; landslide; natural disaster; storm; tsunami	The University of New South Wales	New South Wales	Qihe Tang; Benjamin Avanzi; Bernard Wong; Jose Blanchet	Discovery Projects	2020	Extreme Value Theory Approaches to Insurance in a Catastrophic Environment	Recent decades are marked by numerous significant natural (climate change) or man-made (financial crises) catastrophes, which have significantly altered the landscape of the insurance industry. These have potentially significant negative impacts on the availability and affordability of insurance, and hence on the capability and capacity of households and businesses to take risks and be competitive. This project endeavours to establish progressive approaches (using extreme value theory) to the challenges faced by insurance in such a catastrophic environment. They will enhance the financial stability and competitivity of the Australian economy, and further establish its global leadership in dealing with climate changes and catastrophes.	$310,000	15 Commerce, Management, Tourism and Services 1502 BANKING, FINANCE AND INVESTMENT 150205 - Investment and Risk Management	1502 - BANKING, FINANCE AND INVESTMENT
Active	DP200101885	1	drought	The Australian National University	Australian Capital Territory	Michael Djordjevic; Malcolm Bennett; Siobhan Brady	Discovery Projects	2020	A new route to controlling root system architecture and drought tolerance.	This project aims to transform our understanding of the relationship between root architecture and water and nitrogen acquisition, factors critical to determining yield. We have discovered that mutants affected in a peptide hormone receptor have unique root architectural features relevant to acquiring water and nitrogen. The mutants are drought tolerant and their roots are nitrate insensitive. The project aims to define the receptor's genetic outputs and expects to uncover new ways to improve water and nitrate acquisition and determine if our findings apply to crops. The application of these findings will reduce the severe environmental damage caused by poor nitrogen fertiliser uptake and provide sustainable ways to ensure food security.	$530,000	07 Agricultural and Veterinary Sciences 06 Biological Sciences 0703 CROP AND PASTURE PRODUCTION 0607 PLANT BIOLOGY 060702 - Plant Cell and Molecular Biology; 060703 - Plant Developmental and Reproductive Biology; 070305 - Crop and Pasture Improvement (Selection and Breeding)	0607 - PLANT BIOLOGY
Active	DP200102320	1	natural disaster	The Australian National University	Australian Capital Territory	Stuart Bedford; Christopher Ballard; Shane Cronin	Discovery Projects	2020	Kuwae 1452 AD: multi-disciplinary perspectives on a Pacific super-eruption	This project seeks to resolve the question of whether the mid-15th century eruption of Kuwae in Vanuatu can be confirmed as one of the largest global volcanic and climatic events of the last 2000 years. Through archival, field and laboratory research, an experienced transdisciplinary team from archaeology, volcanology and history aims to conduct collaborative research over three seasons in central Vanuatu. Project goals include dating the eruptive event, defining its scale, reconstructing Kuwae's local social and environmental conditions prior to and after the eruption, and developing practical volcanic risk reduction strategies together with local communities and authorities in Vanuatu.	$328,788	21 History and Archaeology 16 Studies in Human Society 04 Earth Sciences 2101 ARCHAEOLOGY 1601 ANTHROPOLOGY 0403 GEOLOGY 210106 - Archaeology of New Guinea and Pacific Islands (excl. New Zealand); 040314 - Volcanology; 160104 - Social and Cultural Anthropology	2101 - ARCHAEOLOGY

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Active	DP200102395	1	wildfire	University of Tasmania	Tasmania	David Bowman	Discovery Projects	2020	Does fire control vegetation in the Tasmanian World Heritage Area?	Aims: This project aims to discriminate between competing explanations for vegetation patterns in the Tasmanian Wilderness World Heritage Area: (a) fire (the legacy of Aboriginal burning), or (b) soil. We will do this through a novel, transdisciplinary research program. Significance: The project expects to create new knowledge essential for achieving evidence-based fire management, as well as to advance a globally important ecological theory. Outcomes: Expected outcomes include significantly strengthened fire science and fire management capacity in Tasmania. Benefit: Benefits should include the protection of globally significant cultural, biological and landscape values that sustain the vibrant Tasmanian tourist economy.	$321,000	05 Environmental Sciences 04 Earth Sciences 0501 ECOLOGICAL APPLICATIONS 0403 GEOLOGY 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 050104 - Landscape Ecology; 050205 - Environmental Management; 040308 - Palaeontology (incl. Palynology)	0501 - ECOLOGICAL APPLICATIONS
Active	DP200102516	1	storm	The University of Melbourne	Victoria	Todd Lane; Robert Sharman	Discovery Projects	2020	Improving the avoidance and prediction of turbulence from thunderstorms	One of the most critical weather-related safety issues for aviation is atmospheric turbulence caused by thunderstorms. Thunderstorm-generated turbulence is responsible for frequent serious injuries and significant costs to airlines that are ultimately passed on to passengers. Using extensive new data, case studies and state-of-the-art simulations, this project aims to improve our understanding of the dynamics and behaviour of thunderstorm-generated turbulence and its representation in weather forecast models. Expected outcomes of this project include the development of new methods to avoid and predict turbulence for use by the aviation industry. This research should provide significant benefits, such as safer and more efficient air travel.	$468,000	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 040107 - Meteorology; 040108 - Tropospheric and Stratospheric Physics; 040102 - Atmospheric Dynamics	0401 - ATMOSPHERIC SCIENCES
Active	DP200102616	1	heatwave	Western Sydney University	New South Wales	Mark Tjoelker; Rachael Gallagher; Peter Reich; John Drake; Kristine Crous	Discovery Projects	2020	Pushing the envelope: does range size limit eucalypt tolerance to warming?	This project aims to characterise the biogeographic constraints on the physiological flexibility of eucalypts to accommodate climate warming. Do temperature tolerances of diverse taxa vary predictably with native geographic range sizes and climate of origin? In addressing this question, the project expects to generate new knowledge on the comparative physiological responses of diverse eucalypt taxa to warming and heat waves using controlled-environment studies and a unique facility at Western Sydney University for heat wave studies of large trees. Expected outcomes include an enhanced capacity to predict carbon exchange and growth responses of native trees to climate warming over large geographic scales.	$423,000	06 Biological Sciences 0699 OTHER BIOLOGICAL SCIENCES 0607 PLANT BIOLOGY 0602 ECOLOGY 060203 - Ecological Physiology; 060705 - Plant Physiology; 069902 - Global Change Biology	0602 - ECOLOGY
Active	DP200102704	1	bushfire	Queensland University of Technology	Queensland	Mahen Mahendran; Anthony Ariyanayagam	Discovery Projects	2020	Light steel roof and wall systems under combined wind and bushfire actions	The project aims to investigate the complex behaviour of light cold-formed-steel roof and wall systems involving localized failures under the combined action of wind and bushfire using wind suction tests at elevated temperatures combined with advanced numerical modelling. It will generate new knowledge of the behaviour and strength of cold-formed-steel roof and wall systems under bushfire conditions. Expected outcomes include new design models for wind, bushfire and cold-formed-steel Standards. This will significantly improve the bushfire safety of buildings, since non-combustible steel roof and wall systems are used as building envelopes in bushfire prone areas, but are not designed to withstand recently discovered bushfire-enhanced winds.	$277,000	09 Engineering 0905 CIVIL ENGINEERING 090506 - Structural Engineering	0905 - CIVIL ENGINEERING
Active	DP200102961	1	tsunami	The University of Western Australia	Western Australia	Michael Small; Debora Correa; David Walker; Dominique Blache	Discovery Projects	2020	TSuNAMi: Time Series Network Animal Modelling	Our proposal is motivated by and based upon the successful representation of time series as a network (or graph). We construct an abstract representation of a system from measurements of its changing behaviour over time. Properties of that structure (the network) then allow us to infer diagnostic information of the system. Specifically, we propose to apply this to livestock welfare during transport. By measuring the biological and environment condition of the animal we construct a network representation of that system. Geometric features of that network can then be used to infer health or duress of the subject. This proposal will develop the generic mathematical machinery to connect geometric features of the network with system behaviour.	$360,000	02 Physical Sciences 01 Mathematical Sciences 0299 OTHER PHYSICAL SCIENCES 0102 APPLIED MATHEMATICS 010204 - Dynamical Systems in Applications; 029902 - Complex Physical Systems	0102 - APPLIED MATHEMATICS
Active	DP200103100	1	drought	James Cook University	Queensland	Susan Laurance; Lori Lach; Nigel Stork	Discovery Projects	2020	The role of drought-stress and insect attack on rainforest plant health	This project aims to examine the vulnerability of tropical plants to drought and insect attack in a large-scale field experiment. We will pioneer a new research approach that focuses on the causes and stages of decline in plant health prior to death, in order to identify the characteristics of plant species that make them more susceptible to drought and insect attack. Expected outcomes of this project include an improved capacity to predict the function and composition of future forests. This project will provide significant benefits to communities concerned with the direct and indirect effects of droughts in protected areas, forestry reserves and agriculture.	$395,000	05 Environmental Sciences 06 Biological Sciences 0501 ECOLOGICAL APPLICATIONS 0607 PLANT BIOLOGY 0602 ECOLOGY 050101 - Ecological Impacts of Climate Change; 060202 - Community Ecology (excl. Invasive Species Ecology); 060705 - Plant Physiology	0501 - ECOLOGICAL APPLICATIONS
