We gratefully acknowledge the considerable time and effort invested by many individuals and organisations in planning for and running this Conference.

Special thanks go to:

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• David George  
• Chris Lee  
• Jean Palutikof  
• Ann Penny  
• David Rissik  
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The role of the National Climate Change Adaptation Research Facility is to lead the research community in a national interdisciplinary effort to generate the information needed by decision makers in government and in vulnerable sectors and communities to manage the risks of climate change impacts.

Disclaimer: the views expressed herein are not necessarily the views of the Commonwealth, and the Commonwealth does not accept responsibility for any information or advice contained within.
Contents

Welcome 4
About the National Climate Change Adaptation Research Facility 5
About CSIRO Climate Adaptation Flagship 6
Sponsors 7
Supporters and Exhibitors 11
Conference Program 15
Plenary Speakers 28
Panel Sessions 39
Guide to the Parallel Sessions 42
Speedtalk Sessions 43
Poster Presentations 44
Abstracts 51

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James Cook University
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University of the Sunshine Coast
Murdoch University
Welcome to the 2012 National Adaptation Conference Climate Adaptation in Action: Sharing Knowledge to Adapt.

We are delighted to welcome approximately 700 participants to this event.

This 2012 Conference will showcase the growing body of climate change adaptation knowledge in Australia and internationally, how this knowledge is being used by communities, governments and industry to adapt to the impacts of climate change, the contribution of adaptation science to planning and policy making across Australia, and how robust adaptation decisions can be made in the face of uncertainty.

Climate already has a significant impact on our lives and livelihoods, particularly through extreme events such as storms, cyclones, floods and droughts. Climate change, brought about by increasing greenhouse gas emissions, will result in even greater impacts through warmer temperatures, rising sea levels and more intense floods, droughts, and bushfires. While change is inevitable, there is little to be gained by getting caught up in doom and gloom scenarios of the future. Instead, we must proactively plan for and adapt to change, in order to minimize the negative impacts and take advantages of any opportunities that arise. This is a challenge for decision-making at all levels.

Recognition of this challenge led to the formation of the National Climate Change Adaptation Research Facility and the CSIRO Climate Adaptation Flagship approximately 4 years ago. Since then, these initiatives have worked to progress climate adaptation research and knowledge transfer in Australia in partnership with the communities, governments and industries that have the responsibility to adapt Australia successfully to climate change. Building on the success of the NCCARF/CSIRO 2010 International Climate Change Adaptation Conference, the 2012 National Adaptation Conference provides an ideal platform to highlight Australia’s growing and significant contribution towards global understanding of climate change impacts and opportunities and options to adapt to these impacts. With an exciting program of over 270 presenters, focused plenary and panel sessions, together with side meetings, and social functions, we are sure that the Conference will provide a golden opportunity for participants to discuss the latest developments in adaptation research, and to share information, practical experiences and contacts.
Conference Hosts

About The National Climate Change Adaptation Research Facility

An initiative of the Australian Government, the National Climate Change Adaptation Research Facility (NCCARF) was established in 2008 to lead the Australian research community in a national inter-disciplinary effort to generate the information needed by decision-makers in government, and in vulnerable sectors and communities, to manage the risks of climate change impacts.

NCCARF has established and coordinates eight National Adaptation Research Networks, hosted by Australian Universities, with over 5000 members across Australia. It has developed a series of National Adaptation Research Plans which guided investment of approximately $28 million for close to 100 research projects; and funds a program of synthesis and integrative research with over $4 million invested in 40 projects.

NCCARF works to engage with practitioners to better understand their research needs, and to improve their access to information to support climate adaptation. The establishment of a Local Government Climate Adaptation Portal, and the Forum for NCCARF Interaction with State and Territory governments, are examples of these activities. NCCARF also played the lead role in hosting and organizing the 2010 International Climate Change Adaptation Conference, the first in what has now become a regular series of international adaptation conferences.

Based at Griffith University’s Gold Coast campus, NCCARF is a partnership between the Australian Government Department of Climate Change and Energy Efficiency, Griffith University, the Queensland Government, James Cook University, Macquarie University, Murdoch University, Queensland University of Technology, The University of Newcastle, University of Southern Queensland, and the University of the Sunshine Coast.

NCCARF Partners
ABOUT THE CSIRO CLIMATE ADAPTATION FLAGSHIP

The goal of CSIRO’s Climate Adaptation Flagship is to equip policy makers, industries and communities with practical and effective adaptation options to climate change and variability and in doing so create $3 billion per annum in net benefits by 2030.

To achieve this CSIRO’s leading scientists work in partnership with governments, industries and communities to deliver integrated solutions to this urgent national challenge. This research falls into four theme areas each providing insight in different aspects of adaptation.

- Climate change projections and improved understanding of drivers of seasonal climate variability and extreme events are developed to inform decision-making in many sectors, as well as underpin our adaptation research across the Flagship. Basic and synthetic research on cross-sectoral issues centres on vulnerability assessment and adaptive capacity, behavioural aspects of adaptation, and the economics of adaptation.
- Revitalising Australia’s cities and urban coasts to be resilient, liveable, sustainable and productive in response to changing climate is another focus area. The effects of extreme events such as bushfires, storm surges, heat waves and cyclonic winds on people and infrastructure in the built environment are used to engage with stakeholders’ day-to-day decision-making. Climate-affected urban development is explored in terms of these extremes and through the need to achieve low carbon adaptations.
- Developing and delivering adaptation options to protect Australia’s marine and terrestrial species, ecosystems and the services they provide as they respond to the impacts of climate change is the third focus area. These explore: terrestrial landscapes, marine and coastal areas, decision making approaches in conservation management and the genetic ability for adaptation.
- Working to deliver adaptation solutions for Australia’s primary industries, enterprises and communities in a variable and changing climate is the final area of focus. It addresses specific adaptation practices and technologies, such as climate-ready crops; seeks to quantify vulnerability; and identify limits to adaptation in different primary industries, including agriculture, marine fisheries, forestry and mining. It also pays specific attention to transformative adaptation in rural industries and regions, and the interactions between mitigation and adaptation in this sector.
Geoscience Australia provides the Australian Government, the Australian people and industry with geoscientific and geographic information that allows them to make informed decisions about:

- The management of resources
- The management of the environment
- The safety of people and infrastructure from natural hazards, and
- The well being of all Australians.

www.ga.gov.au
The Rural Industries Research and Development Corporation plays an important role in Australia’s response to climate change through conducting research into its impact on rural Australia. Whether it be food security, trade policy or on-farm decision making, the Rural Industries R&D Corporation is providing sound research to help Australia’s rural sector meet the challenges of climate change. To find out more about RIRDC’s climate change-related research visit the RIRDC website www.rirdc.gov.au.

Rural Industries Research and Development Corporation (RIRDC)

Session: Supporting climate adaptation in agriculture

South East Australia Climate Initiative (SEACI)

Session: Adapting water policy and planning for climate change

Fisheries Research and Development Corporation (FRDC)

Session: Enhancing resilience at the marine-land interface

National Water Commission

Session: Adapting water policy and planning for climate change

Murray-Darling Basin Authority (MDBA)

Session: Adapting water policy and planning for climate change

Victorian Centre for Climate Change Adaptation Research (VCCCAR)

Session: Collaborative adaptation: How university-government partnerships turn adaptation research into policy and practice

The South Eastern Australian Climate Initiative (SEACI) is investigating the causes, impacts and prediction of climate variability and change in south-eastern Australia with a particular focus on water availability.

SEACI Phase 2 is a three-year, $9 million research partnership between the Murray-Darling Basin Authority, the Victorian Government Department of Sustainability and Environment, CSIRO Water for a Healthy Country Flagship, the Bureau of Meteorology and the Australian Government Department of Climate Change and Energy Efficiency.

The SEACI study area incorporates the Murray-Darling Basin, the state of Victoria and southern South Australia, including the Eyre Peninsula.

www.seaci.org

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RESEARCH - results, reports, organisations, and expertise
OPPORTUNITIES - professional development and funding
MARKETS - contacts, information and developing opportunities

VISIT: www.frdc.com.au
Managing our water more effectively is one of the greatest challenges facing Australia. The National Water Commission is responsible for driving national water reform under the National Water Initiative (NWI) - Australia’s blueprint for how water will be managed into the future.

National imperatives for water management include more effective planning to determine how we share valuable water resources between competing uses, protection of environmental assets, expansion of water markets, and improved security of water supplies and entitlements.

To advance its reform objectives, the Commission reports regularly on specific aspects of water management such as the performance of urban water utilities and rural water service providers, the operation of Australian water markets, and the impacts of water trading.
The Bushfire Cooperative Research Centre (Bushfire CRC) is conducting national fire research on a range of issues of particular significance since the 2009 Victorian Black Saturday bushfires.

The Bushfire CRC combines the efforts of almost 50 research, fire, land and emergency service management partners in Australasia undertaking research on the complex social, economic and environmental aspects of bushfires.

The fire and land management and emergency services sector is currently building on outcomes of the Bushfire CRC with a broader new research program to include changes in climate, demographics, technology, policy and industry, as well as the lessons of the Black Saturday bushfires and the implications for all natural hazards management.

www.bushfirecrc.com

A view from the EDG ...

The EDG is all about research on making better environmental decisions. We are a network of conservation researchers from Australian & international research centres, hubs and teams, all focused on the science of effective decision–making to better conserve biodiversity. We are funded through an ARC Centre of Excellence and the Australian Government’s National Environmental Research Program.

Director - Prof Hugh Possingham
Deputy Directors - Assoc Prof Mick McCarthy and Dr Brendan Wintle

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PIARN
Primary Industries Adaptation Research Network

The gateway to climate change adaptation research in Australian primary industries

Membership is free and offers access to: primary industries adaptation research overviews and summaries; updates on new research findings and reports, pointers to research and writing opportunities, connections with others working in the area and with research end-users, seminars and workshops, scholarships and capacity building opportunities.

Join now

www.piarrn.org.au
COOL SCIENCE FOR A HOT TOPIC

Collaborative science at the Australian Institute of Marine Science (AIMS) is helping to answer questions on the effects of climate change on coral reefs. Cores extracted from ancient massive corals on the Great Barrier Reef reveal a 300-year climate history, with extreme weather events increasing in frequency. World leading research to be carried out in the National Sea Simulator currently being constructed at AIMS will help us understand how marine ecosystems can adapt to the changing climate.

ADAPTING
MORE INNOVATIVELY

Climate variability is challenging businesses to find new and innovative ways to maintain productivity and high performance while protecting assets.

AECOM’s climate adaptation specialists help clients build risk management strategies into the design, operation and maintenance of their infrastructure, ensuring they are prepared for the impacts of climate change.

To learn more about how AECOM is helping business adapt more innovatively, contact Michael Nolan on +61 409 721 998.

aecom.com
Side meetings and special events

Monday 25th June

Victorian Centre for Climate Change Adaptation Research

VCCCAR’s third Annual Forum will showcase its climate change research program. University researchers, experts from state and federal government and practitioners from local government and the private and not-for-profit sectors will review work to date and discuss future climate change adaptation research priorities.

Presentations include:
• Keynote: Karl Sullivan – General Manager, Policy, Risk and Disaster, Insurance Council of Australia
• Victorian Government adaptation knowledge needs and priorities
• Adaptation Journeys: opportunities and barriers for local government
• Managing risk and uncertainty in climate change adaptation
• Talking Adaptation: a conversation with Victorian Aboriginal People
• A Climate Hypothetical with the Environment Defenders Office
• An industry climate adaptation roundtable breakfast

Anyone can register for this event online at www.vcccar.org.au/

Climate Change Adaptation: Responding to Health Issues

Climate change is already impacting on human health. Inaction will exacerbate this problem. The Adaptation Research Network for Human Health invites local and international experts to discuss how climate change adaptation actions can be successfully implemented across sectors affecting human health. The special session will bring together researchers and end-users to discuss what we are doing to reduce the impact of climate change on human health. Exploring what is working, and what is not working so well, and what other adaptation actions we should be undertaking. This forum will explore progress to date and identify where we should be heading to protect human health from climate change. Opportunities will exist for questions and participant engagement.

• Prof Tony McMichael – Australian National University, pioneer of research on the human health impacts of climate change and author of the Climate Commission’s recent report ‘The Critical Decade: Climate Change and Health’
• Dr Kris Ebi – Executive Director of the Technical Support Unit for Working Group II (Impacts, Adaptation, and Vulnerability) of the Intergovernmental Panel on Climate Change (IPCC).
• Prof Alistair Woodward – University of Auckland, IPCC Lead Author Human Health, Leader of World Health Organization Project on Climate Change in the Pacific.
• A/Prof Sophie Dwyer – Executive Director, Health Protection, Queensland Health
• Dr Liz Hanna – Australian National University and Convenor of the Climate Change

Registration for this event is available through www.nccarf.edu.au/conference2012/

CSIRO Postgraduate Day / CSIRO Postgraduate Workshop

The objectives of this workshop are to allow the students to interact and form connections prior to the conference; give the students an opportunity to present their work in a “friendly” environment; and contribute to creating a community of practice in young researchers working in climate change adaptation.

1 Welcome and workshop opening (Jean Palutikof, Mark Stafford-Smith, Andrew Ash)
2 Update on climate change adaptation research, in Australia and internationally - what have we learned since 2010?
3 Poster activity and networking session – students view and present their posters to a small group. Students then vote for their favourite poster.
4 Short presentations (2-3 minutes) from students voted to have the “best” posters by their peers.
5 Lessons learned from an adaptation higher degree (Post-doc or early career researcher)
6 Roundtable activities:
   • Visioning an adaptive future – using imagination, common sense and your own knowledge, can you envisage the well-adapting Australia which is 2 (or even 4 degrees) warmer and in which you will be living? Working in groups, each table could be allocated a sector, region or even city to discuss.
   • What can we learn from/do at this conference which may help achieve this vision?
7 Navigating Adaptation in Action - a guide to the 2012 conference

Registration for this event is available through www.nccarf.edu.au/conference2012/

Convenors: Mark Stafford Smith (CSIRO) & Ann Penny (NCCARF)
Workshop Opportunity: Systems Thinking Tools for Overcoming Decision Challenges for Climate Changes Adaptation

This workshop will expand on the conference presentation on Overcoming Challenges for Decision Making about Climate Change Adaptation – A Systems Thinking Approach to demonstrate integrated cross-sectoral planning and collaborations in dealing with climate changes adaptation decision making. Systems Thinking tools help create shared understanding of complex issues, and taking into account the associated constraints and limitations, create innovative and sustainable interventions. The presented methodology is a proven and powerful group decision making process which has been applied to numerous projects internationally and in Australia over the last 15 years. It enables working collectively and collaboratively towards common goals and creating shared futures.

Convenor: Kambiz Maani (University of Queensland)

Wednesday 27th June
Business Breakfast Australia’s emerging climate change adaptation challenge

This business breakfast briefing with guest speakers Mark Rogers and Michael Nolan, will be feature a discussion of the opportunities in Australia for climate adaptation.

The speakers will explore smart business responses to a changing climate focusing on:
• investment - emerging questions and responses from lenders
• effective approaches applied by infrastructure intensive organisations to increase resilience to climatic hazards
• who inherits the risk in delivery models such as public-private-partnerships?
• integrating climate risk into design and maintenance regimes

Tickets ($40) for this event available through www.nccarf.edu.au/conference2012/

Who’s doing what? Catching up with adaptation research across Australia

Heads of Australian adaptation research organizations come together to talk about what’s happening in their institutions, what they consider to be the key issues in adaptation research, and their plans for the future. Australia is a leader in climate change adaptation research and practice, so come and join us to find out what’s happening at the forefront of research in these world-leading organizations. We bring together leaders from VCCCAR, the CSIRO Climate Adaptation Flagship, NCCARF, the Goyder Institute, the CSS Centre of Excellence and QCCCE to share their thinking on adaptation research. A light breakfast will be available. This meeting is open to all delegates to attend.

IPCC review meeting

The Lead Authors for the Australasia chapter of the 5th IPCC Assessment Report Working Group II contribution will hold a workshop to enable Expert Reviewers to provide feedback on the first draft of the chapter.

This workshop provides an important opportunity for the wider science community to informally discuss critical issues and provide their views to the lead authors for this chapter, and also inform them of key scientific publications in press or preparation. The discussions will help the lead author team to consider potential revisions of the chapter as part of the IPCC writing and review process, but it is also hoped that the discussions will enable experts to submit concise and helpful formal review comments on the chapter.

The meeting will be chaired by Andy Reisinger, one of two coordinating lead authors for the chapter, and several of the chapter’s lead authors will also attend to hear the views of the science expert community.

Experts interested in attending this session must register as an expert reviewer prior to the meeting. Please contact the Working Group II Technical Support Unit at tsu@ipcc-wg2.gov to register your interest in becoming a reviewer.
Climate Change Readiness – A new legislative proposal for Western Australia

This proposed legislation in Western Australia provides for the regulation of planning, development and management in the coastal zone. The Bill gives legislative weight to important planning decisions that protect human settlements and ecological communities from coastal hazards that are being exacerbated by climate change.

The Bill gives clear direction for coastal climate change adaptation beyond that provided in State Planning Policy. It provides for the preparation of vulnerability assessments for the whole coast, the demarcation of the transition zone for development control, the mandatory placement of memorials on titles that are assessed as vulnerable land and the removal of injurious affection compensation.

The Bill affords protection to protected persons for anything done in good faith in the performance or purported performance of a function under the Bill. This protection does not apply if the WA coastal plan and the local coastal plans have not been approved and maintained in accordance with the Bill.

At present public authorities (including state instrumentalities and local governments) may be ‘damned if they do and damned if they don’t’. For example, if they refuse planning approval in the coastal zone on the basis of projected sea level rise they may face a claim for compensation by developers, but if they give approval they may face a claim by owners (for instance, if the sea level rises) for having given approval for development in a risky area. The rationale for including the “protection from liability” provision is so that public authorities may act in accordance with the Bill without fear of liability to either side. This meeting is open to all delegates to attend.

Friday 29th June

AECOM Masterclass

Climate change impacts to infrastructure and services are a significant risk to companies and government. This impact will be greatest where assets experience accelerated degradation and fail during larger intensity climatic events such as extreme rainfall (flooding), wind, dust storms, hurricanes/cyclones, storm surge, hail, frost, snow storms, heat waves, bushfires and lightning storms. This practical training class focuses on policy issues for how and why to consider climate change in infrastructure planning and how to technically incorporate consideration of climate change into infrastructure intensive organisations from risk, development planning and design to operations and maintenance.

The ‘master class’ training is supported by a workbook and worked examples to enable practical application to each participants own organisation or project.

Training tailored for business managers or government officials. Not academically focused but supports real life consideration and application of solutions. Participants:

- Policy and strategy managers.
- Risk and insurance managers.
- Project development and feasibility managers.
- Strategic procurement and asset managers.
- Environment/climate change/sustainability managers.

The cost of the workshop is $400. To register to attend this one day workshop please visit www.nccarfd.edu.au/conference2012/

Convenors:
Michael Nolan (Global Technical Leader Climate Adaptation, Corporate & Advisory Services, ANZ)
Greg Picker (Associate Director Climate Change (Policy Specialist), Corporate & Advisory Services, ANZ)
## Pre-Conference Events

### Monday 25th June

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>7.30am - 8.45am</td>
<td>Industry Roundtable Breakfast</td>
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<tr>
<td>8.45am - 10.00am</td>
<td>Victorian Centre for Climate Change Adaptation Research (VCCCAR) Annual Forum</td>
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<tr>
<td>10.00 - 10.30am</td>
<td>Morning Tea</td>
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<tr>
<td>10.30 - 12.00pm</td>
<td>VCCCAR Annual Forum (cont)</td>
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<tr>
<td>12.00 - 1.00pm</td>
<td>Lunch</td>
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<td>1.00 - 2.30pm</td>
<td>VCCCAR Annual Forum (cont)</td>
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<td>1.00 - 2.30pm</td>
<td>Climate Change Adaptation: Responding to Health Issues Workshop hosted by: Human Health Network</td>
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<td>2.30 - 3.00pm</td>
<td>Afternoon Tea</td>
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<tr>
<td>3.00 - 4.30pm</td>
<td>VCCCAR Annual Forum (cont)</td>
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<tr>
<td>3.00 - 4.30pm</td>
<td>Climate Change Adaptation: Responding to Health Issues (Cont)</td>
</tr>
<tr>
<td>4.30 - 5.00pm</td>
<td>Climate Adaptation in Action 2012 Conference - Registration desk open</td>
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<tr>
<td>5.00 - 7.00pm</td>
<td>Climate Adaptation in Action 2012 Welcome Reception Grand Lobby</td>
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# Conference Program

## Day 0 – Monday 25th June **Evening**

| 5:00 – 7:00pm | Climate Adaptation in Action 2012 Welcome Reception **Grand Lobby** |

## Day 1 – Tuesday 26th June **Morning**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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| 8.45am – 10.20am | **Opening Plenary – Climate change adaptation in Australia today**  
Room: Grand 1-4  
Welcome to country  
Jean Palutikof (NCCARF) & Andrew Ash (CSIRO) – Welcome to conference  
Simon McKeon (CSIRO Chairman) – Official opening of Conference  
Hon. Greg Combet MP (Minister Department of Climate Change and Energy Efficiency) – Video Message  
Blair Comley (Department of Climate Change and Energy Efficiency)  
Wendy Craik AM (Productivity Commission) – Regulatory and policy barriers to climate adaptation: draft report  
Lesley Hughes (Climate Commission) – The climate commission: conversations with the Australian public  
Voice of Youth |
| 10.20 – 10.50am | **Morning Tea**  
**Grand Lobby** |
| 10.50 – 12.30pm | **Plenary 2 – Health, society and adaptation**  
Room: Grand 1-4  
Chair: Elizabeth Hanna (Australian National University)  
Tony McMichael (Australian National University) – Reducing health risks: Setting the adaptation task in context  
Kris Ebi (Stanford University, IPCC Working Unit) – But is it adaptation?  
Alistair Woodward (University of Auckland) – Adapting to protect health under climate change: general or specific?  
Neville Nicholls (Monash University) – Improved weather forecasting as an adaptation to climate change (by video) |
| 12.30 – 1.30pm | **Lunch**  
**Grand Lobby** |
| 12.40 – 1.30pm | **Workshop Opportunity: Systems Thinking Tools for Overcoming Decision Challenges for Climate Changes Adaptation**  
**Presenter:** Kambiz Maani  
**Room:** Park |
**Day 1 – Tuesday 26th June**  
**Afternoon**

<table>
<thead>
<tr>
<th>Time</th>
<th>Panel Session 1</th>
<th>Panel Session 2</th>
<th>Panel Session 3</th>
<th>Panel Session 4</th>
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</table>
| 1.30 – 3.00pm | **Room:** Grand 1&2  
**The trend toward effectiveness**  
(Chair: Andrew Ash)  
Will Steffen  
(ANU)  
Russell Wise  
(CSIRO)  
Kate Nelson  
(East Gippsland Shire Council)  
Habiba Gitay  
(World Bank) | **Room:** Grand 3&4  
**Barriers to Adaptation**  
(Chair: Graeme Pearman)  
Simon Torok  
(CSIRO)  
Neil Byron  
(Productivity Commission)  
Joe Reser  
(Griffith University)  
Jan McDonald  
(University of Tasmania) | **Room:** State 1&2  
**Policy-relevant knowledge for adaptation: bridging the science-policy gap**  
(Chair: Francis Zwiers)  
Karl Jones  
(Willis Re)  
Steve Dovers  
(ANU)  
Jason Alexandra  
(MDBA)  
Rohan Hamden  
(SA Department of Environment and Natural Resources) | **Room:** State 3  
**Collaborative adaptation: How university government partnerships turn adaptation research into policy and practice**  
(Chair: Rod Keenan)  
Hartmut Fuenfgeld  
(RMIT)  
Halley McCann  
(DSE Vic)  
Paula Arcari  
(RMIT)  
Christine Kilmartin  
(DPCD Vic)  
Lauren Rickards  
(Melbourne University)  
Leon Soste  
(DPI Vic)  
**Sponsor:** VCCCAR |
<p>| 3.00 – 3.30pm | <strong>Afternoon Tea</strong> | <strong>Grand Lobby</strong> |</p>
<table>
<thead>
<tr>
<th>Time</th>
<th>Session 1: Measuring the success of adaptation</th>
<th>Session 2: Human impacts and health adaptation</th>
<th>Session 3: Local Government</th>
<th>Session 4: Communication and Engagement</th>
<th>Session 5: Adapting agriculture to climate change</th>
<th>Session 6: Climate Adaptive Infrastructure</th>
<th>Session 7: Barriers and limits to adaptation</th>
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<tr>
<td>4.30 - 4.35</td>
<td>Short break Grand Lobby</td>
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<td>4.35 - 5.35pm</td>
<td>Parallel Session 8: Managing Biodiversity for Adaptation</td>
<td>Park</td>
<td>Challenges for Services to Homeless Persons in Adapting to Predicted Extreme Weather Events Under Climate Change. M Carey</td>
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<td>Parallel Session 10: Local Government Communication</td>
<td>Grand 1&amp;2</td>
<td>Communicating Across the 'Theory Versus Practice' Divide – the Barriers in the Basics. M Bainbridge</td>
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<td>Parallel Session 11: Adapting agriculture to climate change</td>
<td>Grand 3&amp;4</td>
<td>Will Primary Producers Continue to Adjust Practices and Technologies, Change Production Systems or Transform Their Industry – An Application of Real Options. G Hertzler</td>
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<td>Parallel Session 12: Climate Adaptive Infrastructure and the Built Environment</td>
<td>State 3</td>
<td>Road Pavement Design and Assessment Under Climate Change. M Taylor</td>
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<td>Parallel Session 13: Climate Change, Fire Regimes and Ecosystems Resilience in Alpine Vegetation: Not So Much Doom and Gloom. D Williams</td>
<td>Lake 1&amp;2</td>
<td>Climate Change Adaptation in the Coorong, Murray Mouth and Lakes Alexandrina and Albert. M Finlayson</td>
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<td>Parallel Session 14: Barriers and limits to adaptation</td>
<td>Lake 3&amp;4</td>
<td>Climate Change Adaptation in the Coorong, Murray Mouth and Lakes Alexandrina and Albert. M Finlayson</td>
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<td></td>
<td>Adaptation or Transformation: Adjusting to the Consequences of 40 Years of Hydrological Change in the Jarrah Forest. G Wardell-Johnson</td>
<td>Park</td>
<td>Climate Change Adaptation in the Coorong, Murray Mouth and Lakes Alexandrina and Albert. M Finlayson</td>
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<td>Potential Shifts in Frost Risk for Pome Fruit in Australia. R Darbyshire</td>
<td>State 1&amp;2</td>
<td>Influences on the Capacity to Adapt to Climate Risk in an Australian Primary Industry. N Marshall</td>
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<th>Time</th>
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<tr>
<td>5:45 - 6.00pm</td>
<td>Welcome from Cr Rachel Powning – Mayor of Port Phillip</td>
<td>Grand 1-4</td>
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<tr>
<td>6.00 - 7.30pm</td>
<td>Poster Presentations and mixer</td>
<td>Grand Lobby</td>
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### Day 2 – Wednesday 27th June

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<th>Time</th>
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<tr>
<td>7am – 8.30am</td>
<td><strong>Business Breakfast with Mark Rogers and AECOM</strong> Ticket holders only</td>
<td>Lake 1&amp;2</td>
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<tr>
<td>7am – 8.30am</td>
<td><strong>Who’s doing what? Catching up with adaptation research across Australia</strong> Open to all delegates</td>
<td>State 3</td>
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</table>
| 9am – 10.30am | **Plenary session 3 – Business as usual? How is business adapting**  
**Chair: Gareth Johnston** (Future Ready)  
**John Trowbridge** (Natural Disasters Insurance Review) – **Climate Change: Industry Impact and Response**  
**Mark Howden** (CSIRO)  
**Mark Rogers** (Colonial First State) - **Infrastructure Assets and Climate Change Action – Funding Resilience**  
**John Thwaites** (Australian Building Codes) - **National Construction Code facilitating adaptation to climate change** | Grand 1-4 |
| 9.30 – 10.00am | **Morning Tea**  
Grand Lobby |
| 10.30 – 11.00am | **Panel Session 5**  
**Room: Grand 1&2**  
**Science for Adaptation**  
**(Chair: Jean Palutikof)**  
John Church (CSIRO)  
Malte Meinhausen  
(University of Melbourne)  
Nathan Bindoff  
(University of Tasmania)  
Andy Pitman  
(University of NSW)  
**Panel Session 6**  
**Room: Grand 3&4**  
**Supporting Adaptive Decision Making in the Pacific Basin**  
**(Chair: Rob Kay)**  
Chalapan Kaluwin  
(PNG University)  
Kevin Henessy  
(CSIRO)  
Arthur Webb  
(SOPAC)  
Vic McGrath  
(TSRA)  
**Panel Session 7**  
**Room: State 1&2**  
**Maladaptation, misguidance and missed chances**  
**(Chair: K Auty)**  
Roger Jones  
(University of Victoria)  
Fran Thorn  
(former Secretary, Victorian Department of Health)  
Peter Christoff  
(Melbourne University)  
**Sponsor: Commissioner Environmental Sustainability Victoria**  
**Panel Session 8**  
**Room: State 3**  
**Marine Panel**  
**(Special Marine symposium)**  
**(Chair: Marcus Haward)**  
Kevin Stokes  
(NZ Seafood)  
Alistair Hobday  
(CSIRO)  
Eric Perez  
(Qld Seafood Industry Association)  
Nick Caputi  
(Department of Fisheries Western Australia)  
Gretta Pecl  
(UTas) |  |
| 11.00 – 12.30pm | **Panel Session 6**  
**Room: Grand 3&4**  
**Supporting Adaptive Decision Making in the Pacific Basin**  
**(Chair: Rob Kay)**  
Chalapan Kaluwin  
(PNG University)  
Kevin Henessy  
(CSIRO)  
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(Department of Fisheries Western Australia)  
Gretta Pecl  
(UTas) | |
| 12.30 – 2.15pm | **Lunch**  
Grand Lobby |
| 12.40 – 2.00pm | **IPCC workshop**  
**(Chair: Andy Reisinger)**  
Registered reviewers only | Grand 1&2 |
| 12.45 – 1.45pm | **Climate Change Readiness – A new legislative proposal for Western Australia.**  
**(Lynn MacLaren)** | Lake 1&2 |
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<tr>
<th>Time</th>
<th>Session Title</th>
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<tr>
<td>2.15 – 3.45pm</td>
<td><strong>Parallel Session 15</strong> Ecosystems Room: Park</td>
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<td>Developing and Assessing Strategies for Managing Biodiversity Under Climate Change. M Dunlop</td>
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<td><strong>Parallel Session 16</strong> Human impacts and health adaptation (Heat) Chair: T McMichael Room: State 1&amp;2</td>
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<td>Vulnerability of Low Income Households to Extreme Heat M Beaty</td>
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<td><strong>Parallel Session 17</strong> Finance and business Room: Lake 1&amp;2</td>
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<td>Sir Sidney Kidman: Australia’s Cattle King As Pioneer Of Adaptation To Climatic Uncertainty L Dobes</td>
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<td><strong>Parallel Session 18</strong> Communication Room: Grand 1&amp;2</td>
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<td>Worldviews, Framings and Language: Adapting Our Conversations About Climate Change to the People We Are Communicating With T Lynam</td>
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<td><strong>Parallel Session 19</strong> Supporting climate adaptation in agriculture Sponsor: RIRDC Room: Grand 3&amp;4</td>
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<td>Adaptation to Climate Change: How is It Any Different to Normal? The Case of Agriculture L Rickards</td>
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<td><strong>Parallel Session 20</strong> Adapting cities for future climate change Room: State 3</td>
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<td>Adapting the City of Melbourne’s Urban Forests I Shears</td>
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<td><strong>Parallel Session 21</strong> Strategies for Supporting Reef Ecosystem Resilience. Chair: K Anthony Sponsor: AIMS Room: Lake 3&amp;4</td>
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<td>KEYNOTE: A Decision Science Perspective on Climate Adaptation Strategies for Reefs H Possingham</td>
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<td>Developing and Assessing Strategies for Managing Biodiversity Under Climate Change. M Dunlop</td>
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<td>Identifying Terrestrial Refugia for Biodiversity A Reside</td>
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<td>Preparation of Victorian Public Sector Residential Aged Care Services for Extreme Heat J McInnes</td>
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<td>Underestimating the Fingerprint of Climate Change: Consequences for Adaptation J VanDerWal</td>
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<td>Enhancing the Adaptive Capacity of Small-to-Medium Enterprises (SMEs) to Climate Change and Variability in Australia N Kuruppu</td>
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<td>Effects of Extreme Temperatures on Years of Life Lost for Cardiovascular Deaths: a Time Series Study in Brisbane, Australia C Huang</td>
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<td>Providing Application-specific Climate Projections Datasets for Australia and the Pacific: CSIRO’s Climate Futures Framework P Whetton</td>
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<td>Market Mechanisms for Dealing with the Increasing Cost of Catastrophe Losses R Crompton</td>
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<td>Managing Current Climatic Uncertainty and Adapting to the Future Climate Change in the SAT of Africa and Asia : ICRISAT” Approach. D Asamoah</td>
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<td>Climate Adaptation and The Boardroom. G Johnston</td>
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<td>Adaptation and Transformation in Action: Insights from Climate Change Responses in Five Australian Case Studies A Fleming</td>
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<td>Building Climate Change Resilience from the Source - the NERSA Experience. R O’Hagan</td>
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<td>Water Sensitive Urban Design As Key Adaptation to Climate Change N Tapper</td>
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<td>Planning for Food Security in Climate Changeable Australian Cities. P Burton</td>
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### 2.15 – 3.30pm continued

- **Conservation Planning for Vulnerable Species.**
  - D. Summers
- **Adaptation to Climate Change: Does the Public Associate Heat Waves with Global Warming in Adelaide, Australia?**
  - D. Akompab
- **Climate Change Adaptation In Industry And Business - A Framework for Best Practice in Financial Risk Assessment, Governance and Disclosure.**
  - J. West
- **Successful Climate Change Adaptation Approaches Used in Michoacan, Mexico.**
  - D. George
- **Drought or Aridity – Notes from the Northern Edge of the South Australian Grains Belt and the Southern End of the Murray Darling Basin.**
  - P. Hayman
- **AdaptWater: A Climate Change Adaptation Tool for the Australian Urban Water Sector.**
  - J. Sullivan
- **Fast-tracking Coral Climate Adaptation Research – a Genomics Approach.**
  - E. Abal
- **Understanding Reef Resilience to Manage Climate-driven Shift to Barren Ground: Prevention is Far Better Than Cure.**
  - S. Ling
- **Managing Regional Stressors Reduces the Vulnerability of Coral Reefs to Climate Change.**
  - K. Fabricius

### 3.45 – 4.15pm Afternoon Tea

#### Grand Lobby

- **Parallel Session 22**
  - Avoiding extinctions in a changing climate.
    - **Sponsor:** EDG
    - **Chair:** R. Fuller
    - **Room:** Park

- **Parallel Session 23**
  - Climate change adaptation and Indigenous communities
    - **Room:** State 1&2

- **Parallel Session 24**
  - Legal, Regulatory and Governance
    - **Room:** Lake 1&2

- **Parallel Session 25**
  - Cognitive barriers
    - **Room:** Grand 1&2

- **Parallel Session 26**
  - Social and equity issues
    - **Room:** Grand 3&4

- **Parallel Session 27**
  - Adapting cities for future climate change
    - **Room:** State 1

- **Parallel Session 28**
  - Managing Australia’s marine ecosystems and resources for a warmer climate
    - **Sponsor:** GBRMPA
    - **Chair:** Neil Holbrook
    - **Room:** Lake 3&4

### 4.15 – 5.45pm

#### Parallel Session 22
- Where Should We Invest to Adapt Coastal Ecosystems to Sea Level Rise?
  - R. Fuller

#### Parallel Session 23
- The Role of Culture and Traditional Knowledge in Climate Change Adaptation in Northern Australia.
  - M. Parsons

#### Parallel Session 24
- Regulatory Responses to Facilitate Adaptation of Existing Infrastructure to Climate Change.
  - D. De Sousa

#### Parallel Session 25
- Making Sense of Nonsense: Contradiction and Maleability of Views About Climate Change and Climate Change Actions.
  - I. Walker

#### Parallel Session 26
  - J. Mustelin

#### Parallel Session 27
- Community Led Planning for the Impacts of Climate Change.
  - R. Hamden

#### Parallel Session 28
- An Indicator Framework to Operationalize Resilience Thinking in Australian Marine Sectors Dealing with Climate Change.
  - J. Davidson

- **Future Change in Ancient Worlds: a Preliminary Understanding of Indigenous Adaptation in Northern Australia.**
  - D. Bird

- **Legislation, Land Tenure and Climate Change Adaptation in Australia: the Hothouse Between Public and Private Interests.**
  - E. Gerrard

- **Psychological Barriers and Promoters for Climate Change Adaptation.**
  - R. Sapiains

- **Cultural Resources for Climate Change Adaptation: Identifying Opportunities in Abundance, Scarcity and Variability.**
  - L. Head

- **A Resilient Mob: Media Analysis of How Australian Communities Construct Their ‘resilience’ Following Natural Disasters.**
  - A. Leitch

- **Fisheries Management and Adaptation – the Need for a Double Adapter?**
  - A. Sullivan
### 4.15 – 5.45pm continued

<table>
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<tr>
<th>Time</th>
<th>Session</th>
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</table>
| 4.15 – 5.45pm| Developing Strategies to Combat Increased Coextinction Rates of Plant-dwelling Insects Through Global Climate Change.  
P Vesk       |
|             | Adaptation Options for Australian Indigenous Women Living in Remote Coastal Regions.  
L Petheram   |
|             | Legal & Institutional Dimensions of Adaptation to Climate Induced Disasters.  
M Eburn      |
L Lim-Camacho|
|             | Impacts of Climate Change on Livelihood Conditions: Assessing Adaptation Requirements.  
T Lissner    |
|             | Developing Strategies to Combat Increased Coextinction Rates of Plant-dwelling Insects Through Global Climate Change.  
P Vesk       |
|             | Incorporating Climate Change Adaptation into National Conservation Assessments.  
E Game       |
|             | Ecological-economic Optimization of Biodiversity Conservation Under Climate Change.  
B Wintle     |
|             | Indigenous Voices in Climate Change Adaptation: The Challenges Facing Yorta Yorta People.  
D Griggs     |
|             | The Encroaching Sea and Shifting National Boundaries: Integrating Law with Uncertain Scientific Predictions in Addressing Climate Change Impacts in the Coastal and Marine Environments of Australia and Its South Pacific Neighbours.  
N Rogers     |
|             | Detecting Unexpected Climate Impacts to Guide the Management of Species Threatened by Climate Change.  
E McDonald-Madden |
|             | Building the Resilience of Ahus Island Community and Its Ecosystems to the Impact of Climate Change Through Local Initiatives: A Bottom-Up Strategy for Climate Change Adaptation.  
R James      |
|             | The Economics Of Adaptation: Government Acting As Insurer Of Last Resort.  
L Dobes      |
|             | The Impact of Corrective Normative Feedback on Pro-environmental Intentions and Behaviour.  
M Hurlstone  |
|             | What About Me? The Role of Emotion for Individual Climate Change Adaptation.  
S Russell    |
|             | A Local Response to Adapting Cities for Climate Change: Western Creek Pilot Study.  
M Webster-Mannison |

### 6:00 – 7:00pm

- Poster Presentations and pre-dinner bar  
  **Grand Lobby**

### 7:00 – 11:00pm

- **Conference Dinner**  
  Announcement of the Climate Adaptation Champions.  
  **Dinner Speaker:** David Karoly (University of Melbourne) – *Climate Change and Societal Responses: Reflections from a Slow Learner*  
  **Room:** Grand 1-4
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<tr>
<td>9am – 10.30am</td>
<td><strong>Plenary 4 International developments</strong></td>
<td>Room: Grand 1-4</td>
<td>Kris Ebi&lt;br&gt;Francis Zwiers (Pacific Climate Impacts Consortium, University of Victoria, BC) – On the attributes and challenges of regional climate services&lt;br&gt;Mark Stafford Smith (CSIRO) – Planet under pressure: new knowledge towards solutions in 2012&lt;br&gt;Neville Smith (Bureau of Meteorology) – Progress with the IPCC Fifth Assessment Report on Impact, Adaptation and Vulnerability&lt;br&gt;Ian Noble (Global Adaptation Institute)</td>
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<td>10.30 – 11.00am</td>
<td>Morning Tea <strong>Grand Lobby</strong></td>
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<td>11.00 – 12.30pm</td>
<td><strong>Parallel Session 29 Regional case studies</strong> Room: Park</td>
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<td><strong>Parallel Session 30 Climate change adaptation and Indigenous communities</strong> Room: State 1&amp;2</td>
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<td><strong>Parallel Session 31 Turning science into policy</strong> Room: Lake 1&amp;2</td>
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<td><strong>Parallel Session 32 Climate extremes and disaster management</strong> Room: Grand 1&amp;2</td>
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<td><strong>Parallel Session 33 Adapting water policy and planning to climate change</strong> Sponsors: MDBA, SEACI &amp; NWC Chair: J Alexandra Room: Grand 3&amp;4</td>
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<td><strong>Parallel Session 34 Adaptation for coastal systems</strong> Room: State 3</td>
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<td><strong>Parallel Session 35 Enhancing Resilience at the Marine-Land Interface</strong> Sponsor: FRDC Chair: C Creighton Room: Lake 3&amp;4</td>
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**Building Adaptation Capabilities: Learning by Doing and Sharing.**<br>B Webb

**Exploring the Need for Adaptation in Government Service Provision to Future Climate Through Integrated Regional Vulnerability Assessment (IRVA).**<br>C Lee

**An Eyre Peninsula Report Card: Adaptation Practice and Research in the Far West of South Australia.**<br>D Jones

**NCCARF Projects Speedtalks:**<br>Indigenous Communities Learning from the past, adapting in the future.<br>M Parsons<br>Living Change: Adaptive housing responses.<br>R Horne<br>Indigenous voices in climate change adaptation.<br>D Griggs

**The Role of Social Capital in Transferring and Integrating Adaptation Science in Public Policy:**<br>A Survey of Australian and Canadian Government Agencies.<br>J Sandall

**Disaster Resilience: How Different Stakeholders Frame Resilience and How Useful is the Concept for Policy and Practice.**<br>P Aldunce

**Science Supporting Adaptive Water Planning.**<br>J Alexandra

**Participatory Mapping of Coastal Adaptation Pathways in Mandurah, WA.**<br>L Stocker

**Wetlands Role in Great Barrier Reef Coastal Ecosystems – Their Multiple Values in Biodiversity, Fisheries and Water Qualities and the Opportunities for Repair.**<br>D Audas
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<tr>
<th>Time</th>
<th>Session Title</th>
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<tr>
<td>11.00 – 12.30pm continued</td>
<td>Evaluating Policy Networks for Science Impact: Planning for Climate Change Adaptation in South East Queensland.</td>
<td>R McAllister</td>
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<td>Aboriginal responses to climate change in arid zone Australia.</td>
<td>P Memmott</td>
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<td>TRED – An Example of Science - Policy Translation from the South Australian Government.</td>
<td>S Sweeney</td>
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<td>Costs And Benefits of Public And Private Provision of Post-Cyclone Emergency Services in Coastal Queensland.</td>
<td>L Dobes</td>
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<td>Climate Change Adaptation Planning in the South Australian Murray-Darling Basin.</td>
<td>M Siebentritt</td>
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<td>Coastal Residents, King Canute and Foaming Brine.</td>
<td>A Leitch</td>
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<td>Estuaries &amp; Wetlands – Critical for Key Commercial and Recreational Fisheries and the Frontline for Adaptation to Rising Sea Levels.</td>
<td>M Sheaves</td>
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<td>Comparison of Four Australian Regional Cross Border Governance Arrangements: Implications for Climate Change Adaptation.</td>
<td>S Shearer</td>
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<td>Understanding the use of intertidal marine resources by Indigenous women in the Northern Territory.</td>
<td>L Petheram</td>
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<td>Integration of Science and Policy in Implementing the New South Wales and Australian Capital Territory Regional Climate Modelling Project.</td>
<td>C Lee</td>
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<td>Climate Change and the Draft Murray Darling Basin Plan.</td>
<td>T Stubbs</td>
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<td>Managing the Risks of Inundation and Erosion for Coastal Property and Ecosystems.</td>
<td>R Wise</td>
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<td>Exploring the Land of Blue Carbon Opportunities – Australia!</td>
<td>A Lawrence</td>
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<td>Lines on Maps: Where Do We Put Them - and Why!</td>
<td>G Hunt</td>
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<td>Understanding Coastal Urban and Peri-urban Indigenous People’s vulnerability and adaptive capacity</td>
<td>D Low Choy</td>
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<td>Future change in ancient worlds: Indigenous adaptation in northern Australia.</td>
<td>D Bird</td>
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<td>Towards climate change adaptation in Indigenous communities.</td>
<td>M Nursey-Bray</td>
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<td>Understanding End-user Decisions and the Value of Climate Information Under the Risks and Uncertainties of Future Climates.</td>
<td>T Capon</td>
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<td>Water and Climate Change: Interactions and Responses.</td>
<td>K Olsson</td>
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<td>Retreat or Defend? Planning for Change in Tasmania’s Coastal Zone.</td>
<td>J Harkin</td>
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<td>12.30 – 1.30pm Lunch</td>
<td>Grand Lobby</td>
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<td>Time</td>
<td>Parallel Session 36</td>
<td>Parallel Session 37</td>
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<tr>
<td>1.30 – 3.00pm</td>
<td>Learnings from Around the World</td>
<td>NCCARF Projects Speedtalks: Social, Economic and Institutional Dimensions</td>
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<td>1.30pm – 3.00pm continued</td>
<td>Mainstreaming Climate Change into the Red Cross Red Crescent Movement: a Solomon Islands Case Study. &lt;br&gt; R McNaught</td>
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<td>Social networks analysis. &lt;br&gt; S Kinnear &lt;br&gt; Costs and coasts. &lt;br&gt; R McAllister &lt;br&gt; Native Title and Climate Change Adaptation. &lt;br&gt; J Weir</td>
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<td>Overcoming Challenges for Decision Making About Climate Change Adaptation. &lt;br&gt; K Maani</td>
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<td>Drought and Fire Micro-refuges, Resilience and Climate Change. &lt;br&gt; B Mackey</td>
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<td>Planning For Adaptive Urban Water Systems Under An Uncertain Future. &lt;br&gt; P Mukheibir</td>
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<td>Coastal Urban Futures: from Wollongong to Lakes Entrance. &lt;br&gt; B Norman</td>
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<td>Migration, Climate Change and Environmental Security: a Case Study of Two Coastal Districts in Bangladesh. &lt;br&gt; T Sarker</td>
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<td>Rental housing, climate change and adaptive capacity. &lt;br&gt; J Palmer</td>
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<td>Enhancing the Adaptive Capacity of Small-to-Medium Enterprises. &lt;br&gt; N Kuruppu</td>
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<td>Impact of Climate Change on Disadvantaged Groups. &lt;br&gt; A Sevoyan</td>
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<td>FORAGE – a Web-based System for Delivering Climate, Remote Sensing and Model Calculations for Individual Grazing Properties on a ‘Lot on Plan’ Basis. &lt;br&gt; K Day</td>
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<td>Effective Communication for Community Adaptation to Bushfire in a Changing Climate – A Role for Local Government. &lt;br&gt; S Chaplin</td>
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<td>How to Balance Urban and Agricultural Water Related Needs Under Changing Conditions in the Maipo Catchment, Chile? &lt;br&gt; H Lehn</td>
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<td>Climate Change Assessment for Possible Future Landscapes: Hunter and Central Coasts. &lt;br&gt; P Morley</td>
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<td>Story-telling -the Use of Participatory Video in Communicating CBA Within and Between Communities, and Influencing Policy Decisions in Pacific Island Countries. &lt;br&gt; R James</td>
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<td>Cognitive and affective barriers to climate change adaptation. &lt;br&gt; P Bi</td>
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<td>Climate Change Beliefs and Irrigator Adaptability. &lt;br&gt; S Wheeler</td>
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<td>Preparing for the Impacts of Sea Level Rise in South Western Australia. &lt;br&gt; M. Woolf</td>
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<td>Reflecting on the adaptive capacity of the public policy sector of fire management. &lt;br&gt; K Bosomworth</td>
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<td>Emerging Issues for Climate Change Adaptation in Water Management. &lt;br&gt; B Rhodes</td>
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<td>Using Scenarios to Identify Adaptive Governance Regimes for Marine Biodiversity in a Changing Climate. &lt;br&gt; M Lockwood</td>
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| 3.30 – 3.30pm | Afternoon tea Grand Lobby |

| 3.30 pm – 5.00pm | Closing Plenary 5 Visioning a climate change adapted Australia in 2050 Room: Grand 1-4 |
|                 | Jon Barnett (University of Melbourne) – It ‘aint what you do, it’s the (why) and way you do it: characteristics of an adapting Australia |
|                 | Peter Cosier (Wentworth Group) – What is Failure and What is Success? |
|                 | Dave Griggs (Monash University) – Visioning a climate change adapted Australia in 2030 |
|                 | Voice of Youth |
|                 | Conference Wrap-up Jean Palutikof (NCCARF) & Andrew Ash (CSIRO) |
Plenary Speakers

Tuesday 26th June

Welcome to country

Aunty Diane Kerr, Wurundjeri Elder
The territory of the Wurundjeri lies within the inner city of Melbourne and extends north of the Great Dividing Ranges, east to Mt Baw Baw, south to Mordialloc Creek and west to Werribee River. They are the ‘Witchetty Grub People’ (‘Wurun’ meaning the river white gum or *Eucalyptus viminalis*, and ‘jeri’ meaning the grub that lives in the tree).

Aunty Diane Kerr will offer a traditional Welcome to the Land, as is her right and traditional role as senior woman of the Wurundjeri People.

Aunty Diane Kerr Wurundjeri Elder has worked tirelessly for the last 20 years on social, health and well-being issues that affect Indigenous People. Her working career has included community work at Dandenong & District Aboriginal Co-operative, child-care, Native Title, link up (part of Stolen Generations), education and cultural awareness to the wider community. All of this has led her to her current path of looking for ways to strengthen the social and emotional well-being of Aboriginal Peoples. Currently Aunty Di is working on a research project which looks at chronic conditions and how it affects people’s emotional health and wellbeing.

Plenary Session 1 – Climate change adaptation in Australia today

Simon McKeon, Chairman of CSIRO
Simon McKeon is Executive Chairman of Macquarie Group’s Melbourne office and was the 2011 Australian of the Year. He is also Chairman of CSIRO and Business for Millennium Development. Simon is Chairman of the Federal Government’s Panel conducting a Strategic Review of Health and Medical Research. Simon is a Director of VisionFund, World Vision International’s microcredit arm, Global Poverty Project and Red Dust Role Models.

He is an Australia Day Ambassador for the Victorian Government and serves on the Federal Government’s Human Rights Grants Scheme Advisory Panel, the Federal Government’s AusAID Business Engagement Steering Committee and the Victorian Government’s NDIS Implementation Task Force. He previously served as Founding President of the Federal Government’s Australian Takeovers Panel, Founding Chairman of MS Research Australia and Founding President of the Federal Government’s Point Nepean Community Trust.

Simon is the helmsman of *Macquarie Innovation* which in March 2009 became the first sailboat in the world to sustain more than 50 knots and in so doing, peaked at a speed of 100 kmh (54 knots). He is also a Patron of the Australian Olympic Sailing Team which won 2 gold and a silver medal at the 2008 Beijing Olympics.
Hon. Greg Combet AM MP, Minister Department of Climate Change and Energy Efficiency; Minister for Industry and Innovation

Greg Combet comes from a wine making family, growing up at Penfold’s Minchinbury cellars in the western suburbs of Sydney.

He studied mining engineering at the University of New South Wales, working in the coal industry and later in community organisations. After working in the field of occupational health and safety, he went on to become a union official, at the same time graduating with a Bachelor’s degree in Economics from the University of Sydney. He also has a Graduate Diploma in Labour Relations and the Law. He was awarded a Member of the Order of Australia in 2006.

Following the Labor Party’s Federal Election win in November 2007, Greg was appointed Parliamentary Secretary for Defence Procurement in the Rudd Labor Government.

In February 2009 he was appointed the Parliamentary Secretary for Climate Change and in June 2009 was appointed Minister for Defence Personnel, Materiel and Science and the Minister Assisting the Minister for Climate Change.

After the 2010 Federal Election, the Gillard Labor Government was formed on 7th September. Greg was promoted to Cabinet in the role of Minister for Climate Change and Energy Efficiency. In December 2011, Greg took on the additional responsibility as the Minister for Industry and Innovation.

Greg is a keen student of Australian labour history, a long time fancier of Gouldian finches and has a natural interest in the méthode Champenoise as it is applied to the production of sparkling Shiraz.

Blair Comley PSM, Department of Climate Change and Energy Efficiency

Blair Comley commenced as Secretary of the Department of Climate Change and Energy Efficiency in February 2011.

Prior to this appointment, Blair was a Deputy Secretary in the Department of Climate Change and Energy Efficiency with executive oversight for the climate change strategy and market instruments, international climate change policy and issues related to the land sector.

Previously, Blair held a range of senior positions in the Treasury including as General Manager of the Business Tax Division, Indirect Tax Division, Macroeconomic Policy Division and the Debt Management Review Team. Blair also represented Australia for three years on economic matters at the OECD and was the Acting Chief Executive Officer of the Australian Office of Financial Management with responsibility for managing the Australian Government’s debt and related derivative portfolio.

Blair previously worked on competition policy, environment policy and welfare reform. Before joining the Treasury in 1994, Blair worked at the Industry Commission and was a lecturer in the Department of Economics at Monash University.

Blair holds a Bachelor of Economics (Honours) and a Master of Economics from Monash University and a Graduate Diploma in Legal Studies from the Australian National University.
Wendy Craik AM, Productivity Commission

**Regulatory and policy barriers to climate adaptation: draft report**

In this presentation, Dr Craik will outline the key recommendations from the Productivity Commission’s draft inquiry report into Regulatory and Policy Barriers to Effective Climate Change Adaptation.

The Productivity Commission received terms of reference to commence this inquiry in September 2011. In response, the Commission has examined potential barriers in areas such as information provision, land-use planning and building, local government and emergency management. The Commission will hand the final report of the Inquiry to Government in September. The Commission is accepting submissions on the draft report, and will hold public hearings in July.

Wendy Craik AM was appointed a full-time Commissioner of the Productivity Commission in June 2009 and is currently the Presiding Commissioner on the inquiry into Barriers to Effective Climate Change Adaptation and a Commissioner on the Electricity Network Regulation inquiry. Wendy previously worked on Australia’s Urban Water Sector, Economic Regulation of Airport Services and the Wheat Export Market Arrangements inquiries.

Wendy was Chief Executive of the Murray-Darling Basin Commission from 2004 to 2008. Prior to this Wendy was President of the National Competition Council, Chair of the Australian Fisheries Management Authority and Chair of the National Rural Advisory Council. Other former positions include Chief Executive Officer of Earth Sanctuaries Ltd, a publicly listed company specialising in conservation and eco tourism, Executive Director of the National Farmers Federation, and Executive Officer of the Great Barrier Reef Marine Park Authority. She has also worked as a consultant for AcilTasman Consulting.

Wendy holds a Bachelor of Science (Hons) from the Australian National University, a PhD (Zoology) from University of British Columbia, Vancouver, and a Graduate Diploma in Management from the Capricornia Institute of Advanced Education, Queensland.

Wendy was awarded the Member of the Order of Australia in 2007 for service to the natural resource sector of the economy, particularly in the areas of fisheries, marine ecology and management of water reform, and for contributions to policies affecting rural and regional Australia.

Lesley Hughes, Climate Commission; Macquarie University

**The Climate Commission: Conversations with the Australian public**

The Climate Commission was established by the federal government in February, 2011 to provide an independent voice on climate change and to help build the consensus required to move to a competitive, low carbon economy. The terms of reference for the Commission are to explain the science of climate change and the impacts on Australia, to report on progress of international action, and to explain the operation of a carbon price.

The Commission has now held 16 public outreach events, visiting every state and territory. We have also held many meetings with business and community organisations, schools, local, state and federal government representatives, and research organisations, and produced a series of thematic and regional reports on climate change impacts.

Overall, the Commission has found that the Australian public has a hunger for clear and credible information about climate change, and that many people are eager for advice about how they can personally contribute to climate change mitigation. We have also found that there is a very wide range of preparedness amongst businesses and local governments with regard to climate change adaptation but that many are factoring in climate change risks into their future planning.

Lesley Hughes is an ecologist at Macquarie University who researches the impacts of climate change on Australian species and ecosystems. She was a Lead Author for the IPCC Fourth Assessment Report and is continuing in this role for the Fifth Assessment Report. She is a former Chair of the NSW Scientific Committee and former co-convenor of the ARC Earth System Science Network. She currently co-convenes the Terrestrial Biodiversity Network for the National Climate Change Adaptation Research Facility (NCCARF), is a member of the Land Sector Carbon and Biodiversity Board, and is one of the six federal Climate Commissioners.
Plenary session 2 – Health, society and adaptation

**Tony McMichael,** Australian National University

**Reducing health risks: Setting the adaptation task in context**

Adaptation in relation to health requires, first, a fuller knowledge of climate-health risk relationships, including for higher-risk sub-populations. That knowledge is now accruing. Meanwhile some initial, intuitively obvious, adaptation is beginning to happen (e.g. early warning systems for heatwaves, stricter protocols for avoiding workplace heat stress, controls on mosquito breeding sites). There are three generic pitfalls if adaptation is pursued at the expense of mitigation. First, we may delude ourselves into thinking this is all we need to do – i.e. marginal muddling through over time (with a misplaced linear ‘model’ of future increased stress). Second, we may forget our privileged position and drift into the ‘Going It Alone’ adaptation elite, while poorer countries lack resources to do likewise. Third, the health sector, specifically, is (naturally) more comfortable in shoring up response capacities against increased future demand for services than in joining inter-sectoral planning of genuine preventive strategies (housing design, food system resilience, low emissions transport modes to pre-empt amplification of ambient air pollution). As counterpoint, adaptation can not only protect against the climate change-related risk increment but can extend its reach to reduce the underlying pre-existing component of the problem. Mitigation skims off the increments (for all sectors); adaptation can dig deeper into any one or more sectors.

**Kristie Ebi,** Stanford University

**But is it adaptation?**

Public health and health care institutions and organizations are increasingly incorporating weather, climate variability, and other environmental variables into programs and measures designed to reduce the burden of climate-sensitive health outcomes; doing so can improve the efficiency and effectiveness of early warning systems and other activities. Reducing the current adaptation deficit is presumed to increase the resilience of communities, regions, and nations to future climate change. However, mainstreaming consideration of current weather patterns into public health activities facilitates adaptation to climate change only when there was explicit consideration of short- and longer-term projected changes in the means and extremes of weather variables over time, factoring in uncertainties about the implications of development pathways for the health outcome, and taking into account multiple stakeholder objectives and preferences. It is important for programs and measures to be designed from the perspective that decisions are provisional and modifications are to be expected. Adaptation explicitly incorporates iterative monitoring and evaluation of programs and measures to determine their effectiveness in avoiding, preparing for, and responding to ongoing changes in climate and other drivers, using this information to update knowledge and adjust programs accordingly.

**Kristie L. Ebi** is a Consulting Professor in the Department of Medicine, Stanford University and the Executive Director of the IPCC WGII Technical Support Unit. Prior to these positions, she was an independent consultant conducting research on the impacts of and adaptation to climate change, including on extreme events, thermal stress, foodborne safety and security, and vectorborne diseases. She has worked with WHO, UNDP, USAID, and others on assessing vulnerability and implementing adaptation measures in Central America, Europe, Africa, Asia, and the Pacific. She facilitated adaptation assessments for the health sector for the states of Maryland and Alaska. She was a coordinating lead author or lead author in the IPCC Fourth Assessment Report, the Millennium Ecosystem Assessment, the International Assessment of Agricultural Science and Technology for Development, and two US national assessments. Dr. Ebi’s scientific training includes an M.S. in toxicology and a Ph.D. and a Masters of Public Health in epidemiology, and two years of postgraduate research at the London School of Hygiene and Tropical Medicine. She has edited fours books on aspects of climate change and has more than 100 publications.
**Alistair Woodward**, University of Auckland

**Adapting to protect health under climate change: general or specific?**

There is plenty of evidence that climate change acts largely as a risk multiplier – the present and projected effects on human health are concentrated in populations that already carry relatively large burdens of disease and injury. What does this mean for adaptation? How far will improved disaster preparedness and better public health, in general, take us? And, what are the special elements of climate change that require special responses? In an attempt to answer these questions, I will draw on the experience of coping with earthquakes in Christchurch, the challenges of providing sanitation in Kiribati and the long-term consequences of the 2003 French heat-wave.

**Alistair Woodward** is Head of the School of Population Health at the University of Auckland. He is a medical graduate from the University of Adelaide, and has worked in universities in Australia, the UK and New Zealand. His research interests are in environmental epidemiology and tobacco control, and he has been involved in work on climate change for more than 15 years. He and Kirk Smith are leading the writing of the health chapter for the 5th assessment report of the IPCC.

**Neville Nicholls**, Monash University

**Neville Nicholls** spent 35 years in climate research in the Bureau of Meteorology before joining Monash University in 2006 where he is an Australian Research Council Professorial Fellow.

