



NCCARF
National
Climate Change Adaptation
Research Facility

NCCARF Research

Summary of NCCARF climate change adaptation research

*Leading the Australian
research community
to generate the
knowledge needed
by decision makers to
adapt to the impacts of
climate change.*

Introduction

The National Climate Change Adaptation Research Facility was established by the Australian Government in 2008 to lead the national interdisciplinary effort to generate the knowledge decision makers need to manage the impacts of climate change.

NCCARF manages two research programs, with a combined value of almost \$39 million, and a portfolio of more than 140 projects designed to generate and deliver this knowledge in a succinct and useable format.

The Adaptation Research Grants Program. NCCARF has developed nine National Climate Change Adaptation Research Plans (NARPs) for key sectors of Australian society that identify priorities to ensure Australian decision makers have the knowledge they need. These sectors are:

- Emergency management
- Freshwater biodiversity
- Human health
- Indigenous communities
- Marine biodiversity and resources
- Primary industries
- Settlements and Infrastructure
- The Social, economic and institutional dimensions of climate change.
- Terrestrial biodiversity

The Adaptation Research Grants Program (ARGP) is a \$34 million portfolio of 96 projects that address the high-priority research questions identified in the NARPs.

The Synthesis and Integrative Research Program. This \$4.5 million portfolio of more than 40 projects draws together existing research from a variety of sources and disciplines to support decision-making.

This document provides a brief summary of each project; more details are available on the NCCARF website at www.nccarf.edu.au, or by contacting the project principal investigators.

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EMERGENCY MANAGEMENT

Recovery from disaster experience: its effect on perceptions of climate change risk and on adaptive behaviours to prevent, prepare, and respond to future climate contingencies

Helen Boon

James Cook University

This project aims to identify private and public sector groups' beliefs, behaviours and policies that have supported community resilience to a disaster event and construct a model with findings to help implement appropriate and equitable emergency management policies and mitigation strategies for climate change events.

Harnessing private sector logistics for emergency food and water supplies in flood prone areas

Leo Dobes

Australian National University

Climate change is expected to increase the frequency and/or intensity of cyclones, which will affect the availability of food and water supplies in times of emergency. This project will use the Cairns community as a model for a nationally-applicable scoping study to estimate the costs of supplying water and food using conventional public sector emergency services and of harnessing private sector logistics as an alternative. It will compare the relative efficiency of public and private sector arrangements, and estimate any additional government subsidies that may be justified by a cost-benefit analysis.

The right tool for the job: Achieving climate change adaptation outcomes through improved disaster management policies, planning and risk management strategies

Michael Howes

Griffith University

Australia is highly susceptible to climate change impacts such as more frequent and/or intense floods and bushfires. There is considerable uncertainty about when and how disaster management organisations should address climate change adaptation and the priority that should be granted compared to other problems. This project will create a nationally-consistent approach with a supporting set of risk assessment tools to identify potential conflict, improve stakeholder engagement, and integrate climate change adaptation into disaster management. The tools are derived from a comparison of case studies including the 2010-11 Queensland floods; the 2009 Victorian bushfires; the 2011 Perth hills bushfires and state-wide risk profiles. The research will improve policymaking, planning and emergency risk management by decision-makers at all levels of government.

Adaptation of the built environment to climate change-induced increased intensity of natural hazards

David King

James Cook University

This project will examine the likely impacts on the built environment of increased intensities in weather-related natural hazard events, and identify possibilities for the adaptation of regulatory mechanisms in building construction, housing and planning. It will analyse climate change impacts on the built environment, and review existing regulatory mechanisms and their effectiveness. It will then model policy recommendations that provide for improved emergency management preparations and response capabilities across a wide range of agencies and organisations.

A spatial vulnerability analysis of urban populations to extreme heat events in Australian capital cities

**Margaret Loughnan
Monash University**

This study will identify threshold weather conditions for mortality in Australian capital cities, describe spatial distribution of human vulnerability to extreme heat, and provide information to target emergency responses during heat waves. Baseline risk assessments will be used to predict changes in vulnerability in relation to predicted changes in climate extremes associated with climate change.

Agent based simulation framework for improved understanding and enhancement of community and organisational resilience to extreme events

**Lin Padgham
RMIT University**

Agent-based modelling is a means of analysing systems by simulating the actions and interactions of the individual elements or 'agents' they comprise. This project aims to develop an agent-based simulation platform that allows emergency management stakeholders to explore complex multi-scale, multi-actor, emergency management interactions under uncertain future conditions in order to promote more effective governance arrangements. The platform is also intended to be a long term decision support tool suitable for the development of agent-based simulations which address a range of extreme events, such as coastal flooding and heat stress.

Exploring the adaptive capacity of emergency management using agent-based modelling

**Lin Padgham
RMIT University**

Little is known about how societies, organisations and individuals are responding or might respond to the challenges of climate changes. This project uses agent-based modelling that combines social science research and technical computing to explore a range of potential future scenarios at a scale that is not possible without computer support. It provides the opportunity for a wide variety of stakeholders to work together with the community using a practical tool to determine solutions to evolving changing climate impacts.

Changing Perceptions about Climate Change

**Joseph Reser
Griffith University**

The research addresses diverse psychological considerations posed by climate change, with a focus on how the Australian public perceives and understands the threat of climate change, and how these considerations can be best addressed in terms of policies and risk communication strategies.

Public understandings, risk perceptions, and responses to climate change and associated natural disasters

**Joseph Reser
Griffith University**

This project aims to: examine public understandings, risk perceptions, concerns, and adaptations to climate change and natural disasters in Australia and to identify ways in which public understandings and responses to the threat and impacts of climate change differ across population sub-groups defined in terms of gender, age, urban/peri-urban/rural residence, and other demographic considerations. It will provide a baseline from which the nature and direction of changes in community perceptions can be examined over time.

Developing an Excel spread sheet tool for local governments to compare and prioritise investment in climate adaptation

Stefan Trueck

Macquarie University

This project aims to educate stakeholders by creating a tool to demonstrate the influence of various parameters on the investments they make. Users will be able to enter details regarding extreme events and the tool will show relevant charts and graphs to enhance optimal decision-making. The tool has particular use to local governments, but can also be used to understand the impact of extreme events on sectors such as health, agriculture and the insurance industry.

Understanding the Pacific's adaptive capacity to emergencies in the context of climate change

Juliet Willetts

University of Technology, Sydney

This project will assess Australia's current emergency response systems, the Pacific Islands' current systems, and their future needs in order to enable better preparedness in the event of disaster. This project aims to gather in-depth information from experts in the Pacific across four sectors: healthcare; food and nutrition; water and sanitation and the psychosocial needs of populations.

FRESHWATER BIODIVERSITY

Joining the dots: integrating climate and hydrological projections with freshwater ecosystem values to develop adaptation options for conserving freshwater biodiversity

Leon Barmuta and Peter Davies

University of Tasmania

Information about climate change, how water moves through the landscape, and about where freshwater plants and animals occur provide three 'dots' that must be joined up to understand how a changing climate will impact our freshwater biodiversity. Using Tasmania as a study area, this project will integrate state-wide hydrological models and local-scale climate models with information on freshwater ecosystems to enable climate change scenarios to be modelled for adaptation planning.

Adapting to climate change: a risk assessment and decision framework for managing groundwater-dependent ecosystems with declining water levels.

Jane Chambers, Murdoch University

This project will develop and test a risk assessment and decision-making tool for managing wetland and cave ecosystems that depend on groundwater. The tool will be tested in south-western Australia, a global biodiversity hotspot and one of the earliest regions impacted by climate change, and modified to help manage similar ecosystems across Australia.

It will identify sites of high ecosystem value, including species and communities at risk and produce maps showing the distribution of risk to wetlands and caves in specific regions.

Building the climate resilience of arid zone freshwater biota: identifying and prioritising processes and scales for management

Jenny Davis Monash University

Important wetlands in the Lake Eyre Basin, Western Plateau and Indian Ocean Drainage Divisions of Australia's arid zone include springs, relic streams, rockholes and river pools. Climate change, including rising temperatures and more variable rainfall, will alter connections between these sites, fragment existing habitats and force aquatic animals to follow suitable habitat. Understanding the processes that allow arid zone aquatic communities to persist is critical to understanding how the environment can be managed to help animals adapt to climate change in this region. This project will produce national management guidelines for planning, policy and management decisions and actions across the Australian arid zone.

Contributing to a sustainable future for Australia's biodiversity under climate change: conservation goals for dynamic management of ecosystems

Michael Dunlop

CSIRO Climate Adaptation Flagship

Likely changes in climate and ecological processes due to climate change mean it may not be possible to retain biodiversity and ecosystems in the same form or place. This project seeks to establish a broadened set of goals and objectives for NRM management that will accommodate these inevitable changes of biodiversity in response to climate change and other pressures.

Predicting water quality and ecological responses to a changing climate: informing adaptation initiatives.