Active	DP200103168	1	drought	University of South Australia	South Australia	Stanley Miklavcic; Megan Shelden	Discovery Projects	2020	Root-to-shoot: modeling the salt stress response of a plant vascular system	Salt and drought are the two major abiotic stresses affecting crop plant health, growth and development. We aim to understand salt and water transport in plants and the physiological effects of soil salinity. Using biophysical models, we will quantify the movement of salt through plant organs, tissues and cells, from root to leaf. We aim to answer the question of how salt moves across the different tissues and major organs, how salt accumulates in root, leaf and shoot cells, and how movement and accumulation is controlled by the diversity of transport mechanisms operating in plants. We aim to quantify tissue tolerance, osmotic tolerance and ionic tolerance and discover new mechanisms by which plants can stave off the effect of salt stress.	$420,000	06 Biological Sciences 01 Mathematical Sciences 0607 PLANT BIOLOGY 0102 APPLIED MATHEMATICS 010202 - Biological Mathematics; 060705 - Plant Physiology	0102 - APPLIED MATHEMATICS

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Active	DP200103549	1	natural disaster	The University of Sydney	New South Wales	Artem Prokhorov; Rustam Ibragimov; Stanislav Uryasev	Discovery Projects	2020	Diversification failures and improved measures of uncertainty	The project aims to develop new statistical tools, applicable when the conventional paradigm that diversification reduces risk fails and when textbook approaches to risk quantification severely under-report risk. The new tools enhance our capacity to build and manage natural, social and human-made systems in uncertain environments. Our effective response to many threats including financial crises and natural events, depends on this capacity. Thus, the expected benefits in the form of more reliable and robust risk analytics will accrue when they are most needed.	$305,400	14 Economics 15 Commerce, Management, Tourism and Services 1403 ECONOMETRICS 1502 BANKING, FINANCE AND INVESTMENT 150205 - Investment and Risk Management; 150202 - Financial Econometrics; 140302 - Econometric and Statistical Methods	1502 - BANKING, FINANCE AND INVESTMENT
Active	FL150100035	1	storm	The University of New South Wales	New South Wales	Steven Sherwood	Australian Laureate Fellowships	2015	Revisiting the physics of clouds	This fellowship project aims to bring new rigour to climate modelling by improving our understanding of key phenomena like clouds and storms. Earth's climate has taken a number of turns in the recent and geologic past that so far cannot be reproduced in models. Clouds and atmospheric turbulence are also a problem for weather and climate prediction, the conceptual understanding of which now has evident flaws. The hypothesis of this project is that these two problems are strongly linked, and that this link may be exploited to solve problems across disciplines. This project aims to systematically re-evaluate our conceptual understanding of cloud physics, and investigate how this affects our understanding of climate phenomena in Earth's past and future.	$2,765,281	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 040106 - Cloud Physics; 040104 - Climate Change Processes; 040107 - Meteorology	0401 - ATMOSPHERIC SCIENCES
Active	FL190100056	1	drought	The Australian National University	Australian Capital Territory	Barry Pogson	Australian Laureate Fellowships	2019	Smart Plants and Solutions for Enhancing Crop Resilience and Yield	The Fellowship aims to produce transformative solutions targeting crop resilience and food security. The chloroplast, the site of photosynthesis, regulates a suite of cellular processes that control photosynthesis, growth and drought resilience. It is expected that a first ever blueprint of the suite of communication networks used by the chloroplast will be discovered. I will use synthetic biology to rewire the network in order to generate 'smart plants' that are higher-yielding and more resilient in both good and bad seasons by precisely switching on and off resilience. Such re-imaginings of crop systems, inclusive of societal implications, will help chart the future of Australian agriculture.	$2,795,000	06 Biological Sciences 0607 PLANT BIOLOGY 060702 - Plant Cell and Molecular Biology; 060705 - Plant Physiology	0607 - PLANT BIOLOGY
Active	FL190100164	1	drought	The Australian National University	Australian Capital Territory	Rupert Grafton	Australian Laureate Fellowships	2019	Water Justice: Indigenous Water Valuation and Resilient Decision-making	The aim is to value water and support resilient decision-making for water justice. Its significance is to provide missing socio-cultural-environmental values of First Peoples water, the absence of which means Indigenous demands for water justice are frequently ignored. Project outcomes will empower First Peoples and support resilient and evidence-based decision-making. The key benefit is a sustainable Australia through: first-ever conjoint socio-cultural values of First Peoples' water; transformative decision-making to account for Indigenous values and risks (such as droughts); and a Water Justice Hub to create a generation of scholars in integrated water valuation, resilient decision-making, and Traditional Water Knowledge.	$3,336,000	14 Economics 1402 APPLIED ECONOMICS 140201 - Agricultural Economics; 140205 - Environment and Resource Economics	1402 - APPLIED ECONOMICS
Active	FT130101115	1	drought	Western Sydney University	New South Wales	Brendan Choat	ARC Future Fellowships	2013	Limits to the resilience of Australian forests and woodlands to drought	Water availability is a primary determinant of plant growth and the distribution of plant species and communities throughout the world. In Australia, climate change is predicted to result in increasing temperatures and shifting precipitation patterns, leading to more intense droughts in some areas. This project will examine the resilience of Australian forests and woodlands to drought under both current and future climate scenarios. The results of this work will feed into the new generation of dynamic global vegetation models, allowing for robust prediction of changes in the structure and productivity of Australian vegetation communities in the face of rapid climate change.	$722,214	06 Biological Sciences 0602 ECOLOGY 0607 PLANT BIOLOGY 060705 - Plant Physiology; 060203 - Ecological Physiology	0607 - PLANT BIOLOGY
Active	FT130101220	1	earthquake	Macquarie University	New South Wales	Yingjie Yang	ARC Future Fellowships	2013	How the Earth moves: Developing a novel seismological approach to map the small-scale dynamics of the upper mantle	The concept of small-scale convection currents from about 100-400 km below the Earth's surface is a model proposed to explain the origins of intraplate volcanoes and mountains. However, direct evidence for the physical reality of small-scale convection cells is generally weak. This project will develop a novel seismological approach combining both ambient noise and earthquake data that can image such small-scale upper mantle convection. The outcomes of this project will help to fill the gap left in the Plate Tectonic paradigm by its inability to explain intraplate geological activity (volcanoes, earthquakes, mountains), which would be a significant step towards unifying conceptual models about how the Earth works.	$733,323	04 Earth Sciences 0404 GEOPHYSICS 0403 GEOLOGY 040407 - Seismology and Seismic Exploration; 040313 - Tectonics; 040402 - Geodynamics	0404 - GEOPHYSICS
Active	FT130101319	1	drought	James Cook University	Queensland	Susan Laurance	ARC Future Fellowships	2013	Global change: Rainforest responses to experimental drought	How will rainforests respond if droughts increase in the future? In a globally unique experiment, this project will examine how Australian tropical rainforests are affected by a large-scale experimental drought, using a canopy crane to assess plant responses at all vertical forest levels. It will contrast demographic and physiological responses of an array of plant species and functional groups between experimental and control plots where tree growth, composition, soil water and atmospheric exchange have been monitored since 1999. Drought responses of key species and functional groups will be compared with their distributions across regional rainfall gradients to yield crucial insights into the potential impacts of future climate change on rainforests.	$680,065	05 Environmental Sciences 06 Biological Sciences 0501 ECOLOGICAL APPLICATIONS 0607 PLANT BIOLOGY 050101 - Ecological Impacts of Climate Change; 050199 - Ecological Applications not elsewhere classified; 060705 - Plant Physiology	0501 - ECOLOGICAL APPLICATIONS

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Active	FT130101530	1	natural disaster	The University of Queensland	Queensland	Zi Huang	ARC Future Fellowships	2013	Real-time Event Detection, Prediction, and Visualization for Emergency Response	This project proposes novel end-to-end methods for real-time recognition and prediction of real-world events, leading to timely response to emergencies such as disease outbreaks and natural disasters, as well as prevention of crime, security breaches and the like. It will develop new techniques to quickly detect and predict events by incorporating adaptive learning and probabilistic models, and address fusion and scalability factors to handle vast collections of heterogeneous data. An event surveillance system prototype will be developed to incorporate the findings of the research with tools to visualise and describe events.	$720,320	08 Information and Computing Sciences 0806 INFORMATION SYSTEMS 0801 ARTIFICIAL INTELLIGENCE AND IMAGE PROCESSING 080604 - Database Management; 080606 - Global Information Systems; 080109 - Pattern Recognition and Data Mining	0806 - INFORMATION SYSTEMS