His research has included using the El Niño – Southern Oscillation to predict climate variations such as droughts and seasonal tropical cyclone activity, examining climate and weather impacts on agriculture, ecosystems, and human health, and developing and analysing data sets for monitoring climate variations and change.

Neville is President of the Australian Meteorological and Oceanographic Society, and an editor of the journal Wiley Interdisciplinary Reviews: Climate Change. He was a Coordinating Lead Author for the Intergovernmental Panel on Climate Change (IPCC) Special Report "Managing the risks of extreme events and disasters to advance climate change adaptation" released in 2012.

**Evening poster session**

**Cr Rachel Powning**, Mayor City of Port Phillip

**Rachel Powning** was elected to Port Phillip Council in 2008 and to the role of Mayor in 2010. She has lived in Port Phillip for almost 25 years.

As a Councillor Rachel is committed to accelerating action on climate change, including the important role for local government of advocating to other levels of government. She is also strongly committed to equity and diversity in her community, and to improving access to critical community services such as quality childcare.

Rachel sits on a number of Port Phillip committees and also currently serves on the Boards of Community Chef and the Linden Gallery.

Prior to her now full time role as Mayor, Rachel worked as a management consultant to state and local government, and has had prior careers in the international development sector, local government and public relations. Rachel qualifications include a BA Hons, a MA in International Relations, and she is a Graduate of the Australian Institute of Company Directors.
Wednesday 27th June

Plenary session 3 – Business as usual? How is business adapting

**Gareth Johnston**, Future Ready

Gareth Johnston, Executive Director and Founder of Future Ready, has spent the last 15 years advising Australian and international public and private companies, government and community on environmental risk, climate response, adaptation and resilience. While Victoria’s bush fires and Queensland’s floods have heightened risk managers adaptation awareness and prompted some directors to prepare and act earlier than in the past Gareth believes much still remains to shift thinking from short term through medium to long term planning.

**John Trowbridge**, National Disaster Insurance Review

Climate Change: Insurance Industry Impact and Response

The insurance industry has an abiding interest in climatic events e.g. cyclones, storms, bushfires, floods, landslides, tsunamis and coastal storm surge. Accordingly it has a major stake in any changes to the climate that might alter the frequency, severity and locations of climatic events. When severity of events increases there can be an exponential increase in property damage. Even without climate change, the industry is concerned about increasing exposures through greater aggregations of property risk (urbanisation and development of coastal areas, riverfronts and floodplains). Climate change ‘ups the ante’. But note that the industry manages much of the temporal risk of climate change by operating mainly with one year policies. Hence much of the risk of climate change is transferred through premium adjustments to the buyers of insurance.

John Trowbridge was a government appointed Member of the Executive Group of the Australian Prudential Regulation Authority (APRA) from 2006 – 2010 after a distinguished career in the actuarial profession and in the insurance industry, holding consulting, executive and director roles. After completing his consulting career in 2002, he led Suncorp’s insurance business for a period and was subsequently a local director of Munich Reinsurance. He was the panel Chairman of the Natural Disasters Insurance Review that released its final report in 2011.

**Mark Howden**, CSIRO

Australian agriculture – adapting as usual?

Australian agriculture is constantly adapting. These adaptations have changed the face of the industry, and the communities which depend on them. Changes in relative profitability caused by changes in markets, productivity and technology have led to changes in the numbers and size of farms, and their location. Drivers include product and input prices, market access, technology, policy and climate. This presentation addresses whether 1) there is evidence of adaptation to climate changes already across parts of the agricultural value chains and 2) adapting to climate change is different from adapting to other driving variables. There is strong evidence of high rates of adoptions of incremental adaptations (e.g. changes in inputs to existing systems) such as zero tillage in cropping systems but the drivers of these are generally confounded with other changes consistent with good practice in dealing with Australia’s variable climate. There is similarly some evidence of systemic change (adoption of fundamentally new practices) but these are often confounded by changes in total factor productivity for other reasons. Perhaps the clearest climate adaptation signal comes from the small number of transformational adaptations so far, such as the partial relocation of the wine, rice and peanut industries. We suggest that adaptation to climate change is qualitatively different from dealing with other drivers of change, and requires holistic responses that integrate farm-level management practice, industry and government policy. Hence climate adaptation in this sector is somewhat ‘business as usual’.

Dr Mark Howden is a Chief Research Scientist with CSIRO Ecosystem Sciences, Canberra, Australia. He is also the Theme Leader of the ‘Adaptive primary industries, enterprises and communities’ theme in the CSIRO Climate Adaptation Flagship and is an Honorary Professor at Melbourne University, School of Land and Food. Mark’s work has focussed on the impacts of climate on Australian ecosystems and urban systems dealing with amongst other things: the dynamics of grazed and cropped ecosystems, development of innovative and sustainable
farming systems, biodiversity, energy systems and water use. He has also developed the national (NGGI) and international (IPCC/OECD) greenhouse gas inventories for the agricultural sector and assessed sustainable methods of reducing greenhouse emissions from agriculture. Mark has worked on climate change issues for over 22 years in partnership with farmers, farmer groups, catchment groups, industry bodies, agribusinesses, urban utilities and various policy agencies. He has been a major contributor to the Intergovernmental Panel on Climate Change (IPCC) Second, Third, Fourth and Fifth Assessment reports, the IPCC Regional Impacts Report and the IPCC Special Report on ‘Land use, land use change and forestry’ that addressed issues of carbon sequestration and the Kyoto Protocol, sharing the 2007 Peace Prize with other IPCC participants and Al Gore.

Mark Rogers, Colonial First State Global Asset Management

Infrastructure Assets and Climate Change Action – Funding Resilience

Summary: a broad discussion on infrastructure asset resilience to climate change and the necessity to build business cases around climate change mitigation to protect asset value and the operational integrity of infrastructure assets. Many infrastructure assets operate as critical components of domestic and international economies and provide crucial social services in a community, the evidence points to climate change posing significant additional operational pressure on existing and new build assets as storm events, sea level rises, floods and droughts change the operating environment of these assets. Infrastructure assets are also typical very long life assets (beyond 50 year operating life). A case study will be provided outlining how climate change can be factored into asset resilience for long life assets.

Mark Rogers was appointed Asset Manager, Infrastructure Investment at Colonial First State Global Asset Management in March 2007. Mark is responsible for the development and implementation of asset management strategies for the various portfolio assets and is involved in due diligence during the investment decision processes for Colonial First State’s Infrastructure Investment team. Prior to joining Colonial, Mark was a senior policy officer working on the Federal airport sale process and the development of the regulatory framework for the newly privatised Federal airports. He has also been involved in government liaison, regulatory approvals and regulatory compliance issues for a large number of major infrastructure projects in Australia and New Zealand. Mark has over 16 years experience on all sides of the infrastructure sector from his involvement with the Department of Transport and Regional Services, his private consulting experience in major infrastructure projects and his work with Origin Energy in project construction and operation in the oil and gas sector. He is also Deputy Chair of the Australian Green Infrastructure Council.

John Thwaites, Australian Building Codes Board

National Construction Code facilitating adaptation to climate change

In 2007, COAG endorsed a National Adaptation Framework as part of its Plan of Collaborative Action on Climate Change. A focus of the Framework is to support decision-makers understand and incorporate climate change into policy and operational decisions at all scales and across all vulnerable sectors. An area of action identified in the Framework is the revision and development of codes, standards and guides to increase resilience to climate change.

Buildings have a major role in reducing the impacts of natural hazards. Because buildings are usually expected to last at least 50 years, it is important they can cope with future natural hazard events. This is particularly so when considering that half of all buildings expected to exist in 2060 have yet to be constructed. So, the Code can contribute to positive adaptation of the Australian building stock to climate change.

The paper will outline where the National Construction Code (NCC) fits: in the adaptation to climate change. The paper will focus on the impact of the NCC on business, how business is adapting and how business is involved in the development of the NCC. Case studies relating to climate change will be presented. The paper will also outline the research needs to assist in the development of the NCC in response to climate change.
John Thwaites was appointed Chair of the Australian Building Codes Board in November 2011. John is a Professorial Fellow at Monash University and Chair of ClimateWorks Australia and the Monash Sustainability Institute which promotes interdisciplinary sustainability research including building energy efficiency. He is a consultant at Maddocks Solicitors providing advice to the firm and its clients on climate change, water, sustainability and corporate social responsibility. He also chairs a number of other groups looking at climate change, culture and social responsibility. In 2008-2009, John was a special adviser to the Timor-Leste Minister for Infrastructure and helped develop an Infrastructure plan for Timor-Leste. John was Deputy Premier of Victoria from 1999 until his retirement in 2007 during which he held Ministerial portfolios responsible for health, planning, environment, water and communities. He was Victoria’s first Minister for Climate Change. He has degrees in Law (Honours) and Science from Monash University.

David Karoly, University of Melbourne

**Climate Change and Societal Responses: Reflections from a Slow Learner**

David Karoly will reflect on 25 years of climate change science and action on adaptation and mitigation, as well as political and societal responses in Australia and overseas. This journey will wander from the first CSIRO Greenhouse conferences in the 1980s and the first IPCC assessment report in 1990 to where we are now, and how these experiences can shed light on the path ahead.

**David Karoly** is leader of the Climate Change theme in the Melbourne Sustainable Society Institute and Professor of Climate Science in the School of Earth Sciences at the University of Melbourne. Professor Karoly is an internationally recognised expert in climate change and climate variability, including greenhouse climate change, stratospheric ozone depletion and interannual climate variations due to El Nino-Southern Oscillation. He was heavily involved in preparation of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) released in 2007, in several different roles. Professor Karoly was Chair of the Premier of Victoria’s Climate Change Reference Group during 2008 and 2009. He is a member of the Science Advisory Panel of the Australian Climate Commission and a member of the Wentworth Group of Concerned Scientists. His international activities include as a member of the Joint Scientific Committee of the World Climate Research Programme.

**Thursday 28th June**

**Plenary session 4 – International Developments**

Francis Zwiers, PCIC, University of Victoria

**On the attributes and challenges of regional climate services**

The ultimate measure of the success of the Global Framework for Climate Service will be whether it succeeds in delivering “actionable” climate information to those who must make decisions that affect outcomes that are sensitive to the state of the climate. That is, the GFCS will be successful if it delivers information that is useful for adaptation, in a broad sense, to climate variability and change on timescales from a season to decades or centuries. Success will be determined (i) by the means that are used to determine what information is delivered, (ii) by the quality, utility and timeliness of the information that is delivered, and (iii) by how and to whom the information is delivered. Regional climate service providers will play an important role in that success. This talk describes some of the attributes of a regional climate service, and how it relates to climate services that are delivered on a wider scale. It is based on our experience in Canada, which is a large and regionally diverse country. The delivery of climate services in Canada is evolving towards a multi-tiered system that involves international providers, national providers, regional services (such as PCIC), and private sector consultants.

**Francis Zwiers** is the Director of the Pacific Climate Impacts Consortium at the University of Victoria, a regional climate service for British Columbia and surrounding areas. He is well known as an expert on the application of statistical methods to the analysis of observed and simulated climate variability and change, and for his participation in the IPCC as an author and Bureau member.
Mark Stafford Smith, CSIRO

**Planet under pressure: new knowledge towards solutions in 2012**

2012 could and should be a seminal year in earth system history. In March 2012 the *Planet Under Pressure: New Knowledge Towards Solutions* conference brought together scientists, policy makers, industry and civil society to discuss the increasingly urgent issues about global sustainability that are facing us, and resulted in the first State of the Planet Declaration. Its highest level conclusion was that the Anthropocene – a new geological epoch based on the recognition that the impact of humanity on the world is now of geological proportions – symbolises the need for a profound re-assessment of our relationship with, and responsibility for, our planet. If we want it to continue to deliver the goods and services – clean air, stable climate, adequate freshwater, food, energy – that have benefitted the development of civilisation during the Holocene, then we must take on planetary stewardship to ensure this. As a consequence, the Rio+20 UN global sustainability summit in June 2012 takes on a new significance – it must commit to establish the changes in institutions which could make this possible. The message from science is one of urgency – we cannot delay in the face of an accelerating suite of complex, interconnected problems – and yet opportunity – the past decade has seen an explosion of understanding not only about what to do, but how to do it.

Mark Stafford Smith is Science Director of the CSIRO Climate Adaptation Flagship, coordinating science undertaken across the Flagship’s research themes. He was co-chair of the *Planet Under Pressure: New Knowledge Towards Solutions* global change conference in London in March 2012, and has contributed to feeding its results into the Rio+20 process. By background, he is a desert systems ecologist and past CEO of the Desert Knowledge Cooperative Research Centre (CRC), focusing on the science of desert living and sustainable management of outback environments.

Neville Smith, Bureau of Meteorology

**Progress with the IPCC Fifth Assessment Report on Impact, Adaptation and Vulnerability**

The Intergovernmental Panel on Climate Change is mid-way through the Fifth Assessment cycle and is due to consider and approve the Synthesis Report toward the end of 2014. Working Group II which has responsibility for the scientific assessment of impacts, adaptation and vulnerability is due to accept its Report and approve the Summary for Policy Makers in March 2014. The Working Group II Expert Review of the First Order draft runs for eight weeks commencing 11 June. The second order draft is due in early March 2013. This presentation covers the Working Group II approach to the fifth assessment, the expert meetings and workshops that are informing the assessment, and the outcomes from the two Special Reports that have been completed during this cycle. Coordination of cross-cutting issues that involve other working groups will also be addressed. The Intergovernmental Panel on Climate Change has undergone significant transformation during 2011 and 2012 and the implications of this transformation for Working Group II will be discussed.

Neville Smith is the Deputy Director (Research and Systems) at the Bureau of Meteorology. Dr Smith was previously the Bureau Chief Scientist and head of the Bureau of Meteorology Research. He is currently responsible for the Research and Systems Division in the Bureau, including the Bureau’s observing system and communications and computing infrastructure.

Dr Smith is a member of the Intergovernmental Panel for Climate Change Bureau as vice-chair of Working Group 2, the Group responsible for impacts, adaptation and vulnerability scientific assessments. He is also national focal point for the Intergovernmental Oceanographic Commission. He was elected to the Academy of Technological Sciences and Engineering in 2005.
**Ian Noble, Global Adaptation Institute**

Ian Noble is Chief Scientist at the Global Adaptation Institute. He recently retired as Lead Climate Change Specialist at the World Bank.

Before joining the Bank in 2002 he was Professor of Global Change Research at the Australian National University. An ecologist by training, he held senior roles in the IPCC process and in international cooperative research on climate change as part of the International Geosphere Biosphere Program (IGBP) including chairing the Global Change and Terrestrial Ecosystems (GCTE). In Australia he participated in the public and policy debate over responses to climate change and served as a Commissioner in an inquiry into the future of the Australian forests and forest industries.

**Plenary session 5 – Visioning a climate change adapted Australia in 2050**

**Jon Barnett, University of Melbourne**

*It ‘aint what you do, it’s the (why) and way you do it: characteristics of an adapting Australia*

In order to adapt we need to know why we are adapting. This is of course a matter for deliberation through democratic institutions. But that takes time, and not all voices are equal, which is why democracy produces least-worst outcomes, not necessarily good ones. So instead, in this paper I explain why we should adapt, and how we should do it (I was asked, I said yes).

The goal of this adaptation manifesto is fairness, with respect to both the distribution of social opportunities, and with respect to influence in social processes. The problem with changes arising from climate change is that they seem likely to undermine this goal of a fair Australia: through changes in environments, and changes in institutions in anticipation of or response to the changes in environments. So, adaptation is a matter of ensuring fairness despite climate change.

To achieve fairness in a climate change future the state will need to be more purposeful, including with respect to: the deepening of government, including formalizing the place of local governments in the Australian system of governments; greater protection of public goods, including water and carbon; transformation of vulnerable sectors and places; and selective opening of Australian labour markets to the world.

Jon Barnett is a Professor in the Department of Resource Management and Geography at Melbourne University. He is a political geographer whose research investigates the impacts of and responses to climate change on social systems, with a focus on risks to human insecurity, hunger, violent conflict, and water stress. He has done extensive field-work in the South Pacific, China, and East Timor. Jon is convenor of the national research network on the social, economic and institutional dimensions of climate change, which is part of the National Climate Change Adaptation Research Facility, and is a Lead Author for the forthcoming Fifth Assessment Report of the IPCC. He is the Executive Editor of the adaptation domain of *Wiley Interdisciplinary Reviews Climate Change.*
**Peter Cosier**, Wentworth Group of Concerned Scientists

**What is failure and what is success?**

If Australia has failed to adapt in 2050, many formerly high conservation value ecosystems would have been locked up disconnected from the landscape and unable to adapt. Land would have been carved up into ‘food producing’ and ‘biodiversity producing’ leaving no space to move as species and communities shift. Threats of fires and invasive species would find it easy to move across the landscape as a result of poorly thought out wildlife corridors. We would have covered large parts of the continent in trees for carbon sequestration leaving no room for water or food. And we would be flying blind without systems of environmental information.

On the other hand, a well-adapted Australia in 2050 would have seized the opportunities presented by a new terrestrial carbon economy, created by climate change mitigation policies, to rehabilite degraded land and build resilience into Australian landscapes and. We would have rethought our traditional preservationist approach to nature conservation and have worked out environmentally sustainable ways to increase food production to meet rising demand. We would have reduced other threats to biodiversity, for example, by returning enough water to river systems to ensure their health. We can only achieve all this if we build a system of environmental accounts that enables us to detect and measure change in the condition of our environmental assets to inform economic and environmental decision-making.

**Peter Cosier** is the Director and a Founding Member of the Wentworth Group of Concerned Scientists, a privately funded institution established in 2002 with the aim of connecting science to public policy in Australia. He has a background in science, specialising in natural resources management and urban and regional planning. His expertise is environmental policy. The Wentworth Group’s recent work: Optimising Carbon in the Australian Landscape blueprint, outlined how terrestrial carbon offsets can be used to repair degraded landscapes, restore and conserve biodiversity and improve the condition of agricultural soils.

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**Dave Griggs**, Monash University

**Visioning a climate change adapted Australia in 2030**

The presentation will use generic stepwise approach to adaptation but will populate this approach with examples specific to coastal communities. The first part of the approach is to reduce risks. This is done in two ways, reducing vulnerability of the community, for example through poverty reduction and livelihood diversification, and also reducing the communities exposure to those hazards, for example though building regulation and defensive infrastructure such as sea defences.

However, it is not possible practically or financially to avoid all risk so at some point a level of residual risk must be accepted. This residual risk and uncertainty must then be managed. The second part of the approach sets out three steps to do this. Firstly risks can be pooled, transferred or shared, e.g., through insurance. Secondly, communities will need to prepare for and respond effectively to unavoidable events, for example through early warning, evacuation plans and post disaster support. Finally the community needs to increase its capacity to cope with “surprises”. This requires flexibility in decision-making, adaptive learning and management and improved knowledge and skills.

The talk will also present the findings of a recent consultation exercise that has taken place with two small coastal communities in Gippsland (Sandy Point and Inverloch) and their vision for a well adapted community.

**Dave Griggs** In September 2007 Dave moved to Australia to become Director of the Monash Sustainability Institute (MSI) which aims to deliver solutions to key sustainability challenges. In November 2008 he also became CEO of the newly created organisation ClimateWorks Australia (CWA), focussed on action to reduce greenhouse gas emissions. Previous positions he has held include UK Met Office Deputy Chief Scientist, Director of the Hadley Centre for Climate Change, and Head of the Intergovernmental Panel on Climate Change (IPCC) scientific assessment unit. Dave is a past vice-chair of the World Climate Research Programme and member of the Victorian Ministerial Reference Council on Climate Change Adaptation. He is a Fellow of the Australian Academy of Technological Sciences and Engineering (ATSE), a member of the Australian Council of Environmental Deans and Directors and the Climate Institute Strategic Council. Dave was awarded the Vilho Vaisala award (World Meteorological Organization) in 1992.
Panel Sessions

Panel Session 1: The trend toward effectiveness
The rapid shift from adaptation as something that ‘might’ be needed to something that ‘will’ be needed has resulted in a plethora of projects, programmes and initiatives to promote, fund and assist in the implementation of adaptive actions. Along with this shift has come an active debate on how to create ‘optimal’ adaptation outcomes. This debate is occurring at the international level in relation to ensuring effective adaptation in a development context. At the national and sub-national contexts governments and communities are striving to design and implement ‘good’ adaptation activities. Two years on from the first International Climate Change Adaptation Conference we are reconvening a panel on the trend toward effectiveness in adaptation. Where have we come to in the past two years? Are we getting any closer to effective adaptation?

Chair: Andrew Ash (CSIRO)
Panel members:
Habiba Gitay (World Bank)
Will Steffen (Australian National University)
Russell Wise (CSIRO)
Kate Nelson (East Gippsland Shire Council)

Panel Session 2: Barriers to adaptation
In all efforts to plan and action climate change adaptation there are barriers at a variety of different institutional levels. These are often identified as preventing adaptation from occurring or making it less efficient or effective, or making costs prohibitive. In this panel session we consider communication, economic, psychological and legal barriers to adaptation. What are they? Can they be overcome?

Chair: Graeme Pearman
Panel members:
Simon Torok (CSIRO)
Neil Byron (Productivity Commission)
Joe Reser (Griffith University)
Jan McDonald (University of Tasmania)

Panel Session 3: Policy-relevant knowledge for adaptation: bridging the science-policy gap
We hear much about the need for ever more detailed information on future climate change as a precursor to adaptation action, and examples of the application of this detailed information do exist, but they are few and far between. We have brought together a group of people concerned with adaptation in very different contexts: the reinsurance industry, river basin planning, research and state government, to discuss their science knowledge needs. What information do decision makers need in order to act in the adaptation space? How much information is required to make robust decisions about adaptation?

Chair: Francis Zwiers (University of Victoria, Canada)
Panel members:
Karl Jones (Willis Re)
Steve Dovers (Australian National University)
Jason Alexandra (Murray Darling Basin Authority)
Rohan Hamden (SA Department of Environment and Natural Resources)
Panel Session 4: Collaborative adaptation: How university-government partnerships turn adaptation research into policy and practice

**Sponsor:** Victorian Centre for Climate Change Adaptation Research

This session will present research projects that has been undertaken by VCCCAR and examine the relationship between policy makers and scientists. The panel will discuss co-benefits for policy makers and scientists in the adaptation field and also examine the opportunities and barriers to improved interaction between this two areas.

**Chair:** Rod Keenan (VCCCAR)

**Panel members:**
- Hartmut Fuenfgeld (RMIT University)
- Halley McCann (Department of Sustainability and Environment)
- Paula Arcari (RMIT University)
- Christine Kilmartin (Department of Planning and Community Development)
- Lauren Rickards (Melbourne University)
- Leon Soste (Department of Primary Industries)

Panel Session 5: Science for adaptation

This Panel is intended to update conference participants on the latest developments in climate change science which are of relevance to practitioners in adaptation. We are all familiar with the concept of uncertainty in projections of future climate change, but some of the uncertainty for adaptation practitioners is because we simply don’t know where to go to get the latest, most up-to-date, information. The panelists are all world leading scientists based in Australia – we have asked them to explain to the audience the very latest developments, in language accessible to the non-specialist. Their expertise covers future emissions scenarios, sea-level rise, and future global and regional climate change. There will be opportunity for questions and discussion.

**Chair:** Jean Palutikof (NCCARF)

**Panel Members:**
- John Church (CSIRO)
- Malte Meinhausen (University of Melbourne)
- Nathan Bindoff (University of Tasmania)
- Andy Pitman (University of NSW)

Panel Session 6: Supporting adaptive decision making in the Pacific Basin

The Pacific is at the forefront of climate change impacts. Sea level rise, storm surge, extreme events, changed rainfall patterns and coastal erosion are threatening Pacific communities with potential upheavals to communities. As these nations face the impacts and build mechanisms to adapt to change, what is Australia’s role in supporting effective adaptive decision-making – if any? In turn, what can Australia learn from the experience of our Pacific neighbours to help domestic adaptation priorities?

**Chair:** Rob Kay (Adaptive Futures)

**Panel Members:**
- Chalapan Kaluwin (PNG University)
- Kevin Henessy (CSIRO)
- Arthur Webb (SOPAC)
- Vic McGrath (Torres Strait Regional Authority)
Panel Session 7: Maladaptation, misguidance and missed chances

Sponsor: Commissioner for Environmental Sustainability, Victoria

Historically, we have responded to disasters better than we have planned to minimise their impact. However, uncertainty in climate change, as in every other area where complex decisions are made, is an incentive for innovation and creativity. For those making adaptation decisions, it can be tempting to choose a particular future climate scenario and make the best decision under that scenario (referred to as an “optimal” decision). However, it is becoming increasingly important to re-think how we plan for climate change. Focussing on “optimal” outcomes could lead to maladaptation - misguided investments and infrastructure that is inadequate for mid-century climate conditions. “Robust” decisions - those that are least sensitive to future climate conditions, or that will be good decisions regardless of the extent of future changes in climate - make more sense strategically when faced with an uncertain future. The session will adopt an Oxford-style debating format, pivoting upon audience participation, and calling for pre- and post discussion votes on the observation that Robust decision making in public policy is undermined because scientists are not central to the decision-making process.

Chair: Kate Auty (Commissioner for Environmental Sustainability, Victoria)
Panel Members:
Roger Jones (University of Victoria)
Fran Thorn (former Secretary, Victorian Department of Health)
Peter Christoff (Melbourne University)

Panel Session 8: Special marine symposium

Changes in climate variability and extremes, as well as climate change trends, are expected to impact on Australia’s marine ecosystems and resources – with, for example, biophysical consequences for the marine environment, and distributional changes to fish stocks. Climate change impacts are also expected to have social and economic consequences that are likely to influence debates over management options and outcomes. This panel session will discuss issues related to managing marine ecosystems and/or resources in a warming world. Example issues might include: future harvest strategies; adaptation of cross-jurisdictional management arrangements associated with changing species and/or stock distributions; or ecosystem-based management approaches.

Chair: Marcus Haward (University of Tasmania)
Panel Members:
Kevin Stokes (NZ Seafood)
Alistair Hobday (CSIRO)
Eric Perez (Queensland Seafood Industry Association)
Nick Caputi (Department of Fisheries Western Australia)
Gretta Pecl (University of Tasmania)
Guide to the Parallel Sessions

For the convenience of conference participants, we have organised the parallel sessions into areas of common interest, or ‘threads’. In deciding which parallel session to attend, it may help you to follow a thread. But this is only provided as a guide – there is no requirement to stay with a single thread throughout the conference.

<table>
<thead>
<tr>
<th>Conference threads</th>
<th>Sessions</th>
<th>When and where</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory and action</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maladaptation, Misguidance and Missed Chances</td>
<td>Panel 7</td>
<td>Tues 11.00-12.30pm, State 1&amp;2</td>
</tr>
<tr>
<td>Measuring the Success of Adaptation</td>
<td>1</td>
<td>Tues 3.30-4.30pm, Park</td>
</tr>
<tr>
<td>Barriers and Limits to Adaptation</td>
<td>7, 14</td>
<td>Tues 3.30-5.35pm, Lake 3&amp;4</td>
</tr>
<tr>
<td>Regional Case Studies of Adaptation</td>
<td>29</td>
<td>Thurs 11.00-12.30pm, Park</td>
</tr>
<tr>
<td>Learnings from Around the World</td>
<td>36</td>
<td>Thurs 1.30-3.30pm, Park</td>
</tr>
<tr>
<td>Economic and institutional dimensions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local Government</td>
<td>3, 10</td>
<td>Tues 3.30-5.35pm, Lake 1&amp;2</td>
</tr>
<tr>
<td>Economics, Financial Instruments and Business Strategies</td>
<td>17</td>
<td>Wed 2.00-3.30pm, Lake1&amp;2</td>
</tr>
<tr>
<td>Legal, Regulatory and Governance</td>
<td>24</td>
<td>Wed 4.00-5.30pm, Lake1&amp;2</td>
</tr>
<tr>
<td>Turning Science into Policy for Adaptation</td>
<td>31</td>
<td>Thurs 11.00-12.30pm, Lake1&amp;2</td>
</tr>
<tr>
<td>Decision Support Tools for Adaptation</td>
<td>38</td>
<td>Thurs 1.30-3.00pm, Lake1&amp;2</td>
</tr>
<tr>
<td>Communication and community engagement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication of Information for Adaptation</td>
<td>4, 11, 18</td>
<td>Tues 3.30-5.35pm, Grand1&amp;2 Wed 2.00-3.30pm, Grand1&amp;2</td>
</tr>
<tr>
<td>Cognitive Barriers to Adaptation</td>
<td>25</td>
<td>Wed 4.15-5.45pm, Grand1&amp;2</td>
</tr>
<tr>
<td>Human health and society</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Human Impacts and Health Adaptation to Climate Change</td>
<td>2, 9, 16</td>
<td>Tues 3.30-5.35pm, State 1&amp;2 Wed 2.00-3.30pm, State 1&amp;2</td>
</tr>
<tr>
<td>Social and Equity Issues in Climate Change Adaptation</td>
<td>26</td>
<td>Wed 4.15-5.45pm, Grand 3&amp;4</td>
</tr>
<tr>
<td>Climate Change Adaptation and Indigenous Communities</td>
<td>23, 30</td>
<td>Wed 4.15-5.45pm, State 1&amp;2 Thurs 11.00-12.30pm, State 1&amp;2</td>
</tr>
<tr>
<td>Urban settlements and infrastructure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate Adaptive Infrastructure and the Built Environment</td>
<td>6, 13</td>
<td>Tues 3.30-5.35pm, State 3</td>
</tr>
<tr>
<td>Adapting Cities for Future Climate Change</td>
<td>20, 27</td>
<td>Wed 2.00-5.30pm, State 3</td>
</tr>
<tr>
<td>Adaptation for Coastal Systems</td>
<td>34</td>
<td>Thurs 11.00-12.30pm, State 3</td>
</tr>
<tr>
<td>Scenarios for the Future of Adaptation</td>
<td>41</td>
<td>Thurs 1.30-3.00pm, State 3</td>
</tr>
<tr>
<td>Connecting with the land</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adapting Agriculture to Climate Change</td>
<td>5, 12, 19</td>
<td>Tues 3.30-5.35pm, Grand 3&amp;4 Wed 2.00-3.30pm, Grand 3&amp;4</td>
</tr>
<tr>
<td>Adapting Water Policy and Planning to Climate Change</td>
<td>33, 40</td>
<td>Thurs 11.00am-3.00pm, Grand 3&amp;4</td>
</tr>
<tr>
<td>Marine ecosystems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managing Australia’s Marine Ecosystems and Resources for a Warmer Climate</td>
<td>Panel 8, 21, 28, 35, 42</td>
<td>Wed 11.00-12.30pm, State 3 Wed 2.15-5.45pm, Lake3&amp;4 Thurs 11.00-3.00pm, Lake 3&amp;4</td>
</tr>
<tr>
<td>Terrestrial ecosystems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managing Biodiversity Under Climate Change</td>
<td>8, 15</td>
<td>Tues 4.35-5.35pm, Park Wed 2.15-3.45pm, Park</td>
</tr>
<tr>
<td>Avoiding Extinctions in a Changing Climate</td>
<td>22</td>
<td>Wed 4.15-5.45pm, Park</td>
</tr>
<tr>
<td>Climate extremes and disaster management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate Variability, Climate Extremes: Learnings for Climate Adaptation</td>
<td>32</td>
<td>Thurs 11.00-12.30pm. Grand 1&amp;2</td>
</tr>
<tr>
<td>Disasters, people and climate what does the future hold?</td>
<td>39</td>
<td>Thurs 1.30-3.00pm. Grand 1&amp;2</td>
</tr>
</tbody>
</table>
Speedtalk Sessions

NCCARF has guided the investment of around $30 million for close to 100 research projects as part of its Adaptation Research Grants Program.

There are nine research themes in this Program, and two of these will hold sessions at the Conference to showcase their work. They are:

- Social, Economic and Institutional Dimensions of Adaptation; and
- Indigenous Communities and Adaptation.

Because of the number of projects, these sessions will consist of speed talks. Each presenter, generally the project Principal Investigator, will speak for 4 minutes, with one minute for speaker changeover. Where time permits, there will be the opportunity for discussion. These sessions are open to all delegates, and take place on the 3rd day of the conference (Thursday 28th June).

- **Indigenous communities** 11.00-12.30pm  **Room:** State 1&2
- **Social, economic and institutional dimensions** 1.30-3.00pm  **Room:** State 1&2
## Poster Presentations

### Poster #  Title (by conference thread)

<table>
<thead>
<tr>
<th>Poster #</th>
<th>Title</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Theory and action</td>
<td></td>
<td></td>
</tr>
<tr>
<td>101</td>
<td>Adaptation Challenges in the Built Environment</td>
<td>R. Enright</td>
</tr>
<tr>
<td>102</td>
<td>How Adaptation-ready Are Resource Extraction Industries?</td>
<td>J. Hodgkinson</td>
</tr>
<tr>
<td>103</td>
<td>Barriers to Climate Change Adaptation: Quantifying the Disconnect Between Available Climate Information and the Needs of Rural Community End Users</td>
<td>A. Kiem</td>
</tr>
<tr>
<td>105</td>
<td>Cross-Scale Barriers to Adaptation in Local Government, Australia</td>
<td>P. Mukheibir</td>
</tr>
<tr>
<td>106</td>
<td>Climate Change and Fisheries Partnership – Tackling Barriers and Limitations to Adaptation</td>
<td>E. Perez</td>
</tr>
<tr>
<td>107</td>
<td>Reflections on the Practical Application of a Hybrid Risk / Vulnerability Assessment Approach to Inform Organisational Climate Change Adaptation</td>
<td>H. Scott</td>
</tr>
<tr>
<td>108</td>
<td>Reflecting on the Lessons Learnt from Consultation in the Pacific Islands</td>
<td>E. Warry</td>
</tr>
<tr>
<td>109</td>
<td>Radical Adaptation – the Emerging Norm for Adaptation Planning?</td>
<td>D. Burton</td>
</tr>
<tr>
<td>110</td>
<td>Mississipi. the Inevitable Next Shift of Old Men River</td>
<td>J. Sieweke</td>
</tr>
<tr>
<td>111</td>
<td>Local Governments’ Risk-based Approach to Climate Change Adaptation: a Missed Opportunity for Resilience in New South Wales</td>
<td>N. White</td>
</tr>
<tr>
<td>112</td>
<td>Comparing Adaption to Climate Change Amongst the Electrical Infrastructure in Australia, Canada, US and South Korea</td>
<td>W. Bell</td>
</tr>
<tr>
<td>113</td>
<td>Engaging Community for Climate Change Adaptation: Key Determinants for Effective Engagement</td>
<td>M. Naim</td>
</tr>
<tr>
<td>114</td>
<td>Climate Change Adaptation: Developing Metrics to Evaluate Effective Adaptation</td>
<td>A. Rance</td>
</tr>
<tr>
<td>115</td>
<td>Sustainable Water Management in Australian Industries</td>
<td>I. Senaratne</td>
</tr>
<tr>
<td>116</td>
<td>An Integrated Climate Change Vulnerability Assessment Process and Tools to Identify Adaptation Options for the Central Region of South Australia.</td>
<td>J. Balston</td>
</tr>
<tr>
<td>117</td>
<td>Great Ocean Road Region – Alternative Adaptation Pathways for the Connectivity of Coastal Towns Under Future Climate Effects</td>
<td>P. Roos</td>
</tr>
<tr>
<td>118</td>
<td>Understanding the Pacific’s Adaptive Capacity to Emergencies in the Context of Climate Change</td>
<td>A. Gero</td>
</tr>
<tr>
<td>119</td>
<td>Climate Change Adaptation in a Small Pacific Island Nation</td>
<td>L. Hardwick</td>
</tr>
<tr>
<td>120</td>
<td>1. Building the Resilience of Communities and Ecosystems to the Impacts of Climate Change in the Pacific: Lessons from a Project Partnership</td>
<td>R. James</td>
</tr>
<tr>
<td>121</td>
<td>Adaptation to Climate Change in the Pacific: Enhanced Seasonal Prediction of Climate Extremes</td>
<td>Y. Kuleshov</td>
</tr>
<tr>
<td>122</td>
<td>The Role of Climate Change Adaptation Intelligence System (CCAIS) for Communication and Integration of Information Related to Climate Change Adaptation.</td>
<td>E. Lee</td>
</tr>
<tr>
<td>123</td>
<td>Assessing the Transferability of the Integrated Systems Method for Building Capacity in Adapting to Extreme Events and Climate Change in Fiji</td>
<td>G. Mayes</td>
</tr>
<tr>
<td>124</td>
<td>Climate Change Vulnerability and Children in the Pacific: Challenges and Opportunities for Adaptation</td>
<td>J. Mustelin</td>
</tr>
<tr>
<td>125</td>
<td>Mainstreaming Climate Change Adaptation Through Technology Transfer in Developing Countries: A Case in Bangladesh</td>
<td>T. Sarker</td>
</tr>
<tr>
<td>126</td>
<td>Water-based Communities in the Tonlé Sap Region, Cambodia: Spatial Patterns and Climate Change Vulnerability</td>
<td>A. Travers</td>
</tr>
</tbody>
</table>
## Economic and institutional dimensions

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>201</td>
<td>Canute: A Decision Support Tool for Sea-level Change Adaptation</td>
<td>S. George</td>
</tr>
<tr>
<td>202</td>
<td>Leadership in Uncertain Times - Decision Making Beyond Business As Usual</td>
<td>G. Johnston</td>
</tr>
<tr>
<td>203</td>
<td>Uncertainties in Flood Risk Projections: Support for Risk-based Decision-making</td>
<td>J. Lawrence</td>
</tr>
<tr>
<td>204</td>
<td>From GCM/RCM Raw Data to User Experience: Towards an Extendable Decision Support System for Urban Planning</td>
<td>Y. Li</td>
</tr>
<tr>
<td>205</td>
<td>Adapting to Uncertainty</td>
<td>M. Manning</td>
</tr>
<tr>
<td>206</td>
<td>Beyond Risk Management - Adaptation to Extreme Weather in Victorian Parks</td>
<td>J. Mumford</td>
</tr>
<tr>
<td>207</td>
<td>The ‘Risk Matrix’ Workbook: a Facilitation Tool to Assist Adaptation to a More Variable and Changing Climate</td>
<td>G. Stone</td>
</tr>
<tr>
<td>208</td>
<td>Leading Adaptation Practices, Products and Tools for Australia</td>
<td>B. Webb</td>
</tr>
<tr>
<td>209</td>
<td>Port Phillip Bay Coastal Adaptation Pathways Project</td>
<td>A. Klindworth</td>
</tr>
<tr>
<td>210</td>
<td>Financing Retreat from Coastal Inundation and Erosion</td>
<td>L. Dobes</td>
</tr>
<tr>
<td>211</td>
<td>Retrospective Evidence-Informed Policy and Corporate Climate Change Mitigation: Can It Be Prospective in Case of Climate Change Adaptation?</td>
<td>M. Hossain</td>
</tr>
<tr>
<td>212</td>
<td>A Preliminary Economic Geography of Impacts and Adaptation for Australia</td>
<td>R. Jones</td>
</tr>
<tr>
<td>213</td>
<td>&quot;How Much Will Climate Change Cost Us?&quot; Communicating Clearly What Economics Can Contribute to Government and Industry for Climate Change Adaptation Decision-making</td>
<td>A. Keating</td>
</tr>
<tr>
<td>214</td>
<td>Costs and Benefits of Adaptation to Coastal Inundation to Protect Appreciating Assets</td>
<td>R. McAllister</td>
</tr>
<tr>
<td>215</td>
<td>Farm-level Economics of Adaptation to Climate Change by Broadacre Farmers in Western Australia</td>
<td>D. Addai</td>
</tr>
<tr>
<td>216</td>
<td>Marine Protected Areas and Transboundary Governance</td>
<td>L. Kriwoken</td>
</tr>
<tr>
<td>217</td>
<td>What Role for Systemic and Adaptive Governance in a Climate-changing World?</td>
<td>P. Wallis</td>
</tr>
<tr>
<td>220</td>
<td>Learning from Cross-border Governance Mechanisms to Support and Promote Climate Change Adaption in Australia</td>
<td>W. Steele</td>
</tr>
<tr>
<td>221</td>
<td>Institutional Arrangements and the Interaction of Actors in Heat-health Policy Formulation in Adelaide, South Australia.</td>
<td>D. Akompab</td>
</tr>
<tr>
<td>222</td>
<td>Challenges of Sea Level Rise Policies: Working with Uncertainties in Maps and Models</td>
<td>J. Bell</td>
</tr>
<tr>
<td>223</td>
<td>Climate Change and Pest Risk Analysis</td>
<td>K. Finlay</td>
</tr>
<tr>
<td>224</td>
<td>Building Knowledge and Capacity for Climate Change Adaptation</td>
<td>R. McKellar</td>
</tr>
<tr>
<td>225</td>
<td>Research to Support Decision Making: Australia’s National Climate Change Adaptation Research Facility’s Synthesis and Integrative Research Program</td>
<td>D. Rissik</td>
</tr>
<tr>
<td>226</td>
<td>Evaluating Collaborative Adaptation: The Case of Connectivity Conservation</td>
<td>C. Wyborn</td>
</tr>
<tr>
<td>227</td>
<td>Northern Territroy Climate Change Adaptation Action Plan</td>
<td>B. Carmichael</td>
</tr>
<tr>
<td>228</td>
<td>Local Governments Adapting Climate Change Policy to Local Conditions</td>
<td>D. Fallon</td>
</tr>
</tbody>
</table>
## Communication and community engagement

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>301</td>
<td>Disaster Experience and Climate Change Risk Perceptions</td>
<td>H. Boon</td>
</tr>
<tr>
<td>302</td>
<td>Information, Motivation and Institutions: Exploring Community-level</td>
<td>A. Granderson</td>
</tr>
<tr>
<td></td>
<td>Adaptation Decisions</td>
<td></td>
</tr>
<tr>
<td>303</td>
<td>Regional Risk Perceptions: Longitudinal Study of Climate Change</td>
<td>N. Higginbotham</td>
</tr>
<tr>
<td></td>
<td>Adaptation in Coastal Versus Agricultural Areas of the Hunter Valley,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NSW</td>
<td></td>
</tr>
<tr>
<td>304</td>
<td>What is Everyone Else Thinking? Pluralistic Ignorance and False</td>
<td>Z. Leviston</td>
</tr>
<tr>
<td></td>
<td>Consensus About Community Acceptance of Anthropogenic Climate Change.</td>
<td></td>
</tr>
<tr>
<td>305</td>
<td>Feeling Committed or Making Progress? Examining the Rebound Effect</td>
<td>I. McNeill</td>
</tr>
<tr>
<td></td>
<td>in Adjusting to Climate Change</td>
<td></td>
</tr>
<tr>
<td>306</td>
<td>What About Me? Influencing a Person’s Adaptable Behaviours Through</td>
<td>K. Unsworth</td>
</tr>
<tr>
<td></td>
<td>Priming Goals</td>
<td></td>
</tr>
<tr>
<td>307</td>
<td>Blending Traditional Knowledge and Heritage with Modern Science</td>
<td>D. Asamoah</td>
</tr>
<tr>
<td>308</td>
<td>Narratives and Numbers: Useful Information for Adaptation in</td>
<td>L. Coulter</td>
</tr>
<tr>
<td></td>
<td>Australia</td>
<td></td>
</tr>
<tr>
<td>309</td>
<td>Climate Change Adaptation: Education and Training for</td>
<td>D. George</td>
</tr>
<tr>
<td></td>
<td>Application in Sustainable Land, Water and Natural Resource</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Management</td>
<td></td>
</tr>
<tr>
<td>310</td>
<td>Using the Most Effective Communication Tools and Techniques to Reach</td>
<td>A. Hillsdon</td>
</tr>
<tr>
<td></td>
<td>Primary Producers with Outcomes of Adaptation Research</td>
<td></td>
</tr>
<tr>
<td>311</td>
<td>Climate Change Projections: What Information and Data Do People Need?</td>
<td>P. Holper</td>
</tr>
<tr>
<td>312</td>
<td>Climate Change Coping and the Effect of Social Norms and Message</td>
<td>M. Hurlstone</td>
</tr>
<tr>
<td></td>
<td>Framing on Those with Extreme Worldviews</td>
<td></td>
</tr>
<tr>
<td>313</td>
<td>Science for Decision Makers - Improving Adaptation</td>
<td>G. Johnston</td>
</tr>
<tr>
<td>314</td>
<td>A Simplified Scale for Assessing Current Impact of Climate Change</td>
<td>M. Macfarlane</td>
</tr>
<tr>
<td></td>
<td>in the Pacific Region</td>
<td></td>
</tr>
<tr>
<td>315</td>
<td>Can Words Save Us? An Exploratory Investigation of Climate Change</td>
<td>C. Naum</td>
</tr>
<tr>
<td></td>
<td>Communication in Australia</td>
<td></td>
</tr>
<tr>
<td>316</td>
<td>Fire Management for Healthy Communities and Landscapes</td>
<td>W. Parker</td>
</tr>
<tr>
<td>317</td>
<td>The Role of NCCARF’s Networks in Information Exchange for Climate</td>
<td>A. Penny</td>
</tr>
<tr>
<td></td>
<td>Change Adaptation</td>
<td></td>
</tr>
<tr>
<td>318</td>
<td>The IClimate Framework, from Climate Drivers to Adaptation</td>
<td>E. Poloczanska</td>
</tr>
<tr>
<td></td>
<td>Responses</td>
<td></td>
</tr>
<tr>
<td>319</td>
<td>Photovoice: a Photographic Exploration of Attitudes to Climate Change</td>
<td>J. Shaw</td>
</tr>
<tr>
<td></td>
<td>and Adaptation</td>
<td></td>
</tr>
<tr>
<td>320</td>
<td>Helping Queensland’s Primary Producers Adapt to Climate Change</td>
<td>M. Terwijn</td>
</tr>
<tr>
<td></td>
<td>Through Regional Climate Change Impact and Adaptation Fact Sheets</td>
<td></td>
</tr>
<tr>
<td>321</td>
<td>Alternative Communication Pathways for the Dissemination of Climate</td>
<td>A. Travers</td>
</tr>
<tr>
<td></td>
<td>Change and Adaptation Science for Community Education and Empowerment.</td>
<td></td>
</tr>
<tr>
<td>322</td>
<td>Portrayal of Climate Change in the Mass Media and Associated</td>
<td>A. Travers</td>
</tr>
<tr>
<td></td>
<td>Consumer Responses</td>
<td></td>
</tr>
<tr>
<td>323</td>
<td>Bridging the Gap Between End User Needs and Science Capability: Dealing</td>
<td>D. Verdon-Kidd</td>
</tr>
<tr>
<td></td>
<td>with Uncertainty in Future Scenarios</td>
<td></td>
</tr>
<tr>
<td>324</td>
<td>Communicating Adaptation Effectively</td>
<td>C. Young</td>
</tr>
<tr>
<td>325</td>
<td>Taking a Participatory Systems Approach to Understanding Climate</td>
<td>S. Shaw</td>
</tr>
<tr>
<td></td>
<td>Adaptation Needs: a South-East Queensland Case Study</td>
<td></td>
</tr>
</tbody>
</table>
# Human health and society

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>401</td>
<td>Health Planning for Adaptation: What Do Health Planners Understand About Health Impacts of Climate Change</td>
<td>A. Burton</td>
</tr>
<tr>
<td>402</td>
<td>Heat and CALD: Barriers to Climate Change Adaptation in Culturally and Linguistically Diverse Communities</td>
<td>A. Hansen</td>
</tr>
<tr>
<td>403</td>
<td>Measuring the Adaptive Capacity of Registered Nurses in Global Green and Healthy Hospitals</td>
<td>T. Lewis</td>
</tr>
<tr>
<td>404</td>
<td>Impacts of Climate Change on Mosquito-borne Diseases and Its Implications for Adaptation in China</td>
<td>L. Bai</td>
</tr>
<tr>
<td>405</td>
<td>Connectedness to Nature: is a Sane Mind Resilient to the Psychological Impacts of Climate Change?</td>
<td>C. Materia</td>
</tr>
<tr>
<td>406</td>
<td>Adaptation Begins with Four-hour Work Day</td>
<td>R. McLean</td>
</tr>
<tr>
<td>407</td>
<td>Projecting the Impact of Climate Change on the Transmission of Ross River Virus Disease: Methodological Challenges and Possible Solutions</td>
<td>S. Tong</td>
</tr>
<tr>
<td>408</td>
<td>How Do Heatwaves Affect Older People? A Survey of Aged Care Facility Staff Knowledge.</td>
<td>L. Wilson</td>
</tr>
<tr>
<td>409</td>
<td>Indigenous Climate Change Adaption in the Port Philip Bay Region: A Longitudinal Investigation into the Physical and Cultural Transformation of the Bay from an Indigenous and Landscape Architectural Perspective</td>
<td>G. Pocock</td>
</tr>
<tr>
<td>410</td>
<td>Climate Change and Dengue Fever: Vulnerability and Potential Adaptation Responses in Urban Settings of Bangladesh</td>
<td>M. Islam</td>
</tr>
<tr>
<td>411</td>
<td>Climate Justice: Gaps and Opportunities in Government Policy</td>
<td>M. Maloney</td>
</tr>
<tr>
<td>412</td>
<td>Accessing Regional Capacities for Climate Change Adaptability: A Suggested Methodology</td>
<td>K. Van Vuuren</td>
</tr>
<tr>
<td>413</td>
<td>Efforts to Integrate Gender Considerations into Community Based Adaptation (CBA)</td>
<td>L. Whitford</td>
</tr>
<tr>
<td>414</td>
<td>Total City Adaptation 2. Human Factors</td>
<td>G. Zellmer</td>
</tr>
<tr>
<td>415</td>
<td>Adaptation of Coastal and Beach Safety Services in a Changing Climate</td>
<td>N. Farmer</td>
</tr>
</tbody>
</table>

# Urban settlements and infrastructure

<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>501</td>
<td>Climate Change Decision Support Framework and Software for Coastal Councils.</td>
<td>J. Balston</td>
</tr>
<tr>
<td>502</td>
<td>Climate Change Risks and Adaptation Strategies for Victoria’s Surf Coast</td>
<td>C. Clifton</td>
</tr>
<tr>
<td>503</td>
<td>Coastal Vulnerability in North West Tasmania: Storm Surges and Seasonal Events – the Issues and Possible Solutions</td>
<td>D. Coy</td>
</tr>
<tr>
<td>504</td>
<td>Adaptation Insights from Extreme Weather Impacts on Great Barrier Reef Industries</td>
<td>N. Marshall</td>
</tr>
<tr>
<td>505</td>
<td>Climate Change Adaptation in Coastal Communities: A Blueprint for Investigation and Assessment</td>
<td>S. Metcalf</td>
</tr>
<tr>
<td>506</td>
<td>The Development of Hazard Lines for Coastal Flood Adaptation.</td>
<td>H. Stevens</td>
</tr>
<tr>
<td>507</td>
<td>A Comparative Study on the Decision Making Process of the Coastal Climate Adaptation of Central and Western Coastal District of Bangladesh</td>
<td>N. Sultana</td>
</tr>
<tr>
<td>508</td>
<td>Beach and Surf Tourism and Recreation in Australia: Vulnerability and Adaptation</td>
<td>D. Ware</td>
</tr>
<tr>
<td>509</td>
<td>Assessing the Threats to Beach-nesting Birds from Predicted Sea-level Rises and Strategies for the Conservation and Management of Breeding Habitat</td>
<td>E. Woehler</td>
</tr>
<tr>
<td>510</td>
<td>Learning from the Brisbane Flood: Perspectives of Flood-affected Residents</td>
<td>P. Box</td>
</tr>
<tr>
<td>511</td>
<td>Climate Adaptation in the Noosa Biosphere</td>
<td>S. Chapman</td>
</tr>
<tr>
<td>513</td>
<td>Community Engagement and Resilience</td>
<td>H. Foster</td>
</tr>
<tr>
<td>Page</td>
<td>Title</td>
<td>Author</td>
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</tr>
<tr>
<td>514</td>
<td>Thinking Globally, Acting Regionally – Victoria’s Greenhouse Alliances</td>
<td>G. Hunt</td>
</tr>
<tr>
<td>515</td>
<td>The Power of Local - Empowering Local Adaptation Responses</td>
<td>G. Johnston</td>
</tr>
<tr>
<td>516</td>
<td>Analysis of Spatial Rainfall Patterns in South Australia (SA) Between 2000 and 2010</td>
<td>M. Kamruzzaman</td>
</tr>
<tr>
<td>517</td>
<td>Responding to Climate Change: How Older People Cope with Heat Extremes</td>
<td>M. Loughnan</td>
</tr>
<tr>
<td>519</td>
<td>Total City Adaptation 1. Infrastructure</td>
<td>G. Zellmer</td>
</tr>
<tr>
<td>520</td>
<td>Climate Change Network Adaptation Plan</td>
<td>C. Battle</td>
</tr>
<tr>
<td>521</td>
<td>Adapting Aged Care Facilities NSW to Heatwaves: Preventing Premature Death in Elderly Australians: an Overview</td>
<td>D. Black</td>
</tr>
<tr>
<td>522</td>
<td>Adapting Typical Meteorological Data Files to Suit Climate Change Projections</td>
<td>J. Boland</td>
</tr>
<tr>
<td>523</td>
<td>A Methodological Approach to the Use of On-site Rainwater Retention Tanks in Infill Developments in the Face of a Changing Climate</td>
<td>S. Cobden</td>
</tr>
<tr>
<td>524</td>
<td>Gold Coast Urban Agriculture and Food Supply Chain Redevelopment Project</td>
<td>K. Marshall</td>
</tr>
<tr>
<td>525</td>
<td>Thermal Stress, Outdoor Public Space Use and Climate Adaptation – a Western Sydney Case Study</td>
<td>L. McKenzie</td>
</tr>
<tr>
<td>526</td>
<td>Durability of Housing Materials in a Changing Climate</td>
<td>M. Nguyen</td>
</tr>
<tr>
<td>527</td>
<td>Assessing Sustainability Performance of Precincts Using Modelling and Visualization Platform</td>
<td>M. Arora</td>
</tr>
<tr>
<td>528</td>
<td>Daily Climate Projections Data for Australia Now Available Through the Queensland Government’s SILO Climate Database</td>
<td>J. Rickett</td>
</tr>
<tr>
<td></td>
<td><strong>Connecting with the land</strong></td>
<td></td>
</tr>
<tr>
<td>601</td>
<td>Rainfall Index Insurance as an Approach to Manage Climate Change Induced Drought</td>
<td>A. Adeyinka</td>
</tr>
<tr>
<td>602</td>
<td>Scepticism - Does Not Limit Primary Producers’ Ability to Adapt</td>
<td>S. Argent</td>
</tr>
<tr>
<td>603</td>
<td>Water Thrifty Multipurpose Perennials for Sustainable Planing in Arid and Saline Areas</td>
<td>D. Asamoah</td>
</tr>
<tr>
<td>604</td>
<td>‘Doing More with Less Water’: Integrated Catchment Management Research to Support Climate Change Adaptation</td>
<td>M. Ayre</td>
</tr>
<tr>
<td>605</td>
<td>Assessing Breeding Strategies to Reduce Australian Dairy System Greenhouse Gas Emissions</td>
<td>M. Bell</td>
</tr>
<tr>
<td>606</td>
<td>Capacity of Broadacre Mixed Farmers to Adapt to Climate Change Across Australia: Constraints and Opportunities</td>
<td>P. Brown</td>
</tr>
<tr>
<td>607</td>
<td>Understanding the Capacity of Small-scale Farmers in Asia to Adapt to Climate Change</td>
<td>P. Brown</td>
</tr>
<tr>
<td>608</td>
<td>Farmers taking climate research to the paddock and back again—the Climate Champion program.</td>
<td>S. Cole</td>
</tr>
<tr>
<td>609</td>
<td>Cross Property Planning for Climate Change</td>
<td>T. Cox</td>
</tr>
<tr>
<td>610</td>
<td>Climate Change Impact and Adaptation in Pasture-based Agriculture</td>
<td>B. Cullen</td>
</tr>
<tr>
<td>611</td>
<td>Shrub-encroached Woodlands As Potential Carbon Sink</td>
<td>S. Daryanto</td>
</tr>
<tr>
<td>612</td>
<td>Household and Farm Characteristics of Agroforestry Based Farming System in Dhanusha District, Nepal: Analysis from Climate Change Mitigation Perspectives</td>
<td>A. Dhakal</td>
</tr>
<tr>
<td>613</td>
<td>Impact of Climate Change Adaptation on Agriculture in Sub-Sahara Africa</td>
<td>O. Elemide</td>
</tr>
<tr>
<td>614</td>
<td>Using a Game-workshop to Explore and Discuss Farm Adaptation</td>
<td>J. Fisher</td>
</tr>
<tr>
<td>615</td>
<td>Learning from Exemplars</td>
<td>E. Gaillard</td>
</tr>
<tr>
<td>616</td>
<td>Feeding Management Rules As Adaptation Strategy for Natural Resources and Livestock Systems in Southern Australia</td>
<td>A. Ghahramani</td>
</tr>
<tr>
<td>617</td>
<td>Farmer Climate Change Attitudes, Knowledge and Adaptation Behaviour in Victoria, Australia</td>
<td>M. Graymore</td>
</tr>
<tr>
<td>619</td>
<td>What About Me? Factors Affecting Individual Adaptive Coping in the Agricultural Sector.</td>
<td>J. Heath</td>
</tr>
<tr>
<td>620</td>
<td>Predictability of Global Crop Yield Variations Using Seasonal Climate Forecasts</td>
<td>T. Iizumi</td>
</tr>
<tr>
<td>621</td>
<td>How to Build Soil Carbon with Sub-tropical Pastures on Marginal Crop Lands for Climate Change Adaptation</td>
<td>D. Lloyd</td>
</tr>
<tr>
<td>622</td>
<td>Adaptation Strategies for Apple Orchards Dealing with Climate Challenges in the Goulburn Valley</td>
<td>S. Lolicato</td>
</tr>
<tr>
<td>623</td>
<td>Climate Model Downscaling Data for Impacts Research</td>
<td>I. Macadam</td>
</tr>
<tr>
<td>624</td>
<td>Tropical Perennial Grasses and Hardseeded Legumes: Examples of Using Species Adaptation in a Changing Climate</td>
<td>L. McCormick</td>
</tr>
<tr>
<td>625</td>
<td>Impact of Climate Change on Tasmanian Agricultural Enterprises: Communicating Science to the Broader Community</td>
<td>D. Phelan</td>
</tr>
<tr>
<td>626</td>
<td>Modelling the Responses of Perennial Ryegrass and a Sub-tropical Pasture Species to Future Climate Scenarios in Tasmania</td>
<td>D. Phelan</td>
</tr>
<tr>
<td>627</td>
<td>The Protective Role of Cytokinins During Water Stress in Sugarcane</td>
<td>P. Punpee</td>
</tr>
<tr>
<td>628</td>
<td>The Role of Conservation Agriculture in Climate Change Adaptation of Grain Production in Australia</td>
<td>J. Rochecouste</td>
</tr>
<tr>
<td>629</td>
<td>Measuring the Mass &amp; Energy Exchange of Australian Irrigated Agriculture: Pathways for Adaption to a Changing Climate</td>
<td>C. Vote</td>
</tr>
<tr>
<td>630</td>
<td>Food Security, Social Justice, Environmental Justice and Climate Change: Points of Adaptation in Food-systems.</td>
<td>A. Wardell-Johnson</td>
</tr>
<tr>
<td>631</td>
<td>Climate Change Impacts on the Water Resources of the Remote Communities of the Alinytjara Wilurara Region, South Australia</td>
<td>M. Gibbs</td>
</tr>
<tr>
<td>632</td>
<td>Adapting to climate change: a risk assessment and decision framework for managing groundwater dependent ecosystems with declining water levels.</td>
<td>G. Nugent</td>
</tr>
</tbody>
</table>

**Marine ecosystems**

| 701 | Effects of Near-future Ocean Acidification and Sea Surface Temperature Warming on the Abalone Haliotis Rubra-laevigata | J. Atchison |
| 702 | Pioneering Climate Change Adaption in the Marine Tourism Industry | C. Biggs |
| 703 | Climate Change and the Little Penguin: Adaptation Options | L. Chambers |
| 704 | Adaptation Options Across the Supply Chain: Identifying Options and Barriers in Australian Fisheries | A. Fleming |
| 705 | Working Together Today for a Healthier Reef Tomorrow: Climate Change Adaptation Through Community and Industry Engagement | K. Vohland |
### Terrestrial ecosystems

<table>
<thead>
<tr>
<th>Session Code</th>
<th>Title</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>801</td>
<td>Climate Change Adaptation for Australian Birds</td>
<td>G. Ehmke</td>
</tr>
<tr>
<td>802</td>
<td>Assessing the Climate Vulnerability of Australia’s Threatened Species</td>
<td>J. Lee</td>
</tr>
<tr>
<td>803</td>
<td>Targeted Restoration Will Help Some Functional Plant Types Avoid Extinction in Fragmented Landscapes As Climate Changes</td>
<td>M. Renton</td>
</tr>
<tr>
<td>804</td>
<td>Modelling Impact of Land Use Change Under Different Climate Conditions in the Goulburn Broken Region, Victoria, Australia</td>
<td>X. Cheng</td>
</tr>
<tr>
<td>805</td>
<td>Practical Approaches to Managing Landscapes for Resilience Revealed Through Expert Elicitation</td>
<td>V. Doerr</td>
</tr>
<tr>
<td>806</td>
<td>Developing Regionally Specific Conservation Actions Under Climate Change: a Tasmanian Case Study of Temperate Lowland Grasslands</td>
<td>L. Gilfedder</td>
</tr>
<tr>
<td>807</td>
<td>Climate-adapted Sanctuaries – Securing Refugia for the Future</td>
<td>L. Gilfedder</td>
</tr>
<tr>
<td>808</td>
<td>Identification and Characterization of Freshwater Refugia in the Face of Climate Change</td>
<td>C. James</td>
</tr>
<tr>
<td>809</td>
<td>Space-for-time Substitution to Assess Likely Response of Aquatic Ecosystems to Future Climate-related Change</td>
<td>A. Pope</td>
</tr>
<tr>
<td>810</td>
<td>Protected Area Management in the Face of Climate Change</td>
<td>S. Tanner-McAllister</td>
</tr>
<tr>
<td>811</td>
<td>Refugia in Flat, Drying Landscapes</td>
<td>G. Wardell-Johnson</td>
</tr>
</tbody>
</table>

### Climate extremes and disaster management

<table>
<thead>
<tr>
<th>Session Code</th>
<th>Title</th>
<th>Author(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>901</td>
<td>IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation</td>
<td>P. Aldunce</td>
</tr>
<tr>
<td>902</td>
<td>Analysis of Spatial Rainfall Patterns in South Australia (SA) Between 2000 and 2010</td>
<td>S. Beecham</td>
</tr>
<tr>
<td>903</td>
<td>Framing Climate Change: Newspaper Representations of the Brisbane 2011 Flood</td>
<td>E. Bohensky</td>
</tr>
<tr>
<td>904</td>
<td>Validating Heat Vulnerability Index for Urban Populations in Australian Capital Cities.</td>
<td>T. Phan</td>
</tr>
</tbody>
</table>
Fast-tracking Coral Climate Adaptation Research – a Genomics Approach

E. Abal¹, D. Miller², K. Kassahn³

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²James Cook University
³Queensland Centre for Medical Genomics, University of Queensland

During 2011, the whole genome sequences of two species representing the dominant reef-building coral genus, *Acropora*, became available, and other coral genomes are likely to be released during 2012. At the time of writing, projects are underway aimed at sequencing the genomes of representative dinoflagellate symbionts of corals, and 16S rDNA profiling is enabling characterisation of the microbial community associated with corals. This mass of data enables deep insights into many aspects of coral biology, but at present there is an enormous gap between the fundamental knowledge acquired and its practical application to coral reef management in the face of climate change. Based on molecular data, is it possible to identify genetic loci in the coral and/or its symbiont that are critical to stress resistance, and how can we identify alleles that can confer thermal tolerance? How important is a "healthy" microflora to corals, and how does this change under stress? What are potential rates of adaptation of corals to climate change? Although these issues may appear to be coral-specific, there are parallels in medical genomics, suggesting the possibility of innovative approaches to coral biology and ultimately management programs based on molecular technologies. This paper considers the feasibility of using these novel approaches to fast-track coral climate adaptation research.
Adaptation to Climate Change: Does the Public Associate Heat Waves with Global Warming in Adelaide, Australia?