Fiona Dyer

University of Canberra

Understanding how climate change impacts water quality is essential to provide clean, safe water for people and the environment. This research will use data from the Murrumbidgee catchments to develop a framework for testing how climate change and the use of different water management practices will impact water quality. Researchers will focus on the issues

of nuisance plant growth, changes in fish, including protected and threatened species, and other plant and animal communities. This will provide knowledge for water managers in the ACT and the Goulburn Broken River Catchment on how adapting management practices in a changing climate will affect water quality and stream ecosystems.

Adaptive management of Ramsar wetlands

Richard Kingsford, UNSW

The Macquarie Marshes are iconic Australian wetlands, recognised for their international importance providing habitat for waterbird breeding, as well as complex and extensive flood-dependent vegetation communities. The Marshes are predicted to be increasingly affected by climate change impacts. This project brings together current management and available science to help develop an adaptive management framework. It will take a generic approach to enable the framework to be utilised for other wetlands, ranging from highly regulated to free flowing rivers and their wetlands.

Novel methods for managing freshwater refuges against climate change in southern Australia.

Belinda Robson Murdoch University

Freshwater refuges are areas that provide important safe habitat for aquatic animals and plants. This project aims to determine which methods for managing refuges are most effective as part of a climate change adaptation strategy for freshwater biodiversity. Researchers will evaluate the usefulness of each method to provide knowledge that environmental managers can incorporate into climate change adaptation strategies.

Impacts of elevated temperature and CO₂ on the critical processes underpinning resilience of aquatic ecosystems

Ross Thompson, Monash University

Climate change will affect freshwater ecosystems through changes in temperature, the amount of sunlight reaching the stream and changes in atmospheric carbon dioxide. These impacts could affect the processes that support animal life in streams, including the amount of algae and how fast nutrients are recycled and used. One way in which those effects could be reduced would be to plant trees close to streams to provide shade to reduce stream temperatures. This project uses experimental streams in Victoria to determine the potential effects of climate change on the life-supporting processes of streams. Data from streams with and without riverbank vegetation will be used to assess the potential for replanting trees to reduce the effects of climate change.

Identification and characterisation of freshwater refugia in the face of climate change

Jeremy Van Der Wal

James Cook University

Refuges from climate change within freshwater systems will be crucial for both freshwater biodiversity and for the terrestrial biodiversity that use freshwater habitats, for example riverside zones, during hotter and drier periods. How such refuges will be affected by climate change, however, is poorly understood. This research will improve understanding of which parts of the landscape provide natural refuges in the face of global climate change. Identified refuges will be mapped and assessed for what species and habitats they will protect across a range of possible future climates. The research will quantify the biodiversity assets of each refuge and assess their relative vulnerability under future climate scenarios, enabling management actions to be prioritised to ensure cost-efficient allocation of resources.

HUMAN HEALTH

Displaced twice? Investigating the impact of Queensland floods on the wellbeing and settlement of a cohort of men from refugee backgrounds living in Brisbane and Toowoomba

Ignacio Correa-Velez

La Trobe University

In December 2010, a longitudinal study of health and settlement among 233 refugee men living in urban and regional southeast Queensland (SettleMEN project) was completed. Findings revealed significant improvements over time in their subjective health status. At least 40% of the SettleMEN participants, however, live in areas subsequently affected by the devastating southeast Queensland floods in January 2011. This project will compare the recent pre-disaster measures of health and settlement and offer a rare opportunity to investigate the impact of an environmental disaster on a resettled refugee population. The study will generate new knowledge of elements and resources that best support resettled refugee men and their families to adapt successfully to environmental disasters.

Changing heat: direct impacts of temperature on health and productivity - current risks and climate change projections

Keith Dear

Australian National University

We know that heat waves kill people. Some 50,000 died in the 2003 European heatwave, but little is known of the details. This project will discover three important dimensions of those details: who is at risk and where do they live; how are people at risk, for example from kidney failure; and just what is it about heat that is most dangerous? Mathematical models will be developed of the future risks, and explore what public health measures will best protect Australians in a warming climate.

Health impacts of climate change on Indigenous Australians: identifying climate thresholds to enable the development of informed adaptation strategies

Donna Green

University of New South Wales

This project will provide decision-makers with clear, robust, policy-relevant evidence that identifies the connections between climate and the health and well-being of Indigenous people in Australia's tropical north. This project is the first major comparative study to test the hypothesis that Indigenous people are likely to be disproportionately vulnerable to the future health impacts of climate change. Overall, the research will better enable policy-makers to develop effective adaptation strategies to increase the resilience of Indigenous Australians, in both urban and remote communities, to the health impacts of climate change.

Climate change impacts on workplace heat extremes: health risk estimates and adaptive options

Elizabeth Hanna

Australian National University

Despite its hot climate, Australia has no national guidelines to protect people who work in the heat. This represents an existing health challenge that will be significantly exacerbated as Australia warms within the projected range of 2-4°C by 2070. A policy vacuum exists as we have little understanding about the thermal working environment for Australians. Evidence is lacking about direct heat exposures, worker tolerance levels, early symptoms, the adoption of personal and industry strategies, and which of these are effective in averting heat stress. This innovative project aims to fill that knowledge gap by studying the current effects on health and productivity of heat-exposed workers, and modelling future trends in likely impacts under climate change in eight urban and rural regions, with and without adaptive health protection strategies.

Dengue transmission under climate change in Northern Australia: linking ecological and population based models to develop adaptive strategies

David Harley

Australian National University

The health impact of the mosquito-borne dengue fever virus in Australia is increasing. Epidemics have become more frequent in North Queensland with more than 1000 cases and one death in the most recent epidemic. This project will develop a model of the relationship between climate, other determinants, and dengue for Australia. This will enable health authorities to estimate the impact of impending climate change on total dengue disease burden, the geographic range of dengue, and health system impacts including the availability of donor blood supply. These estimates will enable the development of adaptive strategies to reduce future disease risks and burden.

Climate change and rural communities: Integrated study of physical and social impacts, health risks and adaptive options

Anthony McMichael

Australian National University

Rural Australia has begun to experience climate change impacts, which will increase in future. Losses in farm yields, water supplies, property, community morale and family incomes have diverse health effects. This project will study the separate and joint effects of climate change and associated extreme events such as bushfires on selected health outcomes. Using integrative methods, it will clarify the main influences on health risks, their future projections, and how best to intervene to lessen risks.

Projection of the impact of climate change on the transmission of Ross River virus disease

Shilu Tong

Queensland University of Technology

Human pathogens transmitted by mosquitoes pose a significant threat to population health. Ross River virus (RRV) is Australia's most common and wide-spread mosquito-borne disease, with more than 4000 clinical cases reported each year. Although there have been a number of studies of the relation between climate variability and RRV, no research has examined the possible impact of future climate change on this disease. This study aims to establish baseline relations between climate variables and RRV at a local government area level across Queensland, determine the impact of projected temperature, humidity and rainfall changes on the transmission of RRV in each area; and use the projected impacts to align climate change and public health policies for surveillance and management.

INDIGENOUS COMMUNITIES

Understanding how the use of intertidal marine resources by Indigenous women in the Northern Territory will be affected by climate change, and their preferred adaptation options

Andrew Campbell, Charles Darwin University and

Ann Fleming, Northern Territory Government Department of Resources

Remote Indigenous communities in the Northern Territory are at the end of long, vulnerable food supply chains. This vulnerability is likely to be exacerbated by increased climate variability, more intense extreme weather events, longer periods with roads cut due to flooding, sea level rise in the intertidal zone, and rising energy prices.

There is an increasing imperative to grow food close to where people live, and for coastal communities the main options are fishing and aquaculture. Many coastal Indigenous women are highly receptive to aquaculture as a way to supply fresh, affordable food to their families and provide local jobs. This project will build on an understanding of West Arnhem Indigenous women's preferred adaptation options for improved food security. It will focus on the potential for using open-ocean, intertidal aquaculture enterprises and simple aquaponics for fish and vegetable production. The project will deliver policy recommendations to benefit Indigenous women across Australia's coasts, who can adopt similar approaches.

Indigenous voices in climate change adaptation: Addressing the challenges of diverse knowledge systems in the Barmah-Millewa

Dave Griggs

Monash University

This project will help the Yorta Yorta people of the Barmah-Millewa floodplain to adapt to the challenges of climate change by drawing on traditional knowledge known only to them. A unique database will be used to combine traditional knowledge with more conventional forms of information, such as climate and vegetation, to improve the way natural resources are managed. Trained volunteers from the local community will accompany elders to local places of cultural significance in the Barmah-Millewa National Forest and record knowledge associated with these places with voice recordings, photography and GPS. The data will be entered into a custom designed GIS database which will securely protect the indigenous knowledge while combining it with scientific data to produce products such as interactive 3D visualisation. These products will help Indigenous people, managers and policymakers to make better management decisions utilising the best of Indigenous and conventional knowledge.