Active	FT140100286	1	drought	The Australian National University	Australian Capital Territory	Helen McGregor	ARC Future Fellowships	2014	El Niño in a changing climate: novel long-term perspectives from Pacific corals and model simulations	El Niño and La Niña events have a profound influence on Australian drought conditions and rainfall. Forecasting is hampered by short climate records, which do not capture the full range of El Niño dynamics. This project aims to generate records of unprecedented length and spatial coverage from key sites across the western and central equatorial Pacific. Five hundred years of continuous, monthly-resolution climate data will be integrated with output from state-of-the-art climate model simulations to distil the key processes that cause El Niño to vary. This project aims to provide major advances in determining the full range of El Niño and La Niña behaviour, leading to improved forecasts of future changes, with consequences for Australia's water security.	$771,360	04 Earth Sciences 0402 GEOCHEMISTRY 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0401 ATMOSPHERIC SCIENCES 040605 - Palaeoclimatology; 040299 - Geochemistry not elsewhere classified; 040105 - Climatology (excl. Climate Change Processes)	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	FT140100773	1	drought	University of South Australia	South Australia	Sarah Wheeler	ARC Future Fellowships	2014	Adapting for an uncertain future: farmer behaviour in water-stressed basins	Given the future risk of water scarcity, farmers will need to plan for greater farm-level adaptation. Drought and policy reform have inflicted significant economic, social and personal stress upon Murray-Darling Basin rural communities. This project aims to aid water managers and policy makers with a greater understanding of transformational farmer adaptation in order to plan for the economic, social and health impacts of future water scarcity from climate change and water reform-related policies. The focus will be on the Murray-Darling Basin, as well as undertaking a comparative analysis with water stressed basins in the United States.	$736,554	14 Economics 16 Studies in Human Society 05 Environmental Sciences 1402 APPLIED ECONOMICS 1604 HUMAN GEOGRAPHY 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 140205 - Environment and Resource Economics; 050205 - Environmental Management; 160404 - Urban and Regional Studies (excl. Planning)	1402 - APPLIED ECONOMICS
Active	FT140101062	2	flood; volcanic eruption	The Australian National University	Australian Capital Territory	Oliver Nebel	ARC Future Fellowships	2014	Identifying the secular evolution of chemical heterogeneity in the mantle as probed by deep mantle plumes	This project aims to focus on modes and timescales of melting associated with deep mantle plumes. These melts form massive magmatic bodies and volcanic flood basalt provinces throughout Earth's history and record the secular chemical evolution of the Earth's mantle. Selective igneous bodies contain high-grade noble metal deposits and coincide with global mass extinction linked to anoxic ocean events in response to atmospheric volcanic pollution. This project aims to provide knowledge of planetary surface evolution in response to mantle dynamics, place constraints on enrichment processes of metals in ore quality in plume-derived melts, and may help understandings of the relation between massive volcanic eruptions and climate variability.	$767,544	04 Earth Sciences 0402 GEOCHEMISTRY 0403 GEOLOGY 040203 - Isotope Geochemistry; 040304 - Igneous and Metamorphic Petrology; 040307 - Ore Deposit Petrology	0402 - GEOCHEMISTRY
Active	FT160100162	3	cyclone; drought; flood	Monash University	Victoria	Shayne McGregor	ARC Future Fellowships	2016	Predictability of the El Nino-Southern Oscillation	This project aims to improve understanding of the El Nino-Southern Oscillation (ENSO), the world's largest source of climate variability. ENSO's effects are so large that knowledge of its current phase and forecasts of its future phase underpin seasonal rainfall, temperature and tropical cyclone forecasts worldwide. In Australia, ENSO cycles cause drought and floods. Using a suite of empirical observations and numerical models to analyse ENSO event precursors, initiation and predictability, this project intends to enhance skill in inter-seasonal climate forecasting and help those sectors reliant on accurate prediction.	$652,000	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 0405 OCEANOGRAPHY 040503 - Physical Oceanography; 040102 - Atmospheric Dynamics	0405 - OCEANOGRAPHY
Active	FT160100353	2	cyclone; flood	The University of Newcastle	New South Wales	Sarah Wright	ARC Future Fellowships	2016	Weather cultures: Enhancing adaptive capacity to environmental change	This project aims to understand the relationship between weather, people and place. The current context of environmental change makes it essential to understand how people relate to anomalous weather, and how they might respond. The project will research weather cultures, including their expression through songs, songlines and stories. It plans to work with Indigenous and non-Indigenous cultures affected by Cyclone Oswald (2013) – where winds gathered (Timor Leste), where the cyclone formed (Yolngu Sea-Country, Arnhem Land), and where rivers flooded (Gumbaynggirr Country, NSW). The project aims to enhance adaptive capacity to environmental change through Indigenous-non-Indigenous two ways learning.	$930,000	20 Language, Communication and Culture 16 Studies in Human Society 2002 CULTURAL STUDIES 1604 HUMAN GEOGRAPHY 160403 - Social and Cultural Geography; 200209 - Multicultural, Intercultural and Cross-cultural Studies	1604 - HUMAN GEOGRAPHY
Active	FT160100477	1	drought	University of Tasmania	Tasmania	Zbynek Malenovsky	ARC Future Fellowships	2016	Bridging scales in remote sensing of vegetation stress	This project aims to develop operational upscaling algorithms to map vegetation stress indicators from space-borne missions' optical observations of the Earth. These approaches use computer radiative transfer models and unmanned aircraft systems called drones, and will pave the way for regular satellite monitoring of plant health in extensive and inaccessible Australian and Antarctic areas. More accurate and timely remote sensing maps of early stress symptoms will provide early warnings of droughts, diseases and pests, tell when and where to protect ecological functions of wild natural systems, and help to sustain or even increase agricultural food production.	$652,000	09 Engineering 0909 GEOMATIC ENGINEERING 090905 - Photogrammetry and Remote Sensing	0909 - GEOMATIC ENGINEERING

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Active	FT160100495	1	drought	The University of New South Wales	New South Wales	Andrea Taschetto	ARC Future Fellowships	2016	Tropical ocean interactions and implications for regional climate	This project aims to understand the complex interactions across the world's tropical oceans and their associated climate effects. The El Niño – Southern Oscillation (ENSO), manifesting in the Pacific Ocean, influences precipitation and temperature worldwide. Changes in the tropical Atlantic or Indian Oceans affect ENSO, generating instabilities and irregularities in the response. Understanding the interactions across the tropical Atlantic, Indian and Pacific Oceans can provide critical information for ENSO prognosis, thus improving long-term forecasting. Accurate seasonal and annual climate forecasting is crucial for managing Australia's water resources, and minimising the socio-economic effects of prolonged droughts and severe wet periods.	$652,000	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 0405 OCEANOGRAPHY 040105 - Climatology (excl. Climate Change Processes); 040102 - Atmospheric Dynamics; 040503 - Physical Oceanography	0401 - ATMOSPHERIC SCIENCES
Active	FT170100106	1	heatwave	The University of New South Wales	New South Wales	Sarah Perkins-Kirkpatrick	ARC Future Fellowships	2017	How do humans affect the nature and impacts of Australian heatwaves?	This project aims to provide more accurate information on the human signal behind heatwaves and their impacts, by deriving a comprehensive approach of the detection and attribution of climate extremes. The project expects to generate robust estimates of the human signal behind high-impact events, and an innovative, versatile methodology that can be applied to any extreme event and its impacts. With the specific application to Australian heatwave impacts on human health, key knowledge should support more targeted and accurate mitigation policies, minimising the strain on resources when future heatwaves occur. This should help in safeguarding future generations from deadly impacts of heatwaves.	$686,491	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 040104 - Climate Change Processes; 040105 - Climatology (excl. Climate Change Processes)	0401 - ATMOSPHERIC SCIENCES
Active	FT180100375	1	flood	The Australian National University	Australian Capital Territory	Mark Krumholz	ARC Future Fellowships	2018	The cosmic distribution of metals	This project aims to understand how the elements forged in stars flow through space and find their way into new stars and planets, using a combination of high-resolution numerical simulations and novel methods in machine learning. The history of these elements, and how they came to be in planets like ours, is one of the most basic questions remaining in astrophysics. The expected outcome is to provide a model for the history of the elements that can both stand on its own and provide a theoretical basis and a set of statistical tools to interpret the flood of data that will arrive from Australian and international telescopes over the next five years. The project will provide deeper insight into the history of the chemical elements that make up stars and our planet. It will also leverage Australia's significant investment in observational excellence and hardware and enhance Australia's leadership in astronomy.	$978,125	02 Physical Sciences 0201 ASTRONOMICAL AND SPACE SCIENCES 020103 - Cosmology and Extragalactic Astronomy; 020104 - Galactic Astronomy	0201 - ASTRONOMICAL AND SPACE SCIENCES