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The purpose of this paper was to explore the public’s scientific understanding and views about heat waves in relation to climate change. It further explores whether the public’s views and beliefs influences their adaptive behaviour to heat waves and identifies some of the barriers in adapting effectively to the health impacts of heat waves.

Methods: Semi-structured interviews were conducted among 14 purposively selected residents of Adelaide between December 2011 and January 2012, the months of summer in the city. Informed consent was obtained and interviews were recorded, transcribed and analysed according to themes.

Results: Most of the participants did not associate global warming with heat waves, although a few acknowledged the fact that there have been observable changes in weather pattern in recent years. Among those who did not believe global warming was the cause of heat waves, ozone layer depletion, air pollution, the geographic location and urbanisation was mentioned as the cause of heat waves in Adelaide. While some participants agreed with scientific predictions that heat waves would likely increase in the future, others disagreed maintaining that scientists were not “super human beings” to predict what would happen in the future. Participants’ adaptive behaviour to heat waves was not influenced by their scientific understanding and views about global warming. The most significant barrier to adapt to heat waves was the financial cost of running an air conditioner.

Conclusions: This study highlights differences in expert and lay knowledge on scientific aspects regarding heat waves. Individuals understanding of heat waves depends on human judgement and may equally be influenced by information they get from the media, friends and family. The paper concludes by suggesting some policy options to facilitate adaptation to heatwaves in Adelaide.
Disaster Resilience: How Different Stakeholders Frame Resilience and How Useful is the Concept for Policy and Practice

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\textsuperscript{4}CSIRO Australia

Resilience is not a new concept for Disaster Risk Management (DRM) practitioners and researchers, but only in the last decade has it been strongly introduced into the policy arena. However, there is no single, agreed definition of disaster resilience with the idea being highly contested. As in other fields, in DRM more efforts are needed to investigate whether and how resilience could be a useful framework for policies and practices, and how decision makers are incorporating resilience ideas into their work.

This paper presents results of ongoing research into institutional arrangements that explicitly incorporate resilience as a framework. The research strategy is a single in-depth case study, which included observation process, document review and in-depth interviews. The case study is the Natural Disaster Resilience Program (NDRP) at the state and local level in Queensland, Australia. In understanding how stakeholders frame resilience, special attention has been paid to aspects of stakeholder participation and uncertainty that is inherently involved in climate change hazards. Preliminary results of the research reveal divergent understanding of resilience and also what are the key features in resilience conceptualization.
IUPA: A Proposal of an Index For The Evaluation of Practices For Adaptation to Climate Change and Variability

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\textsuperscript{2}University of Melbourne \\
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\textsuperscript{4}Universidad del Valle, Colombia

Nowadays there is no doubt that climate change and variability is and will impact different sectors. Although, more importance should be given to carry out and intensify actions that allow diminishing society’s vulnerability to this kind of hazard, through the formulation and implementation of adaptation practices, policies and strategies. Adaptation practices may vary considerably among regions, countries and social groups, numerous works describe and analyze past and new adaptation options. However, these works do not provide criteria that may help evaluating usefulness and potential for success of current and future adaptation. Under such circumstances, it seems inappropriate to provide a unique guideline in a prescriptive style for the evaluation of the effectiveness of all possible adaptation strategies. Rather, what is required is a common framework of concepts, linked together in a flexible manner, in the form of a tool that helps policy-makers of different sectors.

A prototype multi-purpose Index is proposed for use in the evaluation of the general Usefulness of Practices for Adaptation (IUPA), these allow users to assign weights and scores to a set of user-defined evaluation criteria. Individual criterion scores are then aggregated into a final index value. Guidance is given to users by providing a list of suggested evaluation criteria and criterion-specific weight factors, which have been defined by a multidisciplinary panel of professionals and researchers working in the Latin-American and Caribbean Region. IUPA is proposed for use by government institutions, practitioners and decision-makers at different levels, for the evaluation of usefulness and chances for success of adaptation practices in their design, implementation and post-implementation phase. The index may further contribute to bridging the gap between researchers and decision-makers. After its publication in 2008, the IUPA has been applied to 10 cases.
When Not Every Response to Climate Change is a Good One: Identifying Principles for Sustainable Adaptation

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²University of Melbourne
³Norwegian University of Life Sciences

Climate adaptation has become a pressing issue. Yet little attention has been paid to the consequences of adaptation policies and practices for sustainability. Recognition that not every adaptation to climate change is a good one has drawn attention to the need for sustainable adaptation strategies and measures that contribute to social justice and environmental integrity. This article presents four normative principles to guide responses to climate change and illustrates the significance of the ‘sustainable adaptation’ concept through case studies from diverse contexts. The principles are: first, recognize the context for vulnerability, including multiple stressors; second, acknowledge that differing values and interests affect adaptation outcomes; third, integrate local knowledge into adaptation responses; and fourth, consider potential feedbacks between local and global processes. The case studies that assist us in illustrating this principals are first addressing the vulnerability context of poor communities affected by floods and rainstorms in the city of Ilorin, Nigeria. Second, including the adaptation interests of vulnerable groups in local government policy in Durban, South Africa. Third, building on local knowledge and capacity in risk reduction in Concepcion, Chile. Fourth linking adaptation with mitigation and transformations towards a resilient society in Norway.

We argue that fundamental societal transformations are required in order to achieve sustainable development pathways and avoid adaptation funding going into efforts that exacerbate vulnerability and contribute to rising emissions. Despite numerous challenges involved in achieving such change, we suggest that sustainable adaptation practices have the potential to address some of the shortcomings of conventional social and economic development pathways.
Science Supporting Adaptive Water Planning
J. Alexandra¹

¹Murray Darling Basin Authority

Australia’s water reforms provide a broad policy framework to enable adaptation to climate change. These include the establishment of a Basin planning framework based on regular review and revision cycles that require the use of the best available science; water markets that support operational risk management and flexibility and the establishment of research partnerships that aim to increase understanding of large scale, complex, climatic and catchment systems. The Water Act 2007 mandates an integrated Murray Darling Basin Plan based on best available science. The Basin Plan will be subject to regular review and revision. Therefore, over time, this planning framework provides an adaptive approach that will be adaptive to both new climatic conditions and new science on the nature of the basin and its climatic drivers.

Uncertainty about future climates and their hydrological and ecological impacts requires ongoing and systemic risk assessments because changing climatic conditions influence the dynamics of large-scale biological and catchment processes (catchment vegetation, bushfire dynamics, ecosystem succession, vegetation responses to higher temperatures and CO₂, etc.) with consequential impacts on water yield and quality. Climate change adds complexity to the trajectories of Australia’s diverse bioregional ecosystems, compounding existing stressors, and offering new challenges for integrated assessment, management and planning. There is insufficient knowledge to accurately predict and respond to thresholds or tipping points in complex ecological systems. Therefore, Australia should invest in building capacity for integrated assessment and planning.

To understand the climatic systems and to interpret this in terms of hydrological and ecological impacts on the scale of the MDB requires a considerable investment in science. For the past 7 years the South Eastern Australian Climate Initiative (SEACI) has focused on improving the understanding of the climate and hydrology of the MDB and adjoining regions (CSIRO 2010).
Lessons from the Bush: Climate Communications with Victorian Farmers

G. Anderson

1Department of Primary Industries - Farm Services, Victoria

Do you want to test your science communication skills? Then jump in a car, drive 3 hours from a capital city and drop by the nearest local community hall and spend a couple of hours talking climate change with a group of farmers.

This is what the Victorian Department of Primary Industries has been doing, and in the process has been able to gather many experiences about communicating to farmer audiences about climate change. We have delivered over 700 information sessions to over 18,000 people in the last four years, developing crucial knowledge on successful ways to engage rural audiences, and more importantly, what doesn’t work.

Victoria’s Future Farming Strategy enabled DPI to deliver its first comprehensive climate extension program. Over the four years the program has:

• Established a cross industry extension team working to convert the climate and emissions story into the right context for farmers,
• Undertaken surveys in 2009 and 2011 of over 2800 farmers which better details their understanding of climate and carbon issues, providing direction for communication,
• Developed an ‘Upscaling’ technique which links a farmer’s local weather and seasons with the larger scale climate drivers
• Created ‘The Climate Dogs’ – an animation series to communicate the complex science of climate variability and change,
• Found a dialogue which merges seasonal variability and climate change into a cohesive story which farmers appreciate,
• Developed a range of products and services for emerging climate information (policy, science and practices),
• Fast tracked capability development of extension staff and service providers, and
• Expanded and developed new industry specific newsletter publications to target climate information for regions and sectors.

Over this period the team has supported face-to-face information sessions through development of a comprehensive website. This can be viewed at www.dpi.vic.gov.au/climate.
Adapting to Climate Change via Strengthened Ecosystem Resilience

K. Anthony¹

¹Australian Institute of Marine Science

Coral reefs are among the most vulnerable ecosystems to global climate and ocean change. Importantly, however, these global threats are often exacerbated by regional and local-scale stressors such as poor water quality and fishing pressures. As our window of opportunity narrows with respect to keeping global carbon emissions at a safe level for coral reefs and other sensitive marine systems, the need for effective and innovative management of local and regional-scale pressures increases.

Here I propose a framework that helps identify “levers of action” for maximising ecosystem resilience and, by inference, lowering ecosystem vulnerability. The framework builds on the principle of sensitivity analyses in which the outcome (e.g. preserved ecosystem goods and services) is maximised through the tuning of combinations of possible management interventions. In this talk I present a set of examples of how smart constellations of such intervention levers can maximise reef ecosystem resilience in an era of climate and ocean change and interacting on-the-ground pressures. Lastly, I present ideas for how such a framework can be integrated with decision support tools in a spatial context where marine resources have varying priority or value, and protection priorities or triage systems have to be employed.
**Managing Current Climatic Uncertainty and Adapting to the Future Climate Change in the SAT of Africa and Asia: ICRISAT Approach**

D. Asamoah¹

¹Remar International, Ghana

Climate variability and change is an important consideration for ICRISAT given its mandate for the improvement of rain-fed farming systems in the semi-arid tropics of the developing world. Climate predictions point to a warmer world within the next 50 years, yet the impact of rising temperature on rainfall distribution patterns currently remains far less certain. (Nobel prize winner UN inter-governmental Panel on climate change (IPCC 2007. Recognizing this ICRISAT has developed as Operational Research Strategy (2007 – 2017) entitled: “Managing current climatic uncertainty and adapting to future climate change”. This strategy addresses climate change challenges through a 3-pronged approach that focuses on:

1). Helping farmers to cope better with current rainfall variability as a prerequisite to adapting to the future climate change. ICRISAT believes that unless the livelihood resilience and adaptive capacity of vulnerable communities can be greatly increased in the context of current rainfall variability, adapting to future climate change will be daunting for most and impossible for many.

2). Adapting our mandate crops to grow in a warmer world. Key factors considered are: higher temperature tolerance, moisture extremes – both increased moisture stress and risk of temporary flooding. Changed distribution and servility of pest and diseases. The “migration” of our mandate crops into geographical areas already marginal for crops currently being grown there.

3). Pro-poor “Bio Power” mitigation approach. Bio Powers focuses on bio-mass sources and approaches that don’t compete with, and in fact could well enhance food production by attracting greater investments that boast food and bio-fuel productivity. Leading examples are: hybrid sweet sorghum for bio-ethanol, and non edible oil seeds such as jatropha and pongamia for degraded and abandoned land to reduce pressure on farmlands and ecological sensitive environments. Fuel wood, the dominant bio-energy source of the poor, is also under thirds.
**Wetlands Role in Great Barrier Reef Coastal Ecosystems - Their Multiple Values in Biodiversity, Fisheries and Water Qualities and the Opportunities for Repair**

D. Audas¹, P. Groves¹, H. Yorkston¹

¹Great Barrier Reef Marine Park Authority

One of the greatest challenges for Great Barrier Reef managers is to understand the role played by coastal ecosystems in maintaining the health and resilience of the Great Barrier Reef. Since European settlement, the diversity of landscapes in the Great Barrier Reef catchments has influenced land use patterns and, as a consequence, there have been significant changes to the landscape. It is clear that there have been some significant losses and modification of the functions of coastal ecosystems especially at a regional or catchment level. The Great Barrier Reef Outlook Report 2009 identified coastal development and run off of poor water quality in the Great Barrier Reef catchment as two of the current major threats to the Great Barrier Reef World Heritage Area. In response to the Outlook Report, the Great Barrier Reef Coastal Ecosystem Project has been undertaken with the assistance of a range of technical experts and management agencies to improve our understanding of the importance of these Great Barrier Reef Coastal Ecosystems in maintaining the health and resilience of the Great Barrier Reef. GBRMPA’s work investigates the important functions of catchment, coastal and inshore marine ecosystems and the role they play in maintaining a healthy and resilient Great Barrier Reef. The work assesses what is known about these coastal ecosystems, their use, their management and the pressures they face now, and into the future.
**Communicating Across the ‘Theory Versus Practice’ Divide – the Barriers in the Basics.**

M. Bainbridge¹

¹NCCARF Adaptation College

Before effective adaptation can occur there must be an understanding of what ‘effective’ adaptation means, and who has the responsibility, capacity and flexibility to deliver it. Notionally adaptation is not effective unless it is completely embedded in all levels of environment and society, and the constructs ‘housed’ therein, such as the built environment and the economy. Such an embedding process requires a widely shared understanding of ‘effective adaptation’.

One primary barrier to effective adaptation is the difference in communication and engagement strategies between those developing knowledge about adaptation (i.e. the research community), and those responsible for understanding and implementing the outcomes of that knowledge in policy and practice (i.e. all levels of government, the community and the private sector). Developing a shared understanding requires a considered engagement strategy, one which clearly demonstrates the need for, and the processes by which adaption might be delivered.

As fellows of the NCCARF Adaptation College, we present the process by which we arrived at a set of key engagement principles which would need to be considered by all parties involved in developing knowledge, strategy, policy or practice around adaptation, and how these might be applied. The group is a diverse mix of early career adaptation professionals, who debated the processes which might need to be applied from both researcher and practitioner perspectives, with interesting results. This paper documents the debate and illustrates its shared outcomes, as an example of the level of flexibility required in understanding the practicalities of turning research into policy, and turning policy into practice. It also shows that, in applying an ‘adaptive’ approach to the conversations that must be had to reach consensus, there are broader lessons relevant to known adaptation barriers, such as bridging the theory/practice divide.
A New Legislative Approach to Coastal Planning Adaption
M. Baker-Jones

1DLA Piper Australia

In a new and contentious amendment to coastal management legislation, the Queensland Government has sought to deal with the impacts of coastal erosion and tidal inundation on Queensland’s coastal regions.

The Queensland Government seeks to achieve its aims through the introduction of the Queensland Coastal Plan. The State government has recognised the need to consider the effects of tidal inundation and erosion on development and, by implementing the new coastal plan, has taken an important step towards confronting these effects.

The commencement of the coastal plan will see widespread development controls and management practices applied to development within the coastal zone. These controls and practices primarily restrict or constrain, and in some cases entirely prohibit, certain types of development. As a consequence, developers, commercial, residential and industrial landowners and occupiers must factor in the constraints imposed under the plan when formulating their development strategies. This new legislation highlights a stronger regulatory shift towards implementing provisions associated with the impacts of climate change. Although this plan only focuses on coastal processes it is possible that future considerations for other climate change events, such as heatwaves, hail and extreme rainfall may also follow.

We look at how the coastal plan applies to all types of development - commercial, industrial, residential and rural and find that the application of the plan will not always be obvious. We also look at compensation available to those that may suffer loss or detriment as consequence of the implementation of the new coastal plan and find that in certain cases, where the use of land is changed by a prohibition imposed under the coastal plan, an entitlement to compensation may accrue.
**Development of Tools That Allow Local Governments to Translate Climate Change Impacts on Assets into Strategic and Operational Financial and Asset Management Plans.**

J. Balston¹, S. Li², G. Wells², J. Kellett³, I. Ivankov³, A. Gray³

¹Jacqueline Balston & Associates  
²University of South Australia  
³Local Government Association South Australia

Australia’s 560 Councils are responsible for the management of a range of assets valued at approximately $212 billion, many of which have a life span greater than 50 years and so will be affected by climate change.

Currently, maintenance and replacement of hard infrastructure by Council is guided by the principles, models and tools provided in the International Infrastructure Management Manual (IIMM), developed by the Institute of Public Works and Engineering Australia (IPWEA) in conjunction with councils, engineers and manufacturers of various components and materials. Currently these tools do not allow for the incorporation of climate change impacts or calculate the likely flow-on effects to asset and financial management and so Councils are limited in their capacity to estimate these changes.

On the basis of an extensive literature review and rigorous methodology developed in collaboration with the University of South Australia, Local Government Association (LGA) South Australia, Western Australian LGA, the Institute of Public Works and Engineers Australia and Municipal Association Victoria, this NCCARF Settlements and Infrastructure funded research project has developed a financial modelling tool and supporting decision tools to provide a clear, comparative analysis of the financial impacts of climate change on three major asset classes of importance to Australian Councils – sealed roads (hotmix and spray sealed) and unsealed roads.

The integrated financial mathematical modelling includes options pricing and uncertainty analysis to deal with the highly variable nature of data inputs that describe the not-static components of climate change scenarios and impacts on the useful life of roads, and economic and price fluctuations. The model will provide Councils with the capacity to regularly update the cost analysis and outputs have been designed to interface with the existing tools developed to support the IIMM to create a simple user friendly front-end that can be used by councils.
Joining the Dots: Connecting Downscaled Climate Projections, Hydrology, Ecosystem Values, and Management Frameworks to Conserve Biodiversity in Freshwaters

L. Barmuta¹

¹University of Tasmania

Increasingly, predictions of the impacts of climate change at regional and local scales will rely on downscaled climate models. This project is the first to use a state-wide downscaled model in Australia and work through the steps needed to use this information for adaptation planning to conserve freshwater biodiversity. By linking climate modelling with hydrological models and a comprehensive database of ecosystem values for freshwaters we seek to identify those areas and values for which protection is critical, those which need active management interventions and those which will be minimally impacted by climate change. We also seek to identify species and ecosystem components that need to be maintained to ensure functioning ecosystems under climate change. End-users and stakeholders are intimately involved with defining ecosystem values and managing biodiversity, and we recognise the prime importance of terrestrial natural resource management on freshwater systems. Consequently, end-users and stakeholders have been involved from the initiation of this project in both technical and policy aspects. Although this project is in its infancy, two clear challenges have been identified for adaptation planning for biodiversity conservation in freshwaters. The first is how to communicate and deal effectively with regions for which different climate models yield widely divergent climate projections. The second is the likely magnitude and uncertainty of future human interventions in rivers and wetlands to secure water for agriculture, industry and urban water supply.
Performance and Adaptation of Low Income Housing

G. Barnett¹, X. Wang¹, D. Chen¹, Z. Ren¹, S. McFallan¹

¹CSIRO Ecosystem Sciences

A growing issue in the housing sector is the major discrepancy between the performance of new and existing housing stock. While all new homes in Australia are required to meet minimum energy and water efficiency standards, almost half (45%) of Australia’s existing housing stock is 30 years of age or older and was built with little consideration for climate change and sustainability. We know that disadvantaged populations are more likely to reside in this older and poorer quality housing stock, highlighting the role for ‘climate adapted housing’ to reduce the vulnerability of those most at risk from future climate change.

In this presentation, we describe the preliminary research findings from an assessment of the thermal performance and indoor environment of selected low income ‘housing types’ under climate change, based on simulations using the AccuRate software. AccuRate is a nationwide energy efficiency assessment tool developed by CSIRO which takes into account the local climate, building fabric and design. In this study, AccuRate was modified to assess indoor thermal comfort by including occupant behaviours. Future climate information for use in AccuRate was constructed using weather data for the current climate, adjusted using ‘morphing’ techniques to incorporate climate change projections.

Engineering, behavioural and institutional adaptation options for improving the thermal performance and indoor environment of low income housing are explored and the associated co-benefits for human health discussed. That is, the role for climate adaptation to not only reduce climate risk, but to also promote human health and well-being.

Targeting populations with the greatest need, through improvements to their housing performance, will provide disproportionate national benefit in reducing climate change vulnerability, and offers a significant pathway for maintaining equity and fairness in the national climate adaptation response.
Vulnerability of Low Income Households to Extreme Heat

M. Beaty¹, G. Barnett¹, J. Meyers¹, A. Spinks¹

¹CSIRO, Australia

Disadvantage tends to be geographically concentrated and endemic to a small number of locations in our cities. While there is a link between socio-economic disadvantage and poor health, the complex interrelationships between factors that define ‘who you are?’ and ‘where you live?’ and how this influences your vulnerability and resilience to climate change, is yet to be adequately explored.

In this presentation, we report on the preliminary findings of a research project that is investigating the vulnerability of low income households to heat related health impacts in four Australian capital cities – Adelaide, Melbourne, Sydney and Brisbane. The goal is to identify the spatial relationships between patterns of heat exposure and the sensitivity of a disadvantaged sub-population at the urban neighbourhood scale. To accomplish this we are addressing three interrelated research questions:

1) How do patterns of heat exposure vary in relation to the structure of the built environment?
2) Are low income households located in neighbourhoods with the highest heat exposure risk?
3) What are the relationships between key ‘risk’ and ‘protective’ factors for heat-related health?

We used thermal infrared satellite imagery to map land surface temperatures (LST) as measure of neighbourhood heat exposure. Risk and protective factors for heat related health were identified and mapped based on population census data for both low income households and the general population. Moran’s I was used to identify and map the spatial relationships between LST and heat vulnerability.

Vegetation was the most important factor controlling LST but there was considerable variability in local controls on temperature. Many of the social heat vulnerability factors co-vary indicating that risk factors are spatially concentrated in some areas and not others. Adaptation options that not only reduce climate change risk, but provide co-benefits for human health and well-being, are identified.
**Downscaling of Climate Change Projections to Produce Sector-relevant Information – the Case of Tourism in the Southern Lakes, New Zealand**

*S. Becken¹, C. Zammit², J. Hendriks³*

¹Griffith University  
²National Institute of Water and Atmospheric Research  
³Montana State University

With an increasing likelihood of greater and faster than expected changes in the global climate, adaptation becomes a pressing need. However stakeholders at the local level are usually facing a double challenge with the information available. First they often find themselves overwhelmed with climate change information presented at both small temporal and spatial scales. Second, the climatic parameters commonly reported are sometimes not specific enough to inform decisions for a range of sectors.

To address this gap, and using a case study approach of the tourism sector in the Southern Lakes region of New Zealand’s South Island, this research aims to link climate change projections and tourism operator information requirements. The climate data are downscaled from global and regional climate models to a grid of 0.05 degrees (approx. 5km x 5km) to then generate detailed climate prediction information for the 2030–2049 time period (i.e. “2040”) for different emission scenarios in the form of sector relevant color-coded maps. In addition, interviews with 34 tourism operators provided necessary insights into the climate parameters that would be useful for their planning. These included change in; mean precipitation; mean temperature; wind speed; snowfall; and number of frost days. Furthermore the interviews indicated the kinds of tourism decisions that could be informed by such climate data.

This paper presents the climate change maps alongside exemplary tourism ‘storylines’ that highlight the usefulness of producing down-scaled climate data in conjunction with information on sector specific needs.
A Climate Change Adaptation Planning Framework for the Great Barrier Reef

R. Beeden¹, P. Marshall¹, M. Turner¹,², P. Goudkamp¹, M. Read¹, C. Schable¹, R. Quincey¹,²

¹Great Barrier Reef Marine Park Authority
²Queensland Parks and Wildlife Service

The 2009 Great Barrier Reef Outlook Report concluded that "the Great Barrier Reef ecosystem is at a crossroads and that it is decisions taken in the next few years that will determine its long term future". Climate change was cited as posing the most significant risk to the Reef, an assessment that was in large part based upon the findings of the 2007 Climate change and the Great Barrier Reef: A Vulnerability Assessment (VA). The VA used the IPCC model to determine the relative vulnerability of key Great Barrier Reef habitats, species groups, species and the social and economic values that rely upon them to a changing climate. Subsequently, the critical knowledge gaps and development of resilience and adaptation strategies to address vulnerability became the focus of GBRMPA’s 2007-2012 Climate Change Action Plan.

To enable Great Barrier Reef managers and policy to effectively respond to climate change, vulnerability needs to be translated into action through an adaptation process. Over the past four years an adaptation planning framework has been iteratively developed that is applicable to vulnerable habitats, species groups, species and industries that depend upon them. The framework includes four key steps: vulnerability assessment, resilience analysis, adaptation planning and implementation planning. These steps enable managers and stakeholders to collectively evaluate the key drivers of vulnerability for priority ecosystem components, the potential options to enhance their resilience, the risks associated with adaptation options, the current and future policy context, to generate a plan for action that can be tailored to climate change impacts as they arise.

The adaptation planning framework apportions accountability for the outputs of each adaptation planning step to the most appropriate partner in the process. Hence, researchers are primarily accountable for vulnerability assessment, managers for policy and stakeholders for adaptation action.
Breathing Easy into the Future: Adaptation for Impacts of Climate Change on Aeroallergens and Allergic Respiratory Diseases

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¹Macquarie University
²University of Western Sydney

Nature, the world’s leading interdisciplinary science journal, recently reported “Climate-change impacts: More sneezing in a warmer world” (3 March 2011). Climate change has the potential to have many significant impacts on aeroallergens such as pollen and mould spores, and therefore related diseases such as asthma and allergic rhinitis. The impacts of climate change on aeroallergens include impacts on atmospheric pollen concentration, pollen season, plant and pollen spatial distribution, and pollen allergenicity; and similar impacts on mould spores. Recent research has also highlighted the potential impacts of changes to extreme weather events, such as “thunderstorm asthma” and tropical cyclones, flooding and indoor mould. Australia is particularly vulnerable to these impacts given the persistence of its internationally high prevalence of asthma, with, for example, the most recent International Study of Asthma and Allergies in Childhood research showing over 30% of Australian children aged 13-14 years having experienced asthma in the last year. This paper examines adaptation measures that could moderate harm resulting from these impacts of climate change on aeroallergens. There is a need for enhanced monitoring of aeroallergens. Education about climate change and human health in general, and aeroallergens and related diseases specifically, is required for the community, health professionals, and others. Improvements are needed in the preparedness of infrastructure, such as health care facilities and early warning systems/forecasting, particularly for aeroallergens. Other adaptation options include better: allergenic plant management; planting practices and policies; building design and heating, ventilating, and air-conditioning (HVAC); and access to health care and medications. Three of these potential adaptation measures are illustrated using case studies from Australia. Finally, the initial stages of a 2012-2013 New South Wales (NSW) Environmental Trust funded project, which specifically examines adaptation for aeroallergens and allergic diseases at the local and state government levels in NSW’s urban areas, will be reported.
Health Adaptation Policy for Climate Change: Global and National Deficits, Local Rural Disadvantage

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The majority of developed countries have developed or are in the process of developing adaptation policy statements. What place does health have in these policy statements? What form should health adaptation policy take? These potentially influential policy statements have not yet been collectively analysed for the ways that they reproduce particular discourses in the operation of their meaning-making for health adaptation. This presentation of a 2012 completed international study investigates and maps health adaptation policy (describing its nature as a policy presence and absence) via a discourse analysis of all available adaptation policy documents from Annex 1 countries in the United Nations Framework Convention on Climate Change. Adaptation policy statements from all intra-government agencies active at the global level in producing climate change adaptation policy are also considered. The study uses the language-based analytic techniques of Fairclough and Foucault to reveal that the policy texts operate within an ordered universe of discourses that works to disguise its social privilege and self-interest. This universe of discourses reproduces certain scientific discourses and knowledge-making and actively marginalises particular communities such as rural and remote communities and particular forms of knowledge for rural health services critical to effective responses to climate change in these communities. The study finds that the implementation of climate adaptation policy documents without critical revision is likely to further disadvantage many communities most at risk from climate change, particularly in terms of health. It identifies what kinds of knowledge is being privileged, appropriated and marginalised at the global and national level by climate policy statements, how, and possible strategies for developing effective climate and health policy for rural communities.
Foreseeing the Health Effects of Climate Change in Rural Communities: A Translational Research Approach

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Rural Tasmania led the nation in loss of farm income over the recent drought yet the health effects there were scarcely noticed by national media and even climate change and health research. Even in areas such as rural Tasmania with relatively benign climate predictions, climate change may bring disproportionately negative health impacts in communities already socio-economically stressed and with unequal health service access. Research that supports local health service adaptation actions for vulnerable groups can do much to reduce the rising health burden of climate change. How should rural communities evaluate the health impacts and risks of climate change and engage with such complexities? This presentation explores the results of a completed pilot Tasmanian project, funded by the Office of Climate Change, which has developed an online health impact and risk assessment (HIRA) tool for rural communities. It analyses the strengths and weaknesses for rural communities of emerging international HIRA approaches developed by agencies such as the UK’s Climate Impacts Programme. It describes the rationale and nature of the 2011-2012 Tasmanian pilot study which tested an online whole-of-community health impact and risk assessment tool in three rural local government sites. It explores the key theoretical and technical features of our online pilot tool integrating local area climate science predictions and local impact/risk assessments as part of a translational research approach for community health planning and development. It concludes with an exploration of critical methodological challenges in preparing rural communities for the health challenges of climate change. We argue that current efforts to develop local area climate science projections on smaller ‘grids’, ostensibly for community decision-makers, are unlikely to be valuable without sophisticated translational research techniques for transforming those scientific projections into informed community adaptation priorities and strategies, especially in health.
**A Framework for the Adaptation of Australian Households to Heat Waves**

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Climate change is resulting in increased frequency and severity of heat waves. Associated heat related deaths as well as increased electricity costs due to increased demand for air conditioning cannot be understated. Research is being conducted to develop a framework to evaluate the parameters which affect the cooling needs of householders. The framework is intended to consider policy options which can reduce the severity of heat waves by improving existing and future housing stock to be more resilient to climate change.

The project aims to develop future climatic data, an understanding of thermal comfort requirements during heat waves, new house designs, an understanding of householder expectations and needs, and an assessment of householder cost and impact on health with and without the framework.

Building energy regulations are progressively incorporating improved energy efficiency in order to reduce related greenhouse gas emissions. However future building regulations will, in addition, need to consider reducing the demand for cooling during heat waves. Peak electricity demand from domestic air conditioning is the most significant driver of electricity prices. Therefore with climate change, vulnerable groups in the community are exposed to both higher energy costs, and an increased need for cooling. Understanding how people experience and respond to heat waves and how they comprehend the air conditioning – electricity price nexus will assist with defining appropriate energy management regulations as well as using less energy consuming air conditioning equipment. A critical element to all this work is developing future climatic data considering climate change. This data will enable improved building and air conditioning design to more effectively cope with heat waves. The paper outlines the project objectives and early research outcomes.
Is Drought Bad for Mental Health and Wellbeing? It Depends ....

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Background. With the southern half of Australia drying and warming, more intense (if not more frequent) droughts are expected. Small, qualitative rural studies indicate that drought can profoundly harm mental health while (few) quantitative studies have produced contested findings. We aimed to better understand whether drought will have implications for mental health because this aspect of health, particularly, contributes substantially to adaptive capacity.

Methods. We asked: (i) how can we measure drought for large epidemiological studies? (ii) How can we characterise human exposure to drought? (iii) Is exposure to drought linked to mental health? These questions were addressed using, respectively, (i) a spatial regression-based derivation of the Hutchinson (precipitation) Index, (ii) multi-wave two-step cluster analysis and (iii) analyses of variance and linear regression modelling. Analyses were conducted on seven waves (2001-08) of the Household Income and Labour Dynamics in Australia (HILDA) Survey (unconfidentialised files), N~15,000/wave. The HILDA Survey includes the SF-36 self-report measure of health.

Results. We identified four types of drought exposure: constant; very dry; very prolonged; and zero-to-moderate. We found that those experiencing very prolonged and constant drought had worse mental health than did their zero-to-moderate peers, with those in the very prolonged category having the worst outcomes of any group – but only if they lived in rural locations. For city-dwellers, we found an opposite pattern. Prolonged drought was slightly associated with better mental health compared to zero-to-moderate drought.

Discussion and Conclusion. Drought is difficult to conceptualise and measure in epidemiology, yet doing so is essential to understanding human exposure to drought and its mental health impact. Identical drought conditions are not experienced identically everywhere; it depends on where people live. Drought-related mental health impacts of climate change will likely be damaging for rural Australians but may be beneficial for city-dwellers.
Responding to Climate Change - Indigenous People's Experiences of and Ideas About Climate Change in Four Sites in Victoria

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Indigenous communities around the world are facing the impacts of climate change (Parry et al 2007). In Australia, the described impacts of climate change on Aboriginal and Torres Islander peoples are far-reaching (HREOC 2009). They include risks to water, land and resources due to sea level rise in coastal zones and drying weather conditions inland, as well as a range of potentially negative impacts on health and economic outcomes, and threats to cultural practices (HREOC 2009; Green et al 2009). Other analyses have emphasised that climate change could undermine the cultural and environmental autonomy and rights to self-determination of indigenous people around the globe, due to their unique ethical and cultural relationship with land (Tsosie 2007).

Despite these analyses, and the concerns expressed by the CSIRO and other bodies about the gaps in evidence on climate change impacts, there is a dearth of research on climate change impacts on Australian Indigenous communities (CANA 2012) and only a small literature on indigenous people’s views about climate change (Green 2010).

This paper presents and discusses some findings from a range of indepth, qualitative interviews with Indigenous individuals from various parts of Victoria. It shows that all those interviewed believe they are experiencing the impacts of climate change. The paper documents their perceptions and attitudes about climate change, in relation to their own cultural knowledge and practices as Indigenous people in Victoria and in relation to climate change as a political and social phenomenon. It also documents and discusses their ideas about what should be done to both adapt to and mitigate climate change.
Future Change in Ancient Worlds: a Preliminary Understanding of Indigenous Adaptation in Northern Australia


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Decisions about how to support Indigenous communities to adapt to and reduce their risks from climate change impacts must be informed by greater understandings of current adaptive capacities. Northern Australia is already highly exposed to a number of natural hazards including: cyclones and storm surges; riverine and flash flooding; coastal erosion, bushfires and drought – which may be exacerbated due to climate change. This project will utilise ethnographic participatory research (from participant observation to interpretations of art and music) to work with Indigenous people to provide a multifaceted understanding of why they may be vulnerable or resilient and how they have coped with and adapted to past and ongoing environmental changes. Broader socioeconomic and political changes that impact underlying vulnerabilities and capacities to adapt will also be investigated. In addition to extreme events, the project will investigate change in relation to slow onset events, e.g. sea level rise and biodiversity loss. Traditionally, Indigenous people relocate or migrate seasonally, and anecdotal evidence suggests that this is also the case following extreme weather events. This project will seek to understand the dynamics of these movements, where and why they go and the vulnerabilities of those who remain behind. In particular, the research will investigate what the most culturally appropriate emergency response strategies are if outside assistance is needed for evacuation and recovery in the event of a large natural disaster. The project case studies include a mix of indigenous communities across northern Australia: Maningrida and Ngukurr, Northern Territory; Broome, Western Australia; and Wujal Wujal, Queensland. In this paper we provide an overview of the underlying vulnerabilities and adaptive capacities within these Indigenous communities and a preliminary understanding of the relationship Indigenous people have with their ever changing environment. Preliminary data on mobility and population statistics from each community will also be presented.
The Insurance Council of Australia’s Building Resilience Rating Tool: Providing the Tools for a Climate Adapted Built Environment

J. Bonnitcha¹, T. Davies¹

¹Edge Environment

Australia has a long history of extreme weather events, which are likely to become more frequent and intense as a consequence of climate change. Combined with growing density and population the case is urgent for more resilient cities.

A climate adapted built environment must be resilient to extreme weather in order to provide safety for communities and reduce economic, social and environmental costs of natural disasters. Despite many organisations identifying the need for more resilient built environments in Australia, there continues to be little implementation, and no consistent approach to this issue.

The Insurance Council of Australia recognized this and commissioned Edge Environment, in partnership with Climate Risk, to develop a Building Resilience Rating Tool (BRRT). The BRRT is intended for use by a wide variety of stakeholders and provides guidance on a building’s vulnerability and resilience to extreme weather events. The BRRT includes information on the resilience of building materials and sets a methodology for assimilating future research as they become available. This information is combined with location specific hazard risk data and material codependency calculations to produce vulnerability and risk ratings. The BRRT provides layered information with increasing levels of detail to suit the needs of different users.

The BRRT is functional in pilot form and rates inundation risks. It is being expanded to include bushfire, cyclones, storm, and extreme heat. As part of the BRRT initiative, wide stakeholder engagement and user testing have been undertaken with positive feedback from a variety of interest groups. The BRRT has stimulated a number of concurrent projects aiming to raise community awareness, streamline terminology and gather information around resilience issues.

The BRRT represents an important industry initiative to contribute to a more resilient built environment.
A Decision Support Guide for Local Government Practitioners: Key Enablers to Enhance Effective Use of Adaptation Tools and Processes

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The Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (ACCARNSI) undertook a collaborative research initiative with the Australian Local Government Association and State and Territory counterparts. It involved case studies and a follow-on national survey of adaptation tools and application processes used in councils and regional organisations of councils (ROCs).

A Case Studies Reporting Template focused attention on key drivers, outcomes and measures of success, challenges and barriers, critical success factors, adaptive learnings, and next steps. A portfolio of 18 case studies and additional statewide synopses were gathered, thematically analysed and shortlisted to build a nationwide understanding of key enablers, salient issues and concerns, and feedback on improvements to tools and applications included developing regional scale climate change models and adaptation scenarios, and web-based tools. The Portfolio is available on-line.

The national survey garnered 115 valid responses. It was designed to incorporate and verify provisional shortlists distilled from the case studies. Respondents were asked to prioritise their ‘top three’ enablers and issues/concerns relevant to their context (in closed questions) or describe others in following open questions - including whether/how their challenges and barriers were resolved. Priorities were tabulated and graphed.

A summary of key findings, conclusions and recommendations includes a Decision Support Guide to assist local government practitioners make better-informed decisions on which adaptation tools and processes best meet their purposes. The Guide condenses practical knowledge, frequently reported experiences and advice gleaned from the case studies and survey into the ‘Top Ten Enablers that colleagues and I need to know in advance, to use climate change adaptation tools and processes effectively’. These enablers are communicated in a user-friendly web-based design, hot-linked to checklists of prioritised drivers, intended outcomes, critical success factors, challenges and barriers frequently encountered and possible ways to resolve these, and appropriate next steps to consider. The Portfolio and Guide contribute to a community of adaptation practitioners.
A Computational Model of How People Reason About Climate Change

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¹CSIRO Australia

The public discourse on climate change which occurs in the media, on the internet, in casual conversations and in the political debate, inevitably involves a considerable simplification of the functioning of the earth system. This simplified representation can dramatically affect the future of the system itself, because it can influence how mitigation and adaptation policies are proposed, discussed, designed, planned, chosen and supported. The numerical modelling of this mental representation (as opposed to the numerical modelling of the actual physical system) allows to articulate explicitly the assumptions underlying the beliefs commonly held among the public, of how the world functions as well as the values which determine decisions, choices and actions. Crucially, it allows to check the consistency of the expectations such beliefs and values generate, that is the expectations of how the system may react to the actions which result from such beliefs and values.

The model accounts for sets of simplified, and stereotyped views as commonly displayed in the climate change discourse. Three main conclusions can be drawn from our results. First, the most polarised worldviews all encompass a set of values and beliefs which, if correct, would result in a safe or only mildly dangerous future. Second, a similarly safe future appears to be less likely under moderate worldviews. From this perspective, moderate worldviews seem to be less internally consistent than the more polarised ones. Third, ‘mistaken’ beliefs, that is misjudgements of how the world functions, can have very different consequences depending on which belief is mistaken. The most important contribution lies not in the model outcome in itself, rather in providing a tool to checking the consistency on highly held assumptions and an avenue for public discussion.
Reflecting on the adaptive capacity of the public policy sector of fire management

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In the public sector, sharing knowledge for adaptation requires consideration of how existing policy frames and informal institutions structure each policy sector’s governance arrangements, policy options and sectoral practices. The degree to which a particular framing of adaptation supports or conflicts with these underlying policy frames and institutions will influence the ‘mainstreaming’ of adaptation and sharing knowledge within and across public policy sectors. A ‘reflexive learning’ approach is needed for public policy sectors to benefit from the collaboration and knowledge sharing that is fundamental to adaptive governance.

Reflexive learning is more than a continuous ‘learning by doing’ process. It is a capacity to reflect on a sector’s underlying policy frames and informal institutions, and to explore that sector’s issues and options through alternative frames. The case for reflexive learning in enabling adaptive governance is supported by insights from a range of literature. That literature also provided a cross-disciplinary theoretical basis for a study of policy frames and informal institutions of the fire management sector in Victoria, Australia. This paper presents some of the results from that study.

Taking its perspective from ‘middle and street-level bureaucrats’ working within the fire management sector, the research indicated an institutionalised emergency management frame that has potential to constrain the sector’s adaptive capacity. The results of this research not only aim to support this public sector’s approach to disaster risk reduction (DRR) and climate change adaptation (CCA), but also to inform the oft-called for interchange between DRR and CCA.
Looking into the Past to Learn for the Future: Climate Extremes Informing Climate Change Adaptation

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Climate change may mean more extreme events, or more severe events, in the future. Studies of preparedness and responses to past events can usefully inform understanding of how societies and environment will adapt to these future changes, and in turn contribute to improved climate change adaptation planning.

We examined past extreme events (caused by tropical cyclone, flooding, heatwave, drought, east coast low and storm tide) in Australia, Europe, America and developing countries to determine how communities, emergency managers, policy makers and research scientist responded. We have used this case study approach to consider: first, the attributes that determined the success or failure of the response and recovery phases - the prior conditions, decision-making around the event, subsequent policy changes; and, second, to explore the lessons to be learned about what determines the success or failure of climate change adaptation strategies in the future.

Our results point to several broad lessons. First, actions need to be realistic and pragmatic as well as forward thinking; some responses or adaptations may be appropriate in the short-term, but prove to be maladaptations in the longer term. Second, while building a ‘resilient’ community is an important response, it must be acknowledged that this may mean change. Third, there is extensive knowledge around extreme events and how to manage their impacts, but for a variety of reasons this knowledge doesn’t necessarily translate into action.

This presentation will highlight the strength of the case study approach and its relevance for decision makers from the community to government.

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Reanalysis techniques show that extreme weather events such as heat-waves and significant, severe hail have increased over most of Australia in the last fifty years of the 1871-2008 period. Indemnity insurance of such weather hazards is becoming increasingly expensive and difficult to price as they become a more systemic feature of the Australian climate. Innovations such as index-based insurance based on site moisture and climate indicators such as the Southern Oscillation may offer a better treatment of such multiple perils by allowing a more widespread offsetting of risks for vulnerable communities. Such benefits may be increased if some aggregation of risks is encouraged by insuring co-operatives, longer-term contracts are used to provide some stability to the market and adaptation incentives are offered to the participating groups as a way to lower the premium costs. We illustrate these arguments by considering the insurance of weather risks for a typical farming community in the Queensland to New South Wales near-coastal strip. There is considerable potential for useful interactions with other sectors such as the energy and water industries.
**Planning for Food Security in Climate Changeable Australian Cities**

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Food security has long been a matter of pressing global concern with food insecurity in developing countries leading to growing problems of malnutrition and starvation. Many of the anticipated impacts of climate change are likely to exacerbate these problems, especially in the rapidly growing cities of the Global South. But in many cities of the developed world food insecurity is also being experienced by a small but significant proportion of the population and increasingly recognised as a major problem for urban leaders and planners.

While the supermarket shelves in cities of the developed world may be well stocked with food stuffs from around the world, the supply lines on which they depend are becoming increasingly stretched and serious questions are now being raised about their resilience in the face of a variety of threats. Cities that have lost much of their local food production and supply capacity are beginning to look again at the potential for urban agriculture to play a greater role in achieving local food security.

This presentation reports on the findings of a review of urban food security, urban resilience and climate change in Australian cities. Drawing on a systematic review of contemporary scholarly and policy literature as well as fieldwork in Melbourne and the Gold Coast, it explores not only the extent of current practices of urban agriculture but also the barriers to any expansion and development of these practices created by regulatory regimes.

The presentation also reviews the threats and opportunities that climate change poses to the extension of urban agriculture and considers how urban agriculture might build resilience and food security in Australian cities.
Understanding End-user Decisions and the Value of Climate Information Under the Risks and Uncertainties of Future Climates

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Climate change adds uncertainty at every stage of the decision-making process – the challenges of forecasting, modelling, and the construction and comparison of scenarios to aid adaptation decisions are all compounded by uncertainty. This presentation examines the potential for decision frameworks to help bridge the gap between the producers of information about climate change and the end users of this information. It will report on the findings from a survey and a workshop that are being used to help identify the sources of uncertainty relevant to the end users of climate information and the relative value of different kinds of information for climate change adaptation decisions. Based on this research, we will give an overview of an online decision support tool that encapsulates the findings and recommendations of this project. This tool is designed to help the end users of climate change information deal with uncertainty as they adapt to a changing climate.
Challenges for Services to Homeless Persons in Adapting to Predicted Extreme Weather Events Under Climate Change

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Extreme weather events, such as heat waves, floods and bushfires, are part of future challenges to health and well-being, predicted to occur increasingly with climate change. Vulnerability to these events is determined by both exposure and coping capacity. People who are homeless in Australia are among those likely to be most at risk, with high existing rates of mental and physical illness, as well as exposure. On any given night it is estimated that over 120,000 people are homeless in Australia. However, there is scant research about the effects of extreme weather on the health and well-being of this population.

We report on the results of our study which investigated the views of service providers to homeless persons in Victoria as to how extreme weather events impacted upon their clients, and their service’s ability to adequately meet the clients’ needs. This research explores a new area of climate change vulnerability in Australia, with important implications for how adaptation responses may need to be tailored for our most vulnerable citizens.
Seabird and Marine Mammal Management Options in the Face of Climate Change

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Climate change is already impacting Australia’s oceans. Responses by marine life to both climate variability and change have been documented for lower trophic levels, however, responses for Australia’s iconic higher trophic level marine taxa are poorly understood, including for many conservation-dependent seabirds and marine mammals. We report initial results from a national study evaluating impacts and adaptation options. Individual time series and combined analyses show consistent responses to historical climate signals, however, improved monitoring protocols are needed to maximize detection of any climate-related demographic signals. Despite differences in sampling, the development of regional multi-species indices of environmental change provides robust climate indicators over large regions.

The range of adaptation options, which we will discuss, to combat deleterious climate impacts fall into three general categories: landscape management, species management, and threat reduction.

This national study has developed, in consultation with management agencies and scientists:

(i) Adaptation guidelines for scientists: Researchers may need to adapt how they monitor their colonies to better attribute changes to process and best practice monitoring standards for climate change will be developed as part of the project, following practitioner workshops and a review of national and international approaches.

(ii) Adaptation guidelines for conservation managers: Declines or increases in population size may be due to climate rather than other anthropogenic impacts (e.g. fisheries); attribution is needed before management action can be taken. Managers may also choose to adapt their response plans, based on the climate response that is observed for these species.

(iii) Adaptation options for seabird and marine mammal species identified as challenged by climate change. Intervention options to enhance species adaptation to climate change may be enhanced if the causal climate factor can be identified.

Overall, results from this project will support adaptation efforts by managers charged with managing these iconic animals.
Effective Communication for Community Adaptation to Bushfire in a Changing Climate – A Role for Local Government

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Many localities in south eastern Tasmania are experiencing rapid demographic and socio-economic changes, which are creating very diverse communities and exposing increasing numbers of people to the risk of bushfire. This is occurring at a time when predictions, from current climate modeling, suggest that there could be an increase of up to 50 percent in the incidence of extreme fire weather during this century. As a result, there is now some urgency in developing communication strategies which can facilitate community adaptation to these changing climatic conditions through increased awareness and preparedness information. Research conducted for the Kingborough and Huon Valley Municipalities has identified a toolkit of communication strategies which could be used to increase knowledge, awareness and understanding of bushfire risk of the diverse groups within these communities. The development of such a toolkit for local government is based on the understanding that household adaptation to an increasing risk of bushfire often takes place via an involvement with other community members through informal networks. As such activities often rely on the informal communication of adaptation information amongst family, friends and neighbours, the toolkit argues that there is role for community volunteers in the dissemination of this bushfire adaptation information amongst residents. But to become a sustainable community bushfire adaptation program, these communication strategies must be supported and coordinated by a dedicated local government officer.
**Priorities for Managing Climate Risk and Adaptation in the Northern Grains Region**

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A high level of variability in seasonal weather conditions is a key feature of environmental influences on summer and winter crop production in Australia’s Northern Grains Region. The most important climate risks to manage as perceived by grain farmers are low and variable rainfall, and catastrophic events such as drought, intense storms, flood and unseasonal severe frost. Consequently, the focus is on managing these challenges and taking advantage of opportunities when seasonal conditions are highly favourable for grain production. Excessive wet weather, severe heatwave and wind can also be important.

The central concept of this paper regards adaptation for climate change is that ‘best practices’ for managing climate risk in grain production should focus on managing the climate variability evident in continuously updated historical weather and climate data. Continual refinement of decisions provides the mechanism for adjustment. This view is supported by recent evidence gathered from industry via a FarmReady funded longitudinal study in the Northern Grains Region (Narrabri to Clermont). The study included information from two reference panels, fourteen grain-grower workshops, three professional development workshops and a series of follow-up interviews. Growers often reject practices for climate change adaptation when expected impacts are beyond a ten-year outlook.

Priorities for management include developing capacity for informed decision making within a robust risk management framework and process. A healthy lifestyle to mitigate climate stresses, business planning and skills in using weather/climate forecasts are important. Other priorities are strategic investments in machinery (particularly effective planting equipment, zero till and controlled traffic farming), maintaining natural resources, diversification, seasonal adjustments to agronomic practices, off-farm activity and periodic reviews of changes in climate on land capability.

RD&E programs should accelerate and incentivise the focus on developing and promoting robust, flexible management systems for managing climate variability as the key approach for adaptation to climate change.
Vulnerability Assessment and Adaptation Planning in Queensland Fisheries Using a Multi Stakeholder Approach

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3Queensland Climate Change Centre of Excellence
4Morison Aquatic Sciences
5Queensland Seafood Industry Association
6Trawl Industry

The Great Barrier Reef Marine Park Authority and Fisheries Queensland coordinated a climate change vulnerability assessment and adaptation planning process for the Queensland East Coast Otter Trawl Fishery (ECOTF). The ECOTF targets prawns, bugs and scallops, and is the largest wild harvest fishery in Queensland with a Gross Value of Production of $99 million. The Queensland Seafood Industry Association, representative fishing businesses, marine park managers, fishery managers, research scientists and the Queensland Climate Change Centre of Excellence collaborated to assess the vulnerability to climate change of key catch species and the fishery as a whole, and to develop adaptation options.

An exposure/sensitivity/adaptation framework was used in a process that allowed all the stakeholders to contribute their expert knowledge to develop an understanding of key species vulnerability to climate change impacts. Informed by this key species vulnerability assessment, a Climate Change Risk Management Matrix was used by stakeholders to identify climate impacts on the fishery as a whole and possible adaptation options. The adaptation options derived from this process can guide businesses, researchers, and resource managers in their response to climate change impacts and allow the resilience of the fishery from a harvest and environmental perspective to be optimised.

Key outcomes of the process included:

- A shared understanding by all stakeholders in the fishery of how climate change will impact on key species and the fishery and whether those impacts are positive or negative in their effect;
- A shared understanding of potential adaptation options that can be explored by stakeholders at all levels in the fishery, from individual businesses, through to management and research responses;
- Improved communication among stakeholders around ECOTF fishery management issues generally; and
- A beginning of business level interventions to assist industry adaptation.
Adapting to Climate Change in Queensland’s Primary Industries Using a Risk Management Approach

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Managing climate variability in association with climate change is a challenge for industries and organisations in Queensland. Significant uncertainties remain regarding the rate of change and the scale and distribution of impacts resulting from climate change.

The Queensland Climate Change Centre of Excellence (QCCCE) has developed the Climate Change Risk Management Matrix (or ‘risk matrix’) as a simple two-dimensional assessment tool to help address these uncertainties and reduce complexity.

Through a facilitated, participatory workshop process engaging with industry, regions and agencies, the ‘risk matrix’ is used to identify positive and negative climate change impacts, adaptive responses, and risk and vulnerability associated with climate change. Using this risk management approach to identify and analyse risks and opportunities supports planning responses, adaptation strategies and action plans.

The ‘risk matrix’ has now been used since 2010 in facilitated workshops by sectoral, industry, regional and agency representatives across Queensland.

A workbook describing the ‘risk matrix’ process has been designed as a stand-alone product for use by extension providers, industry and regional representatives and consultants. An electronic version has also been prepared.

The ‘risk matrix’ is a useful first-step to facilitating a better understanding of climate change impacts and fostering a risk management approach to improving decision making associated with the changing Queensland climate at sector, industry and regional levels.

The ‘risk matrix’ and its associated processes are the primary tools being used in a series of workshops implementing the Queensland Government’s ClimateQ initiative ‘Helping Primary Producers Adapt to Climate Change’, aimed at raising awareness of climate change in the primary production sector and building internal capacity to adapt to climate change.

The presentation will describe the process, discuss the extension activities and demonstrate the tools that have been developed. Companion papers will discuss factsheets that describe regional impacts and adaptation responses and evaluation.
Making Climate Change Adaptation ‘business-as-usual’ for Local Government - the Role of Good Governance Arrangements

D. Corkill¹

¹Gold Coast City Council

The anticipated impacts of climate change including rising sea level, increases in temperature and changes to rainfall patterns will be an enduring challenge for governments and communities over the course of this century and beyond.

Adapting to these challenges as they emerge and change will require continued evolution to the ways in which local governments in Australia make decisions in regard to, for example infrastructure provision, local planning, natural resource management, community health and well being and economic development.

Given the dynamic and long range nature of climate change challenges, successful adaptation cannot be achieved if it is considered to be an additional or 'new' local government service delivered through an isolated program or projects. Rather, success will only be achieved by integrating adaptation considerations into service delivery and organisational core business through key governance arrangements affecting organisational planning, resource allocation and monitoring and reporting supported by robust organisational controls.

Given local government is 'at the coal face' in managing infrastructure, land use planning and many other services likely to be effected by climate change, it is critical for local government authorities to have an integrated and deeply embedded approach to managing these challenges.

The paper explores how existing local government governance arrangements can be used as adaptive management tools, capable of continuous iteration as the science of climate change evolves, to embed climate change adaptation considerations into the day to day decision making arrangements and organisational culture of local governments in Australia hence enabling Australia’s cities to adapt over time to a changing climate. The paper will draw on Gold Coast City Council experience in adapting community planning, land use planning, asset management, risk management, etc to integrate future climate considerations into service delivery and core business activity.
**Australia’s Most Prospective Opportunity for Action Across Adaptation and Mitigation - Australia’s Estuaries and Wetlands**

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Estuaries and associated wetlands are the world’s most productive ecosystems. Not surprisingly then, estuaries sequester carbon at rates well in excess of 5 times that sequestered in tropical forests. Yet these estuarine areas globally are being destroyed at 3 to 4 times faster than forests. Finishing off the carbon sequestration story, globally our oceans absorb about 93.4% of the heat produced by climate change as well as about 1/3 of human induced carbon dioxide. So what are the challenges for ensuring healthy estuaries and oceans and adding these important areas to the climate change policy agenda?

In Australia the opportunities are predominantly about repair while ensuring virtually no further loss of coastal fisheries habitat. This presentation will detail the opportunities for estuary and wetland repair and the steps towards ensuring their multiple benefits are recognised.

As just one example of repair, the Burdekin catchment has over 1500 impediments to tidal flow and of course fish. Improving tidal interchange such as increasing culvert size in road crossings to foster wetland and seagrass productivity, removing bund walls in ponded pastures to re-establish prawn and barramundi habitat, and re-establishing mangrove and salt marsh wetlands are all easily achievable works. Underpinning such works Australia will need to establish a methodology for accounting for the increased carbon sequestration and think through issues such as who owns the carbon as most of these areas are public lands. Going beyond the “tyranny of the common lands” to their recognition in value – for biodiversity, fisheries habitat, water quality, resilience to climate change impacts and carbon sequestration will ensure estuaries and their wetlands are recognised as the most prospective in Australia for synergies across adaptation and mitigation.
**Progress on Adaptation in a Vulnerability Hotspot: the Case of South East Queensland**

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With increasing evidence that our climate is changing, adaptation to climate change has emerged as an unavoidable and critical policy issue for all governments and countries across the world. In particular, in the last few years there has been a growing realisation by governments at all levels of decision making (from local to national) of the need to develop and implement adaptation measures and policies. Nevertheless, this growing realisation does not necessarily translate into the development and in particular implementation of adaptation actions and policies. This paper focuses on the region of South East Queensland (SEQ) in Australia, which has been identified as one of six vulnerability hotspots in a country described as being on the climate change frontline. By focusing on an in-depth study of four local authorities in SEQ, the paper reviews current state, regional and local policies and plans both relevant and specific to climate change adaptation within key sectors for human settlements, including urban and regional planning, infrastructure, human health, and emergency management. The paper provides an investigation of the progress that has been made on adaptation in SEQ. Finally, this paper discusses the gaps in adaptation planning within but also across sectors and how these could be addressed to ensure that SEQ is better equipped to tackle climate change.
Climate Change Adaptation Planning in Cambodia and Potential for Improvements

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Human induced climate change is being evidenced with increasing vulnerability for least developing countries such as Cambodia. Planning for climate change adaptation involves consideration of current and future climate conditions in development plans across all sectors. Such climate-informed planning and decision-making may be able to mitigate future climate risks and disasters more effectively. Relevant knowledge such as projection of future climate with different scenarios, prediction of potential future vulnerability, advancement of vulnerability assessment frameworks and development of adaptation technologies has been well advanced internationally but less so for Cambodia. Also, the communication and cooperation gaps among stakeholders, especially between scientists and policy-makers that occur in many national settings are even wider in Cambodia where formal institutions are poorly developed together with limited resources being available. This research explores how Cambodia may develop climate-informed adaptation planning with limited availability of local climate-related scientific information and scientific entities. It also explores the underlying barriers and challenges to such planning for Cambodian ministries and institutions. The study focuses mainly on the water and agriculture sectors, which have been projected as highly vulnerable sectors in Cambodia. Institutional ethnography and case study research methods are being employed to evaluate a proposed institutional framework for better climate-informed adaptation planning for Cambodia. Information related to current water and agriculture planning practices, in term of information used, interactions among stakeholders and relationships with regional and international entities and platforms is being collated. Furthermore, perceptions related to climate-informed planning, and the underlying barriers and challenges on such planning are being scrutinized. Complementarily, two donor funded adaptation demonstration projects on water and agriculture in Cambodia are being investigated to gain better understanding on the effectiveness of their planning. It is expected that research outcomes will propose an institutional framework for better climate-informed adaptation planning for Cambodia.
Potential Shifts in Frost Risk for Pome Fruit in Australia

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Expected warming to spring conditions as a result of anthropogenically induced climate change may shift frost risk profiles for flowering species, including commercial fruit crops. In the future, because earlier flowering can be stimulated by warmer springtime temperatures, increases in exposure to frost hazard may occur. Frosts can cause significant damage to flowers and in turn affect the productivity and profitability of orchards.