Living Change: Adaptive housing responses to climate change in the town camps of Alice Springs

Ralph Horne

RMIT University

This project will investigate how residents in Alice Springs' town camps have adapted their living practices in response to the delivery of new and refurbished houses. Working with the Tangentyere Council the research will focus on how people maintain comfort levels in the houses and employ healthy-living practices involving water and energy use. The aim of the project is to identify areas where energy and water use can be made more sustainable, and provide a framework that supports residents and tenancy management organisations to develop and promote resilient community practices that are capable of adapting to the effects of climate change.

Future change in ancient worlds: Indigenous adaptation in Northern Australia

Steve Larkin

Charles Darwin University

Northern Australia is likely to experience more frequent and intense extreme weather events as a consequence of climate change. Threats to biodiversity and changes to temperatures

and seasons may impact heavily on Indigenous communities. Decisions about how to support Indigenous communities to adapt to, and reduce risks from, climate change must be informed by greater understanding of current capacity. The project will provide understanding of how Indigenous communities view change and risk, how they may be vulnerable or resilient, and how they have coped with past and ongoing environmental changes such as heatwaves, storm surges, cyclones, floods, sea level rise, drought and biodiversity loss.

Understanding urban and peri-urban Indigenous people's vulnerability and adaptive capacity to climate change

Daryl Low Choy
Griffith University

The challenges facing coastal communities in Australia are potentially immense, and while community and stakeholders generally accept that change is occurring, the degree of change remains disputed, and the visual picture of what settlements might have to adapt to and address is unclear. Using case study areas in Queensland, South Australia and Victoria, this project will investigate the long-accumulated knowledge of Australia's Indigenous community regarding the challenges of climate change for coastal communities.

Aboriginal responses to climate change in arid zone Australia - Regional understandings and capacity building for adaptation

Paul Memmott
University of Queensland

Using the Upper Georgina River Basin as a case study, this project will document Aboriginal perceptions and knowledge of climate change, and the capacity of regional communities to respond and adapt to climate change at a number of levels. Based on these findings, a set of regional climate adaptation planning goals, principles and strategies will be generated, which will be able to be extrapolated for other arid zone regions.

Community based adaptation to climate change: the Arabunna, South Australia

Melissa Nursey-Bray
University of Adelaide

Lake Eyre Basin Traditional Owners will be the first Aboriginal people in Australia to develop culturally appropriate assessments of their risks and vulnerabilities to climate change. The Arabunna people from the Lake Eyre Basin live in a vast region covering one fifth of the Australian continent making this assessment important for them and the wider Australian population. This project will assess the risks and vulnerabilities the Arabunna culture faces from climate change and produce an adaptation strategy to provide practical actions they can take. The outcomes from this project will have significance for the Arabunna, all levels of government and different stakeholders in the Lake Eyre Basin, providing insights into how to identify risk and then adapt to the impacts of climate change over time.

Learning from the past, adapting in the future: identifying pathways to successful adaptation in Indigenous communities

Meg Parsons
University of Melbourne

This project will examine how Indigenous individuals, households, communities, business, and institutions perceive and respond to climate variability and extreme weather events, and explore the importance of climate change relative to other risks Indigenous communities face. It will identify entry points for developing and implementing equitable, efficient and appropriate climate change adaptation plans and policies for Australian Indigenous communities. Using case studies and a systematic review of experiences from across Australia and internationally, it will produce information to assist Indigenous communities and decision-makers develop community-level adaptation strategies, and suggest strategies to enhance adaptive capacity within the communities.

MARINE BIODIVERSITY AND RESOURCES

Adaptive management of temperate reefs to minimise effects of climate change: developing effective approaches for ecological monitoring and predictive modelling

Neville Barrett

University of Tasmania

This project will collate and analyse long-term ecological records for SE Australian reefs and identify optimal locations and species for monitoring programs to best inform climate change adaptive management. It will assess the costs and benefits of existing temperate marine protected areas for biodiversity conservation management in response to climate change, and develop models that quantify and predict the impacts of climate change on inshore reef fishes, invertebrates and macroalgae to enable potential management responses to be identified, considered and developed.

Pre-adapting a Tasmanian coastal ecosystem to ongoing climate change through reintroduction of a locally extinct species

Nicholas Bax

University of Tasmania

This project will develop and promote a national framework to evaluate the potential to translocate native marine species to increase the climate change resilience of temperate reefs. Using the reintroduction of the blue groper as a test case, researchers will design a monitoring and evaluation program to determine the effects of a trial re-introduction, and reach the critical decision point on whether to re-establish blue groper in Tasmania, or to take an alternative approach. This test case will help determine whether translocating marine species is a viable option to improve resilience to climate change and what processes, knowledge, protocols, safeguards and policy changes are required before attempting this.

Management implications of climate change effects on fisheries in Western Australia

Nick Caputi

WA Fisheries and Marine Research Laboratories

This project will assess future climate change effects on Western Australia marine environments using a suite of IPCC model projections, downscaled to the key shelf regions and the spatial and temporal scales relevant for key fisheries. It will examine the modelled shelf climate change scenarios on fisheries and implications of historic and future climate change effects; and review management arrangements to examine their robustness to possible effects of climate change.

Ensuring that the Australian oyster industry adapts to a changing climate: a natural resource and industry spatial information portal for knowledge action and informed adaptation frameworks.

Andrew Davis

University of Wollongong

With the onset of climate change, the predominantly estuarine and ocean oyster industry faces unprecedented, unknown and unpredictable challenges. Climate change threats to the industry must be better informed to manage risks and reduce the potential for local or regional industry collapse. This project will deliver a pilot, online, spatially-referenced, natural resource and industry information portal for resource managers and the industry that makes use of extensive spatial data sources. Researchers will identify pathways for this spatial information portal to inform governance and statutory authorities, strategies and planning policies.

A climate change adaptation blueprint for coastal regional communities.

Stewart Frusher and Nadine Marshall

University of Tasmania & CSIRO

The aim of this project is to develop a 'blueprint' for a tool that provides the relevant information to reduce risks and increase the capacity of coastal regional communities to cope with, and where possible, benefit from climate change. Using community case study sites in south eastern, western and northern Australia, researchers will develop and trial a 'blueprint' that integrates a suite of adaptation assessment and evaluation tools to provide the best choice of marine adaptation options.

Identification of climate-driven species shifts and adaptation options for recreational fishers: learning general lessons from a data rich case.

Daniel Gledhill

CSIRO

This project aims to determine changes in distributions of rocky reef fish in eastern Australia over the past four decades, and establish correlation of these changes to climate induced environmental change, such as temperature. It will develop and test a "process model" for engagement and development of climate change adaptation options that can be deployed for other fishing sectors and user groups, including commercial fishers.

Growth opportunities & critical elements in the value chain for wild fisheries & aquaculture in a changing climate

Alistair Hobday

CSIRO

The project aims to development realistic adaptation management and policy options to enhance cost-effectiveness along the supply chain. It will generate targeted recommendations to improve efficiency and reduce carbon footprints.

Human adaptation options to increase resilience of conservation-dependent seabirds and marine mammals impacted by climate change

Alistair Hobday

CSIRO

Climate change impacts and adaptation options for marine birds (seabirds and shorebirds) and mammals have not being widely or consistently considered. This is a major impediment to ongoing conservation management and planning in the face of climate variability and change. Monitoring approaches for some of these species may also need to be reassessed and modified in order to better detect the impacts of climate change. Efficient ongoing monitoring is also required to allow adaptation responses to be validated. This project will connect researchers, managers and policy makers, to focus on climate-ready monitoring and adaptation options for conservation-dependent seabirds and marine mammals, link ongoing monitoring programs around Australia, and develop practical adaptation guidelines for science and management, including on-ground monitoring protocols

Vulnerability of an iconic Australian finfish (Barramundi, *Lates calcarifer*) and related industries to altered climate across tropical Australia

Dean Jerry

James Cook University

This project aims to develop predictive models incorporating new physiological and genetic data with available population genetic, environmental and fisheries data to identify vulnerable wild stocks and stakeholders under climate change predictions. Researchers will establish a genetic basis of thermal tolerance differences by identifying thermal tolerance-related genes that can be used as biomarkers for the aquaculture industry to identify fish tolerant to thermal stress. It will develop adaptive management strategies to minimise impacts under altered climate scenarios and determine opportunities for expansion of fisheries and aquaculture.

Changing currents in marine biodiversity governance and management responding to climate change

Michael Lockwood

University of Tasmania

This project will identify the requirements for adaptive marine biodiversity conservation governance and management in the context of climate change. It will assess how well current regimes, particularly marine protected areas, meet these requirements, and determine any necessary changes. It will identify alternatives to current regimes that are likely to enhance adaptive capacity and advise how regime reform might be achieved.