Active	FT180100524	1	drought	University of Wollongong	New South Wales	Timothy Cohen	ARC Future Fellowships	2018	Climate extremes and landscape responses across continental Australia	This project aims to determine the magnitude, frequency and duration of dry and wet extremes across the Australian continent over the last thousand years and examine landscape responses to such climate extremes. Using terrestrial records from key lake locations, the project expects to construct a record of mega-lakes and mega-droughts and determine whether such climatic phenomena are becoming more frequent or severe through time. The project will develop palaeoclimatic data at sub-centennial resolution, examining the spatial coherence of the climate extremes. The project will integrate this with both the historical record and global climate modelling, allowing us to assess the dominant oceanographic and atmospheric conditions that lead to such extremes.	$849,125	04 Earth Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0403 GEOLOGY 040601 - Geomorphology and Regolith and Landscape Evolution; 040605 - Palaeoclimatology; 040303 - Geochronology	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	FT190100156	1	natural disaster	The University of New South Wales	New South Wales	Guo Chen	ARC Future Fellowships	2019	Cyber-Physical Security Analyses and Enhancing the Resilience of Smart Grid	The electrical power industry in Australia is undergoing a massive revolution to an intelligent, low-carbon and sustainable smart grid environment. However, due to the heavy reliance on cyber infrastructure and the intermittence of renewables, smart grid will inevitably introduce new security issues, for example, cyber security. This project is to investigate emerging security issues together in a comprehensive framework where quantitative models and analysis methods will be explored for smart grid cascading failure analyses. Then innovative three-stage reinforcement strategies (three lines of defence) will be developed to enhance the resilience of smart grid against natural disasters and intentional attacks, and potential large blackouts.	$748,000	09 Engineering 08 Information and Computing Sciences 0906 ELECTRICAL AND ELECTRONIC ENGINEERING 0801 ARTIFICIAL INTELLIGENCE AND IMAGE PROCESSING 090607 - Power and Energy Systems Engineering (excl. Renewable Power); 080108 - Neural, Evolutionary and Fuzzy Computation; 090699 - Electrical and Electronic Engineering not elsewhere classified	0906 - ELECTRICAL AND ELECTRONIC ENGINEERING
Active	FT190100413	1	flood	The University of Sydney	New South Wales	Paul Spence	ARC Future Fellowships	2019	The Antarctic Slope Current in a warming climate	Melting Antarctic ice sheets are responsible for 28% of global sea level rise in recent decades, and can contribute more than 1 metre of sea level rise by year 2100, and a staggering 15 metres by 2500. Increased glacial melt rates are best understood by studying changes in the circulation of water around the Antarctic coastline. The combination of physical processes that must be resolved in this region places a high demand on ocean observations and modelling systems. This project uses a series of high-resolution ocean and ice experiments, cross-validated with observations, to provide a deeper understanding of how waters at the Antarctic margin respond to both anthropogenic and natural climate forcing.	$871,793	04 Earth Sciences 0405 OCEANOGRAPHY 0401 ATMOSPHERIC SCIENCES 040503 - Physical Oceanography; 040104 - Climate Change Processes	0405 - OCEANOGRAPHY

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Active	IH130200027	1	drought	The University of Adelaide	South Australia	Sigrid Heuer; Maria-Jane Appelbee; Ute Baumann; Nikolai Borisjuk; Nicholas Collins; Delphine Fleury; Stephan Haefele; Juan Juttner; Brent Kaiser; Haydn Kuchel; Peter Langridge; Stanley Miklavcic; Daniel Mullan; Mamoru Okamoto	Industrial Transformation Research Hubs	2013	ARC Research Hub for genetic diversity and molecular breeding for wheat in a hot and dry climate	ARC Research Hub for genetic diversity and molecular breeding for wheat in a hot and dry climate. This Research Hub, in partnership with wheat breeding companies, aims to deliver advanced technologies, germplasm and information to produce new stress tolerant varieties. Genetic diversity and novel traits will be introduced from exotic germplasm and high-throughput field-phenotyping tools will be developed to assist in selection of superior lines. Strategic research will be targeted towards the development of wheat with combined heat and drought tolerance and maintenance of high grain protein.	$4,308,668	06 Biological Sciences 07 Agricultural and Veterinary Sciences 0604 GENETICS 0703 CROP AND PASTURE PRODUCTION 070305 - Crop and Pasture Improvement (Selection and Breeding); 060412 - Quantitative Genetics (incl. Disease and Trait Mapping Genetics); 070303 - Crop and Pasture Biochemistry and Physiology	0703 - CROP AND PASTURE PRODUCTION
Active	IN140100011	1	bushfire	The University of New South Wales	New South Wales	Jason Sharples; Harvinder Sidhu	Discovery Indigenous	2014	Understanding the role of terrain geometry in eruptive bushfire behaviour	This project aims to improve understanding of the physical processes that cause eruptive bushfire behaviour, otherwise known as fire blow-up. Eruptive fire behaviour, characterised by rapid and unexpected escalation in fire intensity and rate of spread, is a global phenomenon that poses a major threat to fire-fighter safety and can seriously compromise bushfire suppression efforts. This project will address the role that terrain geometry plays in the incidence of fire eruption, through consideration of its effect on the attachment of flames to a surface. Expected outcomes include a dynamic fire spread modelling framework and the provision of better advice to bushfire authorities concerning fire blow-up.	$370,000	04 Earth Sciences 01 Mathematical Sciences 09 Engineering 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0102 APPLIED MATHEMATICS 0907 ENVIRONMENTAL ENGINEERING 090702 - Environmental Engineering Modelling; 040604 - Natural Hazards; 010299 - Applied Mathematics not elsewhere classified	0907 - ENVIRONMENTAL ENGINEERING
Active	IN160100029	2	bushfire; storm	The University of New South Wales	New South Wales	Jason Sharples; Jason Evans	Discovery Indigenous	2016	Understanding the role of deep flaming in violent pyroconvective events	This project aims to improve the prediction of firestorms by combining state-of-the-art knowledge of dynamic bushfire behaviour with atmospheric models to provide a comprehensive understanding of how the heat and moisture released by a bushfire interacts with ambient atmospheric instability to produce extreme fire events. Firestorms represent the most extreme and catastrophic phase of development of a bushfire. They often cause broad-scale loss of property, environmental damage and human fatalities. Firestorms cannot be suppressed, and so accurate and timely warnings of their occurrence, combined with appropriate community responses, are the only way of mitigating their effects. Better understanding of extreme fire processes may improve mitigation planning, community safety, environmental outcomes and emergency response measures.	$404,000	04 Earth Sciences 09 Engineering 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0401 ATMOSPHERIC SCIENCES 0907 ENVIRONMENTAL ENGINEERING 040604 - Natural Hazards; 040102 - Atmospheric Dynamics; 090702 - Environmental Engineering Modelling	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	LE150100094	1	earthquake	The University of Adelaide	South Australia	Benjamin Cazzolato; Karl Sammut; Dominic Thewlis; John Wilson; Giles Thomas; Michael Griffith; Andrei Kotooussov; Colin Hansen; Ching Tai Ng; Mark Taylor; John Costi; Youhong Tang; Emad Gad; Susantha Ranmuthugala; Roberto Ojeda Rabanal; Stuart Wildy	Linkage Infrastructure, Equipment and Facilities	2015	Development of a world-class facility for three dimensional dynamic testing	Development of a world-class facility for three dimensional dynamic testing: This project aims to establish a world-class facility for multi-directional dynamic testing. Currently there are no such facilities in Australia. The ability to recreate dynamic motion in all available degrees-of-freedom opens up enormous fields of research not currently possible in Australia. This includes such areas as vibration testing, materials testing, biomechanics and human factors, blast and earthquake simulations, field robotics, automotive safety research, flight/vehicle simulation, and marine applications including sloshing of liquids and liquefaction of fines. In conjunction with a 3D laser doppler system this facility will be unique in the world for dynamic mechanical testing.	$400,000	09 Engineering 0911 MARITIME ENGINEERING 0913 MECHANICAL ENGINEERING 091304 - Dynamics, Vibration and Vibration Control; 091101 - Marine Engineering; 091308 - Solid Mechanics	0913 - MECHANICAL ENGINEERING

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Active	LE190100045	1	drought	Monash University	Victoria	Jeffrey Walker; Linlin Ge; Nemai Karmakar; Mirela Tulbure; Brian Ng; Mark Preiss; Mahta Moghaddam; James Mead	Linkage Infrastructure, Equipment and Facilities	2019	High resolution airborne P-band radar for environmental research	This project aims to establish a new national capability for airborne-radar remote-sensing to provide unprecedented detail on environmental variables including soil moisture, salinity, vegetation and terrain height. This instrument, together with existing radar and radiometer capability, will yield the first airborne satellite simulator of its type in the world, providing Australian and overseas researchers with a unique and affordable tool for world-class pioneering research. This novel combination of sensors is expected to yield a level of detail that cannot be achieved with any one sensor alone. Applications include increased capability for monitoring of important environmental data, such as information on soil moisture status required for efficient and sustainable water use.	$740,948	09 Engineering 05 Environmental Sciences 0905 CIVIL ENGINEERING 0909 GEOMATIC ENGINEERING 0501 ECOLOGICAL APPLICATIONS 090905 - Photogrammetry and Remote Sensing; 090509 - Water Resources Engineering; 050104 - Landscape Ecology	0909 - GEOMATIC ENGINEERING