Although often discussed, only a few quantitative assessments considering shifts in frost risk, that is damage to the plant through exposure to cold temperatures, have been evaluated. Part of the difficulty in assessing changes to frost risk resides in uncertainty in how frost timing and frequency will change under projected climate conditions. This study will discuss projected shifts in frost risk for southern Australian pome fruit based on comparative proportionality. Current frost risk was determined through calculating proportionate coincidence of current flowering times and current frost incidence. Projected flowering times and frost incidence for localised equivalent temperature change for 1, 2 and 3°C increases in global temperatures were then calculated. Standardisation of the projected risk to current risk allows for percentage change in risk to be calculated.

Future frost risk conditions were evaluated using unchanged and perturbed frost conditions to account for uncertainty in how this variable will act under enhanced greenhouse conditions. This evaluation, the first for pome fruit in Australia, provides a simple quantitative assessment of potential changes in frost conditions allowing for risk management strategies to be modified.
An Indicator Framework to Operationalize Resilience Thinking in Australian Marine Sectors Dealing with Climate Change

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In this paper we present a resilience indicator framework developed through an interdisciplinary process that seeks to provide an alternative approach to operationalizing the concept of resilience. Given the level of complexity and uncertainty associated with climate change challenges in the marine system, and the problems involved in assessing the resilience of social-ecological systems, there is a need for (i) methodologies that bring together knowledge from diverse sources and disciplines to investigate the complexity and uncertainty of interactions between climate, ocean and human systems and for (ii) frameworks to facilitate the evaluation and monitoring of the social-ecological resilience of marine-dependent sectors. Accordingly this paper has two objectives. One is to demonstrate the virtues of combining a case study methodology with complex adaptive systems approaches as a means to understanding the complex dynamics of marine sectors experiencing climate change. The second is to advance scholarship on social-ecological resilience beyond a concern with thresholds identification and management.

The resilience indicator framework, which is based on investigations of the system dynamics of four Australian marine sectors already experiencing impacts from climate change, comprises a set of resilience dimensions with suggestions for relevant abstract and concrete resilience indicators. Since the framework is developed on the basis of just a few cases, we present it as exploratory research that requires further grounding and testing, but consider it a useful step towards development of approaches for benchmarking, monitoring, evaluating and reporting on system resilience in the marine environment.
Using Scenarios to Identify Adaptive Governance Regimes for Marine Biodiversity in a Changing Climate
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This paper explores the use of scenarios as a tool for investigating how governance regimes for marine biodiversity conservation may need to change to adapt to climate change impacts. Scenarios are narratives or stories about plausible futures. They help in considering the implications of current decisions and in planning strategies for the future. For our purposes, scenario development was used to examine marine biodiversity conservation in the context of climate variability and change in the Whitsundays (Queensland), Tweed-Moreton (NSW/Queensland) and the Freycinet bioregion on the East Coast of Tasmania. The scenario process we deployed is novel in two ways. First, the scenarios were formulated with the current governance arrangements being kept constant in order to test their ability to secure marine biodiversity conservation under a range of conditions. This approach also allows potential alternative regimes to be similarly tested. Resilience theory suggests that the most adaptive regimes will be those that can achieve positive outcomes for biodiversity conservation under any plausible future. Second, to provide for scalability of the findings from the case regions to other levels, from local to national, scenarios were first developed for each case study, and from these we derived four generalised scenarios. These scale-independent futures were filtered through lenses of climate change/variability and development impacts on marine biodiversity. We demonstrate how using this approach to scenario development can help in identifying potential regime reforms that strengthen the likelihood that governance arrangements can secure the resilience of marine biodiversity in a changing climate.
Regulatory Responses to Facilitate Adaptation of Existing Infrastructure to Climate Change

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Climate change poses significant challenges for Australia's infrastructure. Higher temperatures, lower rainfall and drought, sea level rise and flooding, bushfires and increased frequency and intensity of extreme weather events such as storms and cyclones threaten the operation and ongoing viability of the spectrum of Australia's infrastructure, including our buildings, roads and railway lines, electricity and telecommunications networks, and waste and water storage facilities.

Existing infrastructure is likely to be particularly vulnerable to the effects of climate change given that, for the most part, these assets were built at a time when climate change was not considered to be a significant risk. Furthermore, regulatory frameworks affecting the design, construction and operation of infrastructure typically apply to new rather than existing infrastructure. Therefore, while these regulatory frameworks may be used to facilitate adaptation to climate change for new infrastructure, they are of limited use in enhancing the resilience of existing infrastructure.

Our paper will discuss the range of regulatory mechanisms that could be used to retrofit existing infrastructure to increase resilience to climate change impacts, now and in the future. It will also identify regulatory tools that could be used to facilitate 'retreat' of Australia's existing infrastructure from climate change risks over time. The paper will examine the advantages and disadvantages associated with each of the mechanisms and tools and will identify those that would be most useful and effective for each of the main categories of Australia's infrastructure.
Costs and Benefits of Public and Private Provision of Post-Cyclone Emergency Services in Coastal Queensland

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In managing natural disaster related risks, a key emerging policy issue in the adaptation space is “how much adaptation?”.

If there is too much adaptation, society will forgo the benefits of alternative policies and programs such as more schools or hospitals. Under-adaptation, on the other hand, may risk undue damage to property, or harm to Australian residents.

Social cost-benefit analysis can assist policy makers to resolve the dilemma. However, the adaptation literature to date has tended to use an inferior and potentially misleading measure of benefits in the form of damage costs avoided by implementing an adaptation measure. Financial costs of damage avoided do not include non-market costs such as loss of personnel mementoes in a flood, for example, and are therefore likely to underestimate the economic benefits of adaptation.

This NCCARF-funded project demonstrates that it is feasible to use choice modelling to determine the willingness to pay of coastal Queensland households for post-cyclone emergency services. Some noteworthy results have emerged from the community survey (conducted with the assistance of the Cairns Lions Club) which presented respondents with choices between ‘bundles’ of different levels of police protection, accommodation of pets, accelerated resupply of fresh food and reconnection of utilities. The payment vehicle used was a levy on household electricity bills.

Further research into the likely costs of harnessing private sector resources to provide post-cyclone emergency services enables a direct comparison of relative costs and benefits. The results also throw light on the comparative efficiency of public and private provision of emergency services in scenarios of future climate change.
**Sir Sidney Kidman: Australia’s Cattle King as Pioneer of Adaptation to Climatic Uncertainty**

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Australia’s once-famed cattle king, Sir Sidney Kidman (1857-1935) was an early pioneer of adaptation not only to a highly variable climate, but one that was also unpredictable and compounded by the additional ‘shocks’ of the spread of rabbits, erosion and cattle ticks. His ability to overcome the concatenation of uncertainties makes him an ideal historical analogue for adaptation to climatic uncertainty.

Kidman was often criticised for stocking at less than full capacity, but his strategy avoided over-grazing and erosion, ensuring long-term sustainability. His property acquisitions were generally contiguous, forming chains that straddled stock routes and watercourses. Railheads at the ends of the chains provided access to the main capital city markets, and Kidman’s drovers supplied a wealth of information about competing cattle movements.

It has been claimed that Kidman’s success was due to spatial diversification because of the large area that his properties covered. This would have been true during ‘normal’ seasons, when localised rain fell randomly over his holdings, because he was able to move cattle from drought-affected land to his other properties where rain had fallen. However, spatial diversification would have been ineffective at times of severe region-wide drought such as the Federation drought of 1895-1902.

Because Kidman under-stocked his properties and located them along major stock routes in chains, he created a ‘real option’ of strategic transport flexibility that could be exercised even when competing herds could not travel for want of publicly available feed. Proximity to railheads and information about competitors’ herds created a further ‘real option’ of sending cattle to markets where prices were highest.

An important lesson is that creativity and flexibility in response permitted successful adaptation on a transformational scale to exogenous environmental shocks and climatic uncertainty. Consideration needs to be given to strategies that embed flexibility in future adaptation measures.
Evaluating the Adaptive Capacity of Local Government in South Australia.

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Local government plays a key role in adaptation to climate change, primarily because it is close to local communities, where the impacts of climate change will be felt. Its pivotal role derives from the sector’s jurisdiction over land development, economic development, social structures, health and well-being in communities, and the management of significant public assets and infrastructure. Now, under more pressure from higher levels of government, and as climate change risks on a local scale become more quantifiable, the onus is increasingly on councils to develop and implement climate change adaptation policies and plans. In South Australia, each of the 68 local government jurisdictions governs within a unique geographic, economic and social context. The extent to which individual councils have acted and are planning to act to adapt to climate change also varies greatly. This disparity raises the question of whether some councils are more able than others to adapt to climate change, and what key factors influence an individual council’s capacity to effectively adapt. Research is developing an analytical framework that enables evaluation of individual councils’ adaptive capacity. A set of twelve indicators is proposed, reflecting key aspects of community and council, with an overall ‘capacity index’ enabling comparisons to be made across the councils of South Australia. Interviews with staff of selected councils and key agencies involved in local government climate change adaptation will be used to gain a more in-depth understanding of local governments’ adaptive capacity. It is hoped that outcomes of the research will benefit the local government sector, individual councils, and agencies, by proposing a method to evaluate councils’ capacity to respond to climate change, and further suggesting ways to increase local government’s capacity to plan and act in the face of climate change.
Developing and Assessing Strategies for Managing Biodiversity Under Climate Change

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Policy makers and managers will be increasingly challenged by the impacts of climate change on Australia’s marine, terrestrial and aquatic ecosystems, even with optimistic levels of mitigation. The magnitude of future change, the range of ecological responses and the multi-faceted nature of biodiversity all contribute to the challenge. Species are likely to respond in a range of ways: some species may migrate and establish in new regions; some will expand in their abundance and distribution while others will contract to small populations where there is some local or regional buffering; and many species may become extinct locally, or entirely. Even for those species that are able to migrate, the most similar habitat may be vast distances away where actual conditions may be quite different to their current situation. Current biodiversity management practices and paradigms are in many ways unsuitable given the extent of the likely change and do not adequately recognise that species extinctions and changes in ecosystem types are inevitable. We present a framework to assist managers and policymakers systematically assess options for adapting the management of biodiversity under climate change taking account of uncertainty and multiple valued aspects of biodiversity. The framework is designed to help tease apart the means and ends, explore management priorities, support reassessment of the balance between investing in species, ecosystem and landscape outcomes, and enable development of staged adaptation pathways.
Quenching the Thirst: How Much Detail is Enough for Effective Adaptation Decisions

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Viticulture, along with other primary industries, is sensitive to climatic variability and climate change. The framing of decisions by viticultural managers about climate variability and the subsequent provision of information is reasonably well established. However, in relation to climate change, there is growing concern that some researchers are framing this with a climate-centric, rather than decision-centric, model of decision-making: that the climate is the central issue and the management decisions are secondary. Notably, when providing future climate information, such as projections from downscaled GCMs, researchers have tended to assume which characteristics of climate information are most useful in assisting short- and long-term decision-making. Further, there is an assumption that more detailed, more complex information is better – despite mounting evidence that this is not necessarily the case. This risks creating a gap between supply and demand of information.

This study begins to bridge this gap by taking a decision-centric approach to on-ground decision-making. It asks the question: “How can we best design climate input to assist decision-making in this sector?” In doing so, this research poses questions about what constitutes “better” climate information.

This paper presents the qualitative methodology for, and preliminary results of, the first stage of a two-stage study conducted with viticulturalists, wine-makers and industry representatives in the Canberra District of south-eastern Australia. The user-needs framework focuses on questions about what specific kinds of current and future climatic information these groups find useful in their decision-making. The secondary aim is to determine whether a relationship exists between the complexity of information and the utility of that information.

Results indicate that, for short-term decision-making, increased complexity of information is linked to increased utility. In long-term decision-making however, the relationship is context-dependent, and more strongly linked to spatial relevance and levels of trust in the source of the information.
**AusAgLCI – Building National Lifecycle Inventory for Green House Gas Emissions for Australian Agriculture**

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There has been substantial growth in the development of Life Cycle Assessment (LCA) in agriculture in Australia and globally over the past five years. There is a need to develop a national life cycle inventory (LCI) for agricultural products to support environmental impact studies (such as carbon footprinting) and to provide data for important export commodities, so that importers of Australian agricultural commodities can access representative data to complete LCAs.

The Rural Industries Research and Development Corporation has initiated a project to develop an agricultural LCI database (AusAgLCI) in alignment with the Australian Life Cycle Assessment Database Initiative (AusLCI). The project began in December 2011 and will run for 18 months. The project will draw on the extensive research and data collection undertaken in Australia by industry research bodies, state departments of industry, universities and CSIRO. The first task will be to define important industry sub-sectors to give appropriate representation of agricultural products that reflect differences in environmental impact and market segments required by down stream users of the data. Using existing data, the project will align data quality, breadth of data coverage in terms of the impact categories included and standardise the documentation of inventories. Resulting unit processes from cradle-to-farm gate will be reviewed and published. As part of the project, approaches to key methodological issues are being resolved such as joint production from mixed farming systems, scope of water flows to be included, carbon fluxes and land use for future impact assessment developments. At the completion of the project priority areas for additional data collection will be identified.
Legal and Institutional Dimensions of Adaptation to Climate Induced Disasters

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Climate change is expected to bring about more, and more severe, extreme weather events. Effective planning, preparation, response and recovery mechanisms can reduce the impact of extreme events but a changing climate suggests reassessment of how best to structure these mechanisms, and raises the issue of the future policy and legal context of emergency management.

This paper will report on research conducted at the ANU College of Law and the Fenner School of Environment and Society, funded by the Bushfire CRC, on the impact of law and policy on the emergency services and their capacity to meet increasing demands and expectations. It will be shown that the emergency services’ traditional response role is decreasing in importance – agencies cannot extinguish catastrophic fires, such as those experienced in 2003 and 2009, or divert storms, cyclones or floods. To adapt to changing climate the focus of emergency management is shifting to community engagement and assisting communities to make informed decisions about how they will live with the risks they face.

This whole of community approach is hindered by legal and institutional frameworks that separate emergency response from other aspects of emergency management. This paper will contribute to the discussion on the necessary structural arrangements that will be required to adopt a truly ‘all agencies’ and ‘all hazards’ approach. We identify the need for an open and honest debate recognising that we all live with a level of risk, but that we must ask ‘what is an acceptable level of risk and what price are we prepared to pay to reduce risks posed by climate change?’ and ‘how are sometime conflicting objectives of saving lives, saving the environment and recognising personal autonomy to be balanced?’ These questions are considered against likely and less likely shifts in the policy and legal operating environment.
Predicting Water Quality and Ecological Responses to a Changing Climate: Informing Adaptation Initiatives

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Planning to secure the future water to fulfil the socio-economic and environmental needs is a challenging task because of the uncertainty of future conditions on water demand and water availability. The role of science in developing proactive and robust policies is to provide the "best available" knowledge about plausible changes, and their impacts (i.e. bio-physical and socio-economic). The key objective of this project is to assess the impacts of climate change on water quality and dependent ecological systems in the Upper Murrumbidgee Catchment (SE Australia) to inform water planning and climate adaptation. However, climate is only one of many drivers that influence water quality. Direct and indirect climate-driven changes will combine with, and possibly amplify, the impacts of other stressors, including population growth, community behaviours, and land-use change. Therefore, we take a systems-based assessment approach to assess future impacts on water by considering the complex interactions between: (1) the direct and indirect climate impacts on chemical and biological water quality attributes, (2) the impacts of non-climate pressures, such as population growth, and (3) the impacts of multi-scale, multi-objective adaptation decisions. System drivers, management objectives, and adaptation policies are identified through a process of continuous consultation with stakeholders and end-users. As a result, we define a set of scenarios about the future of the catchment up to 2030. To analyse scenarios and quantitatively assess their outcomes, we develop and use an integrated Bayesian network modelling framework. This framework links a suite of hydrological, water quality, and ecological models. Beyond the direct implications for the Upper Murrumbidgee catchment, the work is expected to demonstrate a transferrable scenario-based framework for integrating knowledge from climate science, hydrology, water management, and stream ecology to support decision making.
Managing Regional Stressors Reduces the Vulnerability of Coral Reefs to Climate Change

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Coral reefs are under increasing pressure due to the cumulative effects of global (warming, ocean acidification) and regional (terrestrial runoff, overfishing) stressors. As a consequence, coral cover and rates of coral growth have been declining on many coral reefs around the world including the Great Barrier Reef (GBR). It is commonly stated that management of regional stressors may ‘buy time’ to help ecosystems to adapt or acclimatise with the effects of global stressors. Although this approach is common sense, it can carry high costs to society, and therefore requires sound scientific empirical evidence to confirm the effectiveness of such regional action. Here we present recent experimental, modelling and field data that confirm direct links between reef resilience and regional-scale management action. As two case studies, we focus on the links between population outbreaks of the coral eating seastar \textit{Acanthaster planci} and the terrestrial runoff of nutrients from agricultural lands. To date, this seastar has been responsible for more coral loss on the GBR than any other form of disturbance. We also show the direct link between macroalgal cover on reefs and its nutrient status. Our data suggest that a reduction in nutrient runoff could lead to a significant increase in coral cover, both on inshore reefs through reduction of competition with macroalgae, and on offshore reefs through reduced coral predation by \textit{A. planci}. The outcome is a greater and genetically more diverse coral population in the GBR, which will serve as broodstock to accelerate reef recovery, physiological acclimatisation or even genetic adaptation to climate related disturbances.
Agricultural Adaptation to Climate Change: Perenniality in Southern Australian Dryland Farming Systems

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Dryland agriculture in Australia is attuned to climate variability, and the associated agricultural systems have been developed by farmers as businesses producing food and fibre for domestic and export markets. The land use systems with specific sequences of grain crops and pastures for livestock have evolved to match the variability and change in climate and markets over the last two centuries. Their evolution has been contingent on local climate and the quality of the natural resources of soil and water. The institutional and economic frameworks and the objectives of decision makers have also significantly shaped the nature of agricultural businesses. The level of, and variability in, farm economic returns for existing systems in an historic climate are important determinants for the patterns of farming activities that are currently practiced. The FFI CRC has conducted substantial work investigating the role of perennials in southern Australian dryland farming systems, to offset the effects of salinity and climate variability. In the work reported here we present the conceptual framework of a project that is investigating the adaptation potential for new perennials (plants, shrubs and trees) to predicted climate change for farming systems at four locations. Some preliminary findings are presented. These were informed by discussions held with farmers, farm management consultants and researchers. An analytical approach is presented in which mathematical models, validated with field observations and industry data are used to conduct the analysis of potential future land uses and farm plans. The use of whole-farm bio-economic models is described for considering potential changes in farm economic return. A paddock-level model is also described for examining issues of potential income risk. The decision time frames and perceptions of farmers are important factors in likely responses to predicted climate change.
Multi-sector Climate Change Adaptation in the Great Barrier Reef, Australia

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Adapting to climate change involves efforts by multiple sectors, such as government, industry and community. In general, these sectors have different stakes, roles and capacities, and therefore are expected to be affected by and respond to the risks and impacts from a changing climate differently. Understanding the different motivations and responses of these sectors are critical to improve overall adaptation outcomes. This paper builds on two separate research efforts undertaken by the authors to examine how different sectors, namely federal, state and local governments, and commercial and recreational fishing and tourism industries pursue adaptation in the context of the Great Barrier Reef region. We compare the type of strategies adopted by these sectors and examine the different drivers and triggers of adaptation. Adaptation strategies vary not only across different sectors but within the sectors analysed. While governments have mostly focused on building capacity by providing information, tools and guidelines, and enabling policy and legislation to facilitate adaptation, industries have in general worked to implement adaptation as part of their business operations and management. Within the government, adaptation has been primarily driven by federal and state governments; with local government being constrained by a range of factors including insufficient information and resourcing, uncertainty and short-term time horizons, and institutional limitations. Adaptation strategies perceived as potentially viable options by the fishing and tourism industries, such as effort management, mobility and diversification, and stewardship and industry organisation depend on the nature of these industries themselves, the characteristics of the resources they exploit, and market characteristics. We propose that complementary adaptation strategies across different stakeholders can be explored to facilitate more integrated governance and adaptation.
Climate Change Adaptation in the Coorong, Murray Mouth and Lakes Alexandrina and Albert

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The Coorong and Lakes Region offers critical lessons for adapting to climate change because it is at the end of the iconic River Murray, and comprises a large and complex wetland system of international environmental importance. In this project we explored the "limits to adaptation" and adaptation options. A key "limit" or barrier to climate change adaptation in the Region concerns the availability of water and arrangements for sharing water. As planning for climate change adaptation is therefore entwined with planning for water management we recommend that climate change adaptation should be mainstreamed into water management, with the proposed Murray-Darling Basin water plan providing an opportunity to integrate non-climate and climate induced reforms into water management. A genuinely anticipatory and long-term approach to management of the Region with climate change is required and includes dedicated institutions to develop, implement and adaptively manage long-term plans covering the two major long-term drivers of change in the Region: inflows from the Murray-Darling Basin and ongoing climate change impacts.

We also recommend the establishment of institutions that can better manage the Region with climate change, and ensure: involvement of the Ngarrindjeri Nation in influential roles in ownership and management structures; ongoing relationships with the wider community; consolidated planning in the Region and reinforced scientific research. Options for enhanced governance include: increasing investment in state government agencies; enhancing Natural Resource Management Boards; establishing a consensus-based Council; and setting up a regional Coorong and Lakes statutory authority. Adaptation would be enhanced by effective implementation of the Ramsar Convention on Wetlands and the assessment and implementation of new adaptation measures.
Using a Game-workshop to Explore and Discuss Farm Adaptation

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Games provide an excellent medium for the exploration and communication of ideas and concepts in a participatory manner. Games are well-recognised as a learning tool in education, but they have also been used in numerous other contexts and sectors. We have produced an interactive farm game, utilising concepts from a scenario planning game and agent-based modelling, for use in interactive workshops with farmers, grower group staff, advisers and researchers. The workshops aimed to explore plausible futures, to examine possible consequences of combinations of future management and land-use options in a no-risk, virtual manner.

The following are the main points to be covered in paper.

Development of the game and factors included:

- Inclusion of the game as the centre piece of an interactive workshop.
- Feedback from workshops conducted with 52 participants at five locations across the wheatbelt of Western Australia. Overall 74% of participants considered that the workshop helped them to consider options that would be useful on their farms. Participants considered that much of the ‘game-play’ reflected their real decision-making, whilst recognising the simplifications and contractions inherent in a game. The opportunity to hear the decision-making of others, and to observe the effects, was of particular value.

The potential for a game-workshop approach to explore adaptation options and, particularly, to identify information needs for farmers in a specific region will be discussed.
Social Networks and Climate Change Adaptation: a Case Study on Regional Governance Arrangements

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As governance arrangements guide and steer human societies, research by the Department of Primary Industries sought to examine the role of regional institutions in effectively governing climate change adaptation. A case study approach highlighted the interactions and decision-making processes of institutions associated with the dairy industry in south west Victoria.

The insights gained from this research were developed using advanced social network mapping techniques based on information obtained from a social network questionnaire. The questionnaire focussed on four key questions: sources and type of information sought on climate change; the topics and frequency of communication; collaborations/activities that are occurring on climate change adaptation; and institutions of trust and influence in the region. Institutions identified had a wide range of interests including: education, land management, catchment management, strategic planning, finance, milk processing and dairy farming.

The research examined the embeddedness of these institutions within local communities and the governance arrangements that play an important role in organising and enabling networks of people to adapt to climate change. Local embeddedness builds high levels of trust and a shared understanding of the issues.

The results highlighted an increasing interest in collaborative efforts to respond to climate change by building trust and engendering an environment conducive to innovation and flexibility. The research developed a typology of institutional arrangements that have evolved in the south west highlighting a tendency to associate and bond with trusted sources of information and institutions perceived to have influence, most often part of the same type of institution. Also highlighted, was the important role provided by newly emerging institutions that are regionally based with a specific focus on climate change adaptation. These institutions are bridging the divide between community/government and industry sectors to create a trusted source of information and influence.
Adaptation and Transformation in Action: Insights from Climate Change Responses in Five Australian Case Studies

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Transformation, such as relocation, in Australian primary industries and communities is already occurring as a response to climate change. The drivers behind transformation are often complex and can include climate change both as a ‘backdrop’ and a key driver. Nevertheless, climate projections suggest an increasing need for transformation, despite current information typically being inadequate to support such changes. For example, industry often has an inadequate understanding of ‘who’ will need to transform as well as ‘if’, ‘how’ or ‘when’.

This presentation describes the decision making processes behind incremental and transformational change in five Australian case studies: peanut farming, rice farming, the wine industry and two communities in agricultural regions. We identify lessons learnt for climate change adaptation and link to theoretical understandings of change and decision making from the ‘adaptation action cycles framework’ (Park et al. 2011).

Three years into this five year project, we demonstrate how a longitudinal approach provides unique insights into the change process. In particular we focus on socio-economic aspects of decision making that have been neglected in the research literature and suggest some key factors that can drive or limit transformation. Factors such as timing of decisions, dependency across supply chains, organizational culture and personality profiles have emerged as key themes that influence transformation.

Discussion of climate change responses in our five Australian case studies provides much needed empirical analysis of transformation and the decision making processes that drive adaptation. This type of contextual data is crucial for understanding the different types of decision making that occur and can be applied to other agricultural industries by informing strategies taken to adapt to climate change.
Flexible Guidance on Adaptation Planning and Decision-making: the Adaptation Navigator Application

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¹Climate Change Adaptation Program, RMIT University

It is widely acknowledged that climate change adaptation is a highly context-specific undertaking. Consequently, much of the action on climate change adaptation will need to take place at the local and regional level and designed in a way that takes the local/regional socio-economic, environmental and institutional context into account. This creates a conundrum for researchers and policy makers involved in organisational capacity building: how can one provide useful and clear guidance on the process of adapting to climate change while ensuring that such guidance is not prescriptive but enables end-users to devise effective, tailor-made adaptation processes? Many adaptation toolkits exist but due to the problem structure of adaptation and the institutional complexity of the organisations facilitating adaptive processes, prescriptive toolkits rarely serve well as blueprints for designing a workable adaptation process.

This paper presents recently completed research on the operational framing of climate change adaptation within the local government sector in Victoria. Through qualitative social and action research, the authors have examined how local government actors involved in adaptation frame and address climate change adaptation. Based on the findings of in-depth case study research with three local authorities and triangulation, the authors have developed a flexible web-based guidance tool called the Adaptation Navigator. This application is designed to enable users to explore and map out a process for climate change adaptation suited to their organisation’s needs, capacity and specific objectives. The design of the Adaptation Navigator emphasises adaptation as an iterative planning and decision-making process and supports peer-to-peer learning (i.e. understanding what processes other local governments have used for addressing climate change impacts). The paper outlines the empirical research basis of the Adaptation Navigator and discusses its structure, design and functionality, with a view to invite feedback and comment from the audience.
Where Should We Invest to Adapt Coastal Ecosystems to Sea Level Rise?

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Sea level rise threatens coastal habitats globally, and the species that depend on them. Borrowing tools from engineering that are used to model water flow through pipeline networks, we have been modelling the migrations of Australia’s coastal shorebirds that travel to and from the Arctic each year to breed. We estimate that 21st century sea level rise will lead to the loss of a quarter of the habitat area used by these species, but cause overall population reductions of about two-thirds across ten taxa because of the way the migration networks are structured. This magnifying effect was particularly strong for taxa whose migration routes contain a small number of bottleneck sites through which a large proportion of the population must pass. These sea level rise impacts can be managed by allowing upshore movement of coastal wetlands, but this is expensive and suitable land is not always available. We have built a flyway-wide schedule for allocating such conservation investments, and the results differ strikingly to simple static conservation planning. Climate adaptation for coastal species will require major investment over the coming decades.
**Incorporating Climate Change Adaptation into National Conservation Assessments**

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¹The Nature Conservancy
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The Convention on Biological Diversity requires that member nations establish protected area networks that are representative of the country’s biodiversity. The identification of priority sites to achieve outstanding representation targets is typically accomplished through formal conservation assessments. However, representation in conservation assessments or gap analyses has largely been interpreted based on a static view of biodiversity. In a rapidly changing climate, the speed of changes in biodiversity distribution and abundance is causing us to rethink the viability of this approach. Here we describe three explicit strategies for climate change adaptation as part of national conservation assessments: conserving the geophysical stage, identifying and protecting climate refugia, and promoting cross-environment connectivity. We demonstrate how these three approaches were integrated into a national terrestrial conservation assessment for Papua New Guinea, one of the most biodiverse countries on earth. Protected areas identified based on representing geophysical diversity were able to capture over 90% of the diversity in vegetation communities, suggesting they could help protect representative biodiversity regardless of changes in the distribution of species and communities. By including climate change refugia as part of the national conservation assessment, it was possible to substantially reduce the amount of environmental change expected to be experienced within protected areas, without increasing the overall cost of the protected area network. Explicitly considering environmental heterogeneity between adjacent areas resulted in protected area networks with over 40% more internal environmental connectivity. These three climate change adaptation strategies represent defensible ways to guide national conservation priority given the uncertainty that currently exists in our ability to predict climate changes and their impacts. Importantly, they are also consistent with data and expertise typically available during national conservation assessments, including in developing nations. This means that in the vast majority of countries, these strategies could be implemented immediately.

J. Gardner¹

¹CSIRO Australia

Much of climate adaptation research is aimed at identifying what actions should be taken now to avoid expected climate impacts in the future. Regrettably, the long-term consequences of specific actions to avoid possible future impacts cannot be measured accurately in advance. The concept of "adaptive capacity" has gained increasing currency in the adaptation domain, because it represents a means of conceptually bypassing this problem. Rather than waiting (perhaps for decades) to observe whether adaptation actions have actually been successful, the adaptive capacity of a system (be it an organisation, region or industry) can be measured now, before any specific climate impacts occur.

However, taking this shortcut involves a number of risks. In this paper, I review literature relating to the measurement of adaptive capacity, and highlight some important considerations in the practical application of this approach. I focus particularly on the sustainable livelihoods framework (Ellis, 2000), which defines adaptive capacity as consisting of five “capitals” or resource types, along with the systems used to access, transform and dispatch those resources. Amongst other issues, I note the conceptual and practical difficulties of measuring any kind of system capacity, and note that capacity for successful adaptation might in many cases also reflect the capacity for maladaptation. I present some conclusions regarding the use (and abuse) of adaptive capacity, both for the “five capitals” approach and for other conceptualisations.
Successful Climate Change Adaptation Approaches Used in Michoacan, Mexico

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¹National Climate Change Adaptation Research Facility
²World Bank

Sustained stakeholder involvement and responsiveness to new information are critical for ownership of policies at the local level where adaptation must occur. A workshop engaged key stakeholders from across the public and private sectors of Michoacan. The risk management approach was adapted from a participatory model. The approach provides a tool for combining the complexities of climate science with local expertise in an iterative and participatory process. A recurring theme was that climate change strengthens the need for efficiency-enhancing improvements and policies, rather than demanding new initiatives. Greater efficiency in the use of natural resources builds greater resilience to climate change and is therefore an economically prudent way of adapting when there are large uncertainties. The climate risk management approach ensured that consensus was reached on adaptation options for water and agriculture.

Infrastructure investments that address the current and future challenges in the water sector were high on the list of priorities. With projections of drier and more extreme climate, there is a greater imperative for balancing variable water supplies with rapidly escalating water demands. Declining storage capacity due to high siltation rates, over-allocations of water, and inefficient uses were among the set of problems that were addressed. Measures leading to greater water efficiency were recommended, but the extent of investment depends on the uncertain climate impact. This further reinforced the need for adaptive management approaches that respond to new information in a consensual manner, as it becomes available.

In the agriculture sector, the focus was on rain-fed maize. With climate change, extreme events, such as lower rainfall that compromise yields are projected to increase in frequency. Adaptation options were prioritized based on perceived cost effectiveness, immediacy of impact and robustness. As a result, there was convergence upon techniques that are extensions of current “best practice” climate risk management approaches.
Legislation, Land Tenure and Climate Change Adaptation in Australia: the Hothouse Between Public and Private Interests.
E. Gerrard

National Indigenous Climate Change Project and Allens Arthur Robinson

The principle of common but differentiated responsibility underpins global agreements on climate change and is central to effective adaptation and mitigation responses. The principle reflects our shared responsibility to act, yet acknowledges the resource gulf between those who can and those who cannot, those who have and those who have not. Climate Change adaptation applies pressure to the root of the public administration and private interest nerve. This paper examines the rights and interests of Australia’s Aboriginal and Torres Strait Islander people, as experts, vulnerable communities, tenure holders and land managers in Australia’s responses to climate change and the powers of public and private interest holders to implement adaptation policies and practices across Australia. The legislative quilt that drapes itself across ancient land and seascapes in Australia is an important consideration in the formulation of effective policy in this area and presents a challenge to the implementation of policy and reform within this patchwork environment. This paper considers social and equity issues in climate change adaptation and the potential barriers and limits to effective adaptation. Scenarios and approaches relevant to the regulatory and legal implications of adaptation are discussed, particularly in the context of property, planning, administrative and native title law and this paper reiterates the proper place for Indigenous expertise in building sustainable and long term pathways.
Community Welfare Sector: Coal Mine Canary or Bastion of Societal Resilience - Initial Results from the NCCARF Funded Research into Risk and Adaptation in the Community Welfare Sector

C. Goldie¹, K. Mallon², T. Westmore¹

¹Australian Council of Social Services
²Climate Risk

This paper will outline initial results from a project to understand the risks facing community welfare organisations that provide a diverse range of important services to groups and individuals in society who are most vulnerable and least able to adapt to climate change in urban, regional and remote settlements. The research will identify and detail the nature of these vulnerabilities especially as they apply to service delivery, the underlying causes of organisational vulnerability and sources of resilience, and measures which have been taken or can be taken to increase adaptive capacity and mitigate, manage and transfer climate change related risks of infrastructure failure.

The first round of results from the project reveal that: (a) Most organisations, and especially their service delivery, are highly vulnerable to the failure or disruption of critical infrastructure exacerbated by climate change (b) Despite a major diversity in organisation characteristics; service types, and geographical distribution the modes of organisational failure and stress show strong commonality across the sector (c) Community welfare organisations have characteristics which predispose them to much faster recovery rates following extreme event disruption than equivalent private sector organisations.

The paper will discuss which risks to infrastructure generated by climate change related hazards are most likely to stress, or trigger failure in, and the ability of community welfare organisations to deliver services in order to test the first project hypothesis that, ‘the community welfare sector in its current form will be a dependable and viable provider of services to vulnerable groups despite projected climate change impacts’.

The paper will also outline the development of the climate change aspects ‘National Community Sector Survey’ of between 750 and 1000 community welfare organisations.
Climate Change Adaptation for Water Resources and Freshwater Biodiversity

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We present a synthesis of insights from a CSIRO-NCCARF project identifying modelling resources and requirements to support climate change adaptation in the Australian water resources and freshwater biodiversity sector. Options for climate change adaptation identified in stakeholder workshops fell into three broad categories:

1. Strategic knowledge acquisition and research (e.g. provision of long-term data-sets, risk assessments, research aimed at understanding key processes and cause-effect relationships).
2. Changing governance structures or problem framing (e.g. regulations, trading mechanisms and markets, stakeholder engagement processes, water stewardship frameworks).
3. On-ground action (e.g. fencing riparian zones, changing storage operations, water recovery and re-use, buying water entitlements).

Participants in cross-sectoral workshops emphasised that water resources and freshwater biodiversity issues are embedded in social-ecological systems – strong feedbacks between social and ecosystem dynamics make working with either in isolation from the other problematic. Many of the climate change impacts of interest to stakeholders were not biophysical impacts of climate change, but rather anticipated societal responses across a range of sectors (e.g. altered energy demands, changed planning regulations, changed land-use decisions and changing mechanisms for trading and allocating water).

Consistent with findings in peer-reviewed literature, stakeholders voiced a well-identified need to adopt strategies that enable integrated, adaptive decision-making rather than strategies reliant on a high level of prediction and control. Whilst important roles exist for modelling, these are in the early stages of development relative to state of the art physical systems modelling. This presentation discusses the role of models in four particular contexts:

1. Making explicit the links between climate change and its impacts.
2. Enabling transparent exploration of potential responses to climate change and impacts of those responses.
3. Facilitating communication and engagement around issues, objectives and decisions.
4. Providing underpinning frameworks and metrics to organise and synthesise knowledge, and structure ongoing monitoring and learning.
Indigenous Voices in Climate Change Adaptation: The Challenges Facing Yorta Yorta People

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The Murray-Darling Basin incorporates Australia’s three longest rivers and spans four States and one Territory. It is important for an agricultural industry worth more than AUS$9 billion per year, but is also the life source and spirit of the Indigenous Yorta Yorta people. Through this project, we address questions on whether the interests of the Yorta Yorta people can encompass the common interest of the wider community in the Basin, and how the colonial and climatic legacy of the past century continue to influence the realisation of the common interest moving forward. We find that shared regional governance with an agreed outcome supports the ongoing sustainability of the country and its people, but because of the legal history of Australia since colonization, recognition and mutual respect are no less important. Further, the high climatic variability that exemplifies the south east of Australia corroborate the need for planning with longer time horizons in the context of climate change. These lessons are supported by the customary law and practice of Yorta Yorta people.

The approach adopted for this project examines how the Indigenous knowledge of the Yorta Yorta can be appropriately legitimised, protected and integrated with more conventional forms of knowledge and science to improve natural resource management and climate change adaptation in the Barmah-Millewa area. The project itself encompasses several components, namely: the construction of a GIS management database that integrates Yorta Yorta knowledge, provisions for Indigenous knowledge protection, and stakeholder perspectives and values analysis using Q methodology. This presentation reports on progress made to date, as well as insights and lessons learnt so far on this multi-stakeholder and interdisciplinary experience.
Community Led Planning for the Impacts of Climate Change
R. Hamden

Department of Environment and Natural Resources, South Australia

When making decisions about the future, communities face a range of uncertainties. These arise not only in the climate change science, but also in economic projections, population growth, land use reform, demographic changes, as well as each community's own capacity to adapt. The Government of South Australia is delivering a community led planning and decision process to drive real adaptation reform.

Ensuring prosperous futures for communities despite the impacts of climate change requires cooperation and planning across all levels of the economy and society. South Australia is adopting a bottom up driven approach that empowers regional community leaders to work together to plan and deliver on adaptation actions for their regions. The Government of South Australia is an active participant in the process, and relies on the ideas and actions arising from regional planning to develop statewide responses to climate change.

Critical to achieving success with this approach is the identification and empowerment of strong regional leaders, and the development of collaborative relationships between these leaders and state government bodies, ensuring that state policies adequately reflect the regional processes.

- This paper describes the South Australian experience and outlines some early benefits. It covers:
  - The mechanisms to identify and empower the right community leaders to participate in planning
  - The integrated vulnerability assessment processes to manage uncertainties, determine acceptable tradeoffs and identify and prioritise adaptation options
  - The planning process to prioritise actions and deliver reform
  - The management framework to ensure that issues raised by communities are considered in government decision making
  - The communications mechanism for community engagement in decision making and planning
  - The many benefits being achieved through this approach.

Through this process South Australia aims to deliver real adaptation reform and prepare our communities for the impacts of climate change on our state.
Can Major Infrastructure Procurement Adapt to Climate Change?
D. Hand¹

¹Maddocks

Over the past 10 years, major infrastructure procurement in Australia has adapted to reflect a growing need for innovative approaches to delivering infrastructure. Key forms of procurement include Public Private Partnerships (PPPs), alliances and relationship contracts and ‘traditional’ contracts. These forms are ‘regulated’ by various means, including the National PPP Guidelines, Alliancing Guidelines and Commonwealth Procurement Guidelines. But, so far, little consideration has been given to how major infrastructure procurement can adapt to climate change. Therefore, it is important to consider the role of major infrastructure procurement in facilitating new infrastructure and enhancing the resilience of existing infrastructure.

With this in mind, this presentation will:

- explore the key forms of ‘regulation’ of major infrastructure procurement, including PPPs, Relationship Contracting and Traditional Contracting;
- discuss how these key forms of ‘regulation’ currently facilitate and hinder adaption to climate change; and
- argue that reforms to the National PPP Guidelines, Alliancing Guidelines and Commonwealth Procurement Guidelines are necessary to adapt to climate change.
Adapting to Working in the Heat
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¹Australian National University

Background: Australia has warmed faster than the global average, and the upward trend in extreme heat events is concerning. Working in the heat is uncomfortable and many work places are impracticable to cool. Thermoregulation requires rest breaks to prevent overheating and serious health problems, yet pressure to keep working persists. Human tolerance to heat exposure has physiological limits, beyond which health stress occurs. Despite its hot climate, Australia has no national OH&S guidelines for working in the heat. No studies have examined thermal exposures, thermal tolerance, symptomatology, health burden, or successful health protective strategies across multiple industries. Heat exposures currently represent a major health challenge, one which is predicted to significantly exacerbate under climate change.

Aim: To address a significant knowledge gap and policy vacuum, and support the development of OH&S guidelines that will carry relevance to other non-occupational settings. We will:

- Assess current impacts of environmental heat stress on the health, safety and productivity of Australian workers,
- Calculate the change in occupational heat exposure since 1980,
- Estimate the likely future increase in exposure to high temperatures using climate change projections to 2030, 2050 and 2080 based on IPCC Emissions Scenarios,
- Identify adaptation strategies likely to be most effective in reducing heat-related adverse health and productivity outcomes during future climate change.

Methods: Assess current working micro-climates and worker’s heat exposures by continuously monitoring climatic variables using QuestTemp36 and Dataloggers at selected worksites across south-eastern Australia, and compare these to BoM data. Future occupational heat exposure will be modelled using IPCC climate projections. Worker’s heat tolerance will be measured by hydration analysis and via self-assessments of symptomatology and productivity, plus analysis of administrative records. Heat polices in operation will be assessed for compliance via surveys with workers and management, and for efficacy via regression analysis of heat exposure responses.
**Heat-health Behaviours of Older Persons During the 2009 Heatwave in South-eastern Australia**

A. Hansen¹, M. Nitschke², B. Peng³, D. Pisaniello¹, J. Newbury¹,², A. Kitson¹, E. Dal Grande⁴, J. Avery¹, S. Slota-Kan⁴, M. Fraser-Adams⁴, L. Kelsall⁴

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Background: A major heatwave which occurred in south–eastern Australia in early 2009 had considerable health impacts on the older population in two states, South Australia (SA) and Victoria.

Objectives: The aim of this study was to investigate underlying reasons why the health consequences were more severe in Victoria.

Methods: A computer assisted telephone survey was conducted at the end of summer 2010-2011 to investigate the adaptive behaviours during heatwaves of 500 persons aged 65 years or over in each state.

Results: There was a significantly higher proportion of households with air conditioning in SA (95.2%) compared to Victoria (86.2%) despite a higher proportion of low income households. It was more common for older persons in SA than in Victoria to be living in houses or retirement villages, and there was a higher recall of heat-health messages in SA. Victorians were less likely than South Australians to undertake adaptive strategies during heatwaves such as staying indoors, reducing physical activities, or using air conditioning. In both states, self-reported morbidity during heatwaves was higher in females and persons in poor health.

Conclusion: Victoria has a generally cooler climate than SA, and the population is likely to have a lower level of acclimatisation to extreme heat. Findings suggest older persons in Victoria have less access to air conditioning and may undertake protective heat-adaptive behaviours to a lesser degree than those in SA. These could be contributing factors to the differences in the heat-health impacts between the populations.
Retreat or Defend? Planning for Change in Tasmania’s Coastal Zone.
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¹Tasmanian Climate Change Office

The Tasmanian Coastal Adaptation Decision Pathways (TCAP) project is focussing on four low-lying coastal settlements with communities, a range of infrastructure and natural values that are likely to be affected by increasing coastal hazards resulting from erosion and sea level rise.

TCAP aims to significantly improve the ability of Tasmanian decision makers and communities to plan and respond to likely futures for coastal communities. To this end, the project team has been working closely with the participating Local Councils to create a dialogue with each of the communities, develop a solid information base and then explore a number of possible adaptation pathways.

The approach is based on a fifteen step flexible community adaptation pathway that relies on open communication of the risks, and two underpinning principles. The first is that risks to private property and public infrastructure must be managed across the community in a coordinated way. The second is that it is poor public policy to subsidise people to occupy hazardous locations.

Using the best available data and information, the TCAP team has mapped inundation hazards and analysed how the hazards are likely to impact on the study areas, to inform assessments of the benefits and costs of living in these project study areas into the future.

A process of scenario workshops has then examined four pathways, ranging from ‘letting nature take its course’ to ‘protecting existing and permitting future development to the maximum possible extent for as long as possible’.

These pathways each have very different implications for the community and governments. The decision to adopt any of the pathways will raise significant questions regarding planning frameworks and roles and responsibilities that have relevance to all coastal communities.

This paper outlines the project methodology, and discusses some of the barriers, challenges and opportunities experienced by the project team.
Dengue Transmission Under Climate Change in Northern Australia: Linking Ecological and Population-based Models to Develop Adaptive Strategies

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¹National Centre for Epidemiology and Population Health

Dengue epidemics have become increasingly common in Far North Queensland through the 1990s to the present. Determining the relative importance of climatic and other factors in dengue risk is crucial in planning for future changes in incidence. We have performed mathematical modelling using the Dengue Simulation Model (DENSim) and found reasonable concordance between modeled and observed epidemics in Cairns over the last two decades.

The principal objectives of this research are:

1. To determine the relation between climate and dengue transmission in Australia, use this information to develop the optimal predictive model, which will then be used to estimate the impact of impending climate change on: (i) total dengue disease burden, (ii) the geographic range of dengue transmission, and (iii) health system impacts including the availability of donor blood supply.

2. To use these estimates of predicted impacts to develop adaptive strategies to reduce the future disease risks and burden associated with dengue.

To achieve Principal Aim 1, we will:

a) Collect and link data to develop new statistical models.
b) Assess the validity of an existing model (DENSim, i.e. Dengue Simulation Model).
c) Determine which of the above models is the most accurate tool for predicting future dengue incidence.

Meteorological data were collated for study sites in North Queensland. Dengue notification data will be used for calculation of incidence rates.

We will present data from DENSim modelling for Cairns. We will discuss empirical modelling, and implications for projection under climate change. Implications for the blood supply and possible responses will also be considered.
Living Beside the Rising Tide: Adapting to Coastal Change in Auckland, New Zealand

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²Victoria University of Wellington
³AgResearch

The Earth’s climate system is entering a period of dynamic change after millennia of relatively stable climate. Coastal communities will need to adapt to dynamically shifting coastal environments as the climate system changes and sea levels rise. We investigated local vulnerability to sea level rise and social and institutional barriers to coastal adaptation through a case study of two coastal settlements in the Auckland region – Mission Bay/Kohimarama and Kawakawa Bay. We used spatial analysis of extreme event inundation and economic and social impacts to underpin in-depth, semi-structured interviews with coastal experts from a range of backgrounds. Both settlements will experience increasing coastal hazard risk as the numbers of people and property potentially affected by storm events increases as sea level rises. Findings from our study suggest that existing settlements in the Auckland region may already be ‘locked in’ to a coastal adaptation approach focused on coastal stabilisation, an approach that will decrease community resilience and increase vulnerability in the long term. Retreat offers an alternative approach that is strongly aligned with reducing community vulnerability and increasing resilience; however, strong opposition from communities to any retreat approach is expected. Developing trusted climate science information, education around coastal hazard risk, and participatory community led decision-making are identified as central enablers for a retreat approach to be included as a viable coastal adaptation option for the Auckland region.
**Drought or Aridity – Notes from the Northern Edge of the South Australian Grains Belt and the Southern End of the Murray Darling Basin.**

P. Hayman¹, B. Alexander¹, B. Mudge²

¹South Australian Research and Development Institute  
²Rural Solutions South Australia

The recent drought or big dry had a major impact on grain farmers on the northern edge of the SA grains belt. This is not unusual. Low rainfall farmers expect droughts. What was new was the discussion about rainfall shifts rather than cycles, drying or creeping aridity rather than a drought, climate change rather than variability.

This presentation will report on interviews and analysis that has been conducted with South Australian low rainfall farmers and irrigated wine grape growers. We report on what low rainfall farmers had learnt at a paddock level, whole farm level and community level from the recent drought and then recovery in the last few above average seasons. We pose the question as to how well managing year to year variability will enable adaptation to climate change.

With irrigated wine grape growers we used a crop calendar as a means to identify and rank key weather and climate risks. This process highlighted the importance of irrigation water as a means of adapting to both drying and heat events as irrigation prior to a heat event and subsequent transpirational cooling was the most effective means of handling heat-waves.

According to the Productivity Commission review of drought policy, the recent drought was considered the first irrigation drought. Almost all irrigation schemes in Australia were set up by governments with the explicit aim of drought proofing production. Perennial horticulture on what was thought to be high security water was thought to be unaffected by drought; yet the recent drought showed that this sector is perhaps the most vulnerable to water shortage.

Discussion will focus on the interpretation of trends in rainfall and stream-flow, ways of communicating the uncertainty from GCMs and planning under uncertainty and the tricky question of disentangling drought and aridity.
Why Science Does Not Drive Wicked Problems of Adaptation

B. Head¹

¹University of Queensland

Policy-makers have had great difficulty in understanding and responding effectively to complex or ‘wicked’ problems, including most aspects of climate change policy responses. Policy innovation become contentious, difficult to formulate and hard to implement when knowledge bases are divergent and incomplete, and when problems are construed or framed in very different ways. These features of ‘wicked’ problems are central for adaptation initiatives addressing the likely impacts of climate change. Given the closely inter-connected nature of social, technical, legal-political, economic and natural-resource issues, the political challenges of encouraging and managing change are numerous. Science often becomes harnessed to partisan positions and is less able to be a neutral authoritative source of advice. Science alone cannot overcome the problems of political gridlock and ideological polarization. Social and political processes for strategic innovation require investment in ongoing pluralistic and adaptive processes, including a major role for scenario analyses. These processes of policy development and stakeholder inclusion should recognize the contested nature of the issues, the multiple bases of knowledge and interests, and the provisional nature of adaptation choices.
Cultural Resources for Climate Change Adaptation: Identifying Opportunities in Abundance, Scarcity and Variability

L. Head¹

¹Australian Centre for Cultural Environmental Research, University of Wollongong

Much of the debate on climate change adaptation has focused, for good reasons, on risk and vulnerability. This paper argues that a well rounded understanding of adaptation should include the identification of existing cultural resources and capacities. Working with these will empower communities and highlight opportunities as well as problems. I draw here on several of our Australian projects that use research methods in the ethnographic tradition among both urban and rural (wheat-farming) households. Attention to everyday practices helps identify capacity as well as vulnerability, opportunity as well as challenge. It also shows that many lower socioeconomic groups are already doing more of the work of climate change adaptation. I discuss how these dimensions of adaptation might play out in the fluctuations between abundance and scarcity projected to increase under climate change scenarios.
Will Primary Producers Continue to Adjust Practices and Technologies, Change Production Systems or Transform Their Industry—An Application of Real Options.

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In Australia the long term sustainability of crop-livestock farms face a substantial threat in the form of the uncertainty associated with climate change and climate variability. Uncertainties associated with the nature and magnitude of impacts presents a challenge for adaptation decisions. These are made at the level of 1) adjusting practices and technologies, 2) changing production systems, or 3) transforming to new areas or industries. Adjustment changes are relatively easy to make but system and transformation changes may be irreversible, or partially irreversible, leaving stranded assets. Making the switch will require investments and infrastructure. This is the so-called hysteresis effect which makes switching difficult and mistakes costly. Real Options offers a framework to structure thinking and analysis for these difficult choices. Previous work has demonstrated how this decision framework applied to adaptation, now referred to as ‘Real Options for Adaptive Decisions’ (ROADs), extends traditional economic analyses of agricultural investment decisions based on net present values, to better represent incomplete knowledge and uncertainty. This project uses transects across space as proxies for future climate scenarios. We draw on climate data and data for representative farms to calibrate the real options models. In this paper, we present preliminary results on the transformation of wheat dominant cropping systems in New South Wales, South Australia and Western Australia.
Biotically-scaled Environmental Stress: an Approach to Assessing Climate Change Threats to Inform Adaptation

D. Hilbert, M. Dunlop, S. Ferrier

CSIRO Ecosystem Sciences

Climate models produce detailed scenarios of physical changes in the Earth system due to anthropogenic climate forcing, changes in atmospheric concentrations of greenhouse gases and land-use change. Due to a large international investment, the quality of fully coupled climate models is increasing as is the capacity to downscale their results to regional scales. However, impacts and adaptation scientists are faced with the challenge of translating (scaling) climate model data into domain-specific, meaningful metrics of future impacts that underpin adaptation strategies. This is generally done by a multitude of more or less ad hoc methods. The challenge of scaling climate change scenarios to broad measures of impact is particularly difficult for ecological systems at large spatial scales because of their complexity and nonlinear responses to climate.

Our approach, applied to all of Australia, is to scale (transform) climate change data into ecologically meaningful metrics of change (implying stress) from the perspective of the biota. These measures of “biotically-scaled environmental stress” (BSES) provide spatial indices of the potential for future environmental change to drive ecological change. Specifically, we developed two methods, each derived from analysis of the observed spatial relationship, over the continent, between a broad descriptor of biodiversity and environmental variables. Artificial Neural Networks [ANN] were used to analyse vegetation classes, and Generalised Dissimilarity Modelling [GDM]) was used to analyse patterns of species composition in broad taxonomic groups. Both approaches estimate how dissimilar local, future environments will be in the future from the environments that sustain the local biodiversity now.

Our results suggest that climate change will be a very significant stressor over large parts of Australia that will likely lead to a large and complex reorganisation of the ecological landscape with significant implications for climate adaptation policy and practice in the conservation area.
**Seasonal Forecasting As Stepping Stone for Marine Industries Adapting to Climate Change**

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Marine fisheries and aquaculture operations have a long history of reactive response to environmental variability, but in recent times, operators are becoming less reactive and more proactive in their planning. Information supporting proactive decision making, particularly when the environment influences business performance, can come from forecasts of future environmental conditions. Weather forecasting, for example, is already widely used for planning activities on time scales from hours to days. Climate forecasting is being used to plan infrastructure, coastal planning and long term industry changes at time scales of decades to centuries, however, for many, long-term projections of climate change are outside the normal planning horizon, and many operators are unsure about appropriate responses. Between these two extremes, is seasonal forecasting, delivering information at a time scale of weeks to months. We illustrate how Australian fisheries and aquaculture businesses are using a range of targeted marine seasonal forecasts developed by our team. In prawn and salmonid aquaculture, operational decisions can be modified on the basis of expected air and water temperatures, and we provide these at lead times of up to four months. Forecasts allow managers to adapt their strategies to maximise production for potentially warm summers or cold winters. In wild fisheries, such as the Australian east coast longline fishery, seasonal forecasts are used to prepare management and fisher responses to expected spatial management. Use of seasonal forecasts are leading to improved decision making, which will improve the ability of marine industries to plan for the longer term and more dramatic changes projected this century.
Local Resilience and Integrated Urban Design: the Role of Urban Design Principles in Climate Change Adaptation

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Making risk resilient cities has many aspects just as the city itself. It needs various approaches including disaster management, urban planning & design, economic, social, structural and environmental sciences to analyse the process of city’s preparedness against disasters be it slow such as climate change or sudden such as flash floods which means helping to protect the valuable resources including: people, buildings, infrastructure cultural values and all the valuable elements of their environment.

Aspects of urban resilience such as adaptability, character which builds community cooperation can have equals in urban design jargon such as robustness, liveability, sense of place and identity.

This article means to tackle main urban design principles which can contribute to climate change risk mitigation and to safeguard sustainable development, meaning protecting ecological, cultural, economic and social values and resources and enhancement of urban environment safety and livelihood as part of sustainability and study the ways of achieving these goals by guiding the perceptual and formal aspects of urban form development.

Seeing climate change as an upcoming threat whether we are still aware of that in our own environments or not, needs to be tackled from urban design point of view along with other disciplines to make sure that future urban form decreases carbon emission as well as reduce the oil consumption and use passive forms of energy to fulfil climate change aims.
Rethinking the Policy/Planning Approach to Climate Change Adaptation and Disaster Risk Management.

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Australia is highly susceptible to the impacts of climate change, particularly through the increasing frequency and/or intensity of disasters such as floods and bushfires. There is, however, considerable uncertainty about when and how disaster management organisations should address climate change and the appropriate level of priority that it should be given. To add to these problems, effective government responses have been hamstrung by a growing antipathy from the general public and uncertainty on the most effective approach to both climate change and disaster risk management. It seems that the release of the best available scientific research, open inquiries and extensive public consultations through existing policymaking and planning processes have not been sufficient to produce a consensus on the best way forward. This paper addresses these issues by summarising the progress to date of an NCCARF funded research project: The Right Tool for the Job: Achieving climate change adaptation outcomes through improved disaster management policies, planning and risk management strategies. The aims of the project are threefold: (1) To reconceptualise the framing of the problem of climate change adaptation and disaster risk management; (2) To develop a new approach to this problem based on this re-conceptualisation; and, (3) To identify how existing policy and planning tools may be modified based on this new approach. To achieve these aims the project is undertaking a comparative analysis of four case studies: the 2011 Brisbane floods; the 2009 Victorian Bushfires; the 2011 Perth Hills Bushfires; and the development of disaster risk management policies at various levels of government. Overall it is argued that we need to rethink the approach to climate change adaptation and disaster risk management, the tools that have been used, and the underlying theoretical framework on which planning and policymaking is based.
Effects of Extreme Temperatures on Years of Life Lost for Cardiovascular Deaths: a Time Series Study in Brisbane, Australia

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Background: Extreme temperatures are associated with cardiovascular disease (CVD) deaths. Previous studies have investigated the relative risk of temperature-related CVD mortality, but this risk is heavily influenced by deaths in frail elderly persons. To better estimate the burden of extreme temperatures we estimated their effects on years of life lost due to CVD.

Methods: The data were daily observations on weather and CVD mortality for Brisbane, Australia between 1996 and 2004. We estimated the association between daily mean temperature and years of life lost due to CVD, after adjusting for trend, season, day of the week, and humidity. To examine the non-linear and delayed effects of temperature, a distributed lag non-linear model was applied. Residuals from the model were examined to investigate whether there were any added effects due to cold spells and heat waves.

Results: The exposure-response curve between temperature and years of life lost was U-shaped, with the lowest years of life lost at 24 °C. For a mean temperature of 10 °C, there were 33 years of life lost (95% CI: 12–54 years) per day. There were 45 years of life lost (95% CI: 22–68 years) per day for days with a mean temperature of 32 °C. The curve had a sharper rise at extremes of heat than of cold. The effect of cold peaked in two days after exposure, whereas the greatest effect of heat occurred on the day of exposure. There were substantial added effects of heat waves on years of life lost for CVD mortality, whereas there was no significant increase in years of life lost during cold spells.

Conclusions: This study shows convincing evidence that people with CVD are indeed at risk of temperature-related deaths. To reduce temperature-related years of life lost, research on specific interventions is needed.
Lines on Maps: Where Do We Put Them - and Why!

G. Hunt

South East Councils Climate Change Alliance

Victoria’s Western Port scores most of the issues for coastal adaptation - booming development (a near doubling of the population in the next 30 years), a high degree of environmental protection (UNESCO Biosphere, Ramsar, CAMBA, JAMBA) and a confluence of climate change impacts (projected sea level rise, increased average temperature, more frequent and severe extreme events in a shallow embayment fringed by very-low-lying land). Pity the poor local authorities trying to deal with this!

Yet deal with them they must for local government operates the planning system - making certain decisions in a time of heightened uncertainty. The local governments charged with this unenviable task have taken a range of steps:

• Formed a formal regional alliance to amplify their capacity to act
• Conducted fundamental research to develop projections for biophysical impacts of climate change and to quantify the socio-economic consequences
• Developed risk profiles for delivering community services and managing infrastructure
• Compiled pathways, informed by thresholds for actions and tools for decision-making, to enable local governments to make decisions with the greatest confidence possible
• Developed and implemented communication programs to bring the community into the discussion.

This is an issue for all spheres of government and will be most likely successful if the community is carried along with the discussion. The work must be done and must be seen to be done. When local planners sit down with their maps of the coastal landscape and their climate change projections, the lines that they draw that allow development, put conditions on development or preclude development must be based in the best data and the best understanding of that data.