Preparing fisheries for climate change: identifying adaptation options for four key fisheries in South Eastern Australia

Gretta Pecl

University of Tasmania

This project will provide scientific information on the likely effects of climate change on rock lobster, abalone, snapper and blue grenadier, particularly where these effects may impact the harvest strategies for these species. It will identify options for improving assessment and management frameworks to ensure that they perform effectively under climate change scenarios, and evaluate options for adjusting management to reduce negative impacts and maximise opportunities that climate change may provide to commercial and recreational fisheries.

Effects of climate change on reproduction, larval development and population growth of coral trout

Morgan Pratchett

James Cook University

Coral trout are the number-one commercial and recreational fisheries species caught in coral reef waters, and account for 41% of wild-caught fish in Queensland waters. This project will assess the sensitivity of coral trout to climate-related changes in temperature and seawater acidity, test for spatial variation in sensitivity in three sectors along the Great Barrier Reef, and measure coral-dependence to test whether coral trout will be adversely affected by climate-induced bleaching and coral loss.

Beach and surf tourism and recreation in Australia: vulnerability and adaptation

Mike Raybould

Bond University

This project will value existing income streams due to beach-related tourism and recreation in a variety of case study locations. It will assess the vulnerability to climate change of assets that are key drivers of marine and coastal tourism and recreation and apply a valuation tool in identified seachange localities to test transferability of results. It will identify social and behavioural responses to climate change impacts on vulnerable tourism and recreation assets and report on the net vulnerability of the regions to climate change.

Climate change adaptation - building community and industry knowledge

Jenny Shaw

WA Marine Science Institution

This project will increase knowledge and understanding of likely climate change and adaptation measures open to local communities. It will support a Case Study for Australia in adaptive management that cross-correlates regional needs with Australia-wide management policies. Key climate change information will be synthesised, analysed and adapted for marine biodiversity and fisheries businesses, and extension and knowledge sharing activities tailored for regional needs.

Estuarine and nearshore ecosystems – assessing alternative adaptive management strategies for the management of estuarine and coastal ecosystems

Marcus Sheaves

James Cook University

The project focuses on developing and assessing adaptation strategies for estuaries and other coastal ecosystems to optimise ecosystem functions, fisheries outcomes and biodiversity values in a changing world. The aim is to develop strategies and tools to facilitate management that are sensitive to regional and typological differences, to the complex nature of estuary ecology, the far-reaching implications of estuary adaptation strategies and to the competing needs, influence, impacts, outcomes, consequences and costs across the spectrum of sectors affected by climate change.

Adapting to the effects of climate change on Australia's deep marine reserves

Ron Thresher

CSIRO

The aims of this project are to develop practical options to manage the impacts of climate change on the South-east Commonwealth Marine Reserve; and develop a generic model that can be applied to forecasting the impacts of climate change on other deep sea biota.

Management implications of climate change impacts on fisheries resources of tropical Australia

David Welch

James Cook University

The aims of this project are to describe the projected climate-driven changes that are relevant to northern Australian marine fisheries, assess the potential impacts of climate change on key fisheries and species in northern Australia and assess current management to identify approaches that are adaptive to potential climate change scenarios.

PRIMARY INDUSTRIES

Everfarm - design of climate adapted perennial-based farming systems for dryland agriculture in southern Australia

Amir Abadi and Bob Farquharson of the Future Farming Industries CRC

Expected higher temperatures and reduced rainfall are likely to reduce crop yields and livestock productivity in Australia unless we develop alternative farming techniques. This project will look at the benefits of integrating perennial plants such as mallee eucalypts into dryland agriculture. Researchers will work with farmers to model the economic feasibility of adopting these new techniques on a large-scale.

Will primary producers continue to adjust practices and technologies, change production systems or transform their industry – an application of real options

Gregory Hertzler

University of Sydney

This project aims to determine the climate change thresholds for transformational change in wheat-dominated agriculture across Australia.

Researchers will communicate with producers who are managing wheat-dominated farms, then mathematically model options for how they may choose to transform the industry as the climate changes. Once the decisions of growers are understood, they will draw implications for stranded assets, new technologies and the resilience of agriculture undergoing climate change.

Adaptive capacity and adaptive strategies of broadacre farms experiencing climate change

Ross Kingwell

West Australian Agriculture Authority

The south-west agricultural region of Australia is projected to experience adverse climate change in coming decades, with many farmers already reporting adverse impacts. Using data provided by farmers, the research team hopes to identify how farmers are adapting to this changed climate. They will study longitudinal farm data, coupled with data from a social/management survey, to identify successful adaptation strategies and the characteristics of a farm, and of a farm manager that makes them better able to adapt. The research findings are likely to be applicable to similar regions across Australia that also risk being affected by adverse climate change.

SETTLEMENTS AND INFRASTRUCTURE

Development of tools that allow local governments to translate climate change impacts on assets into strategic and operational financial and asset management plans.

Jacqueline Balston

University of South Australia

This project aims to identify key council assets vulnerable to climate change; determine the likely impacts of climate change on council assets; undertake an extensive financial risk modelling exercise including full life-cycle economic analysis of options for councils to reduce climate change asset risk, and develop the necessary modifications to asset management and financial sustainability tools so councils may evaluate climate change action scenarios at the management planning level.

Pathways to climate adapted and healthy low income housing

Guy Barnett

CSIRO Climate Adaptation Flagship

This project aims to model the vulnerability of public housing assets and tenants to selected climate change impacts. It will scope the potential co-benefits of climate adaptation action for human health and well-being and identify and evaluate key engineering, behavioural and institutional climate adaptation pathways applicable to other low income housing.

Australia's country towns 2050: what will a climate adapted settlement pattern look like?

Andrew Beer

Flinders University

The project will test the hypothesis that many inland rural and remote communities are vulnerable to the impacts of climate change and that this vulnerability varies by location, industry structure, environment, and remoteness. It will assess whether public sector and community planning and action can reduce the impacts of climate change on the sustainability of settlements and whether some forms of intervention will be more effective than others.

Analysis of institutional adaptability to redress electricity infrastructure vulnerability due to climate change

John Foster, University of Queensland and Deepack Sharma, University of Tech, Sydney

This project will examine the capacity of Australia's National Electricity Market (NEM) to adapt to existing and predicted climate change conditions. It will identify potential issues and analyse climate change impacts on reliability in the Market under different climate change scenarios to 2030, particularly what adaptation strategies the power generation and supply network infrastructure will need.

Reforming Planning Processes Trial: Rockhampton 2050

Penelope Fry

Rockhampton Regional Council

Rockhampton Regional Council will form an alliance of neighbouring small regional councils to determine and demonstrate how existing urban planning principles and practices could accommodate climate change and the uncertainty of climate impacts for a "seachange" region. It will develop and apply spatial information to trial planning approaches in a 'real world' situation involving all levels of government and community engagement. It aims to influence other Councils to take action by producing a mechanism and process to enable the mainstreaming of climate change adaptation within local government.

What would a climate-adapted Australian settlement look like?

David Griggs, Monash University

This project will use two study sites in Gippsland, Victoria Inverloch and Sandy Point, to forecast what a small urban coastal settlement in Australia will look like in 2030. These communities will be asked to envision how they would like their locality to be in 2030. They will be presented with information on how the climate may be in 2030 and where their township is heading given the present trends, then given various choices that could change these trajectories. The outcomes will be used to develop a national framework for decision-making for small urban settlements as a guide for local communities to build and create their own futures within a climate changed world.

Strata Title in a world of climate change: Managing greater uncertainty in forecasting and funding common property capital expenditure

Chris Guilding

Griffith University

This project will determine the extent to which uncertainty of climate change-induced building damage is built into strata and community title capital expenditure forecasts, and whether insurance specialists are equipped with tools that can factor in uncertainty and flexibility when projecting capital expenditure.

Robust optimization of urban drought security for an uncertain climate

George Kuczsera

University of Newcastle

Recent experience with drought and a shifting climate has highlighted the vulnerability of urban water supplies to “running out of water” in Perth, south-east Queensland, Sydney, Melbourne and Adelaide. This has triggered major investment in water infrastructure. With the prospect of rapid population growth in cities, drought security will become more pressing particularly in the face of climate uncertainty. This project will develop and illustrate an urban drought security method that identifies solutions that are both optimal in a triple-bottom-line sense and robust against uncertain knowledge about future climate change.

Climate Change and the Welfare Sector – Risk and Adaptation of Australia’s Vulnerable and Marginalised

Karl Mallon

Australian Council of Social Services (ACOSS)

Services provided to disadvantaged individuals by community welfare service organisations and communities comprise a critical component of social infrastructure. These are the people who are least resilient to adverse changes in circumstance, and will be affected first and worst by climate change impacts to infrastructure and the built environment. This project will research the sectors in society most vulnerable and least able to adapt to climate change in urban, regional and remote settlements, the nature of these vulnerabilities, the underlying causes of vulnerability and the measures that can be taken to increase adaptive capacity and manage climate change related risks of infrastructure failure.