Active	LP130100061	1	drought	The University of Queensland	Queensland	David Edwards; Jacqueline Batley; David Pike; Benjamin Laga	Linkage Projects	2013	Towards genome methylation based crop improvement	Deoxyribonucleic acid (DNA) methylation is a form of genetic control that regulates crop performance and the crop's response to the environment. Improving understanding of the inheritance of methylation in relation to crop performance will provide the basis for methylation based breeding for climate resilient crops.	$683,349	07 Agricultural and Veterinary Sciences 06 Biological Sciences 0703 CROP AND PASTURE PRODUCTION 0607 PLANT BIOLOGY 0604 GENETICS 070305 - Crop and Pasture Improvement (Selection and Breeding); 060404 - Epigenetics (incl. Genome Methylation and Epigenomics); 060702 - Plant Cell and Molecular Biology	0703 - CROP AND PASTURE PRODUCTION
Active	LP130100146	2	bushfire; wildfire	University of Tasmania	Tasmania	Fay Johnston; David Bowman; Michael Abramson; Owen Price; Geoffrey Morgan; Martine Dennekamp; Sarah Henderson; Liam Fogarty; Suzanne Quigley; Paul Torre	Linkage Projects	2013	Bushfires, smoke, and people: assessing the risks and benefits from planned burning on the urban-rural interface	A key strategy to protect people from wildfire is the use of planned burns to reduce fire hazards. The exposure of communities to smoke pollution is a serious side-effect of this intervention. This project will be critical in enabling authorities to protect public health by determining acceptable levels of smoke originating from planned burns.	$559,330	05 Environmental Sciences 11 Medical and Health Sciences 16 Studies in Human Society 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 1117 PUBLIC HEALTH AND HEALTH SERVICES 1604 HUMAN GEOGRAPHY 050205 - Environmental Management; 160404 - Urban and Regional Studies (excl. Planning); 111705 - Environmental and Occupational Health and Safety	0502 - ENVIRONMENTAL SCIENCE AND MANAGEMENT
Active	LP130100408	1	flood	The University of New South Wales	New South Wales	Mirela Tulbure; Richard Kingsford; Richard Lucas; David Keith; Paul Carlile	Linkage Projects	2013	A novel approach for assessing environmental flows using satellite data	This project will determine how ecosystems respond to environmental flow by linking flooding history with vegetation responses, using remote sensing, climate data layers, spatial statistics, models of environmental flows and ecological theory. Beneficiaries will include water and land managers in Australia.	$414,085	05 Environmental Sciences 0501 ECOLOGICAL APPLICATIONS 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 050104 - Landscape Ecology; 050209 - Natural Resource Management; 050102 - Ecosystem Function	0501 - ECOLOGICAL APPLICATIONS
Active	LP140100020	1	storm	The University of Queensland	Queensland	Alexander Broom; Emma Kirby; Jonathan Adams; Jennifer Broom; David Looke	Linkage Projects	2014	Unintended consequences? A sociological study of how social relations influence decisions about antibiotics	Professional decision-making can be difficult to influence, particularly in health contexts. Decisions are often not just about scientific evidence of best practice. Rather, decisions are heavily influenced by social context and the relationships that surround them. An 'antimicrobial perfect storm' is predicted to occur within the next two decades, in part due to poor antibiotic decision-making, presenting a major threat to Australia. Using rigorous sociological research methods, this project aims to explore the social underpinnings of antibiotic decision-making, incorporating professional, lay and managerial perspectives. It aims to provide a means of understanding current practice and the barriers to enacting change.	$172,117	16 Studies in Human Society 1608 SOCIOLOGY 160899 - Sociology not elsewhere classified	1608 - SOCIOLOGY
Active	LP140100232	1	drought	Macquarie University	New South Wales	Belinda Medlyn; Linda Beaumont; David Tissue; Tony Auld; Bradley Evans; Remko Duursma; Paul Rymer; Mark Tjoelker	Linkage Projects	2014	Identifying regions of high drought mortality risk for tree species in NSW	Trees define our landscapes and are crucial for ecosystem services including biodiversity, carbon sequestration and prevention of soil erosion. Drought is a major threat to tree survival across Australia and is being exacerbated by rising temperatures and changing rainfall patterns due to climate change. This project aims to calculate the risk of drought mortality for key tree species across New South Wales in current and future climates. It aims to integrate four independent, complementary research streams to develop robust probabilistic risk profiles that account for variation in drought intensity and species resilience over landscapes. These risk profiles will be fundamental to conservation planning and land management across New South Wales.	$331,000	06 Biological Sciences 05 Environmental Sciences 0699 OTHER BIOLOGICAL SCIENCES 0501 ECOLOGICAL APPLICATIONS 050101 - Ecological Impacts of Climate Change; 069902 - Global Change Biology	0501 - ECOLOGICAL APPLICATIONS

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Active	LP140100239	1	drought	The University of Adelaide	South Australia	Sigrid Heuer; Ute Roessner; Rajeev Gupta; Mamoru Okamoto; Rainer Hoefgen	Linkage Projects	2014	Small molecules with large effect: The dual role of nitrogen-containing metabolites in stress tolerance and nutrient recycling	The main objective of this project is to identify drought and nutrient-deficiency responsive pathways in tolerant wheat and to provide markers to breeding programs that facilitate selection of superior breeding lines. This project builds on a pilot study conducted in rice in which tolerant-specific metabolites were identified which are representative of pathways relevant for the protection of cells from damage through reactive oxygen species (ROS) and for nutrient (nitrogen, phosphorus, sugars) recycling under stress. Available data suggest that these pathways are also relevant in wheat. Quantitative metabolomics, genetics, and molecular tools will be used to deliver either DNA-based or metabolomics markers to breeders.	$524,000	06 Biological Sciences 07 Agricultural and Veterinary Sciences 0607 PLANT BIOLOGY 0703 CROP AND PASTURE PRODUCTION 070305 - Crop and Pasture Improvement (Selection and Breeding); 060702 - Plant Cell and Molecular Biology; 070303 - Crop and Pasture Biochemistry and Physiology	0703 - CROP AND PASTURE PRODUCTION
Active	LP140100279	2	drought; heatwave	The University of Sydney	New South Wales	Mathew Crowther; Daniel Lunney; Benjamin Moore; Clare McArthur; Mark Krockenberger; Clive McAlpine; Brian Wilson; Mark Howes	Linkage Projects	2014	Rehabilitating a changing landscape: using the latest advances in koala ecology to direct adaptive management	The koala has been identified as one of the world's flagship species suffering from environmental change. In contrast to the decline of koalas in New South Wales generally, the eucalypts planted in Gunnedah to combat salinity led to an increase in koalas. However, the startlingly high death rate of Gunnedah koalas (25 per cent of the population) in the heatwave during the drought in 2009 must be understood. There are also new threats brought about by intensive land modification. This project aims to determine the effects of environmental change on the koala population through a study of landscape ecology, leaf chemistry, disease epidemiology and koala movements. This aims to lead to better management decisions for arboreal fauna.	$384,853	05 Environmental Sciences 0501 ECOLOGICAL APPLICATIONS 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 050101 - Ecological Impacts of Climate Change; 050211 - Wildlife and Habitat Management; 050104 - Landscape Ecology	0501 - ECOLOGICAL APPLICATIONS
Active	LP140100317	1	flood	Flinders University	South Australia	Adrian Werner; Ian Cartwright; Wei Yan	Linkage Projects	2014	Dynamics and management of riverine freshwater lenses	Rivers are the main source of freshwater for many ecosystems in semi-arid zones. River water may seep into the floodplain aquifer, providing an accessible store of low-salinity water within freshwater lenses. The project aims to investigate lens dynamics using numerical groundwater models supported by extensive field data from the lower River Murray, where freshwater lenses are declining. The project aims to model lens extent, growth and decline in response to natural variations in climate and to changes in land use, river regulation and groundwater pumping. Project results intend to evaluate management options to promote freshwater lenses, with the aim of improving river salinity and floodplain vegetation health.	$294,000	05 Environmental Sciences 04 Earth Sciences 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040603 - Hydrogeology; 050205 - Environmental Management	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	LP140100369	1	natural disaster	Monash University	Victoria	Majid Sarvi; Abbas Rajabifard; Frieder Seible; Russell Thompson; Elise Miller-Hooks; Andrew Wall; Alison Leighton	Linkage Projects	2014	Planning and managing road transport systems for extreme events through spatial enablement	Transport infrastructure is one of the seven types of nationally significant critical infrastructure identified federally to ensure the continuity of essential services in the face of extreme events including terrorist attacks and natural disasters. This project aims to provide tools for determining the most cost efficient schedule of preventative strengthening works for road networks for reducing the disruption and recovery costs after extreme events. The project aims to develop a novel platform for increasing the resilience of road networks by blending transport resilience modelling and structural health vulnerability analysis of road infrastructure into one integrated spatially enabled road transport planning system.	$225,000	09 Engineering 0905 CIVIL ENGINEERING 0909 GEOMATIC ENGINEERING 090507 - Transport Engineering; 090903 - Geospatial Information Systems; 090505 - Infrastructure Engineering and Asset Management	0905 - CIVIL ENGINEERING