In this paper, a case study of coastal development in a number of local governments will be presented and the lessons learned will be discussed.
The Impact of Corrective Normative Feedback on Pro-environmental Intentions and Behaviour

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A recent study of Australian attitudes towards climate change (Leviston & Walker, 2011) found evidence of consensus biases in peoples’ beliefs regarding what others think about climate change. People who believe that climate change is occurring —whether ‘naturally’ or ‘human-induced’— underestimate the proportion of individuals within the population who share their view (false-uniqueness effect). This uniqueness bias is worrying, because those people who agree that climate change is happening and that it is human-induced are those who are most likely to commit to action to reduce greenhouse gas emissions. If there is a false perception amongst these individuals that they are in a minority, then this may reduce the degree to which they are willing to engage in pro-environmental behaviours. Using a representative sample of Australian respondents, we aim first to replicate the false-uniqueness effect and to explore whether those who demonstrate this tendency also underestimate the likelihood that others who share their view are engaged in actions to combat climate change. Those people in the sample who believe that human-induced climate change is happening will be invited back for a follow-up study in which they will be assigned to one of four groups. Using the normative information established from the first study, one group will receive accurate normative feedback about others’ beliefs, whilst another will receive accurate feedback about others’ pro-environmental behaviours. The third group will receive inaccurate normative feedback about others’ beliefs, whilst the fourth group will receive inaccurate feedback about others’ pro-environmental behaviours. We will then re-examine peoples’ beliefs about climate change and their pro-environmental intentions and behaviour. We predict that accurate normative feedback about both the beliefs and pro-environmental behaviour of others should abolish the false-uniqueness effect in those who believe that human-induced climate change is occurring and, in turn, increase their pro-environmental intentions and behaviour.
Understanding How Our Institutions of Governance Support or Impede Australia’s Climate Adaptation Planning and Practice: Two Case Studies

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Australia’s capacity to adapt to climate change will to a very great extent rely on our institutions of governance, associated policy processes, laws, organisational arrangements and administrative procedures. However, there has been very little detailed investigation into what institutions are important, how these may limit or enable adaptation, or what specific institutional, governance and policy process reforms might be needed. A second gap in our knowledge and understanding concerns the appropriate role and responsibility of the federal government in Australia’s climate adaptation policy. Just as climate change impacts are location-specific, so too must adaptation responses be tailored to local parameters: there is no single one-size-fits-all tool which will be functionally applicable across all sectors.

The challenge in identifying what a national climate adaptation framework might look like is further complicated by the shift in recent decades towards a ‘shared responsibility’ model, involving ever-increasing numbers of state and non-state actors with varying degrees of responsibility and capacity. The state cannot – as previously imagined – be either the sole preparer or responder, or the insurer of last resort, and fierce debates are emerging as theory and practice struggle to define the necessary balance of public, private and community roles and responsibilities. The question for Australian governments, especially the Federal government, is: when is it sensible for governments to intervene, and which of the many policy instruments at their disposal will have the greatest impact?

This presentation explores some of the findings from an NCCARF-funded project. Specifically, we will present (i) our categorisation of governance arrangements, and methodology for choosing our case studies (ii) our assessment criteria against which our case studies will be evaluated and (iii) our preliminary conclusions and recommendations from our first two case studies (inter-governmental agreements and planning regimes).
Rental Housing, Climate Change and Adaptive Capacity: an Asset-Based Approach

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¹University of Newcastle

This research explores the adaptive capacity of tenants and housing managers/landlords in the rental sector. Housing is recognised as a significant contributor to greenhouse gas emissions. While some research has examined the potential for homeowners to adapt to climate change, research has largely neglected the 27% of households in rental accommodation. Low-income renters are particularly vulnerable to climate change, and already face significant housing and utility stress. Research has indicated there is a poor standard of rental accommodation, and a low take up of retrofitting in the sector, as there are disincentives for landlords to install modifications that will primarily financially benefit tenants. The role of housing managers, such as real estate agents and public housing managers, has been neglected in previous research on adaption to climate change. This paper discusses the utility of Asset-Based approaches to climate change adaption. Asset-Based approaches work with people in any situation to enhance the recognition of existing resources and use dialogue between key actors to expand the possibilities for change. Rather than merely focusing on barriers the Asset-Based approach emphasises working with what is already present to build new coalitions that enhance possibilities for positive change. The paper reports on on-going NCCARF funded research in 2 sites in Newcastle, NSW, a coastal location expected to confront significant problems caused by sea-level rise and increased storm and flood activity due to climate change. In particular, the paper addresses key methodological issues in employing Asset-Based approaches.
**The Use of Information and Communications Technology for CBA in the Pacific: Experience with Tools That Help Plan and Implement CBA at the Local Level, and Communicate Lessons and Experiences Between Communities and Amongst Decision-makers.**

R. James¹, J. Hardcastle¹, W.T. Atu¹

¹The Nature Conservancy (TNC)

Customary land owners of coastal Melanesia (including Papua New Guinea and Solomon Islands) face similar challenges from the impacts of climate change and climate variability. Communities share a close connection to traditional governance systems and tenure arrangements, whereby clan-based land ownership provides security of place and access. However, many communities are isolated and ill-informed as to the options and tools they can use to strengthen their resilience to change and development pressures, including climate impacts.

In the Solomon Islands and Papua New Guinea, participatory planning tools that use information and communications technology (ICT), including participatory spatial mapping and 3D modeling, and participatory video, have been successfully employed to help people within communities to share their voice and opinions, and better understand the wider forces affecting their locality. A participatory 3D modeling activity in BoeBoe, Choiseul province, has highlighted the value of participatory tools in garnering collective voice and input into local level adaptation planning. Successful communication of the process and results has inspired neighbouring communities and similar efforts across the region. Participatory film-making has helped people in BoeBoe and other villages share their story within their community as well as to a wider audience.

At least one of these video products from Solomon Islands will be presented as shorts (2-3 minutes - http://www.youtube.com/watch?v=LOL2CdCfRts&feature=youtu.be ) to illustrate the value of ICT in planning for community-based adaptation.
Story-telling - the Use of Participatory Video in Communicating CBA Within and Between Communities, and Influencing Policy Decisions in Pacific Island Countries

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²For Greenies

In many Pacific Island countries, especially Melanesia (Papua New Guinea and Solomon Islands), oral traditions and story-telling form a vital part of daily life and culture. In many instances, these traditions are becoming eroded and undermined by rapid social and environmental change. However, in many instances, individuals and communities are applying their story-telling skills to explore important issues and promote change through community-led action. Participatory video is one tool that can help facilitate discourse and discovery by a community of pressing issues in their locality. Inclusive and voluntary access to the skills and equipment can easily be provided by most civil society and NGO support groups.

Participation in making a film can be an effective way to explore the perceptions and concerns of all demographics of a community, and share these issues within the whole community in an open manner. As part of the AusAID International Climate Adaptation Initiative partnership project, “building the resilience of communities and their ecosystems to the impacts of climate change in the Pacific”, participatory video training and facilitation was implemented with coastal and island communities. Two case studies from Solomon Islands (Chivoko, Choiseul) and Papua New Guinea (Ahus Island, Manus) provide lessons on the role, importance and effectiveness of participatory video in helping plan and evaluate CBA activities, as well as communicate beyond village boundaries to local, national and international audiences. Clips from the making of these videos will accompany the presentation.
Building the Resilience of Ahus Island Community and Its Ecosystems to the Impact of Climate Change Through Local Initiatives: A Bottom-Up Strategy for Climate Change Adaptation

R. James¹, G. Kulwaum¹

¹The Nature Conservancy (TNC)

Ahus, a small low-lying island community north of Manus Island in Papua New Guinea is already experiencing negative impacts from climate change including salt intrusion of fresh water and accelerating coastal erosion. However, the community of Ahus is adopting community based initiatives to both understand and also build resilience of their communities and ecosystems. As part of this process, community based officers on Ahus facilitated group discussions and interviews about climate change and other key issues of concern to all residents, including women and very young children. They also facilitated household surveys with all 114 Ahus households in order to better understand the economic, health, food security and natural resource management issues as well as climate/development impacts. Residents are now implementing a number of adaptation measures such as modifying house design and construction, improving water storage and improving bartering systems for locally grown vegetables and fruit. The community of Ahus are enthusiastic about telling their story and have also made their own video to share their experiences and voice concerns about climate change, overpopulation and recommendations for the future. This information is now being fed into local Ward development plans and with the involvement of Provincial and National Government officials will also inform national priorities such as PNG Vision2050.
Climate Adaptation and The Boardroom

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\textsuperscript{1}Future Ready
\textsuperscript{2}Climate Planning P/L

Although the consideration of climate change risks is becoming mainstream in many government organisations the level of the private sector’s awareness of climate change risks and opportunities is in the nascent stages and underdeveloped.

The authors argue that, in part, the reason for this is that many board members do not yet fully recognise the nature of climate change risks and opportunities. The role of the board is to represent the company and shareholder interest and that the knowledge gap at the board level presents a barrier to adaptation in the private sector. This paper draws on findings from the climate change in the boardroom project, funded by the Australian National Climate Change Research Facility. The project supports adaptation in the wider business sector by increasing climate-related awareness and capacity within the boardroom and at the executive decision level. This project recognises the need for boardroom members and executives to be better informed of potential climate change impacts (Kerstetter and Aust 2010). The outputs will help guide stakeholders to ask climate change impact related questions to support investment-grade decision making. The research also explores climate change risks in the supply chain and therefore helps inform directors and key decision makers in the business community about the upstream and downstream impacts on their business.
An Eyre Peninsula Report Card: Adaptation Practice and Research in the Far West of South Australia

D. Jones

Deakin University

The formation of Natural Resource Management Boards in South Australia provided a robust and integrated, and well resourced, regional landscape planning quasi-authority in South Australia that has had major beneficial outcomes to several SA regions in being able to better co-ordinate long term and creative public and private land management strategies, as well as enable several unique research projects to be tackled that would not otherwise under traditional fragmented state government agency configurations and relationships. One of the quiet success stories has been unfolding in the Eyre Peninsula region to the far west of Adelaide between Port Augusta to Ceduna and down as far as Port Lincoln including the associated coastal line and islands. The Eyre Peninsula Natural Resource Management Board (EPNRM) uniquely took a focused integrated perspective upon climate change, assembled a suite of cross- and multi-disciplinary research teams and directed their activities in this endeavour to comprehend but also establish a strategy to mediate and enable social and economic productive structure changes to the Peninsula’s communities and agricultural productive landscapes. Central in this paper is understanding the agenda and challenges set, the process employed, and participants and their key roles, and the strategic outcomes that are underpinning change management and community resilience strategies on the Peninsula.
Indigenous Climate Change Adaptation Perspectives: Understanding Urban and Peri-urban Indigenous People’s Vulnerability and Adaptive Capacity to Climate Change

D. Jones¹

¹Deakin University

The National Climate Change Adaptation Research Plan: Indigenous Communities (2011) highlighted that research on Indigenous communities and climate change, including the variables of impacts, vulnerability and adaptive capacity, and adaptation has been limited. While most research has focused on identifying the biophysical impacts of climate change, a minority of studies have considered the Indigenous knowledge and peoples whom continue to reside in Australia and care for ‘country’. The report concluded that “there is a need for research that expands knowledge about these and other dimensions of Indigenous adaptation to climate change.” This paper reviews work in progress on a NCCARF funded research project that is seeking to investigate select coastal urban and peri-urban Indigenous community vulnerability to, and capacity for climate change adaptation. Working collaboratively with Indigenous communities resident in Adelaide, Heywood/Portland, Mornington Peninsula, Stradbroke Island and Brisbane, it seeks to explore and articulate strategies that enhance Indigenous capacity to climate change including possible protocols, frameworks, processes and procedures that may lead directly to a more informed appreciation of what is transpiring around Australia’s coastal peri-urban regions for their Indigenous communities who still hold strong bonds and responsibilities to their ‘country’.
The Economics of Adaptation: Government Acting as Insurer of Last Resort

F. Jotzo¹, L. Dobes¹

¹Australian National University

Since the mid-nineteenth century, governments have increasingly assumed responsibility for private risk, including that of shareholders in joint-stock companies, occupational hazards for workers, consumer protection, and disaster management and assistance. Climate change will undoubtedly create pressure for adaptation to be added to the list, but the fiscal and economic implications of the government as insurer of last resort in different circumstances have yet to be explored.

This NCCARF-funded project is testing the hypothesis that government may seek to take on a greater fiscal role than is warranted by deficiencies in insurance and reinsurance markets.

Government responses to the 2011 Queensland floods provide a pertinent case study. Other examples from Australian policy practice are post-cyclone and bushfire emergency assistance, as well as long-established traditions in areas such as drought assistance and the car industry.

Moral hazard is likely where governments act as insurers of last resort. Knowing that government will be there to assist will inevitably inhibit efficient adaptation, because those affected by climate change will not institute adequate protective measures to reduce the overall damage caused by extreme events or other climate change impacts. Governments thus risk bearing most of the cost, resulting in social costs through reduced expenditure in other areas such as schools and hospitals.

Further, there will be distributional implications, with specific sections of society or jurisdictions gaining at the expense of other sections of the community. Current constitutional responsibilities can be used to reflect the principle of subsidiarity, but would be bedevilled by vertical fiscal imbalance. Quantitative modelling scenarios raise some interesting issues.
Limits and Benefits of Using Water Trading as a ‘market-based’ Instrument (MBI) for Climate Change Adaptation

A. Kiem¹

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This presentation summarises a recent investigation into (a) the social, economic, and environmental costs and benefits of water trading and (b) the limitations of using ‘market-based’ instruments (MBIs) like water trading for climate change adaptation. It was found that water trading has potential as a climate change adaptation strategy with many benefits experienced in previous and current versions of water trading. However, there are also limitations and those negatively impacted by water trading are hit hard. These social impacts of water trading have not been thoroughly investigated and are not well understood.

Similarly, significant uncertainty also exists around the impacts of water trading on the environment (e.g. changed hydrological regimes, underestimation of sustainable environmental flows etc). Proper quantification of these impacts is needed, however, it is a complex task given Australia’s large hydroclimatic variability and the current lack of understanding as to how to optimise the water needs of the environment, agriculture, non-agricultural industry, and human settlements.

Finally, it appears that ‘cap and trade’ quantity-based MBIs such as water trading will eventually do what they are designed to do (i.e. reallocate a resource to ‘high value’ users). However, given that the ‘low value’ users in this case are agriculture and supply of drinking water and the ‘high value’ users are mining, manufacturing, and electricity production (i.e. industries with high greenhouse gas emissions) the question that must be asked is do we really want the water trading MBI to achieve its objective? And, what would the social and environmental ramifications of such a shift in water use within Australia be? These questions, along with the above-mentioned limitations and potential implications of using water trading (and MBIs in general) as a climate change adaptation tool, must be carefully considered if past drought and water policy failures are not to be repeated.
Enhancing the Adaptive Capacity of Small-to-Medium Enterprises (SMEs) to Climate Change and Variability in Australia

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1Institute for Sustainable Futures

Small-to-Medium Enterprises (SMEs) comprise 96% of all private businesses in Australia and are the largest employers and the largest contributors to GDP. Moreover, SMEs play a significant role within socio-economic systems; providing employment, goods and services and tax revenue for communities. Climate change may result in adverse business outcomes: business interruptions, increased investment or insurance costs, declining financial measures such as value, return and growth. SMEs face greater short-term losses after natural disaster and may have lower adaptive capacity than larger enterprises for various reasons. This study examines the underlying factors and processes shaping the adaptive capacity of SMEs in Australia to climate change and associated sea level rise. Specifically the research asks the following questions: 1) to what extent have SMEs considered and integrated adaptation into business planning? 2) what are the key barriers and opportunities to adaptation in various SME sectors? and 3) what types of adaptation strategies can businesses adopt in anticipation of climate change? Preliminary results of stakeholder interviews, online survey and workshop with SMEs in Australia will be presented. The study adopts theories from Political Ecology and draws on literature on vulnerability and hazards to understand the processes that mediate adaptive capacity of SMEs.
“It’s a Part of Who We Are”: The Influence of Beef Producers’ Sense of Place on Their Capacity to Adapt to Change

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Rapid changes in Australia’s agricultural and livestock industries due to climate change mean that it is as important as ever for rural producers to strengthen their ability to learn about, and adapt to change. Understanding what both assists and restricts rural producers’ capacity to adapt to change may provide insights that can assist with climate adaptation planning. This presentation aims to enhance understanding through a case study in north-eastern Queensland that explored beef producers’ sense of place and its influence on beliefs to do with adapting to change. The study used mixed methods (28 face-to-face interviews and 91 telephone surveys) and explored how attached beef producers’ are to their properties, why they are attached and how this attachment influenced beliefs about climate change, learning, adaptation and change. Analysis of the interview and survey data revealed that (1) beef producers, in the main, had a strong attachment to the family property that was based on a long and lived connection with the property, (2) there were four main place meanings: identity/belonging, identity/occupation, sustenance/livelihood and tonic/lifestyle, and (3) a strong place attachment influenced producers’ to be more likely to favour destocking during drought times to improve long term viability, but made little difference to them believing in climate change, learning and believing in an ability of the self to be adaptable and unperturbed by adverse economic and climate changes. These results suggest that producers may find it difficult to adapt to planned interventions that involve changes to home and livelihood, but more easily adapt to changes that support long term production goals.
Exploring the Land of Blue Carbon Opportunities – Australia!

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Coastal ecosystems, in particular seagrasses, saltmarshes and mangroves, known as blue carbon Sinks, sequester and store carbon from the atmosphere at rates of up to 5 times those of tropical forests. For Australia, our coastal ecosystems also support many of our inshore fisheries, creating jobs and providing high quality seafood and recreational pasttimes to Australians and more broadly. Since European settlement we have lost large quantities of our coastal ecosystems, which in turn have impacted on fisheries productivity and the sustainability of our fisheries.

This presentation provides a summary overview of a project to explore the opportunity for Australia to take stock of what we know in relation to the role of our coastal ecosystems in carbon sequestration, as compared to terrestrial systems at a bioregional context (temperate and tropical). It will also explore critical baseline information to allow us to move forward and develop a policy and management framework for coastal ecosystems for Australia to repair and conserve the ecosystem services they provide.
Orthodoxy in Decision-making: The Regulatory Legacy for Climate Change Adaptation

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Decision-making regulatory frameworks affecting the management of natural resources and the technical disciplines that support them are well-established in many engineering and planning ‘protocols’ in areas such as water and flood management, coastal planning, and the design and management of stormwater systems. When decision makers consider their responses to climate change, they often default to these well-worn protocols, or—at best—adapt them at the margins. As a result, static barriers can be detected which will affect the potential for flexible adaptive responses that can respond to any uncertainty and surprise over long time-frames in the climate change context.

This paper traces current practice back to the statutory regulatory underpinnings and the disciplines that support them, and forward to the decision-making consequences in the context of local government decision-making in New Zealand, where consideration of climate change effects is devolved to local government. Evidence from three locations in New Zealand, focused on several local council functions illustrates how an evidence-based system and a standards approach focuses attention on single numbers, optimal solutions, best estimates and minimum standards. As a result, the range of possible futures is ignored. This engineering and traditional planning-influenced approach limits societies’ responsiveness to climate change, erodes resilience and burdens future generations with a narrowed set of response options.
Exploring the Need for Adaptation in Government Service Provision to Future Climate Through Integrated Regional Vulnerability Assessment (IRVA)

C. Lee¹, B. Jacobs¹, D. O’Toole¹, K. Vines¹

¹NSW Office of Environment and Heritage

In responding to climate change, one of the principal roles of government is as a catalyst and facilitator of adaptation. Fulfilment of this role requires a detailed understanding of existing social, economic and biophysical vulnerabilities; flexibility with respect to administrative spatial boundaries; and a willingness among government agencies to operate collectively across disciplinary and legislative domains particularly in relation to planning. In this paper, we describe a process, Integrated Regional Vulnerability Assessment (IRVA), designed to assist the NSW Government in formulating a response to climate change and variability. The first phase involves an assessment of cross-sectoral vulnerability at the regional scale through consideration of regional climate and socioeconomic profiles. The impacts of future climate are then identified by state and local government public sector managers (drawn from a range of regional service providers including human services, tourism, emergency management, agriculture, and ecosystem management) in a participatory workshop process. In light of the climate projections and likely impacts, participants then consider sectoral capacity for adaptation to ensure continued effective service delivery to the community; likely constraints to adaptation; and, spatial variation in the need for adaptation across the region. Integration of the workshop outputs across sectors identifies key regional vulnerabilities that should become the focus of adaptive capacity development; a set of qualitative indicators that characterise adaptive capacity of government service provision within and between sectors, to specific communities and for the region; and, a preliminary shortlist of options for adaptation and adaptive capacity development for regional service provision. This information will inform a subsequent phase of detailed regional adaptation planning.
Integration of Science and Policy in Implementing the New South Wales and Australian Capital Territory Regional Climate Modelling Project

C. Lee¹, P. Smith¹, E. Roger¹, G. Turner¹

¹NSW Office of Environment and Heritage

Ensuring that science is policy relevant and that policy is scientifically literate is one of one of the most complex challenges facing both the scientific and policy-making communities. Its importance is often highlighted, particularly amongst academic circles, however very little information exists on how to successfully integrate the two. Often, due to lack of coordination, policy research needs are not met by the scientific community and likewise research findings are unrealised by policy-makers. The complexity of integrating the two lies in the need to share and exchange ideas, a process requiring intensive multi-stakeholder consultations and confounded by issues of technical feasibility, legal requirements and scientific capability. To this end, we discuss the integration of climate change modelling into the adaptive policy-making process, using the New South Wales and Australian Capital Territory Regional Climate Modelling (NARCliM) project as an example. NARCliM, an ongoing project, is an example of a policy need driving scientific research. However, the research outcomes will represent the most comprehensive fine-scale climate projections to date, to exist in Australia. Multi-agency stakeholder consultations continue to drive model output applications, thereby ensuring maximum utility. A multi-tiered web-portal will focus on the operational managers, research and technology providers, providing access to relevant scientific information and ensuring outputs are effectively interpreted into the policy-making process.
Urban Green Cover As an Adaptation Mechanism for Increased Heat Impacts Under Climate Change
C. Lee¹, H. Lochhead², E. Rigby², S. Watson³

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Research indicates that urban environments experience increased temperatures due to infrastructure development, hard paved and dark coloured surfaces, car engines, air conditioners, reduced green cover, soil sealing and global and local climate change. Increased density and heat contributors in cities are creating an urban heat island effect that is increasingly affecting the economy and quality of life of those in our cities.

Climate change is likely to have significant impacts on NSW and, as the most populous state in Australia, necessitates research and policy action to mitigate the impacts of, and take advantage of, the potential opportunities presented by climate change.

The impacts of climate change on temperatures in Sydney indicates that by mid century there is likely to be a larger degree of warming in Western Sydney than in coastal areas. Focusing on two Western Sydney sites, demonstration designs have been developed to showcase leading green cover adaptation options to reduce heat impacts. Ongoing research is investigating the benefits of green cover to moderate the urban heat island, including an historical review of existing green cover in relation to topography, altitude and urban density, and a quantification of the effects of this green cover and likely increases in green cover required to achieve heat mitigation outputs.

Consideration of projected climate scenarios will enable urban planners and designers to create urban environments that can best mitigate the impacts of climate change. Strategies for mitigating temperature increases will enhance a community’s resilience and local government capacity to respond to heat effects of climate change. Green cover is an effective way to mitigate heat impacts in urban areas with a multitude of co-benefits, such as reducing energy demands, storing carbon, filtering airborne particles, providing aesthetic, social and health benefits, managing stormwater and providing habitat for local fauna.
Coastal Residents, King Canute and Foaming Brine
A. Leitch

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An important challenge of local adaptation planning for sea level rise is the need for local councils to balance the expectations, aspirations and values of vulnerable coastal communities. While councils are familiar with community engagement they struggle to deal with post normal issues like sea level rise which feature high levels and types of uncertainty, contested facts and values, and a complex array of stakeholders. Similarly coastal communities are familiar with the dynamics of the coastal zone, and the often dramatic erosion and accretion that occurs, but may struggle with a changing rate and pattern through increasing extreme events and rising sea levels. This paper considers case studies of coastal local government attempts to communicate with their community about sea level rise in Queensland and NSW. I outline the key issues of concern for coastal residents in considering a changing coastline. I also draw on experience in developing a resource kit about communicating sea level rise for local governments from the Sydney Coastal Councils Group. I conclude that local governments need to facilitate a broader conversation with their community about coastal futures and make suggestions that may assist them to do so.
'A Resilient Mob': Media Analysis of How Australian Communities Construct Their ‘resilience’ Following Natural Disasters

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In recent years ‘resilience’ has emerged as a framework for conceptualizing and navigating various types of environmental, economic, political, or cultural change, including disturbance events such as natural disasters. The concept of resilience is also gaining currency in the public discourse in relation to societal hardships or situations of adversity. How individuals construct their resilience to change gives important insights into how to assist individuals, and therefore communities, to prepare for and recover from events such as natural disasters. Following natural disasters, media coverage helps to shape the way that the community, both at the affected and broader scale, begins the psychological and physical recovery processes, and can also help to prompt response by state and national agencies. News media has considerable power in society through its ability to inform and shape public opinion and plays an important role in revealing perspectives across various scales and political and cultural contexts. It also provides a window into a community, and access to individual narratives, that is non-invasive at a time when communities and those managing the disaster response are under pressure. This paper looks at how concepts of resilience are constructed in the public discourse in the news media around preparation and recovery from natural disasters, focusing on Australia, where coping with adversity in a harsh landscape is considered part of the national psyche. We use content analysis of Australian news media articles from 2005-2011 to examine resilience concepts. Articles analysed included those that mentioned resilience in conjunction with disasters such as bushfires, tropical cyclones, floods or drought. Common definitions include the ability to ‘bounce back’, sense of identity, community cohesion, community preparedness, experience and learning. This research has practical and theoretical implications through new insights which improve our understanding of resilient communities that will assist the disaster management and research community.
Communicating Climate Adaptation: the Journey and ‘are We There Yet?’

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The rapidly evolving communication environment has created new opportunities and challenges for communicating climate science, adaptation and mitigation research, and for science communication more generally. Traditional science communication was based on the assumption of the deficit model and privileged the expert knowledge of the scientist. More recently science communication has attempted to address the needs of stakeholders through increased strategic planning and formal processes that enable more inclusion and dialogue between climate experts and the community. These responses have largely been driven by legitimate demands from society for increased accountability and transparency. This paper outlines the current communication thinking and practice for communication adaptation at Australia’s Commonwealth Scientific and Industrial Research Organisation (CSIRO). CSIRO’s professional communicators and social scientists are working together to respond to a number of key factors affecting communication of climate science: accelerating demand for information; the emergence of new technological and social media platforms; and the need to better understand cognitive barriers to effective delivery of expert knowledge on contested topics. The work also recognises various demands of different audiences and draws on the latest social and psychological theoretical approaches for effective communication and engagement. Communication in CSIRO has evolved practically and theoretically through consideration of these factors in communicating complex and contested science issues.
A Diagnostic Approach to Climate Adaptation for Australian Fisheries

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Where climate vulnerability and risk assessments focus on what needs to be done to adapt to climate change, little work has addressed how the process of adaptation can be successfully structured to achieve adaptation outcomes. Even where there is substantial understanding of what needs to be done to adapt to climate change, there are often barriers to the implementation of adaptation actions. Bottlenecks include (but are not limited to) social, cultural and political institutions and practices, which may be firmly entrenched or more amenable to change. In this paper we propose a process-based, collaborative assessment of adaption pathways coupled with a framework for evaluating these pathways via contextually relevant variables that can be aggregated and compared across cases and scales. We develop a trans-disciplinary approach which enables prioritisation of adaptation options and development of adaptation pathways within marine biodiversity and resource systems. This approach to identifying critical pathways to enhance adaptive capacity is replicable, consistent and grounded in a rigorous ‘diagnostic’ framework for analysing resource management systems.
Finding Positive Change: How Mental Models Frame Risk Perception

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Climate change presents a range of risks to businesses, with some sectors more exposed than others. The tourism sector has been identified as being in the ‘danger zone’; “where risk is markedly greater than preparedness” (KPMG International, 2008). Studies that have examined the climate change risk appraisal behaviour of tourism operators have generally found relatively low levels of concern and little evidence of long-term strategic planning in anticipation of future changes in climate (Scott et al. 2009).

Tourism is Australia’s second-largest export earner, but is primarily composed of small businesses. Anecdotal evidence suggests that many of these businesses are initiated by people with little experience or training. Tourism as a whole appears to be poorly engaged with climate adaptation, thus it can be expected that the majority of tourism business operators are unprepared or unaware of the risks they face.

A proprietor’s understanding and beliefs about climate change can define how their business adapts and responds. The nature, timing and scope of adaptation strategies are in some measure defined by a proprietor’s perceptions about climate change risk characteristics. Tourism operators might not undertake adaptation planning because they do not recognise the problem, or are unwilling to take responsibility for developing solutions. Yet, there are some businesses that see opportunity in climate change.

This paper explores how the understanding and beliefs about climate change (i.e. mental models) act to frame climate change risks and opportunities. Small- and medium-sized tourism operators in a specific region were asked to discuss the causes and consequences of climate change to their businesses, exploring how risk perceptions are translated to management behaviour, and the extent to which enterprises transpose this ‘risk’ into commercial opportunities.
Understanding Reef Resilience to Manage Climate-driven Shift to Barren Ground: Prevention is Far Better Than Cure

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Ecosystem change is typified by break-point transitions whereby return to prior ecosystem states may be very difficult or perhaps impossible to achieve if the new state imposes strong feedbacks reinforcing its own persistence. Such “catastrophic phase-shift”, from productive kelp beds to impoverished barren reef has occurred in eastern Tasmania caused by recent climate-driven range expansion of the sea urchin Centrostephanus rodgersii (Diadematidae). Heavy fishing of lobsters on this coast has reduced the abundance of functional urchin predators decreasing resilience of kelp beds against urchin overgrazing. For reef already shifted to barrens the ability of predators to exist and function within this alternative state has not been explored. By conducting a large scale reversal-of-fishing experiment in north eastern Tasmania whereby large predatory-capable lobsters were reintroduced to barrens ground (concurrently closed to fishing), we show that predatory lobsters persist by establishing home-ranges and foraging patterns on barrens ground. While recovery of kelp habitat was not observed on the barrens in the short-term (3 years of monitoring), the persistence of large reintroduced lobsters in combination with strong growth of local lobsters to functional predatory size within the closed area has effectively decreased resilience of the barrens state ultimately favouring long-term (estimated at ~ two decades) return to kelp beds. A simultaneous reversal-of-fishing experiment in south eastern Tasmania (where Centrostephanus is observed to graze small incipient barrens within kelp beds) showed that predator-driven recoverability of kelp depends on the initial size of the barrens patch - demonstrating that prevention of phase-shift to barrens in the first instance will be far more achievable than recovery of kelp beds once spatially-extensive barrens have formed. Management for local-scale reef resilience as a climate change adaptation measure must recognise alternative ecosystem configurations and act to dually promote resilience of desired states while conversely diminishing resilience for undesirable states.
Impacts of Climate Change on Livelihood Conditions: Assessing Adaptation Requirements

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Climate change vulnerability and the consequent need for adaptation are unevenly distributed in the world, with many developing countries especially vulnerable to changes in climate. Often less developed countries are more dependent on climate sensitive sources of income, while resources to cope with impacts are limited in terms of budget as well as knowledge. Climate change often adds on to other conditions that are responsible for low levels of social and economic welfare, increasing the vulnerability of such systems. Climate impacts may substantially reduce the adequacy of livelihood conditions, if adaptation and coping strategies are insufficient. Thus, climate change has to be related to the specific societal contexts. Sectoral impact and vulnerability analyses clearly show that climate change impacts may threaten important livelihood elements and may have severe repercussions for our current lifestyles. However existing knowledge on expected impacts remains unconnected to the consequences that these impacts may have for societal structures beyond sectoral consequences. To identify adaptation needs and prioritize fields of action, assessment methodologies are needed, which allow viewing the social-environmental interface. We present such a method, assessing the consequences that climate change impacts may have for livelihood conditions. The framework calculates resource availability for adequate livelihoods using multi-dimensional sub-indices, thus extending existing indices with societal dimensions. To assess how climate impacts affect these livelihood conditions, country-specific information on climate change and its impacts is compiled. Sectoral impacts and changes over time and space can then be evaluated regarding their consequences for livelihood conditions. The proposed methodology depicts expected climate impacts in a comparable way, making progress towards prioritizing adaptation needs.
Assessing Adaptation Actions from the Ci:grasp Database
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Climate change and increasing climatic variability and extremes make efforts to adapt to the emerging impacts ever more important. Societies have always adapted to prevailing climate and its variability. A lot of knowledge exists, but it is so far not coherently translated into a form which makes this knowledge accessible to those who need it. At the same time, scientific findings on the properties of ‘good adaptation’ are increasing, but existing adaptation options often remain insufficiently evaluated regarding these criteria.

The ci:grasp platform, developed by the Potsdam Institute for Climate Impact Research and the German Agency for International Cooperation, combines scientific knowledge on climate change and impacts with on-the-ground knowledge on climate adaptation. A classification method has been developed, which allows structuring the existing adaptation landscape according to state-of-the-art scientific knowledge to increase accessibility, comparability and transferability of measures. Existing adaptation measures can be uploaded to the website by practitioners and experts, following the structured classification method.

Drawing upon a first sample of adaptation measures in the ci:grasp database, we present insights into the properties of current adaptation practice. Our findings show that most adaptation activities aim at increasing adaptive capacity, while only little investments in building of structures are observed. A high proportion of options are win-win or no-regret options. Additionally, synergies to mitigation are often incorporated. It seems that the outlined adaptation landscape is prepared for uncertainties and the properties of observed adaptation reduce risks of maladaptation.
Migration As an Adaptation to Climate Change in Western China

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In recent decades, Western China has been experiencing unprecedented climate change, exacerbating the already serious adverse impacts of environmental problems on its economy and society. Human migration has become an important adaptation strategy coping with climate change in Western China but is not adequately understood. This paper offers a comprehensive review of human migration produced by climate change and its effects on the development of the sending community and the migrants themselves in Western China. This paper starts with reviewing the literature on the processes and consequences of climate change-induced migration on both government-arranged and spontaneous bases in Western China. Then the factors differentiating people’s migration behaviors and consequences are discussed. A case of ‘environmental migration’ in Minqin County is used to examine the issues concerned with environmental migration in Western China. Finally, this paper provides some recommendations regarding promoting better adaptation to climate change through developing more appropriate and effective migration strategies.
An Economic Assessment of Trade Constraints on Environmental Flow Applications Under Climate Change in Australia

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The Australian federal government is currently buying back water from irrigators for environmental flows at an unprecedented scale. An economic analysis is conducted on any possible third-party effects for irrigation users from policy alternatives related to a Commonwealth environmental water holder’s (CEWH) intervention in the market to deliver environmental flows in the Murray-Darling Basin of Australia. In exercising its role, the CEWH has potential to impact on water trade outcomes as, under certain future policy scenarios, the CEWH could be required to trade large parcels of water in the allocation market on the environment’s behalf. Policy alternatives structured around allocation trade and environmental proportional holding strategies are modelled using a stylised hydrologic economic model in the Murrumbidgee catchment, comprising irrigation water use and the environmental entitlement holder. The model uses data from 1896 onwards under an optimisation approach incorporating an environmental water holder, focused on minimising the distance from an ecologically desired state, and irrigators attempting to maximise profit subject to water allocation constraints. The model accounts for how stochastic seasonal conditions affect environmental flow and irrigation requirements under recovery and allocation constraints. Our analysis of this major water reallocation instrument provides useful insights for environmental water managers.
Addressing Barriers to Adaptation in Australian Resource Communities

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Many mining communities in Australia are particularly vulnerable to extreme weather events, expected to increase under climate change. This is due to their direct exposure to the natural environment, often remote locations, sparse populations and minimal infrastructure. Nearby mining activities can exacerbate this vulnerability, for example, through competition for water during droughts or spillage of contaminated waters during floods.

To identify the types of vulnerabilities that mining operations and communities face from climate change, and the barriers and enablers to adaptation in this sector, we conducted a nation-wide survey of both mining companies and local government bodies in mining regions across Australia in late 2010-early 2011. The survey was complemented with a number of interviews and workshops held in mining regions involving a broad range of industry, community and government stakeholders.

Of the barriers identified in this research, one of the more concerning was the much lower level of belief in climate change, and attendant adaptation activities, by mining companies as compared to local government respondents. This marked difference in beliefs points to a potentially significant impediment to building adaptive capacity in mining regions, given that a degree of coordination is required between the two for optimal adaptation.

Research on addressing barriers to climate change adaptation in other primary industries in Australia (Howden et al. 2007) does however provide insights for potentially useful interventions. Addressing the multiple levels at which barriers operate, for example personal beliefs about climate change, enterprise knowledge of vulnerability and adaptation options, and broader supportive systems, policies and structures to enable change, all appear crucial. This presentation will investigate some of the unique aspects of the resource sector response to climate change in the light of this and other adaptation research, to identify potential ways forward in building the adaptive capacity of mining communities.
There is no ‘silver bullet’ that protects communities and individuals from the impacts of climate change. Rather, good adaptation is a combination of measures that balance risk mitigation with resilience considerations and shared responsibility across all stakeholders, including industry, government, communities and individuals.

Conventional approaches to developing a climate change response are substantially weighted toward risk management processes and assessments of current resilience thresholds. The prevailing presumption is that the best adaptation measure or measures to address risk/resilience disparities will emerge as a natural progression of the process and be implemented. However who should be responsible for what measures? Without an understanding or agreement on who is responsible for leading and funding climate risk management, decision making and action is often hindered.

Addressing questions of responsibility can highlight legal, social, financial and moral obligations of all stakeholders and enable innovative, comprehensive and collaborative approaches to adaptation. What stakeholder actions do existing policy and legal frameworks oblige, enable or constrain? How do notions of diligence, prudence, duty of care or caveat emptor apply? Should adaptation be funded equally by the whole community or should those in high risk areas contribute more?

Building on the author’s experience in developing adaptation plans for a range of public and private sector clients, this paper utilises hypothetical case studies to examine the question of responsibility for action to adapt to climate change. The paper argues that clarifying the responsibility, of government, business and individuals to address climate risks can provide a clear driver for decision making and enable collaborative, flexible and least cost adaptation. It proposes a three-pronged approach that broadens traditional risk and resilience assessments to include considerations of responsibility. The paper contends that while often overlooked, misunderstood or under-utilised, ‘responsibility’ is the vital third ‘R’ in developing adaptation responses and enabling action.
Determining Heat-health Thresholds for Urban Populations in Australian Capital Cities

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Heat waves significantly increase demand for emergency services, in particular, ambulance services. There is a need to be proactive by increasing public health preparedness and to reduce service demand during hot weather. Populations vulnerable to heat have multiple risk factors, these are unevenly distributed around the nation and within individual cities; at present we have a limited understanding of heatwave vulnerability in urban populations. To improve this knowledge requires several steps including defining temperature thresholds above which heat related mortality and morbidity increase. This paper establishes threshold temperatures for mortality and morbidity in all Australian capital cities. This information is used to define heat alert days and identify spatial patterns in heat related mortality and morbidity, the associations with known risk factors. This study used daily maximum temperatures, minimum temperatures, Mean Temperatures and Apparent Temperature in conjunction with 24 hour and 48 hour mortality, daily ambulance calls, emergency hospital admissions, and emergency department presentations to identify threshold temperatures for each capital city. Threshold days were determined as days when the median mortality or morbidity increased from the baseline or expected rate. Threshold temperatures for daily maximum temperature were generally higher in the southern cities ranging from 36°C in Hobart to 44°C in Adelaide. Minimum temperature thresholds ranged from 19°C in Hobart to 28°C in Adelaide and Darwin. Mean Temperature thresholds ranged from 26°C in Hobart to 34°C in Melbourne, Adelaide and Brisbane. Apparent temperature thresholds ranged from 33°in Hobart to 45°C in Perth. These temperature thresholds have been used to define heatwave days in Australian capital cities and contributed to the development of a spatial index of heatwave vulnerability to advise emergency managers about heatwave preparedness and response. The predicted change in heatwave days have been modelled for daily maximum, minimum and mean temperatures for 2030 and 2050.
Learning from People’s Experiences of Adaptation: Monitoring What’s Working, for Whom, and Under What Conditions.

T. Lynam

CSIRO Australia

A great deal of what people do and learn is not codified in the form of books or scientific papers but becomes instead part of their lived experiences which they then share with people within their social networks or groups. This experiential or tacit knowledge is difficult to codify and make explicit and as such is often missed in analyses unless it is intentionally sought out. Across a wide variety of social situations people tell each other stories or anecdotes of their experiences, of what is salient for them and of what these experiences mean for them. Adaptation to climate change is still a relatively new and unfamiliar experience for most people in Australia. However, as more and more people engage with adapting we might expect an ever richer set of stories and themes to emerge from which we can distil essential patterns of experience. Within the stories they tell each other people capture the essence of what has and has not worked in their experience of responding to a new challenge such as climate change. Until recently however, capture of people’s stories or anecdotes has been time consuming and their analysis has usually been limited to relatively small sample sizes. The stories have been difficult to analyse and hence meaningful pattern detection has been difficult. Using a novel narrative capture process we elicited adaptation stories from more than 900 people in Australia and Canada. In this paper we present an overview of the approach and use the results to illustrate how the approach can be used to monitor patterns in the stories people tell of their adaptations. The paper concludes with observations on what a narrative based monitoring system might look like and what the data obtained through this system might tell us about adaptation.
Worldviews, Framings and Language: Adapting Our Conversations About Climate Change to the People We Are Communicating With.

T. Lynam\textsuperscript{1}, A. Leitch\textsuperscript{1}, A. Ryan\textsuperscript{2}, T. Gouskos\textsuperscript{3},

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Social responses to climate change require high levels of coordinated collective action. An important way that people achieve the requisite coordination is through the use of shared understandings which may be reflected in particular worldviews. People hold different worldviews that give rise to different framings of phenomena such as climate change. People holding worldviews of ecosystems as being robust and simple to manage are likely to view climate change and adaptation options in ways that are notably different to those whose worldviews frame ecosystems as fragile and highly complex to manage. Different worldviews are associated with different framings of climate change and with different language used to talk about climate change. They also give rise to quite different orientations to adaptation options.

Using a novel narrative capture process we elicited adaptation stories from more than 900 people in Australia and Canada. Each story was identified with one of four worldviews based on the patterns of causality that each story reflected. We present patterns in the framings of climate change and climate change adaptation that respondents from each worldview used. We also highlight differences in language and concept use among those holding these different worldviews. We use these results to illustrate how we might use this narrative based approach to design (and monitor the effectiveness of) strategies for having more effective conversations with members of society. We also discuss the implications of these results for communication of climate change related material. Our insights have both theoretical and practical implications for the climate adaptation community.
**Overcoming Challenges for Decision Making About Climate Change Adaptation**

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From both scientific and social standpoints, climate change is a ‘new’ challenge involving diverse decision makers with often conflicting values. Here, conventional expert-driven, single focus and top-down approaches with strong adherence to principles of rationality are not effective or advised. This requires new modes of decision making based on collective learning and collaboration. The imperative for partnership at every level is paramount - between private and public, local and national, national and global, poor and rich, powerful and the weak. In sum, this is a human-kind challenge, demanding new levels of cooperation and partnership unlike any in our known history. The response must also be collective, moving us forward towards new and deeper forms of social evolution and learning.

The inherent uncertainty in climate change is exacerbated by the complexity of decision making environment which is caused by the number of institutions involved and the stakeholders affected including NGOs and local communities, as well as frequent changes in policy, regulations, and new leaders. Owing to these dynamic changes, the decision makers and stakeholders are faced with new priorities, challenges, and problems as well as fresh opportunities. The challenge is to create new ways to manage uncertainty and complexity in this environment based on consensus and commonweal. It is for these types of complex environments that systems thinking and new decision-making tools and models are required (after Belton and Stewart, 2001).

In this presentation we outline challenges of decision making for climate change adaptability and present a framework for collective learning and decision making for relevant stakeholders. Case studies of related projects in Australia and South East Asia will demonstrate how the framework is applied in complex decision making environments.
Challenges to Adaptation in Coastal Australia and Implications for Strategic Planning

T. Mackenzie¹, D. van Senden¹, S. Archer¹, L. Collier¹

¹Cardno

Coastal communities at many locations around Australia have been proactive in seeking to understand the potential impacts of climate change to guide future planning and adaptation. The technical capability to assess potential impacts is well developed, and reasonably robust predictions of local impacts can be derived from the available climate change projections when coupled with modelling tools. In practice, however, there are a number of challenges around adaptation planning that need to be addressed, including:

- The legal and policy framework. The policy and legislation around climate change risk assessment often does not provide for holistic consideration of all potential climate change impacts, resulting in increased risk of maladaptation. In addition, the legislation can often act as a barrier to adaptation.
- Selection of appropriate planning horizons. There is a pressure to adopt long term planning horizons. It is recommended that “trigger levels” be developed to allow staged adaptation. This approach effectively takes into account existing uncertainty and provides flexibility as our understanding of climate change consequences develops.
- The position of cadastral and other boundaries. These boundaries are defined by either a water level or a fixed, geo-referenced position. Both approaches present different challenges under rising sea levels.
- The socio-economic impacts of climate change. Impacts on coastal communities may be significant as risk is transferred between public and private stakeholders due to exposure to liability and subsequent cost implications.

These issues highlight the need to seek a balance between a reactive and proactive management approach that into account the practicalities of adaptation.

The paper will present case studies from two jurisdictions to illustrate these challenges and to discuss the implications for strategic planning: one from the Fraser Coast Region in Queensland and one from Gosford in New South Wales.
Drought and Fire Micro-refuges, Resilience and Climate Change
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1Griffith University

Fundamental to managing terrestrial ecosystems for resilience under climate change is maintaining biodiversity of all kinds and at all scales. Networks of habitat patches functioning as refuges constitute a critical element of biodiversity at a beta/gamma scale that contributes to ecosystem resilience. The term ‘refugia’ has been commonly used in the context of ‘glacial’ or ‘interglacial’ refugia where the relevant time-scales of the threatening process (climate change) are millennial or longer. It is helpful therefore to use the term ‘habitat refuges’ to refer to contractions in the range of suitable habitat over relatively shorter time-scales. It follows that habitat locations which might function as refuges in response to human forced, rapid climate change can be called ‘potential climate change refuges’. In bioregions where disturbance regimes are characterized by drought and fire, micro-refuges have been identified as a key factor contributing to the persistence of species at a bioregional scale. A theoretical basis for drought and fire refuges can be found in the source-sink theory of Pulliam and Southwood’s concept of the habitat template. Evidence for drought and fire micro-refuges has been documented in arid Australia, temperate eucalypt forest/woodland, and Mountain Ash forest for birds and mammals. Time series of remotely sensed vegetation greenness and modelled gross primary productivity show promise as an approach to mapping locations that may be functioning as drought and fire micro-refuges. The extent to which these locations will continue to function as refuges under future climate will depend on the vector of change at a bioregional scale. Therefore in those bioregions where the vector of change increases drought and fire risks, current micro-refuges will play an increasingly important role. A necessary adaptation response will be factoring into strategic regional assessments the conservation management needs of micro-refuge networks.
**Optimal Habitat Protection and Restoration for Climate Adaptation**

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Climate change will have major impacts on Australian biodiversity in the coming century. Species distributions and ecosystem compositions will shift drastically and our conservation actions must change equally radically. For example, climate-driven distributional shifts will alter which sites are prioritized for protected area designation and for habitat restoration. We are currently working to move beyond simple predictions of climate change impacts by identifying optimal protection and restoration options for Australia’s threatened species. As a first step, we map the future distributions of threatened species and vegetation types across the continent under multiple scenarios of climate change and for a series of time steps. Using these predictions, we model optimal protection and restoration taking into account costs, benefits and likelihoods of success of a suite of possible conservation actions in a given location. When complete, our project will produce a comprehensive plan for optimal protected area creation and habitat restoration across Australia in the form of spatially explicit time-slice maps of where and when habitat restoration is needed to minimise extinctions from climate change.
Computational Methods for Combined Adaptation Cost-Benefit Analysis for Insurance and Local Government

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1Climate Risk
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This paper presents results from the Pilot Council and Insurance Partnership Project (PCIP) undertaken by the Sunshine Coast Regional Council and the Insurance Council of Australia with co-funding from the Federal Government under the CAP Program. The project has been initiated to test the hypothesis that insurers and councils acting in coordination and with the same information can achieve lower adaptation costs than if acting separately.

The paper covers the integration of risk and resilience quantification tools developed for residential buildings with adaptation cost-benefit tools developed for the Sunshine Coast Council. The paper also shows how spatial hazard information for flooding has been used to develop results which cover annualised costs of risk, net present values and real options values based on probability distributions for current and future risk. The paper will also showcase the real-time on-line risk tools developed for council planners which apply real time Monte Carlo computational analysis with and without temporal correlation functions.

The paper will present results that demonstrate that it is possible to find an optimal adaptation pathway based on minimized insurance costs which balances adaptation action by council (such as building new coast protection) with adaptation requirements placed on residential home owners (such as resilience materials or elevate floor heights required during major renovation).
**Influences on the Capacity to Adapt to Climate Risk in an Australian Primary Industry**

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Climate change is altering the quality and availability of natural resources with far-reaching implications for the social and economic systems that they support. In some instances, incremental adaptations will be insufficient to maintain viable and prosperous communities and transformations of function or structure will be needed. We use the peanut industry in Australia, currently facing substantial changes in resource condition as a result of climate changes, to understand the factors that limit or pre-dispose resource-users to adapt to a range of climate risks. The capacity to adapt of 65 peanut farmers was examined by assessing: a) their perception of the risks, b) their level of skills in planning, learning and reorganising, c) their level of financial and emotional flexibility to make explicit adaptations to climatic changes; and d) the level of anticipation of the need and willingness to make such changes. We test for the influence of resource-dependency on adaptive capacity, where the level of dependency on the natural resource was examined by assessing (i) attachment to place, (ii) attachment to occupation, (iii) family circumstances, (iv) employability, (v) networks, (vi) financial circumstances, (vii) business characteristics, (viii) local knowledge and skills, and (ix) environmental attitudes and practices. Most peanut farmers were capable of making incremental changes but unlikely to undertake transformations of place or identity. Even though there was a general reluctance to consider transformative changes, we found significant correlations between the likelihood to undertake climate adaptations, adaptive capacity and resource-dependency. For example, attachment to place was strong and farmers were more willing to grow something different rather than relocate. In these ways, resource-dependency can act as a potential barrier to some adaptations yet a positive influence on others.
Building Social-ecological Resilience: the Adaptation of Coral Reef Management

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The high vulnerability of coral reefs to climate change puts reef scientists and managers at the frontier of climate change adaptation. Over the last decade we have developed an enviable understanding of the risks posed by climate change, driving broad consensus that coral reef systems face unprecedented challenges. While inertia in social and climate systems commits coral reefs to further degradation, successful adaptation can help avoid the most serious and potentially irreversible impacts. However, we have to move beyond business-as-usual. We need to realise that conventional conservation objectives are decreasingly relevant: we have to shift toward a paradigm that explicitly integrates biodiversity protection and livelihood outcomes, embraces non-equilibrium, non-linear system dynamics, accepts the validity of active interventions and shares in the responsibility for influencing climate policy. Resilience is being widely adopted as a conceptual framework to drive the adaptation of management approaches, and we are now making important progress toward operationalising key resilience concepts. Under the Great Barrier Reef Climate Change Action Plan we have collaborated with scientists and managers from around the world to develop resilience metrics using community participation and are building a vulnerability mapping system to support marine spatial planning. We have developed and applied a framework for integrating social and ecological vulnerability assessments, and successfully advanced adaptation planning with three commercial fishing industries. We are also breaking down policy barriers through adaptive management plans for climate-sensitive biodiversity hotspots. This presentation will review these and other advances in efforts at building social-ecological resilience in coral reef systems.

J. McAllister

AECOM

The National Electricity Objective, as stated in the National Electricity Law is “to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to price, quality, safety, reliability, and security of supply of electricity; and the reliability, safety and security of the national electricity system.”

The physical impacts of climate change will impact on the electricity supply network over the coming decades. AECOM’s analysis (and that of others) indicates impacts from bushfire, storms and heatwave are likely to reduce reliability.

Measures to manage climate change impacts and maintain service standards include:

- Changes to maintenance regimes, including emergency response and business continuity planning
- Changes to specifications for assets
- Deployment of distributed infrastructure
- Enhanced interconnectedness to increase network options to manage partial network failure

Climate change impacts are not the only drivers for change, with increases in demand and shifts in technology driving significant investment in the same period.

Theoretically, the institutional and regulatory frameworks for the National Electricity Market are ideally suited to manage this problem.

But to date, few adaptation measures other than “no regrets” investments have been approved for this sector.

Based on AECOM’s work for both private and public sector clients within the sector, this paper:

- Reprises analysis about practical measures to enhance system resilience in the electricity sector
- Identifies conceptual elements of the institutional and regulatory framework which intersect with climate change adaptation, and are arguably well suited to support autonomous adaptation in the sector
- Argues for the significance of informational interventions by government to enable autonomous adaptation, when complex, conceptual issues are at stake.
Evaluating Policy Networks for Science Impact: Planning for Climate Change Adaptation in South East Queensland

R. McAllister¹, R. McCrea², M. Lubell²

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Policy decisions and plans don’t always have their intended impact, nor should they be expected to. The reason is that ‘impact’ is rarely a function of a single policy, but instead is determined by a system of multiple, overlapping institutions. The interplay between multiple institutions is determined by how various policy actors choose to engage. Furthermore, the motivation for policy actors to engage in particular institutions is ordinarily one of self interest. Policy outcomes emerge from this policy network with no unifying master plan. Hence individual policy has impact only so far as it modifies the dynamical actor-institutional networks at play. Further to these complexities, planning for climate change is a particularly changing space. The impacts of climate change are not felt consistently across sectors or across communities. The nature of the impacts is also diverse. What this means is that there is both a strong rationale for coordination in policy response, but also real challenges in coordinating policy in the context of many competing agendas. We use the ‘Southeast Queensland Climate Adaptation Research Initiative’ as a case study to explore the broader policy and science networks that govern planning for climate adaptation. We examine policy networks, and employ semi-structured surveys to make sense of the policy actors in the network. A greater understanding of the emergent nature of policy networks, and science’s role within the network, will serve as a guide for future consultative planning processes, and will also provide insights into the impact of policies and science within a broader system of governance.
Market Mechanisms for Dealing with the Increasing Cost of Catastrophe Losses
J. McAneney¹, D. McAneney², R. Musulin³, R. Crompton¹

¹Risk Frontiers
²Aon Benfield Analytics Asia Pacific

Following the 2011 Queensland and Victorian floods, there have been calls for a government pool to deal with catastrophe losses. This study has examined the functioning of residual insurance in the US and its potential for dealing with “fat-tailed” catastrophic events in Australia. Most state-run programmes in the US were established after unmanageable losses to the voluntary insurance market following a natural disaster, and the withdrawal of insurers from impacted areas. Residual market mechanisms were created with the intention of providing affordable, last resort, catastrophe event cover to eligible property-owners located in high-risk areas. Political interference has sometimes deflected the operations of pools from their original purpose with some programmes becoming insurers of first resort. Comparisons between the structures of both the voluntary market and government pools, and how they interact with each other, have shown that both have advantages and disadvantages. One point of difference is that governments can spread their liabilities over time and space by running deficits, issuing bonds and putting some costs back to the private insurers to be passed on to policy holders through higher premiums or one-off surcharges on policies. Private insurers are unable to do this because they have to charge competitive rates and large losses from a catastrophic event could render them insolvent. Nevertheless, since the cost of damage caused by natural disasters has the potential to rise significantly through greater development in areas of high risk and the possible aggravation by global climate change, both the voluntary and public market need to adapt to greater uncertainty. With this in mind, we have looked at how they could work together to bring about a residential property insurance environment where the issues of capitalization and sustainability; actuarially-sound rate-pricing; subsidy resolution; mitigation and better landuse planning practices can be responsibly tackled.
Detecting Unexpected Climate Impacts to Guide the Management of Species Threatened by Climate Change

E. McDonald-Madden¹, M. Runge²

¹CSIRO Australia
²United States Geological Survey

Models of the impact of climate on species are essential to formulating good climate adaptation decisions. The uncertainty about the speed and magnitude of global climate changes means that we can develop multiple models describing how a species may respond. While tools are available to make robust decisions in the face of our uncertainty about which climate impact model is the truth (e.g. Info Gap Decision Theory) or to reduce uncertainty through learning (e.g. adaptive management), these approaches require the a priori specification of these models (also called known unknowns). In particular our ability to learn and make good management decisions within an adaptive framework will depend on whether our true model is contained within, bounded by, or close to our set of pre-specified models of climate change impact. If this is not the case we could potentially be making uninformed decisions which may adversely impact the species we are trying to protect. What is needed is a second layer of learning that enables us to determine if the species is responding to climate change as we might expect or if unpredicted responses are occurring. Such uncertainties are called ‘unknown unknowns’ and are arguably one of the most important uncertainties in the face of global climate change. Double-loop learning can be applied to the detection of ‘unknown unknowns’, providing a framework to inform managers if our set of hypotheses does not contain the correct model of climate impacts, or if our system has shifted so that our models no longer capture the reality about how our system is responding. We will present a quantitative approach for guiding decisions about when to reevaluate our assumptions regarding the impact of climate change and enter the second loop of learning in order to avoid mistakes arising from the unknown unknowns of climate impacts.
**Preparation of Victorian Public Sector Residential Aged Care Services for Extreme Heat**

J. McInnes, J. Ibrahim

¹Monash University

**Background:** Climate change projections for Australia indicate an increased frequency and severity of heat extremes. Deaths and illness associated when heatwaves occur quickly and adaptation strategies must include early preparations and planning, identification of vulnerable groups and education of health care providers.

Residents of aged care services are particularly vulnerable to harm from heatwaves. As an adaptation initiative, the Victorian Department of Health (Aged Care Branch) commissioned the development of a written resource manual, the “Residential Aged Care Services Heatwave Ready Resource” (RACS-Heatwave Ready Resource), to support staff preparing for, and responding to, extreme hot weather.

**Study objectives:** To evaluate the use of the RACS-Heatwave Ready Resource, and to describe preparations and responses of Victorian Public Sector Residential Aged Care Services to extreme heat during the 2010/2011 summer.

**Methods:** A convenience sample of 12 Victorian Public Sector Residential Aged Care Services located in regional and rural Victoria participated in the study. Qualitative data was collected through a series of four semi-structured interviews, conducted at monthly intervals from November 2010 to March 2011, with each of 14 senior staff.

**Findings:** The RACS-Heatwave Ready Resource was used to inform heatwave plans, for staff and family education, and as an audit tool. It was reported to have provided a systematic approach to summer preparations.

All interviewees described pre-summer extreme heat preparations, and measures taken during forecast periods, and extreme heat days, were also discussed. Concerns were expressed regarding equipment repairs, air conditioning and staff welfare.

**Conclusions:** An extensive and well-considered approach to minimisation of harm from extreme heat by staff of Residential Aged Care Services was described, and the RACS-Heatwave Ready Resource was reported to have facilitated this process.
The Environmental Epidemiology of Climate-sensitive Diseases in Fiji: Early Results from Fiji’s Piloting Climate Change Adaptations to Protect Human Health Project

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Aim: Fiji’s Piloting Climate Change Adaptations to Protect Human Health (PCCAPHH) project aims to investigate the relationship between climate variability and selected climate-sensitive diseases (dengue fever, typhoid, leptospirosis and diarrhoeal illness) in Fiji. We report the results of this work so far; the intention is to use these results to construct climate-based disease early warning systems, implement adaptation strategies to avoid the worst impact of these diseases in pilot communities and estimate the future climate change-attributable burden of these diseases in Fiji.

Methods: Climate-sensitive disease “hotspots” were identified by reviewing historical notifiable disease data and performing space-time analyses for clustering. The association between cases of each disease and climate variables in these “hotspot” locations was then examined via time series analyses and Poisson regression using monthly lag functions.

Results: Models combining monthly number of cases of each disease with one or more climate variables (monthly minimum and maximum temperature, rainfall and humidity) at lags of up to three months suggested reasonably strong associations (correlation coefficients range 0.41-0.66) at one or more locations for each disease in Fiji.

Discussion: The strength of these associations between historical climate variability and rates of climate-sensitive diseases suggests that climate-based disease early warning systems may be of use in alleviating some of the impact of these epidemic-prone diseases in selected locations in Fiji. In the near term, the PCCAPHH project will pilot adaptation strategies in selected locations aimed at avoiding or, at least, alleviating some of this climate-sensitive disease burden.

Conclusions: Detailed analysis of the relationship between climate variables and climate-sensitive diseases leads to greatly improved understanding of the environmental epidemiology of such diseases and gives policy-makers and communities the opportunity to implement adaptation strategies (including, but not limited to, early warning systems) to avoid and/or manage the threats posed by these climate-sensitive health risks.
Emerging Issues for Climate Change Adaption in Water Management

E. McKeough\textsuperscript{1}, B. Rhodes\textsuperscript{1}

\textsuperscript{1}Melbourne Water

Between 1997 and 2009 Melbourne experienced close to a 40\% reduction in streamflow into its major water storages. Several other severe climate events were also experienced including the largest number of consecutive days above 43\(^\circ\)C (January 2009) and six 1 in 100 ARI flooding events in the Melbourne area. Research has indicated that the observed shifts in rainfall and temperature can be attributed at least in part to climate change.