Limp, leap or learn?: Developing a legal framework for adaptation planning in Australia

Jan McDonald

University of Tasmania

This project will look at the role of law in driving and enabling urban climate change adaptation. It will compare and contrast the legal frameworks for planning for coastal impacts of climate change and those for the increased risks of bushfire. This analysis will consider formal planning laws, coastal and emergency management laws, property law, liability and insurance regimes.

Enhancing the resilience of seaports to a changing climate

Darren McEvoy

RMIT University

This project aims to better understand the vulnerability of critical seaport infrastructure (structural and functional), and to develop new knowledge and methodologies for enhancing port resilience to future climate change. The research will address three research objectives: to gain a better understanding of the complex mix of climate and non-climate drivers that are likely to affect port operations; to assess the vulnerability of core port infrastructure and identify appropriate adaptation measures for enhancing resilience; and, to assess the vulnerability of other elements at risk in the wider port environment and identify adaptation measures. Close engagement with policy and practitioner stakeholders will ensure the deliverables will be 'fit for purpose'.

Past, present and future landscapes: understanding alternative futures for climate change adaptation of coastal settlements and communities

Phil Morley

University of New England

A critical gap in many climate change vulnerability and adaptation studies is that predicted climate impacts are being assessed on current landscape, land-use and settlement patterns. This project aims to develop spatial analysis and visualisation tools to examine future trends of settlement and social patterns. It will provide a quantitative understanding of current settlement trends and their future trajectories and design and test several alternative landscape futures as adaptive strategies to reduce the vulnerability of settlements and communities to predicted climate change events. Using northern coastal NSW as a case study, researchers will demonstrate how the tools can be applied and transferred to other contexts, landscapes or regions

Coastal urban climate futures in SE Australia: from Wollongong to Lakes Entrance.

Barbara Norman, University of Canberra

The project aims to identify what a climate-adapted Australian settlement would look like in 2030. It will investigate a range of coastal communities between Wollongong, NSW and Lakes Entrance, Vic, all with different demographics, economies, environments and social circumstances. Researchers will produce a *Small coastal towns future scenarios* report incorporating descriptions of the desired characteristics of a typical coastal small town in 2030 under a number of climate (and other) change drivers; a *Small coastal towns future scenario/outcomes framework* that other towns can use to assist in their adaptation planning and a *Small coastal towns strategy report* that identifies a preferred future vision for a climate-adapted coastal small-town community and strategies to pursue this vision.

A Framework for Adaptation of Australian Households to Heat Waves

Wasim Saman

University of South Australia

What is the likely impact of heat waves on Australian homes and on the electricity infrastructure in Australia's various climate regions? This project will plan for a national framework that would: develop new summer design conditions for 2030 and 2050 for up to 100 Australian climate zones; establish new thermal comfort criteria for buildings; evaluate the impact of climate change on annual household cooling energy use and peak power demand; examine householder behaviour during heat waves; develop design options to ensure safety and comfort during heat waves, and develop affordable new design options for buildings to avoid heat stress.

A model framework for assessing risk and adaptation to climate change on Australian coasts

Colin Woodroffe

University of Wollongong

Coastal planners and managers urgent need improved methods to forecast how coasts will respond to sea-level rise. This project will develop a modelling framework to provide guidance to the most appropriate adaptation strategies, such as suitable setback lines, more focused dune management, or beach nourishment and/or protection works. The researchers will implement innovative methods incorporating economic cost-benefit analysis with physical probability modelling to derive economically optimal strategies for adapting coastal zones to present or future conditions.

SOCIAL, ECONOMIC AND INSTITUTIONAL DIMENSIONS

The legal, institutional and cultural barriers to adaptation to sea-level rise in Australia

Jon Barnett

University of Melbourne

This project will investigate how legal, institutional, and cultural factors help or hinder effective, efficient and equitable adaptation to sea-level rise. Using the Eurobodalla Shire (NSW) and Westernport Bay region (Vic) as case studies, the project will review state and local government policies, local media, council decisions and conduct interviews with local people including council decision makers, the private sector and community groups to compile a list of barriers to, and enablers of, adaptation. It will devise guidelines to help decision makers identify and overcome these barriers.

Cognitive and affective barriers to climate change adaptation: exploring the risk and adaptation appraisals of South Australians to different climate risks.

Peng Bi

University of Adelaide

Climate change presents different risks to Australian communities, depending on their geographic location. Individuals and communities will need to modify their lifestyle and behaviours to adapt to the changing climate. This study will survey people about their views and beliefs about climate risks – specifically heatwaves and water shortages - and examine how these influence their behaviour. The findings from this study will be used to plan more effective communication of climate risks and adaptation options.

Extreme heat and climate change: adaptation in culturally and linguistically diverse (CALD) communities

Peng Bi

University of Adelaide

Do cultural, socio-economic and language factors affect a person's vulnerability to climate change? This project will study culturally diverse communities in three Australian cities: Adelaide, Melbourne and Sydney to identify factors that may affect people's vulnerability to climate change, and particularly hot weather. It will identify groups of people that may be more vulnerable, explore the behaviour they use to adapt to extreme heat, and their perceptions of climate change and recommend ways to increase their capacity to adapt, such as cross-cultural information materials.

Heat-ready: Adapting aged care facilities to prevent premature death in elderly Australians

Deborah Black

University of Sydney

The project will investigate the capacity of aged care facilities to adapt to increasing periods of extreme heat. It will examine policies, procedures, knowledge and environmental factors such as building design and cooling equipment used in aged care facilities in three Australian states and recommend ways they can adapt to prevent premature death from extreme heat in elderly residents.

Developing adaptively: The role and capacities of private sector development institutions in urban climate change adaptation

Jago Dodson

Griffith University

How equipped is the private urban development sector – developers and financial institutions – to respond to the task of adapting new urban developments to climate change? This study will investigate the capacity of developers and financial institutions to develop and fund climate-adapted urban developments.

Impact of climate change on disadvantaged groups: Issues and interventions.

Graeme Hugo

University of Adelaide

There is growing international concern that the negative impacts of climate change will be disproportionately experienced by the most socially and economically disadvantaged people in society. This project will investigate links between disadvantage and the potential effects of climate change, and what can be done to counteract these impacts. It will focus on three South Australian cities, Port Adelaide (urban coastal), Renmark (rural Riverland) and Wallaroo (rural coastal), which have disadvantaged communities and are expected to experience significant climate change in the next half century.

An assessment of Australia's existing statutory frameworks, associated institutions, and policy processes: do they support or impede national adaptation planning and practice?

Karen Hussey

Australian National University

Do current Australian laws and policies help or hinder climate adaptation, in practice? There has been little detailed investigation into what specific institutional, governance and policy process reforms might be needed to support adaptation to climate change. This project will investigate existing laws, incentives and governance arrangements and their associated institutions to gauge the extent to which they currently support or hinder adaptation planning and practice.

Rental housing, climate change and adaptive capacity: a case study of Newcastle, NSW.

Lesley Instone

University of Newcastle

This project will produce best-practice guides for landlords and tenants to enhance the capacity of the 27% of Australians who live in rental accommodation to adapt to climate change. Research indicates that there is a low take-up of retrofitting rental properties for climate change, as there are disincentives for landlords to install modifications that primarily financially benefit tenants. Low-income renters are particularly vulnerable to climate change, and already face significant housing and utility stress. This project will work with both renters and housing managers/landlords to develop more effective ways of facilitating adaptation to climate change in the rental sector.

Valuing adaptation under rapid change: anticipatory adjustments, maladaptation and transformation

Roger Jones

Victoria University

The project will develop a robust economic methodology to support decision-making for adaptation actions and investments ranging from adjustment to transformation. It will identify and respond to the limitations in current approaches and explore methods for a "good" adaptation test that accounts for existing information and new learning over time. Researchers will investigate four key elements contributing to the economics of adaptation: information, regulation and standards, institutions and public investment.

Social networks analysis: bridging degrees of separation to enhance climate change adaptation

Susan Kinnear

Central Queensland University

This project aims to maximise climate change adaptation in the water sector, particularly through more effective infrastructure management. It will collaborate with local and state government and industry bodies to collect qualitative and quantitative data on adaptive responses to increased climatic variability, through examples of responses to flooding

caused by extreme rainfall events and managing supply/demand pressures on municipal water supplies due to changes in flows. It will analyse the transmission of this information within and between organisations and use the findings to inform regional, state and national policy development, stakeholder interactions, and institutional/governance structures in water supply, infrastructure, disaster response and land use planning.

Enhancing the adaptive capacity of small-to-medium enterprises to climate change and variability.