Active	LP150100062	1	drought	The University of Melbourne	Victoria	David Karoly; Murray Peel; Joelle Gergis; Ailie Gallant; Rory Nathan; Kim Seong Tan; Geoffrey Steendam	Linkage Projects	2015	Megadrought likelihood and its water resource impacts in Australia	This interdisciplinary project plans to assemble a world-class team of hydrologists, climate scientists and water managers to investigate the history and future risk of decadal to multidecadal droughts (megadroughts). Despite Australia's vulnerability to water scarcity, the likelihood of persistent megadroughts has not been assessed in Australia. This has resulted in inadequate capacity to prepare for and adapt to megadrought under future climate change. For the first time, palaeoclimate reconstructions and climate change projections will be used to constrain future hydroclimatic variability, advancing the decision-making capacity of Australian water resource managers.	$387,041	09 Engineering 04 Earth Sciences 0905 CIVIL ENGINEERING 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 090509 - Water Resources Engineering; 040608 - Surfacewater Hydrology	0905 - CIVIL ENGINEERING
Active	LP150100359	2	flood; storm	The University of Adelaide	South Australia	Seth Westra; Michael Leonard; Timothy Pearce	Linkage Projects	2015	A unified approach for estimating coastal flood risk	The project aims to develop a unified approach to quantifying flood risk. Because flooding is caused by multiple mechanisms such as extreme rainfall, storm surge and astronomical tide, accurately estimating flood levels in the Australian coastal zone is challenging. By quantifying flood risk in terms of these mechanisms, the project is expected to provide reliable flood risk estimates for both historical settings and future climate scenarios. The improved estimation should enable Australian water agencies and policy-makers to effectively design defence infrastructure (e.g. drainage systems) and urban planning policies to adapt to future flood risk.	$156,905	04 Earth Sciences 09 Engineering 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0905 CIVIL ENGINEERING 090509 - Water Resources Engineering; 040608 - Surfacewater Hydrology	0905 - CIVIL ENGINEERING
Active	LP150100413	2	flood; storm	RMIT University	Victoria	Chun-Qing Li; Sujeeva Setunge; Jayantha Kodikara; Thomas Kuen	Linkage Projects	2015	preventing reoccurrence of catastrophic failures of stormwater pipelines	This project aims to develop a technique to accurately predict the remaining safe life of deteriorated buried stormwater pipelines, thereby preventing their catastrophic failure. The research also aims to advance knowledge in deterioration science of reinforced concrete and failure theory of buried pipes. The outcomes are anticipated to be a suite of rational, practical and validated models for pipe deterioration as measured by crack growth and residual strength which are integrated in a time-dependent reliability method and coded as a computer program ready for take-up by end-users. Preventing catastrophic failures of buried pipes should deliver economic, environmental and social benefits.	$290,000	09 Engineering 0905 CIVIL ENGINEERING 090506 - Structural Engineering; 090501 - Civil Geotechnical Engineering; 090503 - Construction Materials	0905 - CIVIL ENGINEERING

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Active	LP150100548	1	drought	The University of New South Wales	New South Wales	Fiona Johnson; Ashish Sharma; Shahadat Chowdhury; Richard Beecham	Linkage Projects	2015	Assessing future drought risk for water resources system management	The project aims to develop a new method for understanding drought drivers in eastern Australia and how well these are portrayed by climate models. The intended outcome of the project is to provide a framework for evaluating climate models on their representation of drought drivers and then use this information to develop improved downscaling schemes. Traditional downscaling approaches do not capture changes in variability in rainfall and evaporation at interannual and interdecadal timescales. This project aims to address this problem by providing a comprehensive drought downscaling framework which will provide inputs to water sharing plans that can be used to assess the future risks of droughts in catchments across New South Wales.	$300,000	09 Engineering 0905 CIVIL ENGINEERING 090509 - Water Resources Engineering	0905 - CIVIL ENGINEERING
Active	LP150100654	4	bushfire; natural disaster; storm; wildfire	The University of Melbourne	Victoria	Gary Sheridan; Patrick Lane; Ian Rutherfurd; Owen Jones; Shane Haydon; Charles Showers	Linkage Projects	2015	Mitigating extreme water supply contamination in bushfire burned catchments	This project involves Melbourne Water, the Department of Environment and Primary Industries, and East Gippsland Water in developing tools to evaluate mitigation options that will protect our water supplies and increase the resilience of Australian communities to bushfire. Major bushfires in south-east Australia in 2003, 2007, 2009 and 2013 were followed by storms that triggered extreme soil erosion events in catchments, contaminating water supplies and damaging critical infrastructure. The capacity to mitigate the risk of interruption to the water supplies of our cities and towns in a more fire-prone future is currently limited by our knowledge of where, why, and how often these post-fire contamination events will occur. This project aims to address these knowledge gaps.	$310,000	04 Earth Sciences 07 Agricultural and Veterinary Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0705 FORESTRY SCIENCES 040608 - Surfacewater Hydrology; 070504 - Forestry Management and Environment; 040607 - Surface Processes	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	LP150100682	1	flood	The University of Melbourne	Victoria	Christopher Walsh; Jane Catford; Marie Keatley; Elisa Raulings; Dan Harley	Linkage Projects	2015	Overcoming multiple constraints to wetland forest restoration	This project aims to determine the efficacy of different approaches for restoring wetland forests at the landscape scale. The death and decline of Victoria's wetland forests, crucial habitat for the endangered helmeted honeyeater and Leadbeater's possum, most likely result from modified flooding patterns, low native tree and shrub recruitment and increased competition from understorey plants. The project intends to reinstate a more natural flood regime, planting native species and reducing competition from dense understorey vegetation. In this way, the project aims to test and advance ecological theory, guide wetland restoration and inform management plans for saving Victoria's iconic fauna.	$335,000	06 Biological Sciences 05 Environmental Sciences 0602 ECOLOGY 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 060202 - Community Ecology (excl. Invasive Species Ecology); 050202 - Conservation and Biodiversity; 060204 - Freshwater Ecology	0602 - ECOLOGY
Active	LP150100694	1	heatwave	The University of Adelaide	South Australia	Ute Baumann; Stephan Haefele; Nicholas Collins; Sebastien Praud	Linkage Projects	2015	Exploring genetic diversity to identify new heat tolerance genes in wheat.	This project aims to improve the selection and development of heat-tolerant wheat varieties. Heatwaves seriously reduce wheat yields worldwide, and the situation will worsen with climate variation. This project aims to apply a broad genetic scan to identify the main chromosome regions controlling heat tolerance at the sensitive flowering stage in Australian and European wheat varieties. It is expected that this knowledge will deliver crucial breeders' tools to select heat-tolerant varieties. The project also aims to identify genes most likely to control tolerance at these chromosome locations using gene expression profiling data, trait associations and knowledge of heat-tolerance genes from other species. It is expected that these genes will reveal molecular mechanisms of heat tolerance and create new opportunities to engineer superior levels of tolerance in cereals.	$517,000	06 Biological Sciences 0604 GENETICS 0607 PLANT BIOLOGY 060412 - Quantitative Genetics (incl. Disease and Trait Mapping Genetics); 060405 - Gene Expression (incl. Microarray and other genome-wide approaches); 060705 - Plant Physiology	0604 - GENETICS
Active	LP150100936	1	drought	Western Sydney University	New South Wales	Paul Rymer; Giles Hardy; David Tissue; Margaret Byrne; Nora Devoe	Linkage Projects	2015	Do hotter and drier regions harbour adaptive variation for climate change?	This project aims to improve our understanding of the capacity of trees to respond to climate change. This is essential for the maintenance of biodiversity, forest health and productivity. In south-west Australia, climate variation has increased the frequency and intensity of droughts, which has resulted in tree death and negatively affected essential ecosystem services. Adaptive land management is urgently needed to mitigate the risk of large-scale drought mortality in a rapidly changing climate. This project seeks to deliver a scientific basis for the adoption of assisted gene migration in south-west forests, through a detailed understanding of genetic adaptation and physiological tolerance, to improve drought-resilience under future hotter and drier climates.	$281,506	06 Biological Sciences 0604 GENETICS 0602 ECOLOGY 0603 EVOLUTIONARY BIOLOGY 060411 - Population, Ecological and Evolutionary Genetics; 060303 - Biological Adaptation; 060203 - Ecological Physiology	0604 - GENETICS
Active	LP150101172	2	flood; storm	Queensland University of Technology	Queensland	Richard Brown; Yanming Feng; Suvash Saha; Helen Fairweather; Roy Sidle; Michael Borgas; Christopher Allan	Linkage Projects	2015	Advances in real-time satellite monitoring of flow in rivers and estuaries	This project plans to improve the monitoring of our waterways by developing a novel moving drifter system that takes flow and water quality measurements along the pathlines of the drifters. One of the key challenges for Australian water management lies in monitoring and managing rivers and estuaries effectively over large geographical areas. Traditionally, instrumentation at stationary points has been used for such monitoring, under the simplifying assumption that a single point adequately represents a very large region of water. By contrast, the Real-Time Flow Logging of Water (RT-FLOW) system expects to provide information from large regions of our waterways, providing stakeholders with more information to enable them to better manage issues including storm surge and erosion. The project also aims to provide improved validation of hydrodynamic models.	$397,000	09 Engineering 0907 ENVIRONMENTAL ENGINEERING 0909 GEOMATIC ENGINEERING 0915 INTERDISCIPLINARY ENGINEERING 091508 - Turbulent Flows; 090702 - Environmental Engineering Modelling; 090904 - Navigation and Position Fixing	0915 - INTERDISCIPLINARY ENGINEERING