The shift in climate and streamflow conditions prompted a range of responses to be implemented by Melbourne Water, the retail water companies and government. These included system augmentations, water conservation initiatives and a review of water planning assumptions. Melbourne Water also reviewed its climate risks and developed Adaptation Action Plans to respond to these risks.

There are a number of emerging issues that present challenges to practical implementation of adaptation options. Examples include assessment of multiple and cascading risks, selection of decision support methods for uncertainty, selecting baselines for projections and ensuring a consistency in interpretations of projections. There are many more.

This presentation will explore a range of emerging issues in addition to providing reflections from informal benchmarking of Melbourne Water’s adaptation approach against recent information from sources including refereed papers and journals, information from other water utilities and information gained from our attendance at the inaugural IWA World Congress on Water, Climate and Energy to be held in May 2012.
Implementation of City of Melbourne’s Climate Change Adaptation Strategy

B. McLachlan¹

¹City of Melbourne

The presentation will cover the activities being undertaken by City of Melbourne to implement our Climate Change Adaptation Strategy (the Strategy). The Strategy was developed and released in 2009 and includes a climate change risk assessment of Melbourne. Four key impact areas which faced the city were identified. These risks included;

- Extreme weather events;
- Inundation and flooding;
- Drought and water security; and

Since the development of the Strategy the City of Melbourne has undertaken various projects to minimise risks, establish more local information about key risks and understand our community’s expectations and risk perceptions. Some of the key pieces of work which have been undertaken by the City of Melbourne over the past few years include;

- Social research: This research looked at the level of understanding of Melbourne’s residents, businesses and visitors about Climate Change.
- UHI and cool roof research: Council has undertaken research to understand the key hot and cool spots in Melbourne and the characteristics that influence different infrastructure’s level of heat absorption. A second piece of research undertaking looks at the effectiveness of cool roofs in Melbourne’s climate.
- Flood modelling: Council has been working with various partners to undertake flood modelling for the City and incorporate this information into our decision making processes.
- Corporate risk register: Council has included key climate change risks into its corporate risk register to ensure risks are effectively managed and are incorporated into day-to-day decision making processes.
Mainstreaming Climate Change into the Red Cross Red Crescent Movement: a Solomon Islands Case Study

R. McNaught1

1Red Cross Red Crescent Climate Centre

There has been a surge in acceptance of climate change as a humanitarian concern, and to assist the world’s most vulnerable communities adapt to climate change, humanitarian organisations must themselves also adapt to a new climate regime. There is currently very little academic literature on how to do this in practice, specifically as it relates to climate change mainstreaming. This research aimed to contribute to addressing this gap through investigating and understanding the systematic attempts of the global Red Cross Red Crescent Movement to mainstream climate change adaptation into its work. To enable an understanding of how these global attempts to mainstream climate change are being interpreted and implemented in country, a case study was produced on the work and perceptions of Solomon Islands Red Cross in the Pacific region.

To begin with, a mainstreaming framework was developed from climate change, development, disaster and gender related literature. This framework was then used to assess how the Solomon Islands Red Cross is interpreting attempts to mainstream climate change. A combination of interviews, participant observation and document analysis were utilised to triangulate information. Findings from this case study indicate that the Solomon Islands Red Cross is utilising a broad spectrum of approaches to mainstreaming climate change. Mainstreaming efforts have focused most prominently on areas such as engaging with climate related stakeholders, integration of climate change considerations across disaster management and health programmes as well as outreach to vulnerable communities. Challenges that have been encountered include facilitating the interface between scientific and community understandings of climate change and the tension between the need for technical expertise and the need to scale up and mainstream knowledge of climate change across an organisation. Implications for future work of humanitarian organisations and mainstreaming efforts at large are discussed.
Developing Strategies to Combat Increased Coextinction Rates of Plant-dwelling Insects Through Global Climate Change
M. Moir¹, P. Vesk¹, M-C. Leng¹, L. Hughes², K. Brennan³, M. McCarthy¹, D. Coates³, D. Keith⁴

¹University of Melbourne
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Management actions designed to conserve threatened plant species may be detrimental to co-dependent insect species that use the threatened plants as hosts. For example, ex-situ conservation methods for plants, such as translocating plants to another habitat or conserving the plants in seed banks, have been shown not to be beneficial to either individual insects or the insect assemblage as a whole. We assess the possible strategies that will benefit both the conservation of the host plant and insects, particularly in the light of increased numbers of threatened host plants (and therefore insect species) in the future due to climate change. One such mechanism to increase benefits of resource investment would be to direct conservation resources towards those hosts with more co-dependent insect taxa, and those insects that are more prone to coextinction. Thus we outline methods to determine which hosts may have more insect species reliant upon them, coupled with which insects are likely to become more threatened under a changing climate. Finally, we present field trials of climate change adaptation strategies that we will develop to save insects most at risk from coextinction.
Climate Change Assessment for Possible Future Landscapes: Hunter and Central Coasts

P. Morley¹, I. Reeve¹, D. Brunkhorst¹, M. Coleman¹, J. McNeill¹, R. Stayner¹

¹Institute for Rural Futures, University of New England

This study, recently published by the Department of Climate Change and Energy Efficiency was one of six case studies to support a ‘First Pass’ National Climate Change Coastal Assessment. It examined the sea level rise and flood vulnerabilities for the local government areas of Newcastle, Lake Macquarie and Wyong in New South Wales.

The study investigated a number of ecological concerns from species through to landscape scale and considered a wide range of social characteristics drawn from census data as well as surveyed the attitudes of the local population. Analysis of key concepts, such as the costs and benefits of adaptation to climate change at multiple scales were incorporated into the biophysical, ecological, social and economic modelling of the present for the study area. These models integrating with past-trend future trajectory analysis allowed a multi-scaled hybrid approach to future analysis that is applicable to landscapes of large regions. The resultant possible future landscapes were analysed visually represented as possible adaptation options. Three scenarios were represented as maps and 3D surfaces to demonstrate the areas of ecological, economic and social vulnerability from climate change. By representing this information on both current and possible future landscapes, an area’s future sensitivity to the impacts of climate change can be rapidly assessed and incorporated into current day decision making.
Planning For Adaptive Urban Water Systems Under an Uncertain Future

P. Mukheibir, C. Mitchell

1Institute for Sustainable Futures

Recent droughts have provided a reminder of the variability of the Australian climate and the vulnerability of water systems to climate induced impacts. The challenge facing utilities is the need to balance the increasing water demands with available water supplies under these conditions. In the past reserve supplies and water restrictions have been the default strategy, however more recently water service providers are seeking to diversify their portfolios and introduce flexible strategies as a mechanism to provide improved security and resilience, at reduced costs.

This new approach to resource planning represents a challenge to existing conceptual and analytical models. It requires a shift from traditional deterministic approaches to ones which respond to changes in the future by building resilience, such as flexibility for the phasing of responses based on new information, and robustness to withstand sudden shocks to the system.

Existing theoretical methods for decision making under uncertainty have generally not been applied to the water sector, nor have they been brought together in an integrated, practically-grounded process. As such a planning approach was developed and implemented to incorporate the value of water, future uncertainty (such as climate change, population growth, economic activity and black swan events) and suites of response options.

The presentation will discuss the thinking behind the framework and introduce the new innovations that were incorporated in the planning process. Specifically the approach proposes a method for understanding and prioritising high levels of uncertainty by separating them into future trends, potential shocks to the system and extreme variability in the trends. Based on combinations of the trends and shocks, scenario paths can be described and the resultant projected shortfall in supply calculated for each scenario path. Suites of options to make up the shortfall can be tested against the various scenario paths for flexibility and robustness.
Climate Resilient Seaports: Adapting Critical Infrastructure

J. Mullett

RMIT University

Seaports are vital to the world's current and future prosperity. The Australian sea ports sector is demonstrably growing with new port developments in train as well as expansions of existing port precincts. Current statistics from the Bureau of Infrastructure, Transport and Regional Economics show that 1052.4 million tonnes of cargo was handled by Australian ports in the financial year 2009-10, an increase almost double that of 2000-01.

However, there is growing awareness that climate change will be a significant threat to sea ports and associated infrastructure over coming decades. A rise in sea level is the most obvious and high profile concern, though other important climate-related hazards will also act to amplify adverse impacts on structural and functional resilience. Whilst there has been considerable emphasis placed on the importance of ports and the need for anticipatory planning to ensure a sustainable Australian ports system in the future, the integration of climate change impacts into decision-making processes remains at an embryonic stage and in many cases the required technical detail remains lacking.

Drawing from an ongoing research project funded by the National Climate Change Adaptation Research Facility ‘Enhancing the resilience of seaports to a changing climate’, this presentation will provide an update of the project’s integrated assessment of the complex range of future risks facing Australian ports (climate and non-climate), and how the findings from this analysis are being used to inform an assessment of the structural and functional vulnerability of seaports and their environs, and ultimately to identify relevant adaptation options that are transferable and applicable internationally.
Application of Resilience Concepts for Coral Reef Management

P. Mumby¹

¹University of Queensland

The term resilience is widely used in policy and its interpretation varies considerably among practitioners. Technically, at least two forms of resilience have been defined in the ecological literature: engineering resilience and ecological resilience. Neither is perfectly suited to the management of entire biomes and I begin by discussing the application of each concept to reef management. Practical implementation of these resilience concepts depends on the dynamics of the system, our degree of ecological understanding, and the availability of field information. I contrast two approaches for implementing resilience theory and highlight the challenges facing Australia for incorporating resilience into the management of coral reefs.
Who Wants to Participate? Evaluating the Benefits of Public Participation in Climate Adaptation Policies

J. Mustelin¹, P. Burton¹

¹Griffith University

More deliberative and participatory approaches have been suggested as important mechanisms in enabling more effective policy development and implementation. The putative benefits of more rather than less public participation are numerous and include better framed and more robust policies and more informed, articulate and engaged citizens. These assumptions about the value of greater public participation in policy processes in general are also evident in climate adaptation planning and policy in particular where greater public engagement is advocated by all levels of governance. To date the empirical testing of these assumed benefits has, however, lagged behind their articulation.

This paper evaluates the role, benefits and extent of public participation in adaptation policy and practice in the region of South East Queensland. Based on empirical research with key stakeholders and an analysis of adaptation policies at local, regional, State and Federal levels, we explore how public participation is understood and used in the process of adapting to climate change. Drawing on Burton’s (2009) evaluative framework in examining who should participate, at what scale, when and how and Richardson’s (1983) benefit framework, we critically review both the rhetoric and the reality of public participation in the range of climate adaptation plans, policies and strategies.

Our findings indicate that although different policy instruments treat public participation differently at different levels of government, they all make the critical assumption that the general public is willing and able to participate to a much greater extent in adaptation policy making and practice. We also found a lack of empirical scrutiny of the effectiveness of greater public participation in the policy process and thus little evidence that the assumed benefits of greater participation in policy development have been realised in practice.
Coastal Urban Futures: from Wollongong to Lakes Entrance

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³University of Wollongong

Coastal urban futures in the context of sustainability and climate change are being investigated to better understand what a climate adapted Australian settlement would look like from the perspective of coastal small towns in 2030. This paper will present interim findings on research examining the southeast corner of Australia stretching from Wollongong to Lakes Entrance, a relatively under researched coastal environment. The coastal landscape includes a range of environments; urban settlements from towns to hamlets; and administrative jurisdictions including two states, regional organizations and local councils. A particular challenge of this research is developing a methodology for integrating coastal urban and climate change scenarios. The interdisciplinary team involving three universities has adopted four themes as a framework – (i) coastal developments and infrastructure, (ii) coastal landscapes and water, (iii) human health, wellbeing and society and (iv) regional climate change scenarios. An urban hierarchy approach is connected to a climate risk assessment approach to identify key case studies. The different coastal planning systems of NSW and Victoria provide a contrasting regulatory framework that will influence the shape and resilience of coastal urban futures in this landscape. The trans-disciplinary research will result in a small coastal towns and scenarios framework and strategy for 2030 to assist local coastal councils in developing their land use, infrastructure and coastal plans for future decision-making.
Building Climate Change Resilience from the Source – the NERSA Experience

R. O’Hagan\(^1\), J. Davies\(^1\), G. Baker\(^1\)

\(^1\)North East Regional Sustainability Alliance

North East Regional Sustainability Alliance (NERSA) is a network of community sustainability groups which collaborates with communities, agencies and organisations across the region to ‘promote sustainability across North East Victoria by acting as a hub for coordination and collaboration between community groups and others with focus on sustainability in our region and nationally.’ Importantly, sustainability groups in the Alliance have focused on practical measures of climate change mitigation as well as awareness raising and advocacy around climate change. They have been supported in these activities by local government, Landcare, educational institutions, church groups and service clubs. This indicates the level of concern in these communities about climate change whilst acknowledging a variety of opinion about strategies for adapting to and mitigating climate change.

These community responses and practical actions aim to build resilience from the source – our natural, human and social capital. The North East has a unique capacity to provide sustainable solutions because of our endowments in natural resources, water and biodiversity; renewable energy sources; productive food systems; and adaptive and innovative communities. NERSA acts as a catalyst for sustainability action by linking with and building on efforts of existing environmental groups to raise awareness of climate change effects and mitigation, and provide positive advocacy for change in moving towards renewable energy sources and by encouraging the use of sustainable goods and services and reducing consumption. By working to ensure natural resource management that protects and enhances our water, soils, minerals, landscapes and biodiversity and developing sustainable food systems, local communities can be the key to building resilience for a sustainable future.

This paper documents the journey of NERSA and the challenges that arise when local communities wish to shape their own destiny in the face of climate change.
Oral abstracts

**Water and Climate Change: Interactions and Responses**

K. Olsson, C. Mackintosh

National Water Commission

Climate change and water management are two of the most important public policy issues facing Australia. Adding to existing water management challenges is the fact that climate change, and policies aimed at mitigating and adapting to climate change, can impact on water management outcomes.

Although developed to deal with inherent climatic variability, Australia’s water management policies may not be well-equipped to deal with climate change related impacts. In addition water policy and management will also be affected by the implementation of climate change mitigation policies such as a carbon price.

The National Water Commission recently undertook analysis of the interactions between water policy and climate change. The analysis sought to:

- better understand the interactions between water and climate change policy
- assess the likely location, timing and materiality of impacts on water resources, water infrastructure and services
- assess whether Australia’s water policy settings are sufficiently robust to deal with potential implications of climate change mitigation policies and adaptation responses
- assess whether current water policy settings have implications for the implementation of climate change policy; and
- inform further water policy development and implementation.

Interactions between water policy and climate mitigation and adaptation policy were identified across seven key sectors that supply water, use water or otherwise affect water policy (urban water, rural water, environment, agriculture, electricity generation, forestry and mining). The analysis identified and assessed the potential impacts on water resources and service provision of both climate change mitigation and adaptation policies or actions.

The assessment concludes that overall, current water policy settings are well-placed to address most of the potential impacts arising from climate change mitigation and adaptation. However, it identifies several areas where there is scope for changes in current arrangements to ensure that water policy objectives will continue to be achieved.
The Role of Culture and Traditional Knowledge in Climate Change Adaptation in Northern Australia

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Climate change has profound implications for Australia’s Aboriginal and Torres Strait Islander communities, particularly those in coastal and remote locations, many of whom depend on bush and sea foods for their livelihoods. However research is limited into the ways in which climate change, in interaction with other drivers of environmental change, is or will potentially impact on Australian Indigenous communities at a local level, and how communities perceive and respond to these changes. In this presentation, we explore how three Aboriginal language groups in the Kimberley and Great Sandy Desert conceptualise environmental changes through their own cosmologies, and the implications of their belief systems on the development of successful community-based adaptation strategies. Our case studies serve to highlight the extent to which different social groups are likely to perceive and respond to climate-driven ecological changes differently depending to the extent their livelihoods, belief systems, and daily lives are connected to those ecosystems. We document how situated knowledges about the way in which communities operate, including value systems, modes of living, service provisions, and governance structures, are vital to identify both entry points for adaptation, and the barriers and limits to adaptation.
Enabling Stories of Change – A Narrative Case Study of Adapting to Coastal Change in Port Fairy, Victoria

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Context-specific perspectives on the environmental, socio-cultural, linguistic and behavioural dimensions of local conditions are becoming more prominent in the adaptation debate research agenda. Scholars urge for more social research on vulnerability and adaptation relevant to policy and practice, such as work addressing impediments to knowledge flows into local decision-making and action, and the development of mechanisms that could facilitate interdisciplinary and cross-sector learning processes and social innovation.

In particular, the importance of language, cultural concepts and communication for successful adaptation design has been noted in relation to a number of issues and objectives in adaptation research and practice. For example, cross-disciplinary communication, collaborative learning, and the existence of structures for participatory, deliberative governance have been noted as fundamentally important aspects of building adaptive capacity. Narrative has become a buzz-word in this context. However, in much of the current adaptation debate it predominantly refers to questions of local ‘attitudes’ and how climate change information and policies can be ‘storied’ strategically, in order to achieve broadest possible credence across a variety of stakeholders.

Based on case study research conducted with the coastal community of Port Fairy, Victoria, this paper argues that narrative provides more than a social science methodology for the understanding local ‘attitudes’ and informal knowledge(s). Narratives – or story-telling – are also a mode of knowing and interacting that generates both knowledge and community, for example by bringing competing interpretations and practical knowledge(s) into productive dialogue, and by creating resilient social and knowledge networks. Applied narrative research, it is argued, can mobilise locally existing knowledge(s) and help enhance communicative structures that enable communities to face the challenges of environmental change.
Challenges with Developing Adaptation Pathways for Australia’s Fisheries: Lessons Learned from Iconic Fisheries in South-east Australia.

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Changes in climate are already impacting Australia’s marine ecosystems and yet our understanding of impacts in the ocean, and development of adaptation options, has lagged considerably behind that of terrestrial systems. Regions experiencing high exposure to key climate drivers, like south-east Australia, represent prime locations for assessing impacts and developing, evaluating and implementing adaptation options to cope with a changing future. Institutes within the five jurisdictions of the south-east have been proactive in establishing a formal collaborative structure (the South East Australia Program) to facilitate linkages between biophysical, socio-economic and governance domains, providing solid foundations to develop and implement adaptation options. Using rock lobster, abalone, snapper and blue grenadier fisheries as case studies, we detail how climate change may intersect with the specific management tools and structures for each fishery and use a combination of stock projections, scenario development and identification of critical thresholds to generate likely future scenarios. Development of adaptation pathways, in close consultation with industry and resource managers, will allow a balanced combination of management responses that can be introduced now, through to medium and longer-term responses. Central to our approach is the development of a clear understanding of what values the fisheries are being managed for by identifying objectives of management and understanding how different groups of stakeholders weight these. This will allow adaptation options to be ranked, highlight where stakeholder conflict may arise, and enable relevant performance indicators and metrics to be identified, in a transparent and contextually relevant framework. Accounting for uncertainty, through rigorous analysis of alternative management actions and developing mixed strategies to cope with multiple uncertainties, will help make fisheries in south east Australia resilient, sustainable and profitable through a changing climate. Components of our approach will be generalisable and transferrable to other fisheries in Australia and elsewhere.
REDMAP: Engaging Australia’s Marine Communities and Industries on Climate Change Through Citizen Science

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REDMAP (Range Extension Database and Mapping project) is an online database and mapping resource allowing members of the public to submit and access observational data (including photographs) of marine species occurring outside their known distribution (i.e. species that may be undergoing range shifts). Australian coastal waters are warming at 2-4 times the global average and species are expected to shift where they live in response. The identification of possible range shifts in our marine species – as they are occurring – is critical for understanding the impact of climate change on ecosystems and being prepared to respond appropriately to maximize opportunities and minimize negative impacts. Through participation in REDMAP, the industry and the public will be actively engaged in the generation of knowledge about how our marine systems are responding to both short and long term environmental patterns and changes. REDMAP is a powerful yet simple and positive approach to engage people on issues of biodiversity and climate change, whilst also providing opportunities to learn about scientific principles related to species biology and ecology, oceanography, marine habitats and many other research fields they may normally not be exposed to. REDMAP provides a cost-effective approach for facilitating broad scale marine species observational data capture and display in a time and cost effective manner; allows a system for monitoring over large scales and provides a portal for accessing and understanding these data. Currently a multi-award winning pilot project limited to Tasmania, the REDMAP project is developing an Australia-wide website to be launched October 2012. This initiative has enormous potential to engage communities - including Indigenous coastal communities, fishers and industry - in climate science (using their own data), and to raise awareness of climate change impacts and consequences in the community – and through activities people enjoy like fishing, diving and boating.
Climate Change Adaptation Today: Local Knowledge and Dynamics Across Borders

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Griffith University

Climate change adaptation in Australia has principally become the responsibility of local governments. The Principle of Subsidiarity embedded within the National Climate Change Adaptation Framework attest to the complex role that local governments are required to navigate in order to deliver actual, on-the-ground, adaptation outcomes.

Traditional institutional challenges encountered by local governments in regard to environmental planning processes are magnified at the regional scale when local governments collaborate to develop an integrated regional climate change adaptation strategy. This complexity is again compounded once local governments consider adaptation planning for vital natural resources and services located across borders.

The NCCARF project ‘Learning from cross-border governance mechanisms to support and promote climate change adaptation in Australia’ addresses these complexities. The intention of this paper is to identify the current status of cross-border adaptation strategies facilitated by local governments and supported by State governments. In this desk top study, we focus on the local governments residing along the New South Wales/Queensland border and along the New South Wales/Victorian border to determine whether these individual local governments have a climate change adaptation strategy; are part of a regional collaborative strategy and whether they have any existing cross border arrangements in place. Where there are collaborative strategies in place, we consider the external actors and the processes followed.
**Adaptation Options for Australian Indigenous Women Living in Remote Coastal Regions**

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At present many Indigenous people living in communities experience food insecurity in terms of access to nutritious and affordable foods. Vulnerability is particularly acute for Indigenous people living in remote communities for many reasons, such as logistical difficulties in transporting fresh food at affordable prices, very poor infrastructure and limited local economic opportunities.

It is suggested that traditional harvesting by women from the intertidal zone can provide valuable nutritional benefits to Indigenous families of low health status, particularly through omega-3 lipids, vitamins and minerals from shellfish. However, as climate change impacts on the biophysical nature of tropical oceans and their landmasses, access to the intertidal for seafood is likely to be severely affected. According to the PMSEIC Independent Working Group, the provision of services to tropical coastal communities in the future will be negatively affected and communities will experience greater coastal inundation and erosion. Indeed Indigenous people have already observed ‘strange changes’ to the marine and coastal environment and organisms, attributing some of these to changed climate patterns. Thus as a consequence of climate change Indigenous people are likely to (i) have even less access to regular food provision services than the current poor services and (ii) have less access to local marine resources as food supplements.

This project is a partnership between representatives of ‘formal’ research, governing organisations and representative West Arnhem Indigenous women. It aims to carry out participatory action research with women on Goulburn Island to develop an understanding of today’s customary practices regarding intertidal seafood use by women, to explore and pursue perceptions about climate change and food insecurity issues now and into the future, and to identify preferred adaptation options to identified vulnerabilities. In this presentation, some of the preliminary results that have arisen from the research will be outlined.
A Decision Science Perspective on Climate Adaptation Strategies for Reefs

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While so much of our ecological work has focused on predicting the impact of climate change on biodiversity, we now need to move from prediction to adaptation. Climate adaptation demands decision science tools – it cannot be done by randomly combining maps of threats, assets and values. Adaptation research that is not embedded in a decision-science framework is a waste of time and money.

Good decision science for reef management requires four elements: clear quantifiable objectives, lists of actions in space and time with their costs, the relationship between those actions and the state of the reef (system dynamics models), and an understanding of what would happen if we did nothing. The only way to deliver the sufficient and/or efficient conservation actions we need is by combining these elements in quantitative decision-making framework. Ecologists seem keen to build those system dynamics models, but not the other elements of the problem. In this talk I will outline ways we formulated and solved properly posed problems in the past, and how we should do it in the future. A crucial challenge is to avoid interesting but poorly posed problems such as: which is a higher priority for conservation – a reef threatened by climate change, or a reef that is secure under a changing climate? Problem definition is everything in climate adaptation.
Making Use of Climate Scenarios in Water Policy and Planning

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Water managers base their policy decisions and future planning on best available science and would like to know what the future holds in terms of future water availability across their region of interest. However, this information cannot be derived directly from global climate models. Rather, estimating climate change impacts on future water availability involves a three step process. Firstly, data on current and future climate needs to be extracted from global climate models over the region of interest. Secondly, these data need to be downscaled to provide projections of changes in regional precipitation. This downscaling can be carried out through a variety of methods, including simple scaling (delta change approach), statistical downscaling, dynamical downscaling, or some combination of these. Thirdly, these projections of future precipitation need to be run through hydrological, and in some cases river system and/or groundwater recharge models in order to provide estimates of future water availability.

This presentation will describe how we have utilized these methods to estimate the potential impacts of climate change on future water availability across south-eastern Australia. An assessment will be made of the uncertainties in these estimates, and the sources of these uncertainties will be presented. Limitations of the various approaches will be discussed in light of the needs of water managers and policy makers.
Climate Change and Coral Trout: Adaptation Options for Reef-based Fisheries

M. Pratchett¹, L. Evans¹

¹James Cook University

Climate change poses a considerable threat to coral-reef ecosystems and reef-based fishes. It is expected that changes in environmental conditions (e.g. ocean warming, acidification, sea-level rise), combined with climate-induced degradation of coastal habitats will affect reproduction, recruitment, growth, survivorship, and ultimately abundance of key fisheries species. Herein I represent a large group of researchers that have considered the likely effects of climate change on common coral trout (Plectropomus leopardus), which is the major target of commercial reef-based fisheries on the Great Barrier Reef, and an important recreational species. Consideration was given to the range of ways that climate change will impact the distribution, abundance and catchability of coral trout, as well as follow-on consequences of commercial and recreation fisheries. Our research revealed that coral trout will be extremely sensitive to climate change, based i) extreme temperature sensitivities in fertilisation and development, ii) marked effects of ocean acidification on sensory abilities and habitat selection, and iii) an apparent reliance on reef corals during settlement. As such, effects of climate change must be explicitly considered in developing and adapting management options for commercial and recreational reef-based fisheries. We assessed a wide range of adaptation options that will reduce exposure, reduce sensitivity, and/or enhance adaptive capacity within each of four distinct fisheries sectors; i) commercial, ii) recreational, iii) charter, and iv) indigenous fisheries. While some adaptation options, such as increased stewardship, will have beneficial effects across all fisheries sectors, most adaptation options will have a disproportionate benefit for one or more sectors. Climate change provides a renewed imperative for improved management of marine resources, but selection of adaptation options requires unequivocal consideration of ecological, economic and societal priorities.
Development of a Climate Change Adaptation Evaluation Matrix

A. Rance

EcoLogical Water

With climate change and its impacts accepted by the scientific community and majority of society alike (Clark 2011; Mummy 2011; Philp et al. 2011; Nelson et al. 2007), focus is now shifting towards response mechanisms (Hedger et al. 2008). One approach to attenuating the impacts of climatic change is through ‘adaptation’ and the development of policies that facilitate this. With awareness of our vulnerability to climate change impacts increasing, Australian coastal communities are attempting to take action through various adaptation strategies and management plans. Yet means to evaluate effectiveness of adaptation action is not yet present on any scale; a significant gap in knowledge has been identified (Preston et al. 2010; Preston & Kay 2010).

Through research into developing an Adaptation Evaluation Matrix, is it proposed that adaptation as a measure to reduce vulnerability to climate change impacts will be effectively facilitated in local government areas. An integrated approach is enhanced through evaluation, with stakeholders and all levels of governance aided with baseline, and ongoing auditing methodology. This paper discusses current research and application of an Adaptation Evaluation Matrix in coastal local government areas within Australia.
The Inter-relatedness of Psychological Adaptation, Psychological Impacts, and Behavioural Engagement

J. Reser¹, G. Bradley¹

¹Griffith University

The paper addresses a crucial set of neglected psychological considerations relating to adaptation in the context of climate change. The argument presented is informed by two sequenced and comprehensive national surveys in Australia and an American Psychological Association Taskforce analysis and review of coping with and adaptation to the threat of climate change. In addition to a consideration of those psychological adaptation processes and dynamics underlying climate change adaptation at an individual level, the paper addresses how such psychological responses mediate behavioural responses and themselves constitute important psychological impacts of the threat of climate change. Australian research findings document that intra-individual changes in thinking, feeling, and other psychological responses to and impacts of this phenomenon and risk domain are an integral part of climate change adaptation and that these psychological responses and impacts both strongly influence behavioural engagement relating to mitigation and in turn reflect multiple psychological benefits of taking such actions and some net adaptation costs. The utility and sensitivity of trialled measures of psychological adaptation and psychological impact are discussed, along with the critical importance of a careful documentation and monitoring of such psychological changes and impacts in the human landscape relating to climate change.
Identifying Terrestrial Refugia for Biodiversity

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Identification of natural refugial areas is crucial for protecting biodiversity in the face of climate change. However, despite the potential importance of refugia in climate change adaptation, little is known about the types of refugia that best promote ecosystem resilience, or how to identify them in the landscape. Future refugia for species may be different from areas that have served as refugia under current or past conditions. This is largely due to the speed in which the climatic changes are occurring, and also the potential for climates that are different to anything species have encountered previously. There is a need to further refine the issues surrounding this concept of refugia, and to examine the pitfalls in order to prioritise effectively refugial areas within Australia. In this project we focus on the notion of stability; that areas that change the least into the future will be most valuable to biodiversity. We use species distribution modelling to predict the locations of biodiversity hotspots in 2080, and compare these with the areas of relative stability of future climate. In addition, for the locations that are most instable, areas of micro-habitat buffering (e.g. gorges, rocky outcrops) will be identified. Micro-habitats that buffer the impact of climate change will be particularly important in areas that are facing the greatest changes, and therefore these will be key targets for protection. We discuss solutions to issues such as accounting for environmental conditions that shift throughout space, and the scale-dependency of refugia. Our findings are essential for prioritising conservation efforts at both policy and management levels.
Adaptation to Climate Change: How is It Any Different to Normal? The Case of Agriculture

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The twin questions of how anthropogenic climate change relates to and differs from natural climate variability, and how climate change adaptation relates to and differs from “normal” adaptation, are core concerns for climate change adaptation. The conceptual and practical issue of how climate change adaptation is “additional” or novel is of particular pertinence within the agricultural sector, where adaptation to natural climate variability and other uncertainties has always been a core element of normal practice and remains a hurdle requirement for business longevity. Such experience is necessarily a key starting point for climate change adaptation. Its influence however is ambiguous. On the one hand, its influence can be seen to be positive, with climate extremes (namely drought) being promoted as useful analogues of future climates and industry members’ understanding of climate variability providing them with advantageous knowledge. On the other hand, however, experience to date with climate extremes may prove unhelpful, conceptually, practically and politically. On some measures, such experience is characterised by serious adaptation deficits that demand attention in addition to the further challenges of anthropogenic climate change. Novel climate patterns and the mitigation imperative within climate change adaptation may also require overturning not reinforcing past ways of doing things. This paper provides an overview of, first, the relationship between natural climate variability and anthropogenic climate change and, second, that between the adaptive behaviours that characterise “normal” agricultural practices and those known as climate change adaptation.
The Encroaching Sea and Shifting National Boundaries: Integrating Law with Uncertain Scientific Predictions in Addressing Climate Change Impacts in the Coastal and Marine Environments of Australia and Its South Pacific Neighbours

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At a global scale projected climate change impacts are well documented. There is widespread agreement that these will include rising sea levels and changing coastal and marine environment; nevertheless, the exact consequences for particular locations have yet to be mapped out by the scientific community. Climate change impacts are already occurring in some parts of the South Pacific and these will increasingly be associated with social and economic disruption, human rights violations, and forced migration of groups of people. Of particular concern for Australia and South Pacific, given the region’s economic, social and cultural dependency on the marine environment, is the anticipated disruption to marine ecosystems caused by rising sea temperatures and increasing ocean acidity. This will threaten food security in some areas and result in further social disturbances. Consequently, our region needs to develop appropriate responses to these challenges, including the necessary legal systems and regulatory frameworks to address the issues of migration, changing property rights, protecting and restoring marine ecosystems, and planning for sea level rise and associated impacts. However, fundamental questions must be addressed before such regulatory changes are implemented. Are current legal systems able to accommodate these challenges or is urgent fundamental reform necessary? Furthermore, do particular problems with trans-jurisdictional dimensions require some form of regional agreement? Another issue is the degree of scientific certainty that must be reached about the exact regional and local climate change impacts before regulatory reforms are considered necessary and appropriate. Is regulatory reform only likely once the environmental and social impacts occur or is it feasible for law to adapt proactively? If so, then what is the level of scientific accuracy and precision required of climate change modellers in their regional downscaling before the legal systems in the South Pacific region can respond effectively to future climate change impacts?
The Challenge for the Built Environment – Adapting to Climate Change
T. Roper¹

¹ Australian Sustainable Built Environment Council

The Australian Sustainable Built Environment Council (ASBEC) is the peak body of key organisations committed to a sustainable built environment in Australia.

The buildings and communities we now have, or are developing, are based on our historic climate not the challenges of heat and extreme events they will face during this century. Neither government nor industry is geared to reducing the risks and damage from the impacts of climate change related events. Action to reduce emissions is also a patchwork.

This paper will propose a new national approach through COAG including:

- Changed land use planning processes
- New design and construction practices for building, infrastructure and retrofit investment, also addressing mitigation measures.
- Transition to performance based standards that encourage innovation
- Meet the challenge of retrofitting what we have
- Promote resilience and sustainability through incentives and regulation
- The training and retraining of both the professional and trade workforce

Attention will be paid to best international and Australian practice including New York and Chicago and key performance indicators.
**What About Me? The Role of Emotion for Individual Climate Change Adaptation**

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Researchers to date have generally neglected to explore the affective dimensions of mitigation and adaptation behaviours for individuals. This is somewhat surprising in view of evidence that emotions are reactions to significant events and provide an impetus for action. Emotional appraisals serve as an information processing mechanism that helps actors to distinguish the relevance and importance of events or information. Research has shown that environmental issues are especially emotional and it therefore seems reasonable to conclude that emotions in response to climate change likely serve as important influences on individuals’ decisions and behaviours in response to climate change. In this paper we present a theoretical framework for examining the role of emotion in individual adaptation to climate change.

Using the Cognitive-Motivational-Relational (CMR) theory of emotion (Lazarus, 1991a) we offer propositions about the types of emotions that may be elicited in response to climate change and explain why this is likely to affect subsequent actions and reactions. We examine three attributions in particular: goal relevance, goal congruence (or incongruence), and the ascription of blame (or credit). Goal relevance refers to the amount of investment an individual might have in the outcome of an encounter or event. Goal congruence, concerns the extent to which the outcome (of an event or encounter) is likely to lead to harm or benefit, with (potential for) harm leading to negative emotions, and (potential for) benefit leading to positive emotions. Finally, ascription of blame (or credit) depends on whether the cause of the event or situation can be attributed to an individual or group, and the extent to which the individual or group had full control over their actions. We examine the range of emotions that may be elicited in response to climate change and offer preliminary findings from this burgeoning research area.
Climate Change Adaptation Within the Rail Industry
A. Salardini

Australasian Railway Association

Overview: The Australian Rail Industry has been severely affected by recent extreme weather events. Floods in Queensland, Victoria, Northern Territory and northern NSW, along with extreme heat events in Western Australia has caused significant damage to rail infrastructure and transport supply chains.

The Rail Industry, via the Australasian Railway Association (ARA), began a collaborative initiative to address any shortcomings in the industry’s handling of climate change adaptation assessments. The key findings of the final discussion paper includes:

- A significant knowledge gap of the impacts of climate change and of organisational responses to the issue;
- A lack of a systematic approach in quantifying and assessing climate change adaptation risk;
- Those responsible for weather related assessments ill equipped to properly assess climate change risks;
- Data used was inadequate and usually historical in nature (rainfall run off charts etc.)
- Confusion with respect to data based on modelling (various sources and differing conclusions depending on the model); and
- Lack of granular data provided by government agencies.

The paper recommends:

- A more focussed organisational approach to climate change adaptation risk assessments and provides high level principles based guidelines; and
- That government agencies provide more granular data in relation to climatic variables.

About the ARA: The ARA is the peak body of the Australian Rail Industry including rail operators, infrastructure owners, manufacturers and constructors.
Adapting Agricultural Management Strategies to Cope with Climate Extremes in Northern Tasmania

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Australia is the driest inhabited continent, with a climate characterized by extreme variability. Warming over the coming decades will lead to increased extreme events such as high intensity rainfall, flooding and drought with large agricultural impacts. For instance, in early 2011, three days of extreme rainfall destroyed many vegetable crops, split cherries and wine grapes and spread disease in northern Tasmania, costing agricultural industries ~$100 million.

Here we report some results from a joint NCCAF/TIA project that aims to improve early warning systems and agricultural risk and opportunity management for Tasmania’s potato and dairy sectors. As seen in 2011, extreme events have significant impacts on these two sectors. Some of these extreme events are associated with SST anomalies in the Pacific (ENSO) and in the Indian Ocean (Indian Ocean Dipole, IOD).

Both, positive IOD and La Nina events can cause climate fluctuations that impact on potato operations. Positive IOD events often lead to drying out of soils earlier in spring, enabling early potato planting in September. Conversely La Nina events can produce significantly wetter soil conditions causing potato plantings being delayed by up to four weeks, especially on the heavier, moisture retaining duplex soils.

Further climate change is likely to lead to increases in frequency and intensity of winter rainfall in northern Tasmania. This is likely to delay potato planting in spring, particularly in moisture retaining soils. However, higher temperatures and less rainfall in summer are expected to increase water stress, particularly for rainfed pastures. Based on this knowledge we will develop and report on climate risk management principles designed to assist growers and industry support to increase their profitability and environmental performance. This paper will present results of workshops and practices that demonstrate successful adaptation to climate variability and change giving annual cost savings in the tens of millions.

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To achieve sustainable adaptation to climate change, adaptation science must be transferred and integrated across a number of boundaries in government. However, the ability of bureaucratic decision-making processes to deliver innovative solutions is severely challenged by the temporal and spatial complexities associated with climate change science, policy design and implementation. As a consequence, there are significant constraints on the capacity of public sector agencies to collaborate in ways that enable them to effectively draw on adaptation science to develop innovative and integrated responses to climate change.

Social capital can enhance the ability of individuals and organizations to effectively pursue shared objectives, particularly in complex decision-making environments where co-learning and innovation is required. However, there is little research evidence on the social capital that exist among public sector agencies and its role in facilitating the transfer and integration of science-based knowledge in policy implementation. The objective in this research was to explore whether the social capital that exists among public sector agencies may be an unrecognised and therefore, an underutilized resource in facilitating the uptake of adaptation research in government decision-making processes.

We will report the findings of a survey of bureaucrats charged with working together to address climate change in Victoria, Australia and British Columbia, Canada. The survey was used to pilot some measures of social capital and the transfer of climate-related scientific knowledge among public sector agencies. The results revealed systematic relationships between inter-agency trust, informal and formal communication channels and decision-making across agencies. There were also differences in the type of climate-related science being shared among bureaucrats (e.g. climate forecasts, adaptation options, mitigation options). These findings inform the ongoing efforts of governments to strategically harness science-based knowledge and the expertise that exists within their agencies to deliver meaningful climate adaptation outcomes.
Psychological Barriers and Promoters for Climate Change Adaptation

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All environmental problems have an anthropogenic component, a fact that highlights the importance of better understanding of human behaviour and social factors in environmental issues. In the case of climate change, many psychological processes influence decisions people make about the problem, with consequences for the implementation of adaptation or mitigation policies.

Complex psychological and social factors act as barriers or promoters of behavioural changes, conditioning the success of environmental strategies. People do not change their behaviour just because they are exposed to scientific evidence or new laws are sanctioned. Neither does environmental concern necessarily lead to a behavioural shift. In such a context, the scientific community, as one of the critical actors in this issue, has successfully promoted a growing environmental concern, yet that has not been enough, despite much effort, to encourage deeper and more sustainable behavioural changes in society.

This paper presents the results of two studies aimed at critical questions for the success of climate change strategies: when are people prepared to change their behaviour in a sustainable way?, what are the psychological processes involved?, what are the social factors which encourage such a shift? In the first study, I re-examined data from the CSIRO’s National Survey (2011). This showed that beliefs about climate change are strongly related to the perception of risk, importance, and concern about the problem. The second study involved focus group discussions of such results, and showed the influence of scientific knowledge in the construction of such beliefs and the links between those factors and behavioural responses to climate change.

These results confirmed the importance of psychological variables for environmental strategies, and suggest that a better understanding of these processes can provide a framework for developing and considering better environmental policies, institutions, markets regulations and social norms to address climate change issues.
Migration, Climate Change and Environmental Security: a Case Study of Two Coastal Districts in Bangladesh

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Bangladesh, located at the lower end of the Ganges-Brahmaputra-Meghna delta is extremely vulnerable to the impacts of climate change for a number of reasons. These include cyclones, droughts, rapid land use change, and frequent floods resulting from heavy monsoon rains that often lead to livelihood and food insecurity. The paper presents a case study from two selected coastal districts in Bangladesh where migration has been significantly influenced by the fear of climate change and human induced land use change mainly for shrimp farming. Multiple climate impact predictions including IPCC claim that about 1m rise in sea level could sink about 17% of Bangladesh’s land mass in the coastal region and can create up to 20 million environmental refugees by 2050. On the other hand experts also claim that Bangladesh’s coastal region has been growing by about 20 sq km/year. The study finds that in most of the cases people in the study areas have very little understanding about sea level rise, rather they are primarily focused on finding temporary and seasonal jobs to increase income to support their family and livelihoods. The study also finds that in some cases people are forced to migrate due to loss of property and income in the rural areas. Interestingly, the new land doesn’t provide any extra benefit to the people because of inadequate infrastructure that is needed to ensure security and safety from cyclones and tidal surges. This means the dilemmas are ongoing as people are still migrating from the coastal areas to urban areas and are the main urban centers are getting overwhelmed due to the inflow of migrants. The study suggests an urgent need for domestic and international finance for infrastructure building and environment friendly technological adoption to enhance local resilience for livelihood and environmental security in the coastal areas in Bangladesh.
Opportunities and Challenges for Climate Adaptation – a National Approach Across 4 Climate Impacts

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¹CSIRO Ecosystem Sciences and Climate Adaptation Flagship

We present an approach for a national assessment of climate impact risk across 4 impact categories of coastal storm tide inundation, inland flooding, fire and extreme heat. We assess the costs and benefits of alternative settlement patterns and investment into the adaptation of buildings and infrastructure. Each impact is investigated with reference to three settlement alternatives: an urban intensification scenario that assumes all future population growth would be accommodated in existing population centres within their current residential footprint; a rural development scenario which assumes the majority of national population growth is accommodated in 15 selected inland towns and a business usual scenario based on ABS projections. We combine these settlement alternatives with different levels of investment into climate adapted buildings and infrastructure including new building and design standards, raising of properties, sea walls, etc. Methodologically, geographical maps of exposure to climate impacts at SLA level are used to interrogate the NEXIS database to identify people, buildings and infrastructure exposed under current, mid century and end of the century climate change effects. We apply damage functions and frequencies to these climate impacts and identify the related costs using a net present value approach. Results are compared to the investment into adaptation in order to identify the difference settlement alternatives and adaptation action would make at a national scale. We also identify the effect for different types of SLA, differentiating between North and South of Australia, coastal and non-coastal and urban characteristics including urban core, urban periphery, non-urban. The analysis shows that the exposure of people, buildings and infrastructure is greatest for fire followed by inland flooding and coastal inundation. This is somewhat reversed when likelihood and frequencies are applied. We also analyse the energy use and carbon emission consequences of different scenarios to explore linkages between adaptation and mitigation.
Impact of Climate Change on Disadvantaged Groups: Issues and Interventions

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There is a growing concern in the literature that the negative consequences of climate change are going to be faced in higher extent by the socially and economically disadvantaged groups, than by the rest of the population. However, the associations between disadvantage and climate change effects are poorly understood. At the end of 2011 The University of Adelaide in partnership with the Social Inclusion Unit of South Australian Government and funded by the NCCARF, commenced a project studying the vulnerability and adaptive capacity of disadvantaged groups to the effects of climate change, to find mechanisms for enhancing the resilience and counteracting the effects in South Australia. The research team of the project works closely with the key stakeholders to generate special policy and program recommendations to reduce vulnerability. The project has developed a conceptual framework of climate change vulnerability indicators that allows identifying the most deprived population groups in the region. Mapping the CSIRO projected climate data and the population characteristics from Census using GIS (geographical information system), the project has located the three local governmental areas (LGAs) with the most adverse climate change effects, and the population groups within them, the least able to adapt to these changes. Using CATI survey and in-depth interviews with the households in each of the selected LGAs, primary data will be collected on factors affecting social exclusion in adaptation to climate change. Data collection is planned to be completed by mid May, 2012. The presentation for the conference will include the discussion of the conceptual framework for climate change vulnerability assessment, GIS maps identifying the locations and characteristics of vulnerable populations, as well as the preliminary findings from the household and community surveys. It will also elaborate on the challenges and the next steps of the project.

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This presentation reports on ongoing research that examines extreme weather events in Queensland and the direct and indirect impacts of these events on the resources industry, governments and dependent communities. The project is funded by NCCARF’s Synthesis and Integrative Research Program.

Australia is not only a location of extreme climate variability but is one of the world’s most vulnerable regions to anthropogenic climatic changes. The dependence that national and regional economic structures have on mining-led export earnings combined with the resource sector’s potential to impact significantly on environments and communities during extreme weather events makes the minerals sector an important area of focus for climate adaptation research. This project investigates coal mining operations in Queensland, and examines both climate-influenced drought (water quantity) and flooding (water quality) challenges relevant to the future viability of the industry and local communities.

This presentation will include a) a timeline of extreme events that impacted resource regions in Central Queensland between 2000 and 2011; b) the nature and scope of direct and flow-on impacts from a whole-of-catchment perspective; c) pointers towards what barriers and challenges – both within and outside the mining industry – exist that may prevent the resources sector from developing a coherent adaptation policy for future climatic events; and d) directions for future research on climate adaptation in the resources sector based on lessons learnt from these experiences.

Data for this project is drawn from a variety of sources, including a systematic review of literature (academic sources, newspaper and other media articles, government and industry reports, and ongoing deliberations as part of the Queensland Floods Commission of Inquiry); targeted interviews with representatives of state and local governments, industry, and peak regional bodies; and a series of workshops with a mix of representatives from relevant stakeholder groups.
Comparison of Four Australian Regional Cross Border Governance Arrangements: Implications for Climate Change Adaptation

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In Australia, the federal system has evolved as three separate tiers of government – local, state, national – with the state level largely responsible for natural and environmental resource management, and disaster management. However, these traditional institutional arrangements are changing, particularly at the cross border regional level. The aim of this paper, developed as part of the NCCARF project, 'Learning from cross-border governance mechanisms to support and promote climate change adaptation in Australia', is to explore the range of different regional cross border governance arrangements and mechanisms, and the implications for climate change adaptation.

A comparative analysis of four case examples of regional cross border governance arrangements at different scales, themes, and levels of institutional complexity within the Australian context was conducted. These cases include: [i] the Murray Darling Basin Agreement which has been identified as both a key national cross-border innovation and climate change adaptation flagship initiative; [ii] the Australian Alps co-operative management arrangement; [iii] the Regional collaboration between ACT and NSW; and [iv] the Disaster management sub-plan 2010 between the Gold Coast City (QLD) and Tweed Shire (NSW). Cases were analysed by examining the cross border institutional arrangements, implementation of the agreements, and learnings from these two aspects of the process.

The findings from the comparative analysis highlights the application of a range of different cross border institutional arrangement models, in different contexts, across different scales, and how these different arrangements are implemented. This has important implications for cross border climate change adaptation at a regional scale. Furthermore, these examples may help to guide the development and implementation of existing and future national and state climate change adaptation policies and initiatives.
Adapting the City of Melbourne’s Urban Forest
I. Shears¹, Y. Lynch¹

¹City of Melbourne

The City of Melbourne is renowned for its iconic parks, gardens and boulevards. They have formed an essential part of Melbourne’s identity for more than a century.

Our trees are becoming more important to the city’s landscape than before. Increasing evidence and research points to the fact that urban forests and green space are vital to supporting a healthy community.

However Melbourne’s urban forest is changing. More than a decade of drought has triggered irreversible and unprecedented decline for many of our trees. We expect to lose 44% of our trees within the next 20 years. In addition to this, Melbourne’s urban forest is also contending with two formidable challenges; climate change and population growth.

City of Melbourne has developed an Urban Forest Strategy in consultation with the community to respond to these challenges and provide a robust strategic framework for the evolution and longevity of Melbourne’s urban forest. This strategy will guide the transition of our landscape to a future forest that is diverse, resilient and responsive to the needs of the community and the city.

Core actions within the strategy address how to adapt the city for a dramatically different future. Doubling our canopy cover throughout the city will bring about a decrease in temperatures of 2-4 degrees Celsius. This will minimise the urban heat island effect and the impact of predicted increases in future temperature to improve thermal comfort at street level for pedestrians, reduce heat stress for city users and lower energy use during periods of extreme heat. Increased water sensitive urban design incorporated into the landscape will play an important role in managing frequent inundation and providing essential soil moisture for healthy vegetation growth.

The strategy introduces an ambitious tree species diversity target to maximise resilience against pests, diseases, low water futures and weather extremes.
Estuaries & Wetlands – Critical for Key Commercial and Recreational Fisheries and the Frontline for Adaptation to Rising Sea Levels
M. Sheaves

Estuaries and coastal wetlands comprise a mosaic of interconnected habitats, with most fisheries species requiring access to a series of habitats to complete essential life-history functions. This includes fish like barramundi and mangrove jacks, and invertebrates like mud crabs and prawns. Stage-specific habitat requirements are exemplified in the wide spread use of specific nursery, feeding and spawning grounds. Just as importantly, key forage species also require access to this mosaic of habitats. Alongside recognition that the productivity of estuarine and coastal fisheries relies on the integrity of a chain of crucial habitats, is the realisation that the integrity of connectivities among these habitat units is vital to effective biological functioning. Consequently, the value of estuaries and coastal wetlands to fisheries production doesn’t reside in any one component but rather in the connected mosaic as a whole. As a result, long term viability of fisheries dependent on estuaries and coastal wetlands relies on maintaining a suitable habitat mix, suitable water quality and the integrity of connectivities.

The future health of coastal fisheries depends on the protection of this chain of connected habitats becoming a primary goal of climate change adaptation, but how do we go about protecting it? Hard decisions are needed, so the first step is to ensure we have detailed knowledge of the specific values of different habitats. Armed with this knowledge we can explore the options for repair, protection and facilitation. Repair needs to focus on reinstating connectivities, such as the removal of barriers. Protection should ensure that effective connectivities are maintained; not just ensuring there is a connectivity pathway but ensuring that effective biological connectivity is realised. Facilitation will need to focus on managing the migration of key coastal ecosystems as sea levels rise while accommodating the interaction between environmental needs and human responses to climate change.
Climate Change Adaptation Planning in the South Australian Murray-Darling Basin

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From March 2010 until December 2011 the Environment Institute led a multidisciplinary team of climate, agricultural, landscape and social scientists, planners and community engagement practitioners to develop a climate change adaptation plan for a consortium of 11 councils in the South Australian Murray-Darling Basin (SA MDB) and the SA MDB Natural Resources Management Board. The project integrated strong technical input on future climate change scenarios and potential land use change with feedback from consultation with local government planners and key stakeholders including representatives of the irrigation dry land farming sectors. The broad cross section of skills and disciplines from both the client and project team provides an example of the challenges and insights that can result from integrating different approaches and perspectives on climate change adaption planning. The project found that while the region has been able to adapt to periods of natural variability like drought, or to the threats posed by rising salinity in irrigation districts in years gone by, responding to the warming and drying trend that climate change will bring will require greater resilience and attention to adopting longer term adaptive measures. It was also recognised that the private sector will lead the change in land use in a regional area such as the SA MDB. Key recommendations of the project included the need to: (a) develop strategies to support and facilitate private sector investment in land use change in response to carbon farming opportunities, through leadership training and provision of information to farmers and their support networks; (b) invest in clearer communication of how local government planning guidelines will be applied to new energy projects or changes in land use; and (c) build strong, continued collaboration, coordination and leadership across the region will create a climate for investment.
How to Balance Urban and Agricultural Water Related Needs Under Changing Conditions in the Maipo Catchment, Chile?

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The Central Valley in the metropolitan region of Santiago de Chile (MRS), located in the Maipo Catchment, is the most densely populated area in Chile, with all the main economic, social and technical functions of the country and therefore especially vulnerable to the impacts of climate change. Already today 100% or even more of the available water resources are allocated as private water rights leading to competition for water among agricultural, domestic and industrial purposes. Precipitation shows considerable variations within a year and even stronger between different years. This precipitation pattern leads frequently to droughts, increasing the risk of a growing competition between agriculture and urban water demand. Due to low average annual precipitation and its concentration in winter months most water-related needs in the rest of the year are highly depending on melt water from glaciers and snowfields of the High Andes (MCPHEE ET al. 2011). The regional impacts of global climate change will noticeable influence the future water availability in the MRS. Downscaling of climate models predicts reduced run-off of the Maipo River in summer months up to -40 %. Facing the shrinking water resources the elaboration of suitable measures for climate change adaption is a pressing need.

The Project combines downscaling of global climate change models for the supply side with two socio-economic regional scenarios in order to address possible developments on the demand side in the region. On the basis of the outcomes of both scenarios in a participation process adaptation measures have been developed with relevant institutional stakeholders of the region. These measures include both – the supply and demand side. While supply side adaptation options involve, inter alia, increases in storage capacity, rain water harvesting or making other water resources available, demand side options focus on increasing efficiency and sufficiency of water use.
When Science Meets Policy - Connecting Differing Paradigms, Cultures and Mindsets

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Rigorous science has a key role to play in informing evidence based policy and vice versa. Yet often, scientific endeavour and the processes and outcomes of policy making are not aligned. Varying time horizons, incompatible objectives, organisational structures, inconsistent paradigms and language and differing educational and career backgrounds of scientists and policy makers can all play a part in apparent disconnects. These tensions are likely to be exacerbated in an environment of increasing complexity and uncertainty. Tools such as strategic planning and knowledge management practices can contribute to addressing these differences.

Drawing on a variety of theoretical frameworks, including organisational structures and behaviours, relationship linkages, strategic planning frameworks and decision making under uncertainty, the first section of this paper identifies leading edge thinking in the science-policy space.

The second section draws on case studies and interviews within the Victorian Government Department of Primary Industries, highlighting successful examples of science and policy interfaces. Examples of completed projects and work in progress will be analysed.

The third section identifies key lessons from the theoretical and empirical assessments as a basis for enhancing the science-policy interface.
Participatory Mapping of Coastal Adaptation Pathways in Mandurah, WA

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Our paper reports on a Google Earth participatory mapping workshop conducted at Mandurah, WA. The aim of the workshop was to develop shared understandings about the impacts of climate change on Mandurah's coasts and waterways, and to develop coastal adaptation pathways. The workshop also contributed to the aims of the governance theme of the Cluster which include exploring the use of a participatory, spatially explicit platform in the uptake of climate science on the coast. The workshop was a joint exercise between the City of Mandurah and the Coastal Collaboration Cluster. Participants included Mandurah community members, City of Mandurah officers and Mayor, and stakeholders from NGOs and State government departments. The workshop was framed by presentations from the Mayor, Climate Change Officer and Waterways Manager from City of Mandurah. Deliberating in small groups, participants created four Google Earth layers with Placemarks which reflected respectively the cultural, social, economic and ecological values of coastal places of importance to the participants. The places where all these layers interacted or coincided were identified as sustainability hotspots. Participants next heard a series of specialist talks from a state planner, senior state coastal engineer and consultant, and were invited to ask questions to a larger panel. Next, layers containing information such as a technical coastal vulnerability study were turned on in Google Earth for participants to view and deliberate on. Participants went on to identify and map their concerns about climate impacts on their coastal hotspots. Finally, participants discussed and mapped suggested strategic and adaptive pathways for these hotspots. This paper presents an analysis of the final Google Earth Map and critical reflections on the overall process.
**EReefs - Improved Decision Support for the Great Barrier Reef**

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One of the seven Natural Wonders of the World, the Great Barrier Reef is a significant part of Australia’s natural heritage and economy. A number of threats including climate change, water quality, shipping, fishing and uncoordinated coastal development have the potential to detract from the Reef’s natural, cultural and economic value.

Preventing a loss of value requires improved decision support, and communication tools for all who interact with, manage and depend on the Reef.

EReefs, which commenced in January 2012, is a collaborative project that will contribute to the protection and preservation of the iconic Great Barrier Reef.

Through the use of the latest technologies to collect data, new and integrated modelling and powerful visualisation, communication and reporting tools, eReefs will benefit government agencies, reef managers, policy makers, researchers, industry and local communities.

A partnership involving private investors, the Great Barrier Reef Foundation and the Australian and Queensland governments has been formed to deliver this significant project.

A pilot project concluded in 2010 has proven the capability and scientific approach is valid for Fitzroy River catchment and adjacent marine areas. Significant investment is now being made to apply this approach to the entire GBR region.

Over the next five years, eReefs will deliver:

1. Expanded and improved monitoring data through the application of the latest in measurement technologies;
2. Integrated spatial and temporal data from a wide variety of sources.
3. A suite of new and integrated models across the paddock, catchment, estuary reef lagoon and ocean;
4. An interactive, internet-based reporting and visualisation suite for the reef and its catchments, accessible to all; and
5. Citizen science initiatives to engage the broader community in reporting on the health of the reef.
Climate Change and the Draft Murray Darling Basin Plan

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The most recent climate science is providing a clearer picture of the potential climate change impacts for the Murray-Darling Basin. It is also making it possible to determine if we are already seeing these impacts. For the southern connected system, in particular, the potential climate change impacts do not make for pleasant reading. These include reductions in rainfall and increases in potential evaporation in the southern Murray Darling Basin, leading to increased drought frequency and reduced streamflow. Recent analysis of palaeoclimate data for southeast Australia shows that the 1998–2008 River Murray streamflow deficit experienced during the Big Dry has a return period of 1 in 1500 years, probably indicating some influence of climate change in the region.

Given this improving picture of potential impacts, it is critical that it is used in any policy tools that will have an influence on the management of the Basin between now and 2030. The recently released draft Basin Plan is the first iteration of a document which will govern the use of the Basin’s water resources indefinitely. The Plan must address the potential impacts of climate change based on the best available science. An assessment of the capacity of the draft Plan to deal with the forecast impacts of climate change in the MDB raises some concerning issues. Of particular interest are the water quality implications and long term health of the environmental assets of the Basin, particularly the river mouth and estuary given the view that rivers die from the mouth up.
Fisheries Management and Adaptation – the Need for a Double Adapter...?

A. Sullivan

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This paper considers whether current fisheries management frameworks are prepared for and/or capable of adapting to climate change and considers some of the key barriers to successful adaptation.

Fisheries management is constantly adapting to a range of pressures both fishery related and external. Do we need a double adapter?

Obvious adaptation strategies include the capitalisation of species range extensions, and shifting away from a reliance on species predicted to suffer under predicted climate scenarios. At first glance this appears reasonable and straightforward, yet the issue is far more complex from a regulatory and management perspective. Consider some of the key barriers:

- Jurisdictional boundaries: climate change impacts will be felt at large, multi-jurisdictional regions including multiple state and Commonwealth agencies and stakeholders. Aligning the priorities and resources of all relevant jurisdictions will be a significant challenge.
- Existing access/property rights: fisheries access and property rights have evolved considerably in recent years and will be vigorously protected if management actions look to dilute them in any way. If transferring access rights is identified as the most appropriate adaptation strategy, then it may come at a significant cost.
- Existing regulations: fisheries regulations are extremely prescriptive and restrictive. In addition, access to the majority of resources/species has already been prescribed. This limits options for flexibility and adaptive strategies.
- Stakeholder values/resistance: Australia’s commercial fishing industry has transitioned through significant periods of ‘adaptation’ in response to stock, social and economic pressures. Adaptation or change ‘fatigue’ may present a barrier to adaptation, regardless of whether the need to adapt is driven by climate change.

Fisheries management does need to adapt and this adaptation should be intentional rather than reactive, however this will be a continual process and is unlikely to result in wholesale, overnight changes to current fisheries management frameworks.
**AdaptWater: A Climate Change Adaptation Tool for the Australian Urban Water Sector**

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Climate change poses significant risks to Australian water utility operations and infrastructure. As regulated authorities, Australian urban water utilities must select climate change adaptation responses that are effective, defensible and representative of sound investment. Furthermore, adaptation planning must (a) Minimise climate change risks to corporate objectives at least-cost (financial and nonfinancial). (b) Provide demonstrable evidence that the selected adaptation option or series of options provides an optimal solution and (c) Have a sound and transparent methodology, using plausible projections for climatic and non-climatic changes from reputable sources.

These requirements highlight the need for quantitative analysis. This need is being addressed by a the development of a climate change adaptation tool for the Australian urban water industry, the AdaptWater project led by the Water Services Association of Australia with co-funding from the Federal Government.

The paper will present results from the pilot tool which is being trialed in Sydney, Melbourne and Adelaide and will show how GIS data is integrated into a probabilistic computational platform which accesses databases covering many thousands of assets.