Natasha Kuruppu

University of Technology Sydney

Small-to-Medium Enterprises (SMEs) comprise 96 per cent of all private businesses in Australia and are the largest employers and the largest contributors to GDP. The capacity of SMEs to adapt to climate change and variability will be vital to the resilience of communities, government agencies and other sectors. Climate change may result in business interruptions, increased investment or insurance costs and declining financial value, return and growth. SMEs face greater short-term losses after natural disaster and may have lower adaptive capacity than larger businesses. This research aims to identify the extent to which SMEs consider and integrate adaptation into business planning; key barriers and opportunities to adaptation for SME in different sectors, and strategies to adopt in anticipation of climate change

Costs and coasts: an empirical assessment of physical and institutional climate adaptation pathways.

Ryan McAlister

CSIRO

This research will provide an empirical, grounded and context-sensitive analysis of economic, social and institutional requirements for distributing the costs, risks and responsibilities for adapting to future coastal inundation risks under climate change scenarios. It will provide an economic valuation of coastal inundation, identify what changes to existing local policy mechanisms are required to improve the management of inundation risk and assess the economics of a range of adaptation pathways.

Assessing the potential for, and limits to, insurance and market-based mechanisms for encouraging climate change adaptation.

John McAneney

Macquarie University

Insurance provides a means of helping communities recover from natural disasters. It is clear, however, that many people afflicted by flooding in Southern Queensland in 2011 lacked suitable insurance cover, making recovery difficult and prolonged.

This project seeks to understand why cover for riverine flood was so limited when damage from other natural hazards like bushfire, earthquake, tropical cyclone and hail storm are explicitly covered and routinely dealt with in home and contents policies.

This project will propose solutions to align the incentives necessary at various levels of government to reduce the risk to Australian communities.

Every state for themselves? Learning from cross-border regulatory instruments to support and promote climate change adaptation in Australia.

Wendy Steele

Griffith University

This project focuses on reforming regulatory mechanisms to support and promote cross-border cooperation for climate change adaptation in Australia. It will explore the challenges and opportunities of implementing cross border regulatory reform, by assessing innovative cross-border regulatory initiatives such as: the Murray-Darling Basin water strategy; the Australian Alps conservation management plan; the Cross-border sub-regional

strategy between ACT and NSW; and the Cross-border disaster management sub-plan 2010 between the Gold Coast City (QLD) and Tweed Shire (NSW).

What about me? Factors affecting individual adaptive coping capacity across different population groups.

Kerrie Unsworth

University of Western Australia

As the scientific evidence for climate change becomes more convincing, the public appears to show a paradoxical decline in interest and recognition of the problem. Little research has examined how people adapt to climate change information and initiatives. The project will examine how individual values, beliefs and goals affect adaptive coping goals and behaviours. It will examine positive climate change adaptation behaviour and those that may have other negative impacts.

Changes to Country and Culture, Changes to Climate: strengthening institutions for Indigenous resilience and adaptation.

Jessica Weir

Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS)

This project will seek to understand the barriers to and enablers of Registered Native Title Bodies Corporate (RNTBCs) to facilitate community-driven adaptation on native title lands, and to develop best practice for participatory climate change decision-making.

Water trade, climate change and irrigator adaptability in the Murray-Darling Basin.

Sarah Wheeler

University of South Australia

Water markets have been increasingly adopted by irrigators as a tool to manage water scarcity, but there is still much to learn about the relationship between water markets and farm and community viability and resilience. This project aims to understand more fully the relationship between water markets, irrigators' adaptability, climate change and water reallocation. It will: review the ecological, social and economic consequences of water markets; explore how irrigators in the Murray-Darling Basin use water trading to cope with reduced water allocations, investigate irrigator behaviour in water markets in the region under changing future climates and recommend ways to make water markets more efficient and effective.

TERRESTRIAL BIODIVERSITY

Climate-resilient vegetation of multi-use landscapes: exploiting genetic variability in widespread species

Margaret Byrne

Department of Environment and Conservation, WA

Multi-million dollar investments in ecosystem maintenance through restoring Australia's degraded landscapes currently take little account of climate change. Until recently there has been a strong focus on maintaining local genetic patterns for optimal restoration. In a changing climate this paradigm will no longer be relevant. This project will undertake pioneering research at the interface between molecular genetics, plant physiology and climate adaptation, targeting the question "What new genetic frameworks can facilitate adaptive restoration in changing environments?" Addressing this question will ensure optimal outcomes for Australia-wide investment in ecological restoration and provide solutions to ecosystem adaptation in changing environments.

The architecture of resilient landscapes: scenario modelling to reveal best-practice design principles for climate adaptation

Veronica Doerr

CSIRO

One of the most cost-effective ways to help Australia's native species survive climate change is to ensure their populations are as large and connected as possible. This means that management to protect Australia's biodiversity will need to happen over whole landscapes, not just in national parks. So do we need lots of corridors or more habitats? This project will evaluate different approaches to managing biodiversity across landscapes and calculate how likely they are to improve the resilience of native species.

Optimal habitat protection and restoration for climate adaptation

Richard Fuller

University of Queensland

Research has shown that many species are likely to go extinct because of climate change, but which species these will be, and what we can do to prevent these extinctions remain uncertain. This project will predict how species and habitats will move in response to climate change over the next century, then work out how much it will cost to protect existing habitat and restore new habitat where this would help species survive.

Adaptation strategies for Australian birds

Stephen Garnett

Charles Darwin University

Climate is likely to change so much that many birds may need human help to survive. For some, dispersal corridors may be needed. Others may need help to cross barriers as their favoured habitat shifts across the landscape. Some may even need to be taken into captivity. This project will identify what needs to be done in the next 20-50 years to enable our children to appreciate the same birds that we inherited.

Determining future invasive plant threats under climate change: an interactive decision tool for managers

Leslie Hughes

Macquarie University

This project will provide the first comprehensive, national assessment of the risks of weeds emerging from naturalised plants. In Australia, invasive plants cost the economy at least \$4 billion annually, not including the cost to terrestrial biodiversity. As many invasive species may be advantaged by climate change, this figure will increase significantly. Of the 29,000 introduced plant species in Australia, approximately 400 have become significant weeds and a further 2700 have become 'naturalised' - established self-sustaining populations in the

wild. With around 15 species added to this list each year, these species represent a ticking time bomb of future weed problems.

Adapted future landscapes – from aspiration to implementation

Wayne Meyer

University of Adelaide

Regional adaptation to climate, market and social changes is possible by changing what we do where on the land. Both productivity and conservation goals can be achieved by farming to land capability, changing land use to capitalise on the emerging carbon market and identifying land use practices that provide a mosaic of production and conservation uses. This project will work with two regions in South Australia to develop an experimental process that uses future land use projections to assess different policy and guidance incentives. If the experimental process is successful, it could be adopted for land use planning in other regions in Australia.

Developing management strategies to mitigate increased co-extinction rates of plant dwelling insects through global climate change

Melinda Moir

University of Melbourne

Co-extinction occurs when a species goes extinct as a result of the extinction of the species it depends on. As 30-40% of plant-dwelling insects and other species depend on a host, losses to biodiversity may be extremely high if host species are extinguished. Climate change is predicted to reduce the population size and range of many plants, so there is the potential for climate-induced co-extinction to threaten Australia's biodiversity. This project will develop indicators of the degree to which insect species might be prone to co-extinction across Australia and identify cost-effective conservation strategies to combat this.

Determining high risk vegetation communities and plants species in relation to climate change in the Australian alpine region

Catherine Pickering

Griffith University

The Australian Alps are one of the three most vulnerable ecosystems to climate change in Australia. It's an important biodiversity ark with more than 400 species of plants, 25 of which occur nowhere else.

Snow cover is already 30% less than in the 1950s. With longer, warmer, summers come other threats including bushfires, weeds and feral animals. There is nowhere higher for Australian alpine plants to go – how can we conserve them in a warmer world?

This project will prioritise strategies to increase the resilience of plants to these threats. It will assess the characteristics of plants such as their height, leaf size and shape and how they reproduce to determine which will decline with less snow and which will move in. This will enable resource allocation to maintain key refuges, control weeds and feral animals, and manage increased recreational use of the area.

The role of refugia in ecosystem resilience and maintenance of terrestrial biodiversity in the face of global climate change

Stephen Williams

James Cook University

This research will maximise the protection of Australia's terrestrial biodiversity by improving our understanding of what parts of the landscape provide natural refuges from the impacts of global climate change. Researchers will assess, map and quantify the vegetation types and species associated with each refuge and assess their relative vulnerability and likelihood of persistence across a range of future climate scenarios. This research will form the basis for systematic conservation planning, enabling management actions to be prioritised to ensure cost-efficient allocation of resources.

NCCARF SYNTHESIS AND INTEGRATIVE RESEARCH PROGRAM

An assessment of the nature and utility of adaptive capacity research.