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Active	LP150101206	1	storm	James Cook University	Queensland	John Ginger; John Holmes; Peter Ridd; David Henderson; Scott Woolcock	Linkage Projects	2015	Optimization of internal pressure for designing industrial buildings	The project seeks to understand the internal pressure in a building during windstorms, to improve safety and performance. The internal pressure in a building is dependent on its volume and flexibility and the sizes of openings in the building envelope, and is a critical loading parameter in building design. Windstorm damage investigations have shown that incorrect internal pressures are frequently used in building design, leading to damage. This project aims to study the internal pressures generated in buildings with a range of volumes and openings in the envelope. A combination of model-scale and full-scale tests and theoretical analysis are planned to determine critical parameters for highly turbulent air-flow though openings. Results will inform the revision of design data in codes and of guidelines for consistent, optimal design of buildings.	$185,000	09 Engineering 0915 INTERDISCIPLINARY ENGINEERING 0905 CIVIL ENGINEERING 090506 - Structural Engineering; 091599 - Interdisciplinary Engineering not elsewhere classified	0905 - CIVIL ENGINEERING
Active	LP160100241	1	storm	Monash University	Victoria	Ana Deletic; Peter Bach; David McCarthy; Rhys Coleman; Leon Metzeling; Wolfgang Rauch	Linkage Projects	2016	Advancing water pollution emissions modelling in cities of the future	This project aims to advance stormwater pollution modelling and enhance its link with urban development. Management of stormwater pollution by industry often results in inadequate strategies and, crucially, sub-optimal financial investments. Since this is unlikely to improve in light of urban growth and climate change, addressing decade-old pollution modelling knowledge gaps and the lack of a multidisciplinary approach to stormwater pollution management is urgent. The anticipated outcome is a modelling tool which industry can use to manage stormwater pollution in changing cities through smarter and economic technology and policy.	$319,052	09 Engineering 0907 ENVIRONMENTAL ENGINEERING 0905 CIVIL ENGINEERING 090508 - Water Quality Engineering; 090702 - Environmental Engineering Modelling	0905 - CIVIL ENGINEERING
Active	LP160100661	1	bushfire	The University of Melbourne	Victoria	Janet Stanley; Alan March; James Ogloff	Linkage Projects	2016	Building an integrated system for Australian bushfire prevention	This project aims to develop a comprehensive approach to prevent arson. Bushfires are a serious issue in Australia, made worse by climate change; since most of these fires are started by people, it is important to prevent arson. Building on previous work, this project intends to improve community responses, and build a model to predict risk and improve data sharing. The intended outcome is an all-risks approach to arson prevention and community engagement. This research should reduce the incidence of arson in Australia, and also be useful overseas.	$115,000	16 Studies in Human Society 12 Built Environment and Design 1602 CRIMINOLOGY 1205 URBAN AND REGIONAL PLANNING 160201 - Causes and Prevention of Crime; 120504 - Land Use and Environmental Planning; 120501 - Community Planning	1205 - URBAN AND REGIONAL PLANNING
Active	LP160100687	1	storm	The University of Melbourne	Victoria	Spas Kolev; Vincent Pettigrove; Rhys Coleman	Linkage Projects	2016	Smart passive sampling of heavy metals in aquatic systems	This project aims to construct smart devices with extracting polymeric membranes for advanced passive sampling of heavy metal ions. These devices should improve the passive sampling of pollutants such as heavy metals by overcoming the effect of the variability of water temperature, composition and velocity during sampling, which substantially reduces the reliability of analytical data. These devices are expected to reliably identify sources of heavy metal pollution in urban municipal wastewaters and stormwaters without the need for labour intensive monitoring operations, thus saving considerable time and expense to the Australian water industry.	$288,000	09 Engineering 05 Environmental Sciences 0904 CHEMICAL ENGINEERING 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 090404 - Membrane and Separation Technologies; 050206 - Environmental Monitoring	0904 - CHEMICAL ENGINEERING
Active	LP160100941	2	drought; storm	The University of Queensland	Queensland	Karen McNamara; James Watson; Patrick Nunn	Linkage Projects	2016	Optimising community-based climate change adaptation in the Pacific Islands	This project aims to evaluate community level climate change interventions in the Pacific to provide guidelines for better practice. The effects of climate change—rising sea levels, more droughts, and more frequent and intense storm activity—have been particularly concentrated in tropical areas such as the Pacific Islands. In response, interventions to adapt to a diversity of impacts have accelerated at the community level across the region, but there has been no analysis of their long-term effectiveness in reducing livelihood and resource vulnerability to climate change.	$180,098	05 Environmental Sciences 16 Studies in Human Society 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 1604 HUMAN GEOGRAPHY 1699 OTHER STUDIES IN HUMAN SOCIETY 160403 - Social and Cultural Geography; 050210 - Pacific Peoples Environmental Knowledge; 169905 - Studies of Pacific Peoples' Societies	1604 - HUMAN GEOGRAPHY
Active	LP160101229	1	earthquake	The University of New South Wales	New South Wales	Chongmin Song; Ean Tat Ooi	Linkage Projects	2017	Seismic analysis of cracking and deformations in concrete gravity dams	This project aims to establish a rational predictive capability for the responses of concrete gravity dams subject to extreme design earthquakes. This will include the development of innovative numerical methods for effective modelling of crack propagation and closure, large slips on crack faces and weak interfaces, dam-reservoir interaction, dam-foundation interaction and automatic mesh generation. The expected outcomes of the project will be a significantly improved prediction tool. It is also anticipated that the project will result in improvements in dam and public safety, and more efficient use of funds for dam safety upgrades and management.	$351,731	09 Engineering 0905 CIVIL ENGINEERING 090506 - Structural Engineering; 090505 - Infrastructure Engineering and Asset Management	0905 - CIVIL ENGINEERING
Active	LP160101494	1	storm	Monash University	Victoria	Steven Siems; Yi Huang; Michael Manton; Bart Geerts; Alain Protat; Charmaine Franklin; Thomas Chubb; Andrew Peace; Suzanne Kenyon; Johanna Speirs; Stuart Allie	Linkage Projects	2017	How does orography enhance precipitation in Australian wintertime storms?	This project aims to employ targeted field observations, numerical simulations and new satellite capabilities to identify the dynamical and microphysical mechanisms that enhance and redistribute precipitation across the alpine regions of south eastern Australia and Tasmania. These observations will be used to evaluate operational numerical weather simulations specifically focusing on quantitative precipitation forecasts and estimates. The observations will also be used to extend known biases in the national gridded precipitation analysis that are a result of the complex mountain terrain. This identification of the physical processes that enhance and redistribute precipitation over the alpine regions across south east Australia and Tasmania will lead to better precipitation estimates and forecasts and better water management.	$457,074	04 Earth Sciences 0401 ATMOSPHERIC SCIENCES 040106 - Cloud Physics; 040107 - Meteorology; 040105 - Climatology (excl. Climate Change Processes)	0401 - ATMOSPHERIC SCIENCES

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Active	LP160101508	1	cyclone	Curtin University	Western Australia	Zoe Richards; Michael Bunce; David Miller; Ira Cooke; Michael Stat; Jim Underwood; Nerida Wilson; James Gilmour; Andrew Halford	Linkage Projects	2017	Coral resilience and the optimal management of biodiversity	This project aims to examine the resilience of coral biodiversity to disturbances and build on recently developed genomic resources to explore the genotypic traits that confer thermal tolerance. The project will research how coral biodiversity responds to climatic disturbances; the potential for acclimation and adaptation; and the best ways to monitor, manage and restore biodiversity. The project is expected to generate tangible outcomes and strategies to optimise the management of Australia's coral biodiversity while engaging the public through museum-based outreach, in collaboration with government, regulatory sectors and an industry group.	$221,973	05 Environmental Sciences 06 Biological Sciences 0501 ECOLOGICAL APPLICATIONS 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 0604 GENETICS 050206 - Environmental Monitoring; 050101 - Ecological Impacts of Climate Change; 060411 - Population, Ecological and Evolutionary Genetics	0502 - ENVIRONMENTAL SCIENCE AND MANAGEMENT