The paper shows how cost benefit analysis tools such as AdaptWater can be used to resolve the complex nature of climate change related decision-making (including temporal, spatial, technical, financial, social and probabilistic information management). It also considers how such systems must provide a flexible risk management investment/adaptation approach acceptable to stakeholders (financial controllers, economic regulators and environmental authorities) to allow effective climate change adaptation.

By establishing the AdaptWater on a foundation of risk analysis, it will be possible to apply different sets of adaptation actions to the system to explore how they reduce climate change risks. If this is done repeatedly, it allows different adaptation plans to be compiled and compared. This in turn allows an optimum adaptation solution to be discovered.
Conservation Planning for Vulnerable Species

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The geographic ranges of plant species may shrink and/or shift under climate change thereby affecting their resilience and vulnerability. This in turn will have consequences for conservation priorities within the landscape, particularly where conservation of the most vulnerable species is a priority. In order to assess the potential tradeoffs in conservation decisions we quantified the vulnerability to climate change of plant species based on exposure, sensitivity and adaptive capacity. We then assessed the effects of including these components in complementarity-based spatial conservation prioritisation. In an 11.9 million hectare fragmented agricultural region in southern Australia, we modelled the vulnerability of 584 native plant species under three climate change scenarios. We calculated species’ geographic range under the different climate scenarios to represent their exposure and identified their sensitivity by as a function of the relative geographic change from the current climate. As a surrogate for adaptive capacity we used a dispersal kernel to identify species ability to migrate to new geographic ranges. We then combined this information using the conservation planning software Zonation to identify spatial priorities and examine levels of species representation within the landscape under each climate change scenario. The findings demonstrate that this approach provides an effective methodology for identifying spatial conservation priorities to reduce species vulnerability under climate change with higher representation of sensitive species. Nonetheless, we also conclude that this increased representation of sensitive species comes at the cost of reduced representation of other species.
TREND – An Example of Science - Policy Translation from the South Australian Government

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South Australian TRansect for EnVironmental monitoring and Decision making (TREND) is a component of the national Terrestrial Ecosystem Research Network (TERN) initiative. TREND is establishing baseline monitoring transects in South Australia to assess the likely impacts of climate change on the state’s terrestrial (natural and production) and marine ecosystems. TREND aims to adapt to changing needs, continuously collecting new data that will assist policy makers and managers of natural resources and agricultural systems to incorporate the actual and predicted impacts of environmental change into their planning.

However, according to Jones et al (1999), scientific results are often ignored by decision makers because they are not timely, clearly connected to policies, or generated with specific policy-related priorities in mind. They believe the following four conditions are necessary for the integration of scientific information with policy-making processes:

1. Research results must be relevant to currently pending decisions.
2. Research results must be compatible with existing policy-making processes and models.
3. Research results must be accessible to the appropriate policy makers.
4. Policy makers must be receptive to the research results.

The policy translation theme of TREND is addressing these issues by:

- Ensuring that the research undertaken in TREND is policy relevant and supports evidence based decision making by government
- Identifying the broad policy questions that government needs answered
- Ensuring that the data collected and methods used are producing information that is useful to answering these policy questions
- Translating the scientific information into a format suitable for policy makers
- Helping government convert this information into practical action
- Encouraging policy makers to respond to the scientific information being delivered to them

This presentation will discuss how we are integrating the scientific information obtained from TREND with the policy making process in the South Australian Government.
**Water Sensitive Urban Design As Key Adaptation to Climate Change**

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Links between population size, urban density, removal of storm water and the urban heat island (UHI) have been long established in the scientific literature. Typical maximum UHIs for large cities are of the same order of magnitude as projected warming in many regions during the 21st century, so a realistic concern is that urban consolidation with no consideration of the climatic effects of such a process will be problematic, particularly in the face of climate change. This is the so-called urban climate - climate change nexus. The message from this is that a holistic approach needs to be taken to matters involving urban design. In the case of urban consolidation a range of approaches known to reduce urban temperatures (green infrastructure, maintenance of water in the urban environment, smart building materials, etc) must be applied at the same time as the consolidation process. It must also be recognized that not all heat island mitigation approaches are appropriate in all urban environments. Under the auspices of the Centre for Water Sensitive Cities at Monash University [http://www.watersensitivecities.org.au/](http://www.watersensitivecities.org.au/) multi-disciplinary research efforts are currently being devoted to, amongst other things, identifying what heat reduction strategies, particularly those associated with water in the environment, are best applied in a range of Australian climates. Actively pursuing heat reduction strategies in urban environments, where most of the global population live, and where temperatures are already elevated, might provide some ‘head room’ for management the increased temperatures associated with future climate change.
Road Pavement Design and Assessment Under Climate Change

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Conventional models and methods for the design of road pavements and the assessment of pavement deterioration have ignored climate and environmental factors. The focus has been on the levels and quantities of heavy vehicle traffic. Under a changing climate this approach will fail. Given that the road network is by far the largest infrastructure asset managed by state and local governments and provides society’s fundamental system for economic and social activity, a properly functioning road network managed in an economically and environmentally responsible way is essential. Thus highway engineers have been seeking methods for the adaptation of their design and analysis tools to include climatic and environmental variables.

Recent research by the Australian Road Research Board (ARRB) has indicated how to include climatic factors in the models of road pavement performance. The Thornthwaite Moisture Index, which accounts for temporal variations in rainfall and temperature, has been recommended as a useful variable to represent the impact of climate on at- or below-ground infrastructure facilities, such as roads. In the research reported in this paper, the ARRB models have been extended to include traffic, maintenance and climatic factors as input variables and then applied to alternative climate scenarios for regional road networks in South Australia. The resulting model system, primarily for the spray-sealed road pavements that dominate Australia’s rural regional road networks, enables planners and engineers to assess the likely effects of climate change on road design and maintenance requirements, consider the interactions between traffic load and environmental factors, and plan road maintenance and rehabilitation strategies in line with available budgets and climate scenarios. The model system and associated databases thus provide useful tools for road network asset management and road planning adapted to climate change.
The Basis for Successful Transformation of Farming Industries as an Adaption to Future Climates

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Climate change is driving some primary industries to consider large scale, long-term changes to their production systems, i.e. transformational adaptation. One potential transformation strategy is to move from areas of decreasingly favourable climates, to regions becoming more suitable for crop production. These strategies may underpin future food production and food security, but they are yet to become the focus of adaptation research. An example of such transformation is efforts by the Australian peanut industry to establish a ‘greenfield’ production base in Katherine, Northern Territory, to protect against climate-driven poor production in traditional areas. This case study aims to better understand the transformation process and identify attributes needed for success from a multi-disciplinary perspective.

Biophysically, results suggest that there is potential for substantial nitrogen leaching from peanut production systems to groundwaters, which sustain dry season flows and valuable ecosystems in the region’s rivers, unless nitrogen fertiliser inputs are carefully managed. Also, future climates in the Katherine region may be less favourable to agricultural production than they are now and the most productive crop rotations may not meet industry objectives for out-of-traditional season peanut supply. Conversely, biosecurity risks of establishing a peanut production industry in the Northern Territory are small, and pest and disease pressures could be reduced through maintaining native vegetation cover of >20%, an achievable target given in the region.

Social data suggests that current Queensland peanut farmers may experience difficulties with transformation because of their high level of dependency on planning and their attachment to place and occupation. Also, government policy support is vital for establishing new agricultural industries. We have captured these attributes of the transformation process in a ‘blueprint’, that would be useful in bringing all stakeholders (farmers, industry, and all levels of government) together to identify the requirements to build a successful transformation pathway.
Assessment of the Health Impacts of the 2011 Summer Floods in Brisbane

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Background: During December 2010 and January 2011, torrential rainfall in Queensland resulted in the worst flooding in over 50 years. We carried out a community-based survey to assess the health impacts of this flooding in the city of Brisbane.

Methods: A community-based survey was conducted in 12 flood-affected electorates using postal questionnaires. A random sample of residents in these areas was drawn from electoral rolls. Questions examined sociodemographic information, the direct impact of flooding on the household, and perceived flood-related health impacts. Outcome variables included perceived flood-related effects on overall and respiratory health, along with mental health outcomes measured by psychosocial distress, reduced sleep quality and probable post-traumatic stress disorder (PTSD). Multivariable logistic regression was used to examine the association between flooding and health outcome variables, adjusted for current health status and socioeconomic factors.

Results: 3000 residents were invited to participate in this survey, with 960 responses (32%). People whose households were directly impacted by flooding had a decrease in perceived overall health (OR 5.3, 95% CI: 2.8–10.2), along with increases in psychological distress (OR 1.9, 1.1–3.5), decreased sleep quality (OR 2.3, 1.2–4.4), and probable PTSD (OR 2.3, 1.2–4.5). Residents were also more likely to increase usage of both tobacco (OR 6.3, 2.4–16.8) and alcohol (OR 7.0, 2.2–22.3) after flooding.

Conclusions: There were significant impacts of flood events on residents’ health, in particular psychosocial health. Improved support strategies may need to be integrated into existing disaster management programs to reduce flood-related health impacts.
Envisioning Alternative Adaptation Futures for Coastal Settlements and Communities

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Current climate change vulnerability and adaptation studies tend to examine future climate change induced disturbance and impacts on present day landscapes, ecosystems, settlements and land uses. These approaches can compound the uncertainty associated with climate change. Future landscape patterns are likely to vary from current landscapes, especially as human settlement continues to expand. Examining past land use change can help understand the historic and current drivers of land use change. This project, funded by the Climate Change Adaptation Research Grants Program, assesses past and current land use trends to model possible future settlement patterns in the northern rivers region of NSW. By quantifying the spatial patterns of likely future settlements, we can begin to identify areas that are most likely to be affected by climate change impacts (increased flood events, sea level rise, storm surges, and higher maximum temperatures). Spatially modelling scenarios of alternative landscape development is then used to assess adaptation strategies for designing more climate change resilient landscapes.
**Changes to Climate, Changes to Culture: Native Title Holder Experiences in the Kimberley and Cape York**

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¹AIATSIS

Native title lands now comprise nearly 17 per cent of Australia, and native title holders hold formal land management, community development and governance responsibilities including climate change adaptation. Indigenous and non-Indigenous people necessarily meet and negotiate the building of infrastructure, town planning, and other adaptation work. Indigenous people bring to this work their unique knowledge and relationships with the country, which are also the basis of their native title. The combination of this knowledge, the land holdings and their responsibilities under legislation, places Indigenous people in a strong position to contribute to climate change adaptation. However, Indigenous people and their knowledge are currently marginalised in the governance, institutional and decision-making structures and practices designed to facilitate climate change adaptation. Often, Indigenous peoples’ legal rights are ‘last in line’, excluding the priorities and aspirations of native title holders in the design and funding of adaptive measures. The retrospective recognition of native title has required other legal regimes, planning process and organisations to adapt to the emergence of a new governance institution. Given the context based and community driven nature of successful adaptation, the legal and social marginalisation of native title, combined with its core governance role, creates the potential for serious maladaptation. Our research investigates how institutional arrangements can better facilitate Indigenous participation and decision-making through collaborative case study work undertaken from February-May 2012 in Bidyadanga in the West Kimberley and Kowanyama in Western Cape York. For the Karajarri, Kokomnjen, Kokoberra and Kunjen traditional owners of Bidyadanga and Kowanyama, their native title rights and interests reflect relationships to the country asserted through song, ceremony and knowledge of the land. Priority setting, decision making and institutional design needs to better understand these values if climate change adaptation is to occur in collaboration with the governance, legal, and land holding authority of native title holders.
**Optimal Time for Catastrophic Losses Mitigation Investment Under Climate Change**

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It is of significant concern that climate change will exacerbate the frequency and severity of extreme events such as floods, storms, droughts and bushfires. As the value of properties under risk increases due to economic and population growth and the probability of catastrophic events increases under climate change, there is a need for local governments to evaluate adaptation measures that reduce potential losses from these catastrophes. Previous studies have mostly examined only static adaptation strategies, i.e. adapt now or never adapt. For studies that examine optimal adaptation timing, numerical dynamic programming computation is required, making it costly to evaluate adaptation strategies and difficult to get insights into factors that affect the value of adaptation projects. In this paper, a framework that links the Loss Distribution Approach often used in insurance modelling with real option theory is provided. The closed functional form for the option to invest enables easy computation of the optimal investment rule. Empirical results for a bushfire management project show that ignoring the flexibility of the adaptation decision as in previous studies may result in significant losses or nonoptimal timing of investments.
Underestimating the Fingerprint of Climate Change: Consequences for Adaptation

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Species are largely predicted to shift poleward as global temperatures increase, with this ‘fingerprint’ of climate change already observed across a range of taxonomic groups and geographic locations. However, the assumption of uni-directional distribution shifts does not account for complex interactions among temperature, precipitation and species-specific tolerances. We quantified 60 years of past climate change on the Australian continent, assessing the velocity of changes in temperature and precipitation, as well as the species-specific changes in the geographic space representing the individual climatic niche for 464 Australian birds. We show that Australian birds have experienced large magnitude, high velocity and multi-directional, including equatorial, shifts in suitable climatic space over the past 60 years in response to temperature and precipitation changes. Species-specific velocities for these shifts ranged from 0.1 to 7.6 km yr\textsuperscript{-1} (mean of 1.27 km yr\textsuperscript{-1}) and were on average higher than either temperature (mean 0.77 km yr\textsuperscript{-1}) or precipitation velocity (mean 0.67 km yr\textsuperscript{-1}) alone. Our analysis suggests that the fingerprint of climate change is grossly underestimated when considering only poleward shifts; for Australian birds, actual velocities were underestimated by an average of 53\% (mean of 0.59 km yr\textsuperscript{-1}). We suggest that shifts in climatic niche, measured as a function of temperature and precipitation, for any given species are likely to occur at much faster velocities than currently predicted for the future. Understanding the rate and magnitude of past changes in suitable climatic space provides a vital backdrop for assessing the capacity of species to keep pace with future climate change.
**Assessing Climate Change Adaptation Interventions: Health Impacts of Extreme Temperatures and Air Pollution in Cities**

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There is increasing scientific evidence of the adverse effects of climate change on health. These include increased mortality, morbidity and injuries attributable to extreme weather events such as heatwaves and floods, air pollution, food and water safety, and vector-borne diseases. So far, emphasis has been placed in assessing health impacts at the population level and predicting future vulnerabilities under different greenhouse gas (GHG) emission scenarios. Although environmental and public health interventions for adapting to climate change are often proposed, limited systematic effort has been put in assessing their effectiveness. In high-income countries, adaptation options may include air pollution alerts, heat-health warning systems, improved urban planning and building design. In low-income countries, interventions tend to focus on increasing the general capacity of health systems to deal with underlying vulnerabilities related to poverty, malnutrition, inadequate housing and sanitation. In both contexts, climate change adaptation competes (often unsuccessfully) for resources with other pressing public health needs, e.g. controlling infectious diseases, chronic illnesses, smoking, alcohol and drug addictions. Therefore, evaluating the effectiveness of climate change adaptation interventions is essential for prioritising resources.

In this paper we review adaptation interventions focusing on temperature extremes and air pollution in cities. Certain interventions, such as increased availability of air conditioning in residential buildings, reduce the human health burden of hot weather, but they increase environmental burdens due to higher energy consumption (and associated GHG emissions) and exacerbate health inequalities due to their limited affordability. Therefore, a combination of assessment techniques, including health impact assessment, environmental impact assessment, sustainability assessment, vulnerability assessment, cost-effectiveness analysis, and multi-criteria decision analysis, may need to be used to evaluate the effectiveness of different options. Using examples drawn from three types of adaptation interventions at building (improved insulation), city (urban greening), and population scale (warning systems), we explore the applicability of the above assessment techniques.
Making Sense of Nonsense: Contradiction and Malleability of Views About Climate Change and Climate Change Actions.

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Beliefs about the causes of climate change predict levels of mitigation and adaptation behaviour, and predict support for climate change policies. However, the causal links between people’s acceptance of the science and their acceptance of adaptation behaviours and policies is far from straightforward. We report here results from two large national surveys, conducted in 2010 and 2011, which investigate people’s responses to climate change. We find widespread inconsistencies and contradictions in people’s responses about what causes climate change, and their perceptions of who is responsible for doing something about it. Nowhere are these inconsistencies more evident than in people’s acceptance of the government’s proposed price on carbon. A split-sample design revealed much greater support for a carbon price when framed in general terms, than when associations with politics and governance were primed. This suggests that support for, or opposition to, proposed adaptation measures depends on how those measures are framed. Laboratory experiments tested these framing effects in more detail. Results suggest that making salient the impact substantive climate change actions will have on an individual’s daily life, for instance, increases opposition to government action on climate change. Our research suggests that people are motivated to change their attitudes to climate change if they conflict with underlying values of importance. Accordingly, the framing and communication of adaptation policies should be flexible enough to appeal to the broad range of values upon which people base their decisions and behaviours.
Adaptation or Transformation: Adjusting to the Consequences of 40 Years of Hydrological Change in the Jarrah Forest

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In forest ecosystems world-wide, hydroecological processes are being altered at unprecedented rates by the interactive effects of climate change and management history, with potentially far-reaching consequences for forest biodiversity. The jarrah (Eucalyptus marginata) forest is a model system for investigating influence of forest management history and anthropogenic climate change. The area has been experiencing climate change for decades, with further warming and drying predicted. In these forests, a legacy of sustained timber production and mining has resulted in large areas of regrowth. Both the higher evapotranspiration demand of the regrowth and climate change have contributed to a new hydrological regime, with pronounced declines in groundwater levels and reductions in stream-flow. Enabling forest management and policy to plan for a range of potential futures is the goal of current research. We outline a hydrological modelling study of options for management of bauxite-mine rehabilitation to address the needs of riparian ecosystems in the light of rapidly declining water tables in the western high rainfall zone of this forest. We used the WEC-C model in a scenario modelling of the 31 Mile Brook catchment. We found that rehabilitation at low densities (particularly with understory alone) is required if a useful hydrological response is to be attained through the treatment of mine revegetation. Simulations showed a tripling of streamflows in the last decade of simulation and a doubling of flow-days where rehabilitation was of understory alone. However, results were similar (for the groundwater system) where half the revegetation area was targeted with an emphasis on hydrology (understory only), and half for timber production. These responses were achieved with 53% of the mine area (16% of the catchment) devoted to treatments emphasising hydrology. We commend our approach to providing treatment options grouped according to those for further consideration, and those unlikely to provide a response.
Improving Climate Intelligence – a Framework for Better Informing Adaptation Decisions in a Variable Climate

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The Bureau of Meteorology provides weather and climate information for the safety, security and economic well being of all Australians. While recent floods and long term droughts have highlighted the vulnerability of Australia to climate extremes, recent work also suggests around $A58b of annual GDP is exposed to climate variability. Intelligence about climate variability and trends is central to Australia’s ability to adapt to climate change, and this intelligence is being supplied and enhanced through the Bureau’s scientific research and information services.

Two key areas with direct relevance to adaptation are those of climate monitoring and prediction. The Bureau is currently exploring how climate intelligence can be enhanced to support future adaptation challenges. One idea is the establishment of a ‘red flag’ climate information service that provides greater forewarning of unusual and higher risk climatic trends. At shorter timescales, improving seasonal forecasting information has enormous potential to forewarn of extreme climate events on the horizon and assist adaptation efforts, while also providing sectors, such as agriculture, an opportunity to capitalise on good seasons and mitigate for the bad.

Future services may include online access to climate change projections data and information, enabling users to determine impacts, develop adaptation strategies and lower the costs of research, while climate change attributions’ of recent significant events would provide greater clarity on real climate change signals. The effective communication of climate intelligence remains a challenge and a greater investment in climate literacy could provide dividends for Australia’s adaptation success. This presentation will outline the efforts by the Bureau of Meteorology and its partners to improve climate intelligence, show areas of potential for future services, and highlight the benefits to Australia of progressing climate services.
Building Adaptation Capabilities: Learning by Doing and Sharing

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International and Australian studies on climate change adaptation have identified many challenges including how best to support policy, planning and decision-making. However increasingly well-developed theoretical frameworks have not been matched by extensive and synthesised evidence of what is working best in practice. To address this gap, this presentation draws on the experience of 20 regional adaptation initiatives across a range of sectors, scales and locations in Australia. It summarises the practical issues and some emerging good practices identified by representatives of those projects. A significant conclusion is that whilst the emphasis and detail may be context-specific, most of the issues identified were common across the range of different projects represented. The insights have been mapped to a risk management framework, within which the lessons for specific phases and steps of a typical adaptation process are described. This approach will assist those seeking to relate the issues and practices to the various stages of their own initiatives, whether a single adaptation project or a broader, ongoing and iterative adaptation process. It will also facilitate the ongoing integration of learnings from additional research and experience as they become available.

The experience of these regional adaptation initiatives also identified several potential national initiatives that would support adaptation capability development within Australia and shared learning internationally. The presentation notes two projects that are currently progressing some of these. The first is a project developing a strategy to identify how web-based tools might best support Australian adaptation capability development, including assessing how such tools can be grounded in leading adaptation practices. The second is an enhanced process of drawing on local, regional and national adaptation experience to inform adaptation policy development.

Together with other initiatives these approaches provide an opportunity to significantly enhance Australia’s adaptation capabilities.
Earlier Wine Grape Ripening Driven by Warming, Drying, and Changes in Management.

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Winegrapes are ripening earlier in Australia in recent years, often with undesirable impacts. Here we test the assumption that this trend is due to recent warming.

By conducting a detailed attribution analysis of detected trends in winegrape maturity, using time-series of up to 64 years in duration, we discover a portion of the trend is ascribed to warming, but trends in soil water content as well as in yield, and introduction of new management practices, also contribute to the earlier ripening trend.

Potential adaptation options are identified as some drivers of the trend to earlier maturity can be manipulated through directed management initiatives.

Here we demonstrate that detailed, quantified attribution helps to effectively target adaptation strategies, and also may counter some recent tendencies to over-attribute detected phenological shifts to climatic changes.
A Local Response to Adapting Cities for Climate Change: Western Creek Pilot Study

M. Webster-Mannison

Centre for Sustainable Design, University of Queensland

This paper explores how a new understanding of our natural environment may influence the future planning of cities for climate adaptation.

Historically, natural features have not only physically defined neighbourhoods, but have also provided settings for shared experiences that have united generations. The rapid growth of cities, development pressures and limited public funding have challenged the ability of local governments to protect natural areas and to provide sufficient ecologically healthy, accessible green space.

Furthermore, there has been little exploration of potential for the surviving natural areas to contribute to urban infrastructure in a way that establishes a sustainable framework for increased densities and more resilient communities.

This paper lays the groundwork for a new way of structuring cities as part of a climate change adaptation strategy with particular emphasis on the potential of the green infrastructure to moderate increasing energy and water supply pressures.

A pilot study demonstrates how this can happen through the retrofit of the inner city Brisbane neighbourhoods situated in the historical catchment of Western Creek.

The pilot study shows how a local response to climate change, based on trans-disciplinary understandings that are sensitive to climate, water, land use, energy, food security, ecological and social issues, leads to practical, and more sustainable, urban and regional forms.
Translocations and Mixing Gene Pools of Fragmented Populations to Cope with Climate Change

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Populations of native species are becoming increasingly fragmented due to human pressures, climate change and the onslaught of invasive predators and competing species. When populations of animals and plants become small, they lose genetic variation and their ability to evolve and adapt, increasing the threat of extinction. The imperative for conservation managers should now be conservation and restoration practices that maintain and increase genetic diversity within species and populations, thereby promoting adaptive processes. In situ translocations provide a novel method for threatened species management by increasing genetic diversity, reducing inbreeding and preparing populations for changing climatic conditions. They can also be considerably cost effective when compared to more traditional approaches for threatened species management. We illustrate how genetic translocations can be used for the conservation of threatened species using the endangered alpine mountain pygmy possum. The Mt Buller population of this species has been isolated from other mountain pygmy possums for over 20,000 years and has recently gone through a dramatic decline in population size and genetic diversity, placing this highly unique population at threat of imminent extinction. We undertook a wild translocation of male mountain pygmy possums, moving them from a genetically healthy population at Mt Hotham, to Mt Buller in spring 2010 and again in spring 2011. These translocations were undertaken to genetically rescue the Mt Buller population, the first genetic rescue undertaken in Australia. We show how these translocations have reduced inbreeding and inbreeding depression in the Mt Buller population and substantially elevated genetic variation. We discuss how this approach could be applied to other threatened species and populations to increase genetic diversity and adaptability of populations to help counter stressful conditions arising from climate change.
Climate Change Adaptation in Industry and Business

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The aim of this project is to develop a consolidated framework from which boards and executives can develop a robust approach to climate change adaptation governance, climate change risk assessment and financial disclosure. In particular the study will assess likely impacts on company finances and outline a matrix of disclosures required by investors to enable them to evaluate corporate exposure to climate change risk. Critically the project must develop this framework within existing governance principles and requirements. The outcomes include a summary statement that contains the main guiding principles and governance metrics for climate change adaptation as well as a set of case studies for companies to use to adapt the guiding principles in their own business structures. These case studies will be designed to be broad enough to cater for a wide range of Australian industries. The high-level framework will align climate change adaptation policies to best practice financial risk assessment and governance mechanisms as well as to external disclosures. These outcomes are expected to be a pragmatic and comprehensive framework for climate change adaptation measurement and reporting for Australian businesses. Importantly these outcomes will receive the rigour required for scholarly research coupled with guidance and endorsement from industry participants through close interaction with representatives from industry, regulators, educators and corporate governance bodies.
Providing Application-specific Climate Projections Datasets for Australia and the Pacific: CSIRO’s Climate Futures Framework

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¹CSIRO Marine and Atmospheric Research

Demand for detailed climate change projections for use in impact assessment and adaptation has grown dramatically in recent years. Many applications require projections for multiple climate variables that are used in combination. In such cases, it is essential that the data are related in a physically plausible way; in other words, they must be internally consistent. However, many end-users of projections find the complexity (or range of uncertainty) difficult to deal with. There are projections from up to 24 climate models, up to six emission scenarios, and around a dozen climate variables. Given limited resources, end-users often seek a narrower range of projections for their applications.

CSIRO Marine and Atmospheric Research has developed a novel approach to deal with this issue in a way that is tailored to the specific needs of applications. The Climate Futures Framework allows climate scientists in close consultation with end-users, to provide simplified projections while still managing uncertainty. This approach also facilitates the selection of a sub-set of climate models from which internally consistent data can be obtained for multiple variables. Supporting software for the approach has been developed and has been made available to trained users in the Pacific and a similar development is planned for Australia. The Framework also offers other benefits, including improved communication of projections to a wide audience, but this presentation will focus on its use in providing application-specific datasets and will illustrate this with examples from Australia and the Pacific.
Climate Change, Fire Regimes and Landscape Management in Australia: What Does Climate Change Mean for Risk Mitigation?

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Climate change will affect fire regimes in Australia through effects on fire weather and fuels. We discuss how climate change may affect weather-fuel interactions, and the opportunities and constraints for fire management. We used simulation- and statistical modelling to test the effects of climate change on fuel mass, fuel moisture, rate of spread and area burnt, in forests of southeastern Australia where: (1) fire regimes are likely to be sensitive to climate change; (2) there are significant natural and commercial assets; and (3) there is considerable debate concerning the extent to which prescribed burning reduces risk posed by unplanned fire. Modelling using climate change projections showed an increase in the frequency of warm-dry years to 2100. This in turn caused modest declines in fuel mass, substantial changes to seasonal patterns of fuel moisture, and a longer fire season. Climate change will present novel opportunities and constraints for the deployment of prescribed burning. In warm-dry years there will be fewer opportunities for prescribed burning in autumn and spring, but more in winter. Landscape-scale analysis of major fires close to Sydney and Melbourne from 2001-2009 showed that area burnt and fire severity could be mitigated by low fuel age/mass but that the effects were highly contingent on fire weather; implied effectiveness of prescribed burning declined with increasing severity of fire weather. We examined 'leverage' – the reduction in area burnt by unplanned fire per unit area of planned fire. In southeastern Australian forests, reducing area burnt by unplanned fire by 1 unit requires 3-4 units of prescribed fire. We conclude that risk reduction in these forests will be partial under achievable levels of prescribed burning; there will always be residual risk. Consequently, fire management under climate change requires a robust cost-benefit framework, to identify the various trade-offs that arise in fire management.
Climate Change, Fire Regimes and Ecosystems Resilience in Alpine Vegetation: Not So Much Doom and Gloom

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Global warming threatens alpine ecosystems worldwide. Australia’s alpine landscapes face the potential twin stressors of a warming, drying climate and altered fire regimes. Australia’s alpine landscapes are predominantly within protected areas, yet the biodiversity conservation implications of altered alpine climate and fire regimes are poorly known. We present research designed to test the interactive effects of warming and fire in alpine vegetation on Victoria’s Bogong High Plains. Following the global ITEX protocols, open-topped chambers were established in heathland sites in 2003. These raised mean annual temperature by 1-2°C compared with control sites. There was no singular clear effect of this warming on a suite of vegetation attributes. Changes in phenology were idiosyncratic, and often compensated by changes to fruiting phenology. Grass cover declined due to drought, but there was no decline in species diversity or change in species composition due to warming. The effects of warming and burning on phenology, diversity and composition were within the range of inter-annual variation measured over the period of the experiment and longer-term variation monitored over the past 30 years. Reciprocal transplant experiments showed that there is a variable genetic capacity within key species to adapt to warming. Monitoring of regeneration in heathland after the 2003 fires showed rapid convergence to the unburnt state and that fire severity had little impact on diversity and composition. We conclude that there is a high degree of resilience in alpine heathlands to a 1-2°C increase in MAT, landscape scale fires, and the interaction between warming and fire. Directions and rates of change that we have documented, in collaboration with land managers, are not within the domains of concern that may require management interventions. Management resources are thus better directed towards managing other potential deleterious effects of global change, such as invasion by exotic species.
Translocation Scenarios to Inform Biodiversity Management Strategies Under Climate Change

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Baseline monitoring of weather has demonstrated that climates are rapidly changing with the warming of the atmosphere, and that warming has accelerated in recent decades. Climate change projections indicate continuing, rapid change over the next few decades; even with optimistic mitigation scenarios. Geographically, climate patterns can be viewed as shifting southward and to higher elevations. Some environments will disappear entirely and some novel environments will appear, and so too, will the structure, function of composition of ecosystems will change. For species, these changes will play out in a number of ways. Species that can move easily could migrate to new areas by tracking their envelope of suitable conditions; but the rate of change may isolate many species in diminishing pockets of marginal habitat where competitive interactions intensify. Understanding and visualising how these conditions are likely to play out in different regions can inform the timing and urgency of adaptation decisions such as translocation. The application of community level modelling in both time and space can provide insights into these processes. We present two trial indices designed to inform such decisions which, in collaboration with policy makers and land managers responsible for implementation, can usefully guide biodiversity management strategies that address issues at landscape scales. One index considers the “benefit” of translocation or assisted migration and the other of restoration. In combination, these can inform translocation scenarios.


**Ecological–economic Optimization of Biodiversity Conservation Under Climate Change**

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Substantial investment in climate change research has led to dire predictions of the impacts and risks to biodiversity; the IPCC Fourth Assessment Report cites 28,586 studies demonstrating significant biological changes in terrestrial systems. Yet there is little advice or precedent in the literature to guide climate adaptation investment for conserving biodiversity under realistic social and economic constraints. Given that there is an impending extinction crisis, we need to move urgently from predictive science to decision science in order to support difficult choices between climate adaptation options under severe uncertainty. Here we present a systematic ecological and economic analysis of a climate adaptation problem in one of the world’s most species rich and threatened ecosystems; the South African Fynbos. Our approach integrates models of climatic and ecological change, population demographic models to predict plant abundance fluctuations in response to environmental stressors and management, and a decision theoretic approach to identifying optimal adaptation strategies.

We discover a counter-intuitive optimal investment strategy that switches twice between fire management and habitat protection options as the available adaptation budgets increases. We demonstrate that optimal investment is non-linearly dependent on available resources, making the choice of how much to invest as important as determining what to invest in and where. Our study emphasizes the importance of a sound analytical framework for adaptation investment that integrates information and tools from ecology, economics, social science and decision science. Our method for prioritizing investment can be applied at any scale to minimize the loss of species under climate change. We anticipate that the approach illustrated here will form the basis of future climate adaptation investments.
Managing the Risks of Inundation and Erosion for Coastal Property and Ecosystems

R. Wise

CSIRO Ecosystem Sciences

An important component of adapting to climate change involves building the capacity to analyse options. This is particularly important in situations where the timing and magnitude of the threats are uncertain, systems are complex, and where traditional evaluation approaches are largely inappropriate. We developed a 'proof of concept' model of a house-dune system to explore the ecological and economic implications of building a seawall or not and of rebuilding or abandoning homes as inundation and storm damage increase over time. The model was developed in consultation with planners, asset managers, and scientists and was designed to: account for the full range of costs and benefits to residents, governments, and natural assets; model long time horizons; consider the scheduling of decisions over time; explore the implications of multiple interacting and uncertain changes; consider scenarios with low probabilities but potentially large costs; be adaptable to the site-specific nature of system behaviour; and permit the model structure to be based on expert opinion about the key processes driving system change. The model is a dynamic stock-and-flow model that uses Bayesian belief networks to capture understanding of the uncertain behaviour of the system and evaluates the flows of uncertain benefits and costs within a Cost-Benefit-Analysis framework using Monte-Carlo simulations to estimate the probability distributions of the Net Present Values of options. An application of the model to a situation where houses may be threatened by 1 in 20- to 30-year storms indicates: a) there are substantial private incentives to invest in at-risk waterfront housing; b) investment in built protection is unlikely to be justified on economic efficiency grounds due to the relatively low probabilities of loss; and c) there is a clear conflict between private interest in at-risk housing and public interests in the amenity and existence values of dune systems.
Preparation for the Impacts of Sea Level Rise in South Western Australia

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\textsuperscript{1}Geosciences Australia

This paper describes two studies modelling the potential impacts of extreme events under climate change in two potentially vulnerable coastal communities: Mandurah and Busselton in Western Australia (WA). These studies, undertaken in collaboration with DCCEE and the WA Department of Planning, respectively, aim to support local adaptation planning by developing methods for high resolution modelling of the impacts from sea level rise scenarios.

Both studies modelled potential storm surge associated with a Tropical Cyclone. The conditions were based on those observed during TC Alby (1978), with the track shifted to create maximum impact of the wind field on the respective community studied. The storm surge associated with the cyclone was modelled using a hydrodynamic modelling approach, assuming sea level rise scenarios varying from 0.0 m (current climate) to a ‘worst case scenario’ of 1.1 m. In Mandurah, we also modelled potential shifts in the shoreline, caused by changes in the sediment transport under sea level rise. The resulting inundation from the modelled surge and erosion events was projected onto the coastline to give impact ‘footprints’ for each event. These footprints were overlaid with Geoscience Australia’s National Exposure Information System (NEXIS), which includes built assets, also roads, railways and bridge infrastructure. This yields a direct quantification of the potential impact of various future sea level rise scenarios on the community of Mandurah. In Busselton, we considered the impact of coincident flooding during the surge event.

Results highlight the most exposed areas in the communities given the scenarios and events considered, and they enabled quantification of the potential impacts. This paper demonstrates how integrating modelling approaches can capture complex processes that drive the impact of climate change. Studies such as this support planning and evidence-based decision making that will ultimately improve the resilience of coastal communities to the impacts from climate change.
Collaborative Governance: How a Geographically-remote Community Established an Exemplar, Bottom-up Adaptation Governance Model.

C. Woolford¹,², B. Foster¹, H. Horrocks²

¹EP Climate Change Sector Agreement Committee
²Brain Train
³EPICCA

Australia’s Eyre Peninsula (EP) - large, isolated, beautiful – has developed a governance model, propagated by governments as an exemplar, that delivers Australia’s first cross-sectoral, regional climate change adaptation mechanism.

The region - a 230,000 km² triangular land mass, including 254 islands, 1,800 kilometres of coastline, 55,000 people and 11 local government authorities - has no rivers. An ecotone, it supports a high degree of species endemism but is vulnerable to a hotter, dryer future with rising sea levels. Agriculture, aquaculture, tourism and mining industries, all reliant on sustainable natural resources, contribute $2 billion to the economy.


How did this happen in a remote region despite widespread climate change scepticism? Because climate shocks and complex decision-making were not new. In 1993, drought and record interest rates forced EP communities to build a regional strategy, driving innovations such as ‘no till’ farming. In 2005, nine people died in a bushfire. In 2006, drought struck again. The community re-built using bottom-up solutions. In 2009, the EP’s Natural Resource Management Plan led by addressing climate change and now EPICCA is developing the region as a renewable-energy province.

His governance structure is a community-led planning and decision-making mechanism delivering collaborative, coordinated, cross-sectoral adaptation responses to develop innovative, achievable, cohesive, sensitive and practical outcomes, while ensuring government policy reflects the resilience embodied in identified, proven, regional capacities.

This paper, by practitioners, reviews EPICCA’s strengths and achievements.
Connecting with Local Government
C. Young

1Victorian Centre for Climate Change Adaptation Research

Council Connections has been a collaborative peer to peer learning program for local government involving three Victorian Climate Change Alliances, MAV and VCCCCAR. The original concept was developed by Celeste Young who was working in local government at the time and was based upon an innovation learning model that she has previously used in her work in industry.

The program was developed because it was identified that practitioners in local government faced a number of challenges as adaptation knowledge and practice and is still evolving. It was identified that skills and understanding to perform this work needed to be developed to effectively implement adaptation at a local government level. It was also identified that a large number of learnings were coming from the the practitioners themselves and these were not being captured or shared. This program was developed to actively address those issues.

The overriding objective of the program is to develop a knowledge network that would become a community of practice that allows researchers, experts, local government practitioners and state government stakeholders to interact in a way that created greater understanding of the different adaptation agendas and how they could work together.

This program is now established and the model is being used more broadly by other organisations as a tool to effectively engage with stakeholders in the adaptation field.

This presentation would show what the program is, how and why it works as well as detailing outcomes to date of the program.
Learning from Failure (or Benefitting from Success) in the Management of the Gnangara Groundwater System

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The Gnangara Mound is a groundwater system located under the northern suburbs of Perth. This groundwater system supports a range of end users including domestic consumers, horticulture and ecological systems. Over recent years, declining rainfall, partly attributed to anthropogenic climate change, has seen a corresponding reduction in groundwater levels. Subsequent allocation of this declining resource has been somewhat unsuccessful despite an awareness of the problem and an intense interest in fixing it.

This research used the water resource issue in Gnangara as a case study to explore the question ‘Why do we so often fail to manage slow onset environmental problems?’ and hence start to consider how we can succeed in the future. Through stakeholder interviews, it looked at how different stakeholders defined success or failure. It then went on to explore the frames used for explaining the causes of success or failure, including the ability of social and political processes to negotiate competing values. It found that there is not one definition of ‘successful adaptation’ pointing to the need for collaborative processes that engage a range of stakeholders to debate the ‘boundary’ of adaptation planning, deliberate over goals and agree upon collective actions.

The conclusion was that the framework was useful for exploring failure (and success) in Gnangara and potentially for other complex wicked problems such as climate change.
**FORAGE – a Web-based System for Delivering Climate, Remote Sensing and Model Calculations for Individual Grazing Properties on a ‘Lot on Plan’ Basis.**

B. Zhang¹, J. Carter¹, A. Panjkov¹, K. Day¹

¹Queensland Climate Change Centre of Excellence

There is a strong demand from various interest groups for property-level decision support information in grazing lands to assist environment management, regulatory compliance, managing for climate variability and adaptation to climate change.

A web-based information generating and delivery system called FORAGE has been developed by the Queensland Climate Change Centre of Excellence (QCCCE) within the Department of Environment of Resource Management (DERM). FORAGE was designed to provide contextual information (both regionally and temporally) to assist in the Queensland State Rural Leasehold Land (Delbessie) assessment process. FORAGE is currently being enhanced to support other DERM programs, specifically the development and assessment of Environmental Risk Management Plans (ERMPs) for the Burdekin region. ERMPs are aimed at minimising the risk of sediment, herbicide and nutrient run-off affecting the health of the Great Barrier Reef, while keeping the land in optimum productive condition.

FORAGE integrates information from various departmental databases and information systems to generate a range of property scale reports including a rainfall and pasture seasonal outlook report, a climate change report, various ground cover reports, and a fire-scar report. FORAGE links to several departmental databases including the SILO climate database, a database containing remotely sensed images, a GIS database and a database containing field observations and photographs. The grazing system model (GRASP) runs within the system, simulating outputs of pasture growth, ground cover, soil erosion and many other components of the grazing system.

FORAGE provides a simple web interface which allows users to request specific information products (2-page PDF reports, data tables or GIS layers) for a specific Lot on Plan. The user simply specifies the location of the property (latitude and longitude or Lot on Plan), the type of information required and an email address for delivery of the information. This presentation will highlight the various FORAGE products and their uses.
**Psychological Preparedness for Disaster Threat**

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¹Griffith University

Natural disasters are common recurrences, rather than rare events, which, as some argue, may be related to climate change. In 2011 alone, Australia witnessed several devastating extreme weather events, including the Queensland, NSW, and Victoria floods, cyclone Yasi, and WA and NT bushfires.

Natural disasters are costly, not only in terms of property damage, but also in terms of human lives and psychological health. More than ever, it is important to prepare people, especially those living in disaster-prone areas, for the eventuality of a natural disaster impact. Preparing for natural disasters includes both physical and psychological preparedness. Psychological preparedness involves anticipating and preparing for one’s own emotional and behavioral responses, including a reviewing of anticipatory coping strategies.

In Northern Australia, with an annual wet-season and frequent cyclone activity, preparedness for cyclones and severe storms is paramount. While community preparedness programs and services exist, much work remains to be done to successfully achieve widespread disaster preparedness on a community, as well as on an individual level.

Integral to effective community disaster preparedness is the evaluation and improvement of existing preparedness programs, as well as the continuing development of new programs. This in turn requires an instrument to assess the effectiveness of psychological disaster preparedness programs, which to date does not exist. To address this short-coming, an 18-item measure called the Psychological Preparedness for Disaster Threat Scale (PPDTS) was developed and validated on a sample of 578 students and staff members of universities in Australia. The instruments’ test-retest reliability was examined with 82 participants and showed to be reliable over a short term (2 weeks) and also stable across the span of one year.

This presentation provides an overview of the construct “psychological preparedness” and reviews the results of the newly developed and validated measure of psychological preparedness, the PPDTS.
**Preferences for the Distribution of Responsibility for Adaptation to Sea Level Rise.**

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

J. Barnett¹

¹University of Melbourne

Uncertainty about how responsibility for adaptation to sea level rise will be distributed across government, the private sector, civil society and individuals is a potential barrier to adaptation from a legal, institutional and social perspective. This project aims to understand the preferences of coastal users and managers for the distribution of responsibility for adaptation by conducting surveys and interviews in two case study locations: the Westernport region of Victoria and the Eurobodalla Shire in New South Wales. The project will compare these preferences with current allocations of responsibility for coastal management as well as developments in adaptation planning at different levels of government. Findings will help inform the development of institutions capable of effectively managing adaptation to sea level rise.
Cognitive and affective barriers to climate change adaptation: Exploring the risk and adaptation appraisals of South Australians to different climate risks

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

P. Bi¹

¹University of Adelaide

A cleavage exists between how mainstream science appraises the degree and scope of risk attributable to anthropogenic climate change, and how this same risk is construed by the ‘non-science’ public. The interrelationship between risk perceptions, self-efficacy and associated adaptation behaviours, has received scant psychological attention in Australia. This study, employing qualitative focus groups and telephone interviews, examines how lay people perceive climate change risks in their local contexts, and how these risk characterisations interact with, and impel, intended adaptation responses. Findings will inform adaptation communication strategies, and extend our understanding of how psychological antecedents influence adaptation practices.
**Extreme heat and climate change: adaptation in culturally and linguistically diverse (CALD) communities**

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

P. Bi

University of Adelaide

A qualitative study is being conducted in Adelaide, Melbourne and Sydney to gain an understanding of how migrants and refugees cope and adapt during periods of extreme heat and the potential implications for climate change adaptation. Focus groups and interviews are being conducted with a range of stakeholders including service providers to a range of CALD communities. In this ongoing study, it appears that people from CALD backgrounds are particularly vulnerable during periods of extreme heat, with those most at risk being from two distinct groups – aging migrants in established communities, and refugees and asylum seekers in new and emerging communities.
**Heat Ready: Adapting Aged Care Facilities to cope with heatwave**

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

**D. Black**, L. Wilson, C. Veitch and A. Hansen

1 University of Sydney
2 University of Adelaide

Introduction: The 2000s have seen an increase in extreme weather events. How Aged Care Facilities (ACFs) prepare for the impact of heatwaves has never been systematically studied. Methods: NSW, Qld and SA Aged Care Facilities were invited to participate in a 15 minute telephone interview. Using a semi-structured validated questionnaire ACF staff outlined the current strategies they use to manage a heatwave. Results: This paper presents the preliminary results of the first 250 ACFs enrolled in the study. Conclusions: Preliminary results indicate that the effect of heatwaves on elderly ACF residents is a priority for health service providers, but many facilities have not addressed the long term adaptability of their service to extreme heat.
Developing Adaptively: Understanding the urban climate adaptation role of the private development sector
Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

E. Coiacetto¹, J. Dodson¹

¹Griffith University

Operating on a mix of institutional and spatial scales and capabilities, the private development sector undertakes the majority of urban development in Australia and is thus a key agent in the task of adapting cities to climate change. The primary focus of this presentation is to examine the structure and institutional capabilities of the urban development sector to adapt to climate change and to appraise its capacity to support climate adaptation planning responses. This includes an understanding of the way developer skill sets intersect with institutional scale and market segment as well as planning policy and regulatory frameworks.
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

Indigenous Communities (IC) ARGP Speedtalks

A. Fleming¹, L. Petheram

¹NT Government, Darwin Aquaculture Centre
²Australian National University

This project will develop an understanding of West Arnhem Indigenous women’s preferred adaptation options for improved food security under future climate change. A focus will be placed on the potential for open-ocean, intertidal aquaculture and simple aquaponics systems for fish and vegetable production. The project will deliver policy recommendations that will benefit Indigenous women across coastal Australia who may be able to adopt similar food provision approaches and thereby strengthen resilience to climate change. The project addresses the NARP’s Priority Research Questions ‘Climate change adaptation and Indigenous biodiversity management’, Topic 11 and ‘Identifying Indigenous vulnerability and adaptive capacity’, Topic 5.
Indigenous voices in climate change adaptation: Addressing the challenges of diverse knowledge systems in the Barmah-Millewa Indigenous Communities (IC) ARGP Speedtalks

D. Griggs\textsuperscript{1}, A. Lynch\textsuperscript{2}, L. Joachim\textsuperscript{3}, X. Zhu\textsuperscript{4}, C. Adler\textsuperscript{5}, J. Walker\textsuperscript{3}, P. Wang\textsuperscript{1} and T. Kestin\textsuperscript{1}

\textsuperscript{1}Monash Sustainability Institute, Monash University
\textsuperscript{2}Brown University
\textsuperscript{3}Yorta Yorta Nation Aboriginal Corporation
\textsuperscript{4}School of Geography and Environmental Science, Monash University
\textsuperscript{5}Institute for Environmental Decisions, Swiss Federal Institute of Technology (ETH Zurich)

This talk will provide a brief overview of this NCCARF ARGP-funded project, which examines how the Indigenous knowledge of the Yorta Yorta can be appropriately collected and integrated with more conventional forms of knowledge and science to improve natural resource management and climate change adaptation in the Barmah-Millewa area on the Murray River. We will describe progress to date and future plans for the project, including collection of Indigenous knowledge by the Yorta Yorta, the construction of a GIS management database that integrates this knowledge, and the analysis of perspectives and values of stakeholders in the region.
Living Change: Adaptive housing responses to climate change in the town camps of Alice Springs
Indigenous Communities (IC) ARGP Speedtalks

R. Horne 1

1 RMIT University

The project aims to understand the extent that change in response to climate is already underway in individual households and housing related institutions in the town camps of Alice Springs. Two significant gaps in knowledge are targeted: 1) identifying the mix of passive and active responses to climate control and healthy living practices that are present in town camp communities, and 2) identifying the motivations (cultural, social, economic, technical or institutional) behind the practices. Understanding these opens up possibilities for energy and water efficient practices to be encouraged that also link to adaptive capacity development amongst residents. The context is to inform an anticipatory, planned adaptation program for housing services.
**Impact of Climate Change on Disadvantaged Groups: Issues and Interventions**

G. Hugo¹, A. Sevoyan¹

¹University of Adelaide

To understand how the adverse effects of climate change affect disadvantaged population groups, this project incorporates social inclusion, one of the national priorities in Australia, into climate change research. Using the concept of social inclusion we have identified the localities within South Australia most vulnerable to climate change effects. Disadvantaged population groups in the selected LGAs, will be surveyed to collect data on the factors affecting social exclusion in adaptation to climate change. We are working closely with the key stakeholders to generate policy recommendations to enhance community resilience and counteract the disruptive effects of climate change in South Australia.
A national strategy for climate adaptation: rationale, scope and limitations

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

K. Hussey

Australian National University

Irrespective of any visible or invisible hand of direction, responses to climate change will take place; concerned change agents will act and adaptation will occur. But will it be enough, and at what cost will it occur? From a societal level, taking a concerted, shared and synergistic approach to adaptation throws out a particular policy challenge demanding the need to understand how laws and legal institutions support or impede adaptation planning and practice and what the roles and responsibilities might be within a federal system so as to enhance and achieve appropriate levels of adaptation. This very brief presentation will describe the rationale for a national strategy, the possible scope of such a strategy, and the inherent limitations.
Rental housing, climate change and adaptive capacity: an Asset-Based approach

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

L. Instone\textsuperscript{1}, K. Mee\textsuperscript{1}, J. Palmer\textsuperscript{1}, M. Williams\textsuperscript{1} and N. Vaughan\textsuperscript{1}

\textsuperscript{1}University of Newcastle

This research, based in 2 sites in Newcastle NSW, explores the adaptive capacity of tenants and housing managers/landlords in the rental sector. This paper discusses the utility of Asset-Based methodologies to investigating climate change adaption in the housing sector. Asset-Based approaches work with people in any situation to enhance the recognition of existing resources and use dialogue between key actors to expand the possibilities for change. The paper reports on the project design and methodology of the research.
Valuing adaptation under rapid change: anticipatory adjustments, maladaptation and transformation

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

R. Jones¹ and J. Handmer²

¹Victoria University
²RMIT University

The economics of adaptation are in their infancy and a stable set of methods has not yet been developed. Without clear advice on such methods policy-makers and planners are reluctant to invest in adaptive measures. However, damages from recent weather extremes to regional and the national economy imply that a lack of action can be potentially very costly. We summarise the progress the project has made in merging disaster and adaptation economics within the Australian context. Particular emphasis is being placed on the literature of decision-making under uncertainty and assessment of real options.
Social networks analysis: bridging degrees of separation to enhance climate change adaptation

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

S. Kinnear\(^1\), K. Patinson\(^1\)

\(^1\)Central Queensland University

Addressing knowledge gaps and finding ways to effectively communicate information will be critically important in adapting to climate change. Social networks analysis has been used to successfully manage complex natural resource management problems, but its application to the challenge of climate change adaptation remains in its infancy. This research will use social networks analysis to understand and address communication and knowledge barriers for climate adaptation in the context of responding to extreme flood events, as well as in planning for continuity of municipal water supply during periods of water resource constraints, in case study locations of Central Queensland (Rockhampton, Emerald) and South-East Queensland.
Enhancing the Adaptive Capacity of Small-to-Medium Enterprises (SMEs) to Climate Change and Variability in Australia

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

N. Kuruppu

1University 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. Moreover, SMEs play a significant role within socio-economic systems; providing employment, goods and services and tax revenue for communities. SMEs face greater short-term losses after natural disaster and may have lower adaptive capacity than larger enterprises for various reasons. This study examines the underlying factors and processes shaping the adaptive capacity of SMEs in Australia to climate change. Preliminary results of stakeholder interviews, online survey and workshop with SMEs in Australia will be presented.
**Future change in ancient worlds: Indigenous adaptation in northern Australia**

Indigenous Communities (IC) ARGP Speedtalks

S. Larkin\(^1\), **D. Bird**\(^2\), J. Canuto, D. Carson\(^3\), S. Harwood\(^4\), K. Haynes\(^2\), D. King\(^6\), H. Murphy, S. Russell\(^5\) and E. Wensing\(^6\)

\(^1\)Charles Darwin University  
\(^2\)Risk Frontiers, Macquarie University  
\(^3\)Flinders University  
\(^4\)James Cook University  
\(^5\)University of South Australia  
\(^6\)SGS Economics

There is little research on adaptive strategies employed by Indigenous communities in northern Australia in regards to slow onset environmental changes and extreme weather events. In particular, the capacities and reasons for mobility and use of relocation are unknown. This project will utilise ethnographic participatory research to provide a multifaceted understanding of why Indigenous people may be vulnerable or resilient and how they have coped with and adapted to past and ongoing environmental changes. Broader socioeconomic and political changes will also be investigated. The project case studies include: Maningrida and Ngukurr, Northern Territory; Broome, Western Australia; and Wujal Wujal, Queensland.
Understanding Coastal Urban and Peri-urban Indigenous People’s vulnerability and adaptive capacity to Climate Change

Indigenous Communities (IC) ARGP Speedtalks

D. Low Choy¹, D. Jones²

¹Griffith University
²Deakin University

This brief presentation will commence to address a number of emerging questions that are underpinned by the current NCCARF research project: Understanding Coastal Urban and Peri-urban Indigenous People’s vulnerability and adaptive capacity to Climate Change. In terms of climate change adaptation barriers, options and priorities, what are the major considerations for indigenous communities residing in coastal peri-urban and urban places that may differ from those of their non-indigenous counterparts and possibly from Indigenous communities living away from the coasts? It will speculate on whether these considerations can be addressed through existing planning and management frameworks.
Costs and coasts: an empirical assessment of physical and institutional climate adaptation pathways

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

R. McAlister¹, C. Fletcher¹, A. Rambaldi², and B. Taylor¹

¹CSIRO Australia
²University of Queensland

This project combines governance theory with empirical economics, focusing on coastal inundation events which are expected to become more frequent as weather changes and sea level rises. One of the challenges in making sensible adaptation happen is in being clear about who adaptation is sensible for, where and when. Different players in the governance system will experience climate change differently, so a key aim is to develop a framework that responds to the need to determine who accommodates the risks. In doing so, we will develop economic analysis for adaptation options in three coastal settlements.
Market Mechanisms for dealing with the Increasing Cost of Catastrophe Losses
Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

J. McAneney¹, R. Crompton¹

¹Macquarie University

As the cost of natural disasters increases through greater development in areas of high risk and the likely aggravation by global climate change, both voluntary and public insurance markets need to adapt to greater uncertainty. Most state-run residual insurance programmes in the US were established after unmanageable losses to private sector insurance following a natural disaster. Political interference has since meant that these programmes have often become insurers of first resort. This study examines how government and the private sector might work together to bring about a residential property insurance environment that encourages mitigation/adaptation and better landuse planning practices.
Aboriginal responses to climate change in arid zone Australia – Regional understandings and capacity building for adaptation

Indigenous Communities (IC) ARGP Speedtalks

P. Memmott¹, James Davidson¹

¹University of Queensland

This conference paper presents the preliminary findings from research carried out in Northwest Queensland as part of an NCCARF project. Our research takes an interior arid-zone region (the upper Georgina River basin) as a pilot study in which to investigate, document and generate planning principles concerning Aboriginal perceptions and knowledge of climate change. Moreover, this study investigates regional community capacity to respond and adapt to climate change, specifically preparedness for both changes in the mean climate, changes in the frequency and intensity of extreme weather events, changes to land and riverine management processes, settlement infrastructure adaptation and enterprise-building responses.
Towards climate change adaptation in Indigenous communities: The Arabunna

Indigenous Communities (IC) ARGP Speedtalks

M. Nursey-Bray

University of Adelaide

The Arabunna people from the Lake Eyre Basin live in a vast region that covers one fifth of Australia. This paper presents progress on a project called "Community Adaptation to climate change for the Arabunna. We detail the assessment of the risks and vulnerabilities the Arabunna face and also outline some of the challenges and lessons in undertaking a cross cultural and inter-disciplinary project. Outcomes from this project will have significance for the Arabunna, government and provide insights into how to 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

Indigenous Communities (IC) ARGP Speedtalks

M. Parsons¹

¹University of Melbourne

In this presentation I discuss our ongoing research project in the Kimberley and Great Sandy Desert regions, which examines how different Aboriginal communities conceptualise environmental changes through their own cosmologies, and the implications of varying risk perceptions (both climate and non-climate risks) on the development of suitable adaptation strategies. Our study serves to highlight the extent to which different social groups are likely to perceive and respond to climate-driven ecological changes and climate risks in differing ways depending on the extent to which their livelihoods, worldviews, and day to day activities are connected to their local environments.
Every state for themselves? Learning from cross-border regulatory instruments to support and promote climate change adaption in Australia

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

W. Steele¹

¹Griffith University

This project focuses on learning from, and enhancing the efficacy of, the development of institutional reform that supports and promotes cross-border regulatory mechanisms for climate change adaptation within Australia. The 3-staged project involves: [i] a desk-top review of four diverse cross-border regulatory initiatives within Australia [ii] a case-study focused on the identification of challenges/opportunities for cross-border regulatory reform around climate change adaptation in the Tweed (NSW)/Gold Coast (QLD) region; and [iii] the conceptual synthesis, integration and dissemination of key lessons learnt from diverse regulatory practices that work to both support and/or impede cross-border climate adaptation within the Australian context.
**What about me? Factors affecting individual adaptive coping capacity across different population groups**

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

K. Unsworth¹

¹University of Western Australia

Our project examines individual-level coping and adaptation to climate change and some of the psychological factors that influence such adaptation. In particular, our research framework suggests that an individual’s world-views, priming, emotions, organizational support, goals and goal conflict influence his/her uptake of an organizational adaptation initiative or willingness to invest time into adaptation initiatives or use of adaptive agricultural techniques, amongst other coping and adaptation measures. Our team of multi-disciplinary scholars from four universities will address this overall framework from different angles and in both laboratory and field contexts.
Native Title and Climate Change Adaptation
Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

J. Weir¹, T. Tran¹

¹AIATSIS

Native title holders have land management, community development and governance responsibilities for almost 17% of the Australian land mass. They are in a unique and strong position to contribute to climate change adaptation. However, their rights and knowledges are legally and socially marginalized in the governance, institutional and decision-making structures and practices designed to facilitate climate change adaptation. In this presentation I will give a brief overview of this situation, introduce the case study sites for the NCCARF project, and give preliminary results for our fieldwork conducted in February-May 2012.
Climate Change Beliefs and Irrigator Adaptability in the Southern Murray-Darling Basin

Social, Economic and Institutional Dimensions (SEID) ARGP Speedtalks

S. Wheeler\textsuperscript{1}, A. Zuo\textsuperscript{1}, H. Bjornlund\textsuperscript{1} and M. Shanahan\textsuperscript{1}

\textsuperscript{1}University of South Australia

Possible adjustment strategies irrigators can implement on their farm to cope with future water variability include expansive and contractive strategies, such as irrigators buying/selling land and water, increasing/decreasing the area under irrigation and adopting efficient infrastructure. We provide an overview and comparison of irrigators planned and actual strategies in the MDB over the past fifteen years. In addition, we explore in depth the influences associated with planned farm adjustment strategies of MDB irrigators. We find those who are convinced that climate change is occurring are more likely to be planning not to undertake expansive strategies in the future.
Farm-level Economics of Adaptation to Climate Change by Broadacre Farmers in Western Australia

Poster Number: 215

D. Addai¹, D. Pannell¹, R. Kingwell¹, M. Ewing², J. Finlayson¹

¹The University of Western Australia
²Future Farm Industry CRC

Scientists have pointed out that climate change is unavoidable, to some extent. It is acknowledged that agriculture may be among the more vulnerable sectors to the risks and impacts of climate change. Farmers, there, need flexible and resilient agricultural systems to cope with a range of possible changes to climate. This research employs an adapted version of MIDAS (Model of an Integrated Dryland Agricultural System) and uses it to. MIDAS is a whole-farm bio-economic optimization model which represents the biological, physical, technical and managerial relationships of a mixed farm in a specified region. The model maximizes farm profit subject to various environmental, managerial and resource constraints. The study examines possible impacts of different climate change scenarios, quantifies the impact of adaptation options that are available or could become available to farmers, and quantifies the impacts of climate policy on farmers’ incomes and optimal farm management strategies. We find that, in the shorter run (2030), given the current (2012) farming technologies and adaptation options available, farming in the case study region will still be profitable under most scenarios. In the scenarios where farming is not profitable, improvement in crop yield and pasture growth could potentially offset predicted losses. In the longer run (2050) current (2012) farming systems would be profitable unless climatic changes are at the more serious end of predicted ranges: 20% rainfall reduction and 4.0°C temperature increase. The study highlights the importance of continuing agricultural R&D to maintain and improve agricultural productivity in the long run.
Rainfall Index Insurance as an Approach to Manage Climate Change Induced Drought

Poster Number: 601

A. Adeyinka¹, C. Krishnamurti², T-N. Maraseni¹, S. Chantarat³

¹Australian Centre for Sustainable Catchment, University of Southern Queensland
²Australian Centre for Sustainable Business and Development
³Arnt-Corden School of Economics, Australian National University

Our study will explore the possibility of using rainfall index insurance as an adaptation mechanism to deal with climate induced drought in Australia with specific reference to the wheat crop. In this paper, we examine the viability of rainfall insurance in Australia using two preconditions outlined by Bardsley (1986). The first precondition requires a correlation between wheat yield losses and the payoff from an insurance policy based on rainfall. The second precondition requires that the risk of the insurance portfolio be diversifiable. To test the first precondition, drought risk will be benchmarked at different percentiles on a decadal basis and the payoffs and the actuarially fair premiums (prices) will be calculated using burns analysis. The payoffs will be tested in a time series analysis against wheat yield losses at the shire level over 100 years up to 2005. The second precondition will be tested by considering the diversification prospects of a portfolio of rainfall insurance. We test the covariate structure of the prices of insurance contracts using loss ratios and copula analysis across Queensland and Western Australia over different time frames.