Tim Smith

University of the Sunshine Coast

Vulnerability to climate change is described as 'a function of exposure, sensitivity, and adaptive capacity'. The science, however, has been dominated by research on exposure. There has been a recent increase in studies on adaptive capacity, yet there has been no assessment of the nature of adaptive capacity research, or on its utility for decision-making. This project will assess the interpretation and approach to adaptive capacity research in different disciplines, and assess the utility of the concept for decision-making and make recommendations to improve synergies between climate change adaptation researchers and decision makers. The project will actively involve stake holders through interviews and an online survey.

An assessment of the vulnerability of Australian forests to climate change.

Forests and the industries associated with them are vulnerable to the impacts of climate change. Australia has 149 million hectares of forest managed for conservation and heritage areas and for production of forest products.

This five part project comprises:

Part I: Establish needs and consult with key stakeholders.

Helen Wallace

University of the Sunshine Coast

This part of the project identifies key issues to be addressed in the forest vulnerability assessment, determines the extent to which climate change adaptation is being considered in current planning and management, and what type of information forest managers and policy makers will need.

Part II: Scene setting and biophysical impacts review.

Belinda Medlyn

Macquarie University

This part of the project discusses the overall impact of climate change on vegetation and the ecosystem services provided by forests. It reviews the evidence of impacts of climate change on Australian forests in relation to direct stresses (CO₂, temperature and rainfall), indirect stresses (fire, pests, pathogens and weeds) and plant processes (growth, transpiration and phenology).

Part III: Socio-economic impacts review.

Geoff Cockfield

University of Southern Queensland

This part of the project identifies the potential socio-economic impacts of climate change and develops a framework for thinking about coordinated responses to socially and economically adverse outcomes. It develops a model of plantation decision-making under climate change, and surveys people in two timber growing regions to determine their response to climate change.

Part IV: Adaptive capacity, barriers to adaptation and vulnerability.

Steve Turton

James Cook University

This part of the project considers the adaptation options and strategies available for the forest sector to adapt for climate change, including tools and guidance available to inform planning and policy in government and the private forestry sector.

Part V: Synthesis and final report.

Roger Kitching

Griffith University

This project summarises the four parts of the assessment into a succinct report for policymakers and forest managers. It identifies region-specific vulnerabilities and critical gaps in the knowledge needed to improve adaptive management of forests.

Learning from experience: Historical case studies and climate change adaptation (synthesis report).

Anthony Kiem

University of Newcastle

This study analysed and synthesised the results from a series of seven case studies of past extreme events. It examined management actions taken before, during and after the event including preparedness, immediate response, post event response and policy changes implemented as a result of the events. It proposed a series of key lessons learnt for adapting management regimes to cope with future climate events.

Historical Case Studies: Adaptation lessons from Cyclone Tracy.

John McAneney

Macquarie University

This case study reviewed the impact of the December 1974 Tropical Cyclone Tracy on the city infrastructure and people of Darwin, and examines the engineering, institutional and regulatory responses that it invoked and the relevance of these lessons for future events.

Historical Case Studies: The 2008 floods in Queensland: A case study of vulnerability, resilience and adaptive capacity.

Armando Apan

University of Southern Queensland

A warmer climate, with its increased climate variability, will increase the risk of floods, and the accompanying damage to people, property, and the environment. Focusing on two flood events in Mackay and Charleville in 2008, this study aims to enhance understanding of the vulnerability, resilience and adaptive capacity of people and communities to flooding, and to assess the extent to which flood mitigation measures have been implemented. It will explore how societies that are regularly flooded operate and the characteristics of their resilience or non-resilience, as well as the characteristics of communities that are 'on the edge', where flooding might push them into nonviability. The findings will provide information, knowledge and insights on how various stakeholders can better respond and adapt to flood events.

Historical Case Studies: Adaptation lessons from Cyclone Tracy Part II – the institutional response and Indigenous experience of Cyclone Tracy.

Katharine Haynes

Macquarie University

The project will document how indigenous people in and around Darwin were impacted by, responded to, and recovered from Cyclone Tracy in 1974. Through a combination of qualitative interviews and quantitative population data analysis, the project aims to determine whether Indigenous communities in the Darwin area are now more or less vulnerable to cyclones than they were in 1974.

Historical Case Studies: Storm tides.

Rodger Tomlinson

Griffith University

This case study examined the socio-economic vulnerability and adaptation responses to extreme coastal storms that result in severe erosion and coastal inundation.

It reviews past technical, planning and regulatory responses to extreme tide events, erosion and flooding and their effectiveness for future events. It seeks to identify alternative and additional strategies to improve management of future events.

Historical Case Studies: Impacts and adaptation response of infrastructure and communities to heat waves - the southern Australian experience of 2009.

Jim Reeves

Queensland University of Technology

This study details the impact, vulnerability and adaptation responses, at state and local government level, to the unprecedented heatwave that struck Victoria and South Australia in early 2009. It focused on the failures in utilities and related infrastructure, and on emergency management and human health impacts. It analyses institutional responses and identifies lessons learnt for sectors, regions and communities.

Historical Case Studies: East Coast Lows and the Newcastle-Central Coast Pasha Bulker Storm.

Garry Willgoose

University of Newcastle

The storm that hit Australia's east coast in June 2007 was one of the most significant weather events in Australian history, causing the 4th largest recorded insurance loss. Impacts included flash flooding in Newcastle city, general flooding of the Hunter River, high winds and waves, the loss of electricity to 300,000 people for 4 days, a halt to coal export chain for two weeks and the loss of five lives.

This project provides a whole-of-government, business and community perspective on adaptation measures being put in place as a result of knowledge gained from the experience during and immediately after the storm, and adaptation measures being put in place following subsequent reflection on ways of better preparing for such storms.

Historical Case Studies: Drought and the future of small inland towns.

Anthony Kiem

University of Newcastle

Australia's vulnerability to climate variability and change has been highlighted by recent droughts. Climate change may increase the frequency, intensity and duration of droughts, requiring robust adaptation strategies. This project assesses two rural Victorian case study sites that have been impacted by the current drought, Donald and Mildura. The objective is to provide a whole-of-government, business and community perspective on adaptation measures being put in place as a result of previous droughts, and areas where future adaptation measures need to be developed following reflection on ways of better preparing for such events.

Historical Case Studies: Resilience and water security in two outback cities.

Glenn Albrecht

Murdoch University

This project explores the adaptive capacity of Kalgoorlie and Broken Hill, two inland regional centres that face different challenges relating to climate change and water supply. It will outline the challenge of water security and sustainability, identify historical and current processes that create this challenge, consider the infrastructure, cultural and organisational change needed to meet the water security challenge for each city and provide a range of water security future scenarios to assist in planning for, and adapting to, climate change and other pressures.

Coastal Ecosystems responses to climate change – adapting to climate change in the coast zone.

Wade Hadwen

Griffith University

This project will synthesise knowledge of climate change impacts on various Australian coastal ecosystems including estuaries, coral reefs, sandy beaches, dunes and headlands, to review and integrate current understanding of potential adaptive pathways, both ecological and human, to identify priorities for future research and management.

Flooding in Australia: Damage to buildings during the 2010-2011 Eastern Australia flooding events.

Matthew Mason

Macquarie University

Insured losses from the 2010-11 floods approached \$3 billion. When accounting for damage to essential infrastructure, lost productivity and the under- or noninsured, the true cost is several times this value. Many affected properties have a history of flood damage, which shows there are clear deficiencies in our ability to adapt to or mitigate the impact of this hazard.

This research will detail the extent of damage to buildings during the recent Eastern Australia flooding and explore the role planning and design/construction regulations played in these failures. It will highlight weaknesses in the current systems and propose effective solutions to mitigate future damage and financial loss under current or future climates.

Living with floods: key lessons from Australia and abroad.

Karen Hussey

Australian National University

The project will compare findings from current flood inquiries underway in Queensland, Victoria and New South Wales with studies from the US, China and the Netherlands. It aims to identify key lessons that could help local and state governments, emergency services and resource managers prepare for future floods.

Extractive resource development in a changing climate: learning the lessons from recent weather events in Queensland, Australia.

Vigya Sharma

University of Queensland

Researchers will examine the devastating impacts of extreme weather events on mining operations, including the 2010-2011 floods that cost Queensland more than \$2 billion in export earnings. By applying the lens of the recent floods the project aims to understand the impact on mining operations and the flow-on socio-economic and ecological impacts on the wider region. It will identify measures needed to get operations back on line after a disaster, and strategies to limit impacts from such events in the future across other Australian mining operations.

Investigating factors that inhibit and enable adaptation strategies following the 2010/11 floods.

David King

James Cook University

This project will identify the factors that inhibit and enable adaptation strategies within communities by explore issues of underlying vulnerability and constraints to recovery as well as adaptation and risk reduction strategies. It will focus on case study sites in Emerald, Qld, suburbs of Brisbane, and Donald in Victoria, all of which suffered severe loss from flooding in the summer of 2010/11.

IClimate Project – a searchable database on climate change impacts and adaptation in Australia.