Active	LP170100152	1	bushfire	The Australian National University	Australian Capital Territory	David Lindenmayer; Geoffrey Cary; David Wardle; Paul Kardol	Linkage Projects	2018	Fauna, fuel and fire: effects of animals on bushfire risk	This project aims to determine the extent that animals influence fire regimes through effects on fuel load and characteristics. Minimising the risk of large, severe bushfires, while conserving native species is one of the greatest challenges facing managers of fire-prone ecosystems globally. Using a powerful combination of landscape-scale field observations, experimental manipulations of animal densities, and modelling, the project expects to quantify interactions between animals, bushfire fuel and fire regimes in south eastern Australian forests, woodlands and scrublands. This evidence should benefit the design of integrated, efficient, and complementary strategies for fire and fauna management in Australia's extensive fire-prone ecosystems.	$645,000	05 Environmental Sciences 06 Biological Sciences 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 0602 ECOLOGY 0501 ECOLOGICAL APPLICATIONS 050205 - Environmental Management; 050102 - Ecosystem Function; 060202 - Community Ecology (excl. Invasive Species Ecology)	0502 - ENVIRONMENTAL SCIENCE AND MANAGEMENT
Active	LP170100161	1	storm	The University of New South Wales	New South Wales	Ian Turner; Ryan Lowe; Diana Greenslade; Nathaniel Plant; Jeff Hansen; Kristen Splinter	Linkage Projects	2018	An Australian storm wave damage and beach erosion early warning system	This project aims to develop a new coastal hazard early-warning system capability for Australia, to alert coastal communities, emergency managers and coastal engineers to impending storm wave damage and coastal erosion. Emergency preparedness informed by early warning is expected to significantly benefit vulnerable communities and infrastructure along Australia's coasts.	$505,000	04 Earth Sciences 0405 OCEANOGRAPHY 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040604 - Natural Hazards; 040503 - Physical Oceanography	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	LP170100317	1	drought	The University of Queensland	Queensland	Benjamin Hayes; Lee Hickey; Sandra Dunckel; Jesse Poland	Linkage Projects	2018	FastStack - evolutionary computing to stack desirable alleles in wheat	This project aims to investigate rapid development of new, high-yielding wheat varieties with appropriate disease resistance. An emerging challenge in wheat breeding is how to stack desirable alleles for disease resistance, drought, and end-use quality into new varieties with high yielding backgrounds in the shortest time. As the number of known desirable alleles for these traits increases, the number of possible crossing combinations that need to be considered increases. This project aims to use evolutionary computing with speed breeding and genomic selection, in the partners breeding program, to address this challenge. Potential outcomes will lead to more profitable wheat varieties for Australian growers, and expanded exports to high value markets that require quality grain.	$345,465	01 Mathematical Sciences 07 Agricultural and Veterinary Sciences 06 Biological Sciences 0103 NUMERICAL AND COMPUTATIONAL MATHEMATICS 0703 CROP AND PASTURE PRODUCTION 0604 GENETICS 070305 - Crop and Pasture Improvement (Selection and Breeding); 060412 - Quantitative Genetics (incl. Disease and Trait Mapping Genetics); 010303 - Optimisation	0703 - CROP AND PASTURE PRODUCTION
Active	LP170100598	1	drought	The University of Melbourne	Victoria	Michael Stewardson; Rory Nathan; Murray Peel; Angus Webb; Nathan Poff	Linkage Projects	2018	Vulnerabilities for environmental water outcomes in a changing climate	This project aims to assess the vulnerability of freshwater ecosystems to extended droughts in a variable and changing climate. Governments around the world are investing in the restoration of regulated river systems with environmental water. However, the risks of climate change for environmental water management are seldom considered. This project will model the change in environmental and consumptive water use during extended dry periods, and couple this to models of ecological dynamics and failure thresholds. This will improve the success of Australia's major environmental water programs in sustaining benefits through future multi-year droughts.	$404,000	04 Earth Sciences 05 Environmental Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 0502 ENVIRONMENTAL SCIENCE AND MANAGEMENT 040608 - Surfacewater Hydrology; 050205 - Environmental Management	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	LP170100846	1	earthquake	Curtin University	Western Australia	Hong Hao; Xihong Zhang; David Yong; Su Kwong Tan	Linkage Projects	2018	Analysis and design of interlocking brick system against earthquake loading	This project aims to develop optimised interlocking bricks to resist static and earthquake loads. Using conventional bricks in masonry construction requires skilled labour to connect bricks with mortar. Development of interlocking bricks for mortarless connection has been attracting great interest because the easy alignment improves construction efficiency and quality. Interlocking also leads to better mechanical performance of the resulting structures. This project will have significant impact on construction technology and the Australian masonry industry, and greatly improve the competitiveness of the Australian construction industry in the international market.	$277,092	09 Engineering 0905 CIVIL ENGINEERING 090506 - Structural Engineering; 090504 - Earthquake Engineering	0905 - CIVIL ENGINEERING
Active	LP180100234	1	cyclone	Monash University	Victoria	Mark Thompson; Kerry Hourigan; Marc Parlange; David Burton; Bernard Chen; John Sheridan; Marco Giometto; John Holmes	Linkage Projects	2019	Structural Reliability of Engineering Structures in Cyclonic Winds	This project aims to address the challenge of predicting the impact of extreme cyclonic winds on complex engineering structures. By applying advanced computational and experimental techniques the project expects to develop new insight into turbulent flows at a sub-cyclone scale and how these produce aerodynamic loads on closely spaced cylindrical structures and elements. The expected outcomes of this project include enhanced simulation techniques leading to better understanding of structural vulnerability to cyclones. This should provide significant benefits, such as improved structural design and cyclone mitigation strategies applicable to both high-value engineering structures and vulnerable communities in cyclone regions.	$465,000	09 Engineering 0915 INTERDISCIPLINARY ENGINEERING 0905 CIVIL ENGINEERING 091504 - Fluidisation and Fluid Mechanics; 091501 - Computational Fluid Dynamics; 090505 - Infrastructure Engineering and Asset Management	0915 - INTERDISCIPLINARY ENGINEERING

Attachment F

Project Status	ProjectID	Number of Keyword	keywords	Admin Organisation Name	Admin Organisation State Name	Investigator List	Scheme Name	StartYr	Project Title	Project Summary	Funding Amount	FOR Classification Code List	Primary 4-digit Field of Research
Active	LP180100796	1	drought	The University of Melbourne	Victoria	Murray Peel; Tim Peterson; Francis Chiew; Lu Zhang	Linkage Projects	2019	Observed streamflow generation changes: better understanding and modelling	This Project aims to investigate drivers and triggers of variable streamflow response during and after drought and develop modelling strategies and model structures more robust to changing streamflow response. In many catchments during the Millennium Drought, streamflow generation was less than expected and hydrologic models performed poorly. After the drought, streamflow generation is yet to recover in some catchments. This Project expects to generate new knowledge about variable streamflow response to drought and develop strategies and models to robustly simulate runoff during and after changed conditions, which should provide significant benefit via better understanding and modelling of streamflow response under changing conditions.	$410,334	04 Earth Sciences 0406 PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE 040608 - Surfacewater Hydrology	0406 - PHYSICAL GEOGRAPHY AND ENVIRONMENTAL GEOSCIENCE
Active	LP180101109	1	storm	Swinburne University of Technology	Victoria	Richard Manasseh; Luke Bennetts; Tom Denniss; Ian Turner; Benjamin Cazzolato; Francois Flocard; Justin Leontini; Oliver Moles	Linkage Projects	2019	Controlling coastlines while generating power	The Project aims to produce strategies for protecting coasts from storms using farms of wave-energy machines, which also generate electricity. Increasing lengths of coast need protection as the climate changes, but conventional barriers create permanent environmental impacts and are a sunk cost usually borne by the taxpayer. The Project expects to derive a strategy for the setting of each machine in the farm, so that they collectively absorb or reflect damaging waves under severe conditions. Under normal conditions, enough wave energy to sustain environmental processes would pass through. Sales of electricity would help to pay back the capital cost. Outcomes would include reduced coastal-erosion costs and a low-intermittency energy supply.	$427,000	09 Engineering 0906 ELECTRICAL AND ELECTRONIC ENGINEERING 0915 INTERDISCIPLINARY ENGINEERING 091504 - Fluidisation and Fluid Mechanics; 090602 - Control Systems, Robotics and Automation	0915 - INTERDISCIPLINARY ENGINEERING
Active	LP180101118	1	earthquake	The Australian National University	Australian Capital Territory	Meghan Miller; Brian Kennett; Trevor Allen; Stephen Gray; Klaus Gessner; Huaiyu Yuan	Linkage Projects	2019	Enhanced 3-D seismic structure for Southwest Australia	The ancient cratonic lithosphere of Southwest Australia appears to have a distinct contrast in geophysical properties and complex geologic structure, while having some of the highest levels of earthquakes on the continent. The project aims to produce novel 3-D models of this region that combine new seismic data collected over two years with previously collected geophysical datasets from the partner investigators. A compilation of 3-D models will subsequently be developed, to form an effective characterisation of the geologic structure of the craton and its margins. These models will provide enhanced assessment of seismic ground shaking from regional earthquakes and facilitate an improved understanding of mineral resource potential.	$442,000	04 Earth Sciences 0404 GEOPHYSICS 040407 - Seismology and Seismic Exploration	0404 - GEOPHYSICS