The impact of climate change on rainfall will be analysed using simulations. The distribution of historical rainfall will be used and perturbation to capture possible variations due to climate change will be incorporated in the analysis. This simulated rainfall will also be tested for dependence. A t-test analysis of the historical prices and the simulated prices will also be considered.

Our work has special significance for Australia in the context of its National Drought Policy, which advocates self-reliant adaptation to Climate Change in the agricultural sector. The results of this study will inform the prospects of engineering insurance products. Furthermore, it will also facilitate the possibility of channelling drought relief through reinsurance by the Australian Government.
**Institutional Arrangements and the Interaction of Actors in Heat-health Policy Formulation in Adelaide, South Australia.**

Poster Number: 221

D. Akompab

1Department of Public Health, University of Adelaide

Introduction: This paper explores the systems, structures and processes that were in place during a participatory process in the design of an adaptation strategy (herein referred to as heat-health policy) for heat waves in Adelaide. It focuses specifically on the approach that was used; the extent of consultation, engagement and communication among the different stakeholders during the participatory adaptation process that took place in the aftermath of a severe heat wave that was experienced in the city.

Methods: A case study methodology was used for this study. Semi-structured interviews were conducted among eighteen (18) stakeholders who were involved in the participatory adaptation process. Interviews were recorded, transcribed and analysed thematically. In addition, there was also a review and analysis of key policy documents.

Results: We found that the participatory adaptation process was “top-down” with a high level of leadership and political commitment that was demonstrated throughout the process. Despite gaps in making the process inclusive, there was good consultation and a “multi-tier” engagement of stakeholders involved in the policy process. Communication was well promoted as stakeholders used both formal and informal approaches to exchange information among each other. The success of the participatory adaptation process was partly attributed to two key consultative working groups and committees that were established to coordinate the process.

Conclusion: This paper contributes to our understanding of certain institutional mechanisms and processes that were put in place during the design of a heat-health policy. It concludes that strong institutional arrangements provide a conducive environment, the framework and the platform for meaningful engagement of stakeholders in the design of heat-health adaptation policies. Institutional mechanisms in participatory adaptation processes should be aimed at facilitating the efficiency and effectiveness of a policy process.
IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation

Poster Number: 901

P. Aldunce1,2, P. Lal3, J. Handmer4

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4RMIT University

The IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation was approved by governments in November 2011. This work was the result of a worldwide scientific collaboration of 220 authors, representing 62 countries. The aim of this session is to present the main contents of this report. The focus of the Report is on climate change and its role in altering the frequency, severity, and impact of extreme events or disasters, and on the costs of impacts and the actions taken to prepare for, respond to, and recover from extreme events. The emphasis is on understanding the factors that make people and infrastructure vulnerable to extreme events, on recent and future changes in the relationship between climate change and extremes, and on managing the risks of disasters over a wide range of spatial and temporal scales. The assessment considers a broad suite of adaptations and explores the limits to adaptation. The assessment was designed to build durable links and foundations for partnerships between the stakeholder communities focused on climate change and those focused on disaster risk reduction.

The Report begins with material that frames the issues, and an assessment of the reasons that communities are vulnerable. Two chapters assess the role of past and future climate change in altering extremes and the impact of these on the physical environment and human systems. Three chapters assess knowledge on impacts and adaptation, with chapters considering the literature, stakeholder relationships, and potential policy tools relevant to the local, national, and international scales. Longer-term components of adaptation to weather and climate extremes and disasters are assessed in the context of moving toward sustainability. Finally case studies are provide that integrate themes across several chapters or are so unique that they need to be considered separately.
Scepticism - Does Not Limit Primary Producers' Ability to Adapt

Poster Number: 602

S. Argent¹, D.N. Lawrence¹, R. Toms-Morgan², H. Cox¹, R. Routley¹, D. Singh¹, L. Pahl¹, B. Daniels¹, R. Sneath¹, T. Emery¹

¹Department of Employment, Economic Development and Innovation
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Farmers are no strangers to change. They have adapted to rising costs, pest, disease, urban sprawl and changing policy and despite this adversity primary productivity has tripled in the past 50 years (NFF 2011). Farmers are confident that they can continue to adapt to climate changes, but they will need continuing support for change and sustainable outcomes. A partnership between Regional Natural Resource Management Organisations, farmer based Landcare groups and State and Federal Government recently ran a series of workshops to help farmers understand climate change, soil carbon and carbon pricing in the Queensland Murray Darling Basin. The emphasis was on helping farmers develop individual strategies to deal with climate change on their own farms. Participants gained the latest local information on past climate trends, the science behind climate change processes, regional climate change projections, the role of soil carbon, carbon pricing policy, and soil carbon levels under different farming systems. Each person used their local climatic risk assessments to develop a strategy to deal with climate change. These strategies show that many farmers are sceptical of climate change. Several participants (6) fully accepted the premise of anthropogenic climate change with only one participant fully rejecting climate change. The remaining participants remained sceptical and will continue to manage their existing climate variability. However, they were open to information on how to improve their management and agronomic practices into the future; and on climate policy and science. Despite individual primary producer’s scepticism of climate change; many have the optimism, attitude and ability to source and interpret relevant information needed to make positive ongoing changes to improve their farming business in the face of adversity – climate change or other. Further investment in Research, Development and Extension (RD&E) will therefore support primary producers to adapt and meet the needs of the growing global population.
Assessing Sustainability Performance of Precincts Using Modelling and Visualization Platform

Poster Number: 527

M. Arora¹, H. Malano¹, P. Mendis¹, T. Ngo¹, L-H. Zhang¹, L. Aye¹

¹University of Melbourne

This paper presents the current development of a design and simulation tool for precincts, MUtopia. It envisages facilitating the achievement of a sustainable future for our cities, at a time when cities are growing in size and complexity and the basis on which they have previously been built - that of abandoning use of fossil fuels - is drawing rapidly to a close. With modern computing power we now have the technological capacity to visualise, analyse and compare vast amounts of detailed information and results over a large study region. The tool is intended to provide integrated assessment of environmental, social and economic dimensions. The main focus of this interdisciplinary project is to lay the basis for building an integrated modelling-visualisation platform that will enable the quantification of sustainability performance in key four areas – Energy, Water, Waste and Transport. The tool is expected to be able to analyse foreseeable scenarios at various stages of the precinct development: pre-design, design and operation. This paper presents and discusses the current scenario analysis methods applied for pre-design stage.
**Blending Traditional Knowledge and Heritage with Modern Science**

Poster Number: 307

D. Asamoah

1Remar International

During the last couple of decades information technology has become a vital tool used in every discipline. Blending this very fast growing technology with the traditional knowledge and heritage has become a very vital issue in order to preserve the traditional knowledge and heritage and transfer it into a sustainable development mechanism. Heritage and other factors need to be seen in a holistic manner. This would mean combining different transferred traditions, into one system. In this regard, a national and a regional strategy have been developed in Egypt that allows the collection of information in a systematic way. The system is based on building a thesaurus of terms in every field and then using it to build specialised databases using geographic information system (GIS) techniques. This system allows establishing different layers of information for every sector of cultural and natural heritage. The layers are coupled through a geographically coordinated system. A strategy for managing such systems is discussed. It has several components such as documentation, capacity building, economic considerations, etc. This strategy would allow integrated growth of different sectors in a harmonized way and permit balanced socio-economic development.
**Water Thrifty Multipurpose Perennials for Sustainable Planning in Arid and Saline Areas**

Poster Number: 603

D. Asamoah¹

¹Remar International

Agriculture in the desert is too often focused on commercially valuable crops from different climatic zones with considerable effort expanded in adopting such crops to arid and saline conditions. This effort is often wasted as baric physiology of the target cultivars often cannot be modified. For example, the citrus tree can be grafted on salt tolerant root stock, but the tree still requires 60 cubic meters of water per tree per year to sit and bear fruit, in a chaff-edging environment, the amount of water is out of proportion to the value of the fruit produced by the tree.

Since crop candidates brought in from other climatic zones so often fail the test of sustainability, crop plants for arid and saline areas should be developed instead from plants that are already physiologically appropriate. The domestication and development of same such plants have led to the establishment of a new set of cultivars whose basic requirements and character allow for thrifty and sustainable cultivation in arid and semi-arid areas.

The new crops, divided roughly into categories of fruiting trees, medicinal, oil, seeds and plants for arboreal pasturage are the subject of the following paper and presentation.
Effects of Near-future Ocean Acidification and Sea Surface Temperature Warming on the Abalone Haliotis Rubra-laevigata

Poster Number: 701

J. Atchison¹, R. Day¹, J. Shimeta²

¹University of Melbourne
²RMIT

By the end of this century ocean acidification will have caused a pH drop in surface seawater by 0.3-0.5 units, a rate of change unparalleled in recent geological history. If predictions about seawater warming are borne out simultaneously (+4°C by 2100), the synergistic effects could be worse than either change occurring in isolation. As most aquaculture setups source their seawater directly from the ocean, any negative effects of these environmental disturbances on key marine aquaculture species will have serious implications for the fisheries and aquaculture worldwide. This study aims to determine the effects of ocean acidification and/or warming on an abalone aquaculture hybrid, Haliotis rubra-laevigata, which was exposed over 100 days to seawater conditions predicted for 2100. A biochemical profile of the haemolymph over 77 days exposure to acidified seawater revealed permanent and uncompensated decreases in extracellular pH and [HCO₃⁻]. The concentrations of various biologically-significant ions (Ca²⁺, Mg²⁺, K⁺, Na⁺ and Cl⁻) varied over time, but the differences between treatment and ambient replicates were not significant. Similarly, the number of immune cells (haemocytes) circulating in the haemolymph was not significantly altered by exposure to acidified or warmed seawater. There was also severe erosion and discoloration of the upper shell surface after 100 days, and structural deficiencies may result from continued exposure to an acidified environment. While there were no obvious changes in behavior or feeding patterns, these observed sub-lethal effects, especially acidosis of the haemolymph, may lead to negative impacts on energetically costly processes like growth or reproduction with continued exposure, threatening the viability of this species in current aquaculture setups.
‘Doing More with Less Water’: Integrated Catchment Management Research to Support Climate Change Adaptation

Poster Number: 604

M. Ayre¹, R. Nettle¹

¹University of Melbourne

After a period of extended drought in southern Australia and likely continued impacts of climate change on natural resource and agricultural systems, national efforts at reforming water policy and management provide the context for a large interdisciplinary project called Farms Rivers and Markets (FRM). The FRM Project aimed to create opportunities to ‘do more with less water’ using the Goulburn-Broken catchment in North-east Victoria as a study site.

This paper reports on findings from an investigation of community engagement for adaptive catchment management in the FRM Project. Our research asked: how do diverse groups develop new knowledge and practice and policy options for catchment management under climate change? In this paper, we identify critical processes of catchment management research as ‘integration’ and ‘co-development’ and describe the challenges, benefits (value) and lessons that emerged from supporting these as key processes of adaptation.

We also present an innovative community engagement strategy for catchment management research used in the FRM Project to actively manage and support interactions between diverse practice groups including policy makers. From an evaluation of this framework we describe the roles, resources, places and people required to support processes of integration and co-development.

Overall this study shows that the value of integrated research lies in the production of new knowledge for changing catchment management as well as enhanced links between research and governance institutions, catchment communities and other stakeholders for implementing change. We provide recommendations for future integrated catchment management research as a critical part of exploring new options for adaptation to climate change.
**Impacts of Climate Change on Mosquito-borne Diseases and Its Implications for Adaptation in China**

Poster Number: 404

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Global climate change is an emerging threat to public health, particularly the transmission of infectious diseases. The purposes of this paper are to briefly summarize what is known about the likely impacts of climate change on three main mosquito-borne infectious diseases (malaria, dengue fever and Japanese encephalitis) in China, and to provide important information and direction for adaptation policy formulation. Variability in climate, in particular temperature, precipitation, humidity and extreme weather events is linked to transmission and distribution of malaria, dengue fever and Japanese encephalitis in some regions in China, despite limitations in research, data, and considerable uncertainties and complexity in the climate-health relationship. This requires strengthening current evidence for timely adaptive plans formulation. We suggest that, some guidelines will be essential to the development of adaptation policies including: improving current surveillance and monitoring systems integrated with climate-sensitive conditions; focusing adaptation strategies and policies on vulnerable communities and groups; strengthening the capacity of health systems to adapt the impacts of climate change; developing multidisciplinary approaches sustained by an new mechanism of inter-sectional coordination; and enhancing awareness promotion and mobilization of the public, health professionals, and other important stakeholders.
**An Integrated Climate Change Vulnerability Assessment Process and Tools to Identify Adaptation Options for the Central Region of South Australia.**

Poster Number: 116

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The Central Local Government Region of South Australia comprises approximately a quarter of the incorporated area and regional population of the state and has a diverse population, geography and economy. A forum in 2008 identified a lack of information available on the vulnerability of the region to climate change and highlighted the need for close collaboration between regional organisations. In response, a framework for undertaking a relatively low-cost, locally relevant, regionally coordinated integrated climate change vulnerability assessment was developed to evaluate regional vulnerability and identify adaptation options.

In its 2007 Third Assessment report, the IPCC provided a conceptual model for describing climate change vulnerability as a function of exposure, sensitivity and adaptive capacity. This model was used for the basis of the framework developed to assess vulnerability in the region. For the scope of the study, a ‘Triple Bottom Line’ approach was chosen to consider the environmental, economic and social capitals of the region and indicators for each identified.

A climate change scenario for the year 2030 was developed for the region and included a price on carbon. A team of technical experts and representatives from regional Councils, Natural Resource Management and Regional Development Australia boards met regularly to have input to the project, and a one-day workshop was run to gain local knowledge and help evaluate the sensitivity, impacts and adaptive capacity of each indicator to the climate change scenario described. Regional values and visions were also captured.

Although qualitative and subjective in nature, the framework provides a transparent and comparative vulnerability score for each indicator, a suite of practical adaptation options and a measure of the regional values. Most importantly, the process facilitated significant learning and collaboration for key stakeholders and individuals responsible for climate change adaptation in the region.
Climate Change Decision Support Framework and Software for Coastal Councils.

Poster Number: 501

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The “First Pass National Assessment” of the risks to Australia’s coasts from climate change identified a range of impacts over the coming decades and highlighted the fact that residential buildings valued at approximately $63 billion, and significant but unquantified numbers and values of other assets, are at risk of inundation from a 1.1 metre sea level rise. Other assets including commercial and recreational land and associated infrastructure are often owned or under the planning jurisdiction of Local Government.

Currently, however, there is no consistent policy response across Australia, nor decision support tools or financial evaluation software to guide Councils on the most cost effective options for the management of these assets under future climate change scenarios.

In collaboration with the Local Government Association of South Australia, Department of Premier and Cabinet, the Institute of Public Works and Engineers Australia, University South Australia, Department of Environment and Natural Resources Coast Protection Board this DCCEE funded Coastal Adaptation Decision Support Pathways project has developed a decision pathways framework and financial modelling tool, that includes an evaluation of cost effective policy options and actions for existing coastal infrastructure.

Based on climate change driven inundation and coastal erosion scenarios for the years 2050, 2070 and 2100, the options based financial model can assess the likely costs associated with a suite of actions for existing infrastructure categorised as either defend, adapt, retreat or delay and the optimum timing for the implementation of each. The decision framework and financial model can evaluate any coastal infrastructure for which there is data including residential and commercial buildings, roads, footpaths and sea walls and has been tested using real data for two case study councils in South Australia. The tools have been designed for easy used by coastal planners and asset managers.
Climate Change Network Adaptation Plan

Poster Number: 520

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Arup worked with Ergon Energy and Energex, Queensland’s electricity distributors, to understand the critical climate impacts on the network infrastructure and develop a Network Adaptation Plan.

The project involved the development of climate scenarios and the assessment of the potential impact of these scenarios against the entities’ infrastructure. The risk assessment process involved an assessment of vulnerability and adaptive capacity of the infrastructure and mitigation measure were identified by working with specialist technicians within both organisations.
Analysis of Spatial Rainfall Patterns in South Australia (SA) Between 2000 and 2010
Poster Number: 902

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The aim of this study, which is being conducted as part of the Goyder Institute for Water Research’s Climate Projections Project, is to use geographical information system (GIS) tools to investigate the effect of topography on the spatial relationship of rainfall time series. We discuss three spatial statistical techniques, Kriging, rainfall oriented by a directional distribution model, and a graphical regression model for understanding rainfall behaviour in the context of the Adelaide Plain and the Mount Lofty Ranges. The spatial properties of the rainfall time series and their distributional features are investigated and related to topographical features. The time series is adjusted by removing seasonal and orographic effects so that they can be considered as individually stationary series on a plane. The standard deviational ellipse is calculated and this indicates directional trends in the time series. Variograms are calculated and their suitability is assessed. The anisotropy of the spatial field is also considered.
Challenges of Sea Level Rise Policies: Working with Uncertainties in Maps and Models

Poster Number: 222

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Climate change adaptation in coastal and flood-prone areas is a key issue for Australian governments. A legacy of development in low-lying areas combined with predictions of future sea-level rise make properties along the coast vulnerable to the impacts of climate change.

Whilst it is difficult to decrease the vulnerability of existing developments, governments can regulate new developments through planning schemes. A growing trend in Australia involves governments undertaking detailed mapping of regions, and basing development decisions on whether a property is designated as at risk on the relevant map. Most recently, the Queensland government released a new Coastal Plan, accompanied by comprehensive mapping of the state’s coastal zone. The maps designate areas as high hazard areas (erosion prone, projected to be permanently inundated due to sea level rise, or projected to be inundated temporarily by 1m+ during a storm), and medium hazard areas (projected to be inundated temporarily by less than 1m during a storm), with corresponding restrictions on development.

This mapping trend has some clear benefits. Although there is some discretion left to decision-makers, the maps give developers and property owners a degree of certainty as to whether development is likely to be approved. However, the ultimate success of the decision-making process depends upon several factors. These factors include whether the maps are accurate and use the best available technology, whether the maps flag areas subject to potential inundation, as well as areas needed for ecosystem migration, and whether the legal and governance regime is flexible enough to be updated as soon as scientific advancements occur.

This paper will explore these factors in detail, and apply them to the Queensland approach as a case study. It will then make some preliminary recommendations as to how mapping technology can best be utilised to promote climate change adaptation in coastal areas.
Assessing Breeding Strategies to Reduce Australian Dairy System Greenhouse Gas Emissions

Poster Number: 605

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Dairy production has made large advances in efficiencies over the past 60 years as a result of changes in breeding, nutrition and management. However, losses of dietary energy in the form of methane (CH₄), as well as nitrogen in manure, are still significant inefficiencies and pollutants. This study provides a methodology to identify breeding strategies that could be used by farmers to reduce emissions intensity and/or claim carbon credits under the Australian Government’s Carbon Farming Initiative. This study developed an animal model to describe the average Australian dairy herd and assess the impact of improving breeding traits. The sensitivities of farm profit, total carbon dioxide equivalent (CO₂-eq.) emissions of CH₄ and nitrous oxide (N₂O) from the dairy system and emissions intensity per kilogram of milk solids (MS) were assessed by a phenotypic standard deviation (SD) improvement of 9 traits (production and fitness traits), as well as the proportion associated with any genetic improvement. A change of 1 phenotypic SD unit in each of the chosen traits was chosen as the fairest basis on which to evaluate the impact on emissions and of changes affected by any means. A change of 1 genetic SD unit is the equivalent basis on which to compare the effect of changes brought about as a result of breeding. The production data, phenotypic SDs and the heritabilities of the traits were obtained from the Australian Dairy Herd Improvement Scheme.

This study showed that a phenotypic and genetic improvement in feed efficiency and fitness traits can increase farm profit, reduce total system CO₂-eq. emissions and per kg MS. If future climates and an increase in the demand for milk products require more efficient production systems, then selective breeding could reduce the carbon footprint of dairy production.
Comparing Adaption to Climate Change Amongst the Electrical Infrastructure in Australia, Canada, US and South Korea

Poster Number: 112

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Renewable Energy Policy Network of the 21st Century (RENE21) observes how Australia, Canada and the US are unique amongst countries because they have state or province feed-in tariff policies. This distinctly contrasts with national policies elsewhere. This preliminary study extends REN21’s observation to find if there is a relationship between a state based response to climate change and speed of adaption to climate change. The study uses feed-in tariff implementation as a climate change adaption performance indicator and is part of a wider international comparison of further climate change performance adaption indicators within a bigger project ‘Analysis of institutional adaptability to redress electricity infrastructure vulnerability due to climate change’ funded by the Australian Government. The amount of electricity administered per state or province is used as a measure of distributed or centralised government. The climate change performance adaption indicator results for the three countries with state based systems or distributed governments are compared with the centralised government of South Korea. This study shows that the state based or distributed government hinders adaption to climate change. Implications within the context of the wider project are that the electricity system’s transmission and distribution lines are a natural monopoly providing network externalities. The legacy of the state systems is multiple ownership of and multiple jurisdictions requirements of the network contrast with the Korean Electric Power Corporation (KEPCO)’s monopoly ownership of both distribution and transmission networks. This project shows that political and economic fragmentation in Australia, Canada and the US hinders the adaption of the electricity system compared to the national legislative framework and monopoly ownership of transmission and distribution of South Korea.
**Pioneering Climate Change Adaption in the Marine Tourism Industry**

Poster Number: 702

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The sustainability of the marine tourism industry and the reef are inextricably linked and climate change poses the single most significant risk to both of their futures. Whilst the extent and severity of climate change impacts will largely be influenced by the action or inaction of the global community, Marine tourism operators in the Great Barrier Reef are proving they are leaders in adaption and mitigation efforts.

Tourism operators and Queensland and Commonwealth government agencies formed a Climate Change Adaptation Committee to address the challenges of climate change and its impacts and in 2007 a Tourism Climate Change Action Strategy was developed to guide action to be taken by the industry to improve reef health and the vulnerability of the marine tourism industry.

This continuing partnership has enabled the development and adoption of tools which improve sustainability and reef resilience through best practice strategies in education and interpretation, reef health monitoring and climate change mitigation and adaptation.
Adapting Aged Care Facilities NSW to Heatwaves: Preventing Premature Death in Elderly Australians: an Overview

Poster Number: 521

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Introduction: The 2000s have seen an increase in the intensity and frequency of extreme weather events. How Aged Care Facilities (ACFs) prepare for the impact of extreme weather events has never been systematically studied. This paper presents the results of an in-depth study of NSW ACF staff on how ACFs are adapting to heatwaves.

Method: Aged Care Facilities across NSW were invited to participate in a 15 minute telephone interview. The interview used a semi-structured validated questionnaire to identify the current strategies used by ACFs in managing heatwave events. The study was funded by NCCARF and approved by the Ethics Committee of the University of Sydney and the organisational Ethics Review Boards or Management Committees of the participating institutions.

Results: This paper presents the results of the first 250 ACFs enrolled in the study. The majority (80%) of ACFs were aware of the importance of planning for heatwaves. Of these, many already had heatwave strategies in place, but some did not have access to air-conditioning or appropriate heat health plans. The age of the facility and facility design clearly places some ACFs at a disadvantage when the weather is extremely hot.

Discussion and Conclusion: Until now, the way Aged Care Facilities plan for the impact of heatwave events has never been systematically studied. Although these results indicate that the immediate effect of heatwaves on elderly ACF residents is a priority for the majority of service providers, many facilities have not addressed the long term adaptability of their service to an increase in daily average temperatures.
**Framing Climate Change: Newspaper Representations of the Brisbane 2011 Flood**

Poster Number: 903

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In the wake of the flood that affected Brisbane in January 2011, public attention turned to the causes of the event. The news media is instrumental in both reflecting and framing public opinion by defining and limiting the discourse around natural disasters such as the Brisbane flood. Media therefore has significant power to regulate the visibility of particular issues, how they are interpreted by decision-makers and whether they find a place on policy and planning agendas. Climate change, already a highly visible and political issue in Australia, featured prominently in news reporting and reader commentary about the flood. We investigated coverage in national and Queensland newspapers of the 2011 Brisbane flood event, from forecasts and first warnings to the inquiry, first anniversary and ongoing reflection process, to identify societal discourses related to the floods and their relationship to climate change. Two conflicting narratives stand out: one that denies a relationship between the flood and climate change, and one that argues that increased frequency of extreme events in general is evidence of climate change. Less frequently, articles argue that climate change caused the Brisbane flood in particular, and a minority suggest that the relationship is uncertain. The concept of blame is a key theme, with many articles attributing the flood to a single cause, such as urban development or “Mother Nature,” rather than conceptualising floods as the outcome of multiple drivers in complex systems. Emphasis is also given to the economic and political implications of identifying the cause of the flood. This research aids understanding of how media representations of the flood may affect capacity to prepare for and manage future events, and can assist longer-term learning by agencies responsible for disaster management. Ultimately, this analysis highlights the critical role of media at the science-policy interface.
Adapting Typical Meteorological Data Files to Suit Climate Change Projections

Poster Number: 522

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In Australia, the design for a new domestic dwelling must pass a thermal efficiency evaluation test, achieving 6 stars on a scale of 10 before getting approval for construction of the dwelling. Used in the evaluation is a set of weather data called a typical meteorological year (TMY) that is designed to reflect the expectations and variations in climate variables that will affect the performance of the building for the locale in which it is to be built. What is the chance that a building designed to perform well under present climate conditions will still be robust in its performance under climate change. Our task has been to redesign present TMY data files to fit the predictions of the effects of climate change on the various climates of Australia (as set in a 2007 CSIRO report). The changes are not simplistic – for example, the prediction for change in temperature for Adelaide in summer is a 50% probability of an increase of 0.6 degrees on average, but however, it is predicted that the level of increase in the minimum temperature will be greater than the increase in the maximum. Thus, as well as increasing the average, the daily profile must alter. The situation is similar for other climate variables like solar radiation as well. We report on our investigations to date.
Disaster Experience and Climate Change Risk Perceptions

Poster Number: 301

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This paper reports some findings from four case studies which constitute part of a larger project aimed at identifying indicators of individual and community resilience to a disaster event. The case studies were conducted in eastern Australian communities which have experienced different kinds of natural disasters or extreme weather events, namely: cyclone, flood, fire and drought. Reported here are findings concerning the links between disaster experience and its effects on perceptions of climate change risk and adaptive behaviours to respond to future climate change contingencies.

The research design followed two phases: a qualitative phase, comprising interviews with a cross-section of community residents or stakeholders (e.g. small business owners, farmers, construction workers, women’s groups), and disaster emergency and recovery respondents who were involved in assisting the communities during and after the event; followed by a quantitative phase, designed to generalise findings from the qualitative phase.

Analyses of interview data and the body of relevant literature were the source of the survey questions that were employed to gather quantitative data. Survey data were collected from 1008 individuals in the four different study locations: Innisfail, Ingham, Bendigo and Beechworth. The sample used was designed to be representative of the demographics existing within the disaster impacted communities.

Key findings that emerged from Rasch analyses and structural equation modelling analyses show that prior experience with disaster does not lead to increased climate change risk awareness, although, along with good communications, it does predict preparedness for weather related events. Climate change knowledge was the only predictor of climate change risk awareness across the four communities. Resilient individuals are no more likely to have greater climate change knowledge, or an appreciation of climate change risks, though results vary slightly across the four disaster-impacted communities. Implications of the study highlight the importance of trustworthy communication and education about climate change.
Learning from the Brisbane Flood: Perspectives of Flood-affected Residents
Poster Number: 510

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With high populations in areas of significant flood risk, and the potential for climate change to exacerbate existing risks, how cities deal with current threats is useful as an indicator for how they might cope with adapting to a changing climate. In this context, the flooding of Brisbane in January 2011, the first major flood in a large urban area in Australia in almost 40 years, presents a unique case study. People within flood-affected parts of the city were surveyed and interviewed, with questions asked about the experience of the floods, awareness and preparation beforehand, issues pertaining to insurance, and the role of council and emergency services, as well as the availability of flood information. The results presented here are part of an NCCARF-funded project of residents affected by the summer 2010-2011 floods.

Many residents were ignorant of their flood risk, having assumed the city was ‘flood-proof’. While anger about the flood was high, the number of respondents willing to make changes to reduce their personal risk or the risk to their home was relatively low, which does not bode well for adapting to future climate risk. Confusion about insurance was a recurrent concern for many residents who had discovered their policies did not cover riverine flood. There was also a widespread expectation that the council should be more proactive in preventing floods and high levels of dissatisfaction with the operation of Wivenhoe Dam, suggesting that many residents saw flood purely as a governmental responsibility and policy imperative. The experience of Brisbane amongst those at risk showed that current knowledge of flood risk was inadequate, and that a much better understanding of the roles and responsibilities of different stakeholders will be necessary if this country is to adapt to both current and future climate risks.
**Capacity of Broadacre Mixed Farmers to Adapt to Climate Change Across Australia: Constraints and Opportunities**

Poster Number: 606

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Australian farmers experience a highly variable climate and strive to continually adapt to changing circumstances. In the future, the changing climate will present further challenges but also many new opportunities for farmers. To enable successful adaptation, it will be necessary to understand both the constraints and the opportunities that farmers face in their attempts to adapt. To gain some insights into this we ran fourteen workshops across a range of cropping regions of Australia using a rural livelihoods framework. Farmers identified barriers and constraints to adaptation and then scored these indicators on the extent to which they might assist with adapting to increased climate variability or climate change.

Farmers identified that financial issues were most constraining, and natural capital assets most enabling. Most indicators identified were of broad-scale significance, affecting broadacre mixed farmers from differing locations such as Tasmania, Queensland and Western Australia. Constraints identified were isolation/rural decline, access to services, regional infrastructure, equity/debt, and the high cost of production. Conversely, enabling factors identified were farmer education/experience, sense of community, and off-farm income. Actions to address these constraints were identified and logically grouped into issues relating to farm management practices, training, community, technology/research, communication, funding and governance. Adapting to climate variability and change is more than just implementing a new technology, but is also about enhancing the resilience of the community in ways that will ensure its long term viability. To achieve this it will be necessary for different components of government and other agencies to work together to improve the adaptation capacity of farmers in the future.
Understanding the Capacity of Small-scale Farmers in Asia to Adapt to Climate Change
Poster Number: 607

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Small-scale farmers in developing countries are continually making decisions about their livelihoods in response to a range of drivers. Different farmers have varying capacities to respond to these drivers. An approach, based on the sustainable livelihoods framework is proposed to better understand the constraints and opportunities faced by farming communities to respond to climate variability and/or climate change. Focus group discussions and in-depth interviews were conducted with farmers in India, Bangladesh, Laos and Cambodia to provide a self-assessment of community ability to adapt (adaptive capacity) and identify collective actions to improve their capacity. This allowed in-depth discussion of the issues facing farmers in rice-based farming systems. A range of indicators were generated through the bottom-up process and were scored on their ability to contribute to climate change adaptation. Through the self-assessment workshop process, practical ideas for action were identified to improve the participants’ capacity to adapt. Results show that practical measures for climate variability and climate change must be viewed in a broader livelihoods (5 capitals) context rather than focusing on individual sets of technologies.
Health Planning for Adaptation: What Do Health Planners Understand About Health Impacts of Climate Change

Poster Number: 401

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Climate change is likely to adversely affect many existing disorders and amplify health inequities; and how the system responds will impact on the health of individuals and the community as a whole. To ensure that the health system is proactive and suitably responsive, those tasked with planning for future health services must be aware and informed on the potential health issues that will arise as a result of climate change.

This paper explores the current knowledge that Australian health planners have of climate change related health impacts with a view to identifying data needs and developing educational tools to enable a proactive adaptive planning response for a climate changed future.

Methods: Direct interviews with current professionals were undertaken using an interpretivist paradigm. Planners were all senior public servants from five States and Territories from Australia. A set of standard interview questions was used.

Results: Preliminary results indicate that there is a reasonable understanding of some, but not all, potential health impacts of climate change. Recent severe weather events and associated media in Australia may have contributed to this awareness. However, most planners do not see the health impacts of climate change as a major factor to be considered in future planning. Although this is, in part, due to a perceived lack of available data, many planners identified their priorities to be day-to-day operations and an ageing population, while they believe the impacts of climate change will be minor in comparison.

Conclusion: While some agencies and planners have been proactive in planning for the health impacts of climate change, many health service planners within Australia have a limited appreciation of the potential health impacts of climate change. They find it a challenge to plan for the “day to day” activities, let alone plan for the potential health impacts of climate change.
Radical Adaptation – the Emerging Norm for Adaptation Planning?
Poster Number: 109

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This paper introduces the notion of “radical adaptation” and shows that traditional incremental steps in adaptation are likely to be ineffective in a world with a rapidly changing climate (IPCC, 2011). Although the aim of adaptation planning is to support the resilience of socio-economic and natural systems, it can present and aggravate risks. The early climate change adaptation literature recommended a focus on win-win and low-regrets strategies, which have spilled over to current adaptation practice and policymaking. However, it is very likely that as time progresses and non-linear climate change occurs, win-win and low regrets options are likely to dwindle and radical adaptation is likely to be the norm. Adaptation is not necessarily a smooth and easy process (Adger and Barnett, 2009) but involves difficult decisions, which can have negative implications for current systems despite future benefits.

This paper hypothesizes that radical adaptation is the emerging norm, which is constrained in multiple competing interests. The ramifications will require brave decisions and careful stakeholder engagement. Otherwise strong opposition will emerge as a barrier to its implementation – especially on projects and sectors including water, property development and energy. We present three cases where radical adaptation is taking place in Australia: the recent Queensland Coastal Plan, the draft Murray-Darling Basin Plan and the failed attempt to dam the Mary River in Queensland. In particular, the recent Queensland Coastal Plan mandates adaptation planning for developments in high and medium hazard zones and has the potential to result in hundreds of millions of dollars of stranded assets for property developers and increased transaction cost associated with local government planning. We argue that the time has come to cast aside the dominant framing of adaptation as a win-win or no-regrets approach and start to negotiate different forms of radical adaptation.
Climate Change and the Little Penguin: Adaptation Options

Poster Number: 703

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Long-term data sets (since 1968) on breeding success and survival, as well as shorter datasets on foraging and breeding distributions (since 1984) have been used to assess observed and projected impacts of climate change on Little Penguins on Phillip Island, Australia. These datasets also provide valuable information the mechanisms for, and likelihood of, this species autonomously adapting to environmental change. In addition, a number of management adaptation options exist that reduce climatic impacts and increase penguin resilience are presented. These include: increasing appropriate ground vegetation within breeding habitats to better insulate burrows, placing a high priority on fire response planning and training and encouraging colonization of other suitable breeding areas through active management. Continued monitoring of penguin populations will enable judgments to be made on the effectiveness of these management actions and can inform further adaptation responses.
Climate Adaptation in the Noosa Biosphere

Poster Number: 511

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The Noosa Climate Action Project is an on-going process for action to minimise the vulnerability and maximise the preparedness of the Noosa Biosphere and its inhabitants in a changing climate. The planning process that underpins the project was undertaken over a year and a half with the community and its government of this coastal peri-urban region, supported by SEQ Catchments Ltd and the University of the Sunshine Coast.

This collaborative process uses a community-based risk reduction approach to climate change adaptation known as Climate Proofing that combines bottom-up and top-down issues, strategies and actions to ensure shared responsibility, good governance and effective review. Recommended by the Intergovernmental Panel for Climate Change (IPCC), this approach has been used by international bodies such as the European Union, the World Bank and the Asian Development Bank.

The Noosa Climate Action Plan integrates Health & Lifestyle, Agriculture, Biodiversity, Coastal Management, Economics, Planning and Infrastructure and Emergency Management as all these areas of responsibility converge at the community level.

The key findings to date are threefold:

1. Productive relations between the engaged community groups and the local council is of paramount importance in achieving an effective climate adaptation response.
2. With a significant proportion of the community continuing to deny that the rate of climate change is being increased by human activity, it is beneficial to promote positive actions that have both adaptive and mitigational benefits where possible.
3. Many of the actions and networks required to build and support resilience and minimise vulnerability in communities are already underway, often for other reasons. By identifying and acknowledging these initiatives as wise adaptation strategies and viewing them through the lens of climate change, fresh support and a new sense of collective purpose is afforded whilst validating and reinforcing the efforts of many.
**Modelling Impact of Land Use Change Under Different Climate Conditions in the Goulburn Broken Region, Victoria, Australia**

Poster Number: 804

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The south-west region of the Goulburn-Broken catchment (SWG) in the south-eastern Murray-Darling Basin in Australia faces a range of natural resource challenges. A balanced strategy is required to achieve the contrasting objectives of remediation of land salinisation, and reducing salt export, whilst maintaining water supply security to satisfy human consumption and support ecosystems under difference climate conditions. This study linked the hydrological CATNode model to the CAT1D model and investigated the effect of landuse change and climate variation on stream flow and salt export. The CAT1D comprises a suite of farming systems models ranging in complexity from a simple crop factor approach to phenologically based crop and pasture modules. The modelling explored and contrasted the impacts of a series of different revegetation and climate scenarios. The results indicated that planting only to satisfy biodiversity needs is unlikely to have much additional impact on streamflow and salt load above random plantings. They also indicated that focused salt reduction planting can effectively reduce salt export while disproportionately impacting upon flows. Furthermore, streamflow declines can be mitigated by targeting revegetation activities without significantly increasing salt export. The study also found that climate change scenarios will have an equal if not more significant impact on these issues over the next 70 years.

Uncertainty analysis associated with the CATNode model streamflow predictions was investigated by taking into account the effect of model parameter uncertainty. The knowledge gained through this study has informed a NRM trade-off decision process that aims to develop and prioritise NRM options.
**Climate Change Risks and Adaptation Strategies for Victoria's Surf Coast**

Poster Number: 502

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Victoria’s Surf Coast Shire extends from Torquay south and west to Lorne. Its 55 km of coastline includes: important ecosystems, towns, tourism infrastructure and iconic beaches and surfing breaks. Surf Coast Shire’s economy is strongly dependent on its coastal amenity: the Great Ocean Road, attracts over 2.5 million visitors annually; tourists treble the Shire’s population during summer and add over $258 million to the local economy. Projected population growth of over 40% by 2026 is also underpinned by ‘sea change’ migration.

Risks to Surf Coast environments and built assets that may be posed by sea level rise and associated coastal recession were assessed using a GIS-based exposure analysis and a stakeholder risk assessment workshop. Four sea level scenarios were considered: including late 20th century conditions and 0.8 m of sea level rise, as suggested by the Victorian Coastal Strategy.

Only relatively small areas of the Surf Coast are exposed to inundation from sea level rise and storm tide events. However, the generally erodible nature of landforms means that more assets and environments may be exposed to coastal recession. Risks are concentrated around the main Surf Coast towns and five broad asset classes: beaches and associated tourism infrastructure; environment and cultural heritage features; residential and commercial properties; roads; and beach or reef-based surfing breaks.

Sea level rise and coastal recession pose critical risks to the assets, amenity and economic potential of the Surf Coast and warrant adaptive responses by planning authorities and infrastructure and natural resource managers. While many risk are long-term, some critical risks will be posed by only 0.2 m of sea level rise.

The paper describes the exposure and risk assessment processes used in the project and their outputs, as well as the framework for adaptation that responds to experienced and emerging risks resulting from sea level rise.
A Methodological Approach to the Use of On-site Rainwater Retention Tanks in Infill Developments in the Face of a Changing Climate

Poster Number: 523

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The Victorian Planning Provisions (VPP) compels local Councils to ensure that developers of small residential infill subdivisions provide sufficient drainage infrastructure to protect downstream drainage systems from overloading as a consequence of cumulative development. Typically, this is achieved using a retardation system consisting of a rate of discharge control and storage for temporarily detained stormwater. The same VPP also requires developers improve the stormwater quality to specific targets; consequently, drainage infrastructure on infill developments often consist of two separate functional components. Rainwater tanks are regularly provided to partially achieve the required stormwater quality improvements and have long been recognised as able to somewhat reduce the discharge rate from a redeveloped site. At this point in time no methodology has been described that will allow a municipal engineer to confidently estimate the effect stormwater retention has on Council drainage systems without detailed analysis. This shortcoming may become even more significant given the widely-anticipated increase in rainfall intensities as a result of our changing climate. Preliminary research by the author has supported the development of a simplified model which is based on the concept of setting the developed Directly Connected Impervious Area (DCIA) on a subdivision equal to the pre-development DCIA. Simply stated, a rainwater tank must capture all additional runoff from the increased impervious area after development in order to maintain the pre-developed hydrograph. A series of design charts will subsequently be formulated to determine the relationship between DCIA retained, depth of rainfall and rainwater tank size, over a range of water reuse intervals. Critical to the research is determining the sensitivity of these charts to varying rainfall patterns as a result of climate change. It is envisaged that the methodology be based on sound research of a quality able to be incorporated into documents such as the Infrastructure Design Manual.
Farmers Leading Climate Change Communication in Australia’s Primary Industries

Poster Number: 608

S. Cole

Econnect Communication

Climate change will exacerbate Australia’s already variable climate, which presents challenges and opportunities for primary industry in Australia.

The agricultural sector will better adapt to climate change if farmers can increase their knowledge of climate change and variability, use climate-relevant tools and practices, and apply risk management principles to their businesses.

An influential way to communicate with individuals and businesses is to showcase local and regional examples of climate change successes through illustrating changes, and the people who’ve made them—creating ‘champions’. Most farmers gain new knowledge and adopt new practices through interaction with respected peers.

This paper will present about a program involving 34 farmers across Australia who are being supported and trained to communicate with their peers about climate change science and actions for mitigating and adapting to climate change.

They are knowledgeable about and interested in adapting to climate variability and change, and many are early adopters of new tools and practices to better adapt to the climate on their properties.

The paper will report on the research behind developing this program, the activities of the program and the ongoing evaluation of the program.

The program aims to help farmers and natural resource managers deal with risk and exploit opportunities in Australia’s variable and changing climate. The role of the participants is to raise awareness about impacts of climate on regional climates and farm businesses, disseminate knowledge from relevant research, and increase adoption of practices and tools for better adapting to climate.

Climate Champion participants are communicating locally, with researchers and decision-makers, and presenting a tangible, positive face of adapting to climate change in a sustainable way.

The Climate Champion program and its participants are ideally suited and increasingly active in a move to help Australian farmers take viable, effective steps to adapt to climate change.
**Narratives and Numbers: Useful Information for Adaptation in Australia**

Poster Number: 308

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¹NCCARF

The National Climate Change Adaptation Research Facility (NCCARF) is a boundary organisation developing adaptation research networks and national climate change adaptation research plans and programs to address information needs for policy and practice. As is increasingly common for organisations which function in the boundary between research and application in climate science and adaptation, NCCARF uses communication to increase access to useful and emerging knowledge. A framework which informs NCCARF’s communication and engagement strategy identified three key factors associated with preparing to adapt: first, a history of strategic planning; second, access to evidence based information and third, a structured assessment of their vulnerability to climate impacts.

As part of this strategy, NCCARF carried out a pilot survey of 103 landscape architects from around Australia to gain insight into their information needs for adaptation. We asked where this industry looked, or would look, to incorporate climate change factors into planning and decision making in their practice and the type of information they would seek. The initial findings show a strong preference for internet search engines as starting places, followed by peak industry bodies and established institutions. Including information on how the climate will change is relatively new in design projects and they preferred information formatted through case studies, successful examples and location specifics.
Cross Property Planning for Climate Change
Poster Number: 609

T. Cox¹

¹NSW Department of Primary Industries

To achieve greater adoption of practices that will see a wider adoption to climate change from landholders a cross property approach can achieve greater outcomes through working with landholders with connections in both the landscape and community. This form of extension was used by Communities in Landscapes and has been used with 6 groups of landholders throughout NSW. The groups were set up to look at many issues within their farming communities and provided a focal point of learning and community interaction. Farmers were able to take advantage of learning from a multi agency approach where other agencies such as NSW DPI, CSIRO and Land care provided expertise to landholders. This form of extension model can be adapted to deliver any extension material required by landholders and the farming communities in particular in terms of adoption to climate change. The groups were made up of landholders with connections throughout the landscape by adjoining properties and around existing groups. This provided them with the ability to change across a landscape and adopt practices that had a wider outcome then just on their own individual properties.
Coastal Vulnerability in North West Tasmania: Storm Surges and Seasonal Events – the Issues and Possible Solutions

Poster Number: 503

D. Coy

Central Coast Council

In July 1964 a ten-year old boy read in the local newspaper that there was a high chance of an extreme weather occurrence in the form of a storm surge which could inundate the coastal foreshore in and around Devonport, Tasmania. Having completed school for the day he rode his bicycle to the Devonport Bluff to watch this phenomenon.

The scope of the damage was dramatic; the solid concrete amenity block was completely decimated as was the Coles Beach Surf Club on a neighbouring beach. Damage was not confined to the local area; the coastal rail line was completely undermined in large sections between the townships of Devonport and Burnie.

These events would reshape the landscape for evermore. Documents and images from the news media plus a personal collection of images underpin this story.

Many years later as an adult I began to study and measure the coastal erosion in the local area. Undoubtedly the expansion of human settlement and the infrastructure including dredging of estuaries and the deep sea wharfs have impacted on coastal foreshores. This, however, may only be one of the factors. Extreme weather events and the subtle encroachment on the natural environment by tidal changes may wreak havoc for current and future generations unless action is taken at local, regional, state, and national levels.

The proposed presentation will include:

- Initial research from 1964
- Images identifying changes to coastal foreshores – time series
- Flood mapping
- Historical research data relating to Tasmanian Aboriginal communities and their stories about coastal areas prior to, and leading up to, white settlement
- Thorough examination and accurate referencing of current research papers and local publications against the argument set out in this Paper.
- The way forward, identifying potential solutions for adaption across Australia’s coastal communities
Climate Change Impact and Adaptation in Pasture-based Agriculture

Poster Number: 610

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Climate change projections for warmer and possibly drier future conditions will impact on the productivity of pasture based agriculture. These impacts will not only be on annual pasture production, but will also include the seasonal pattern of pasture growth, species composition, the water balance and the length and timing of wet and dry periods. In this study the impact of future climate scenarios on these aspects of pasture production systems are considered for the medium-high rainfall zone of south-eastern Australia. The impact of future climates on pasture production will vary according to existing climate and pasture type, with temperate regions more likely to be adversely affected than the cool temperate zones. Across the regions warmer temperatures and higher atmospheric carbon dioxide concentration will lead to higher winter and early spring pasture growth rates, but lower rainfall will cause a contraction of the spring growing season particularly in the temperate regions. In locations with mixed C3 and C4 pasture systems, changes in species composition with an increasing length of growing season for C4 species, will mitigate the impact of warmer temperatures.

Currently available pasture species with higher heat tolerance and greater rooting depth than traditional pasture types appear better suited to warmer and drier climates in the temperate pasture zones, for example tall fescue and phalaris compared to perennial ryegrass. These species also appear to be better adapted to future climates unless there is greater than 2ºC warming.

This analysis highlights that there are options available to adapt systems to warmer and drier climates, and that climate change impact analyses need to consider these rather than assuming that the traditional systems will continue.
Carbon, Biodiversity and Regional Natural Resource Planning: Towards High Impact Next Generation Plans in Australia

Poster Number: 218

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The literature on the management of natural systems has long argued the importance securing landscape resilience in the face of climate change. Emerging market-based terrestrial greenhouse gas abatement programs present a real opportunity to secure adaptation through enhanced landscape resilience. The international natural resource management (NRM) and environmental governance literature, however, provide few cohesive examples or critiques of how the NRM governance systems of the world’s developed and developing nation-states might be able to take advantage of these opportunities to achieve such landscape-scale transformations in the face of enormous change.

In this paper, we review the literature concerning natural resource governance and the emerging plethora of greenhouse gas abatement programs. We then explore the Australian situation as an ideal opportunity to contextualise these issues in real world circumstances. In Australia, the national landscape predominantly comprises agricultural land-holders. The regional aggregation of Agriculture, Forestry and Land Use (AFOLU) activities carried out by these landholders will be required both to mitigate Australia’s greenhouse gas emissions and to secure the transformational changes needed to enable adaptation to climate change in these landscapes and in the communities that rely on them.

Importantly, Australia has also developed the cohesive set of national NRM governance system of the kind needed to make regional aggregation, regardless of biophysical environment and land holding arrangements, possible. This article outlines the strengths and weaknesses of this system in supporting landscape-scale mitigation and adaptation. Consequently, we focus on the required reforms to the Regional NRM Planning to best direct the nation’s emerging greenhouse gas abatement programs in ways that best support landscape adaptation in the face of climate change. This provides pointers to those involved in the national governance of, and planning for, natural resources management in regard to maximising the effectiveness of international, national and provincial abatement programs.
**Shrub-encroached Woodlands As Potential Carbon Sink**

Poster Number: 611

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The encroachment of shrubs which occurred in most semi-arid grasslands due to the change in land management practices and atmospheric CO2 concentration has been seen as a threat which decreased pastoral productivity in the agricultural, production-based landscapes. Therefore, various attempts (i.e. ploughing) have been made to manage these woody shrubs though results were inconsistent. Attempts to convert shrublands to their original grassland–woodland communities using mechanical methods followed by grazing only reduced the number of vegetated patches and plant diversity as well as prolonged the domination of woody shrubs without any increase in perennial grasses. As vegetated patches became the preferable foraging sites for a variety of organisms, the surrounding areas experienced some increases in biological activities, resulting in higher level of soil resources around shrub canopies compared to bare soils. Furthermore, the effect of ploughing and grazing was species specific which might lead to the species extinction or domination. Ploughing only created a young, mono-specific strands of shrubs which were less capable than their mature and heterogenous counterparts in trapping and accumulating resources. The destruction of cryptogamic soil cover due to ploughing also decreased the potential of carbon fixation in these landscapes. Area that experienced ploughing and grazing thus stored a significantly lower amount of carbon compared to the undisturbed landscapes. Ploughing was therefore an inappropriate strategy to manage semi-arid woodlands. In the context of pastoralism, an alternative perspective, which is gaining attention worldwide, is to value these encroached shrublands as carbon sinks. However, land managers will only benefit from selling emissions if the price of carbon credit is high. Therefore, the development of carbon-management system requires a regional planning that includes incentives or compensatory payments, particularly if there is conflict between land-managers and greenhouse abatement.
Practical Approaches to Managing Landscapes for Resilience Revealed Through Expert Elicitation

Poster Number: 805

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The resilience of terrestrial ecosystems depends in large part on the population sizes of their constituent species, which need to be managed at landscape scales. Climate change may ultimately require us to develop new, transformative approaches to landscape-scale management of biodiversity. But in practical terms, landscape management has proved difficult to implement due to a variety of social, economic and governance constraints. Thus, the reality is that it might be many decades before transformative approaches could be implemented on the ground. In the meantime, we need incremental approaches to managing landscapes for adaptation and resilience of biodiversity that are achievable within the current set of constraints. To identify immediately achievable approaches to landscape management, we used an expert elicitation process to elicit sets of landscape design principles currently in use by landscape planners and managers throughout Australia. Specifically, we used an indirect elicitation procedure, asking managers about the actions they would prioritise in order to gain an understanding of their underlying conceptual models about how landscapes can and should be managed. Here, we present the landscape design principles that we most frequently elicited to illustrate the set of potential tools that could be used to support resilient ecosystems and species under climate change. This work is part of a larger project, in which we are now evaluating how successful these sets of design principles are at supporting larger populations in future landscapes, in which land uses have been altered as a result of climate change. The outcome of this work will be a richer understanding of which approaches to landscape management are both practical to implement and likely to support resilient ecosystems under climate change.
Climate Change Adaptation for Australian Birds

G. Ehmke

BirdLife Australia

The highly diverse Australian avifauna already faces many pressures, something climate change can be expected to exacerbate. We have followed a six step process to identify which taxa to concentrate on first if we are to save them in all their diversity, and what we need to do. First we assembled the largest database of Australian bird locality records ever. Then we modelled changes to their climate space under different scenarios. At the same time we created a database of the characteristics of all the Australian species and subspecies of birds that are most likely to be important in adaptation. This includes obvious characteristics like current population size and distribution and also more subtle factors like brain size relative to weight. From this we created a ranked list of Australian bird taxa most likely to be affected by climate change.

Here we present preliminary results from the research including likely climate space shifts and sensitivity analysis for a number of bird populations. The next steps will be to use the climate models and our database of ecological characteristics to identify the actions most likely to lead to persistence. Potential actions include creation of corridors to assisted migration through to captivity or germplasm storage. The project will also provide an indication of the number of taxa likely to need each strategy and indicative costs. The potential for this model to be used to assess climate change impacts for the rest of Australia’s biodiversity is also discussed.
**Impact of Climate Change Adaptation on Agriculture in Sub-Saharan Africa**

Poster Number: 613

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¹Federal College of Agriculture, Nigeria

The impact of climate change adaptation on agriculture is now real and without adequate adaptation and mitigation strategies to climate change, food insecurity and loss of livelihood are likely to be exacerbated in sub-Saharan Africa. Such climatic changes are affecting agriculture through their direct and indirect effects on crops, soils, livestock and pests, and hence the global food security. It was also recognized that a reliable and timely early warning system of impending climatic risks could help in the determination of potential insecure food areas and communities.

Such a system could be based on using modern tools of information and space technologies and is especially critical for monitoring cyclones, floods, drought and the movements of insects and pathogens. This paper declares that a concerted effort, backed by policy makers at the national level would be the key to enhance food security as well as ensuring agricultural sustainability. Climate change adaptation is expected to have a high impact on food security. This may specifically affect African countries, since predictions indicate that the African climate may be subject to more extreme conditions, and food security is already at risk in large regions of Africa. New genotypes tolerant to multiple stresses: drought, floods, heat, salinity, pests and diseases, will help further increase food production adaptation. This would require substantial breeding and biotechnology (including genetically modified varieties) related efforts based on collection, characterization, conservation and utilization of new genetic resources that have not been studied and used.
Adaptation Challenges in the Built Environment

Poster Number: 101

R. Enright¹

¹AECOM Australia

Unlike the issue of greenhouse gas mitigation, climate change adaptation is an emerging policy area in Australia. Despite action taken to date by all levels of government and the private sector to address the impacts of climate change, there remain a number of issues and challenges to adaptation in the built environment. This presentation will provide an overview of the current state of play with regards to adaptation action in Australia’s built environment sector, and an analysis of key issues, including the:

- fragmentation that exists across institutional arrangements for the built environment and the need for collaborative approaches;
- fact that current planning and design specifications are based on historical climate information;
- inconsistent and uncoordinated approaches that are being taken by state and local governments;
- lack of adaptation incentives;
- lack of access to adaptation tools and information;
- challenges associated with retrofitting existing buildings to make them more resilient to the impacts of climate change;
- lack of information about the full costs and benefits of adaptation options;
- long-term time scales are required to achieve net-benefit outcomes;
- need for better understanding about the allocation of risk and alternative risk management mechanisms;
- legacy of poor land use planning and decisions;
- uncertainties associated with the ongoing effectiveness of market mechanisms;
- education and training issues;
- concerns about potential future liability for designers, architects and engineers; and
- lack of detailed and downscaled information.
**Local Governments Adapting Climate Change Policy to Local Conditions**

Poster Number: 228

D. Fallon

1Southern Cross University

Australian Federal and New South Wales (NSW) State government plans place obligations on NSW local governments to undertake activities to adapt to climate change. This task has been given to local governments in order to provide adaptation solutions that account for local conditions and demographics.

This paper will discuss the ways in which local governments in NSW have responded to the threat of climate change. The public documents of all 152 NSW local government authorities have been examined to observe strategies used by local government to adapt to climate change. It was found that to date, most NSW local government authorities have taken some steps towards adapting to climate change. It was also found that these local governments may take action on climate adaptation either individually, or as part of regional organizations.

Two policy implementation strategies, originating from higher levels of government in Australia, have been identified as being used by NSW local governments to drive a suite of adaptation actions. The first strategy involves carrying out risk assessment to inform the creation of a climate change adaptation plan; while the second strategy involves building consideration for climate change into all types of plans as they are reviewed. The response of a selection of NSW local governments to these two strategies are presented in this paper; and the benefits, disbenefits, drivers and barriers of these strategies will be discussed.
**Adaptation of Coastal and Beach Safety Services in a Changing Climate**

Poster Number: 415

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Aim: To investigate the impacts of extreme weather events and climate variability on Surf Life Saving Australia (SLSA) and to develop adaptation options and enhance the capacity of SLSA to adapt to climate change.

Methods: Literature search; Collection of information from stakeholders, including surf lifesavers and club officers; 2012: workshops to explore adaptation options and capacity using systems thinking techniques in selected case study.

Results: 63 per cent of Australia’s surf clubs are situated in coastal areas potentially susceptible to the impacts of climate change, namely coastal erosion. Further research will ascertain levels of vulnerability, including understanding the capacity of SLS clubs to respond to projected climate changes.

SLSA will need:

- Ready access to information and knowledge on current and emerging CC science, issues and legislation.  
- Good systems, procedures and CC decision making mechanisms to guide operations at all levels  
- A dynamic planning process that considers changes in social, economic, environmental and political matters.  
- Funding for adaptation measures and emergencies.  
- To be well connected with political debate, processes, grants and the decision makers.

Discussion:

- Australia’s beaches provide high social and economic value.  
- Research reveals without the surf lifesavers a further 596 people could die annually, 555 additional permanent incapacitations and 2,591 additional minor injuries.  
- Adaptation is possible and a Road Map will assist SLS, however all levels of SLS and governments need to respond in harmony.  
- Workshops in 2012 will engage all levels of SLSA and focus on (i) scoping the problem and (ii) building conceptual models of adaptation options and capacity using systems thinking techniques.
Conclusion: This program of research will deliver to SLSA a problem-solution mapping tool, overarching strategies for adaptive capacity developed using participatory techniques and an adaptation Road Map.
Climate Change and Pest Risk Analysis
Poster Number: 223

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Projected climates are predicted to influence the growth, development and behaviour of pest and pathogens necessitating the revision of current biosecurity practices such as preparedness, prevention, and containment policies and trade / market access issues. A review led by the Quadrilateral Biosecurity Climate Change Working Group considered the implications of climate change on biosecurity policy and recommended that a template be developed for incorporating climate change projections into Pest Risk Analysis (PRA) to enhance biosecurity decisions.

PRA’s involve pest identification; pest risk assessment (categorisation, assessment of probability of entry, establishment and spread, assessment of consequences) and pest risk management. We discuss the key elements required to incorporate the consideration of climate change into PRA’s with the view for developing a prototype template for use in biosecurity policy arenas. For example, determining new pests and pathways of quarantine concern relating to the “pest identification” component; potential changes to surveillance activities affecting “probability of entry” and new knowledge of changes to the biology and invasiveness of species that may underpin decisions on the “probability of establishment”. Also discussed are procedural guidelines for possible inclusion such as the use of a standard climate change emission scenario, nominating a specified time horizon (eg 2020-2030 as opposed to longer range forecasts) and consideration of the climate change parameters to be included.

Projections of future climate trends indicate that the nature, extent and intensity of climatic change will vary spatially and temporally. Responses of Pests and pathogen responses to these changes are expected to be species and region-specific and made more complex by their interactions and interdependencies. Determining the effect of climate change on pest risk analyses will lead to new directions in biosecurity management and implications for biosecurity policy benefiting by directing scarce resources where they are most required.
**Adaptation Options Across the Supply Chain: Identifying Options and Barriers in Australian Fisheries**

Poster Number: 704

A. Fleming¹, A. Hobday¹

¹CSIRO Australia

Climate change is impacting the oceans around Australia and will do so into the future. Research to date has focussed on the relationship between climate drivers (e.g. temperature and ocean currents) and the biological system. Recent efforts have also considered the impacts of biological changes on the fishing operators. Catching fish is, however, only the first step in a sustainable seafood industry. That seafood passes from sea to consumer through a number of stages where ‘value’ is added – the value chain – all of which can also be impacted by climate change. Holistic assessment of potential impacts across the value chain is needed to realise the potential benefits and minimise the climate-related losses for Australian fisheries. There will be opportunities for growth in some fishery sectors and steps in the value chain, which may be prevented by inefficiencies, or policy that does not enable opportunities to be realized. Very little assessment has been made at the intersection of climate change and legislative frameworks and how stakeholder perceptions are working to drive or constrain potential adaptation options. We identify steps in the value chain where climate impacts can be reduced, and where policy can be developed to improve uptake of adaptation options. An understanding of how climate and adaptation information is interpreted and used by stakeholders is vital for developing viable adaptation options to underpin sustainable future fisheries. Our cross-disciplinary research covers a number of different fishery cases studies (Southern Rock lobster, Black Bream, Oyster) to represent the diversity of climate change impacts and