Elvira Poloczanska

CSIRO

This project reviews and synthesises climate change literature, both published and unpublished, to develop a database of ‘facts’ in a user-friendly, succinct and efficient form. It will focus on material produced since the completion of the Fourth IPCC Assessment Report, and form a useful reference for authors preparing the Australia and New Zealand chapter for Working Group II of the IPCC Fifth Assessment Report.

The finished project will be made available online through a searchable web database, providing a valuable resource to underpin adaptation planning and decision making in Australia.

Learning from regional climate analogues.

Jon Kellett

University of South Australia

This project explores the potential of learning from experience for selected target cities by studying cities that currently experience climate conditions similar to those predicted for the target cities. It focuses on developing relationships between paired climate target /climate analogue locations to share experiences and knowledge.

Urban food security, urban resilience and climate change.

Paul Burton

Griffith University

This project will extend knowledge of the diversity of agriculture in urban areas. It will identify the social, economic and political barriers to urban agriculture and explore the potential for extending its practice in the climate change-affected future. The results of this work will provide a much-needed commentary on the public health, nutritional and environmental benefits of greater urban food production and to make a valuable contribution to the development of the federal government’s national food plan.

Australian Food Security: Impact of Climate Change for Risk Management: How prepared are food industry leaders?

David Michael

Wondu Business & Technology Services

The combination of a drier and more volatile climate, limited arable land, subsidised competition from biofuel crops and a growing population suggests food availability and prices will become more volatile in Australia and offshore.

The Project examines the preparedness of food industry leaders for riskier operating scenarios, and the implications of climate change for risk management.

Creating a climate for food security: the business, people & landscapes in food production.

Angela Wardell Johnson

Curtin University

This project will identify and interview stakeholders including producers, businesses, community and government in agricultural areas in south-west WA and south east Qld to identify risks, current productivity and approaches to adaptation related to climate change in agricultural production, and test approaches to strengthening resilience in agriculture in these areas.

Uncertainty I: Understanding end-user decisions and the value of climate information under the risks and uncertainties of future climates.

Alan Randall

University of Sydney

This project aims to understand how real people make decisions under conditions of climate uncertainty, how optimal climate change adaptation decisions can be made, and how to provide practical guidance to end users. It will review current literature to establish the nature of the uncertainty facing decision makers and the existing decision frameworks available. It will test the efficacy of selected methods, then refine the results to develop a decision support tool to help decision-making under conditions of climate risk and uncertainty

Uncertainty II: Bridging the gap between end user needs and science capability – dealing with uncertainty in future scenarios.

Danielle Verdon-Kidd

University of Newcastle

This project will work with climate scientists and government and business practitioners to bridge the disconnect between what decisions-makers need and what climate science can provide. Researchers will survey decision-makers to identify what climate information they most need, and in what format. They will conduct workshops to connect climate scientists with decision-makers to discuss ways to govern effectively within the limitations of climate science, and work with the team from the partner Uncertainty project (see above) to deliver products for practitioners including a masterclass, handbook and decision support tool.

Web based tools for adaptation in Australia – an international and Australian review.

Bob Webb

Australian National University

This project will test the usefulness for Australian decision makers of a range of adaptation tools available on international websites. It will assess the strengths and weaknesses of each tool for Australian situations, determine what is required to make tools more applicable and recommend the best approach for delivering suitable tools for Australian users.

Adaptation and mitigation: Identifying low risk climate change mitigation and adaptation in catchment management while avoiding unintended consequences.

Max Finlayson

Charles Sturt University

Some climate change adaptation and mitigation measures proposed for water resources can be considered 'maladaptation' as they may have negative or unintended consequences for other elements of the catchment. This project will focus on three catchments in the Murray Darling Basin and examine the practicalities of a range of complementary measures for managing rivers and wetlands that have the potential to enhance the resilience of catchments to bio-physical and economic impacts. It will deliver a plain-English guide to the risks, costs and benefit of different mitigation and adaptation options for southern Australian rivers.

Communication: Enhancing climate change communication: Strategies for profiling and targeting Australian interpretive communities.

Donald Hine

University of New England

Surveys indicate that Australians differ in their understanding of, and response to, climate change threats. Effective climate change communication must take these differences into account, and tailor messages to specific audiences. This project will identify how people from different groups and sectors of Australian society respond to different types of messages, to enable communications about climate change adaptation to be better designed and targeted.

Communication: Climate change adaptation in the boardroom.

Gareth Johnston

Future Ready Pty Ltd

This project aims to support Australian businesses to include climate change impacts and adaptation in their decision making processes by increasing climate awareness and capacity at the executive level. It will explore climate change risks to the supply chain to help inform directors about possible impacts on their business, and will develop and disseminate a climate change adaptation guide for the boardroom.

Overcoming barriers: Cross-scale barriers to adaptation in local government in Australia.

Natasha Kuruppu

University of Technology Sydney

Many climate change impacts will be experienced at the local level, and many local governments have initiated adaptation plans. The pathway to planning and implementation of adaptation is not a barrier free process, as local governments are embedded in a larger governance context that has the potential to limit the effectiveness of adaptation initiatives on the ground. This study will identify barriers that limit planned adaptation at the local government level. It will identify factors that give rise to these barriers, for example, process and governance structures, and suggest options for how barriers can be overcome.

Adaptation in industry and business: Climate change adaptation for Australian minerals industry professionals - best practice guidelines.

Damian Giurco

University of Technology, Sydney

The minerals industry generates 50% of Australia's export earnings, yet research into its ability to adapt to climate change is limited. In a recent study, stakeholders identified the major challenges as use of scarce resources such as water and energy; impacts on the environment and community; hazards and workforce issues; impacts on infrastructure; and mine planning and design. This project will evaluate industry awareness, and existing strategies, and develop best practice guidelines for climate change adaptation and planning by minerals industry professionals.

Adaptation in industry and business: Climate change adaptation – a framework for best practice in financial risk assessment, governance and disclosure.

Jason West

Griffith University

This project will deliver a consolidated framework for Australian industry to integrate risk management and governance principles in relation to climate change adaptation with existing governance principles. It will identify a matrix of financial disclosure principles to act as guidance for Australian industry to use for information disclosures relating to climate change risk and adaptation costs. These outcomes will be developed in conjunction with representatives from industry, regulators and corporate governance bodies.

Systems thinking: Adapt between the flags – enhancing the capacity of Surf Life Saving Australia to cope with climate change and to leverage adaptation within local communities.

Marcello Sano

Griffith University

Surf Life Saving Australia has assets and facilities exposed to climatic drivers on the frontline of climate change, including 310 surf life saving clubs and 150,000 trained volunteers, 63% of which are zones of potential instability. This project will identify the adaptive capacity of SLSA at the national level and options to enhance its capacity internally and in collaboration with allied national level organisations, local governments, allied emergency services and community groups.

Systems thinking: Overcoming challenges for decision making about climate change adaptation.

Kambiz Maani

University of Queensland

This project will compile, categorise and synthesise a variety of 'systems thinking' tools and approaches relevant to climate change adaptation. It will develop an end-user's guide that demonstrates the applications of various systems thinking tools to climate change adaptation decisions. This will enable end users to understand the relative utility of each approach and select the best approaches and tools for their purpose.

Economics: Economics of government as insurer of last resort for climate change adaptation.

Leo Dobes

Australian National University

This project will provide new insight into the economic, financial and distribution implications of government taking on the role of insurer of last resort for climate change adaptation. It brings together Australia's foremost climate change adaptation economists, policy analysts and modellers to identify the potential risks in government assuming the role of insurer of last resort. It will model and analyse the fiscal flows and the distributional implications, and potential tensions between the principle of subsidiarity and vertical fiscal imbalance, and develop proposals for obviating identified adverse fiscal effects where government does take on the role of insurer.

Economics: Leading gifted horses to water: the economics of climate adaptation in government-sponsored irrigation in Victoria.

Lin Crase

La Trobe University

Irrigated agriculture accounts for over 30% of Victoria's agricultural output. This sector is highly exposed to predicted climate change, and irrigators must adapt to manage with less water. Government response to water reform has included water buybacks, but also public investment in irrigation infrastructure, however water users are not obliged to pay water prices that reflect the cost of this infrastructure. This project aims to understand farmers' willingness to pay water and infrastructure tariffs under different pricing regimes and water availability scenarios; model the financial impacts of different scenarios at farm level and from the perspective of irrigation supply corporations; and map a reform path that ensures gifted assets do not hinder the future adaptation of water users. It will provide vital information to irrigation supply businesses about the sustainability of different pricing regimes under alternative water availability and infrastructure scenarios.

Supporting evidence-based adaptation decision making in Australia's states and territories.

Investigators to be announced June 2012

This project will comprise a suite of up to eight projects that synthesise the knowledge generated through NCCARF's 140 research projects to provide useful information for policy makers. It will identify key policy-relevant research useful to decision makers in each state and territory, and those with national implications. It will also identify remaining gaps in the knowledge needs of each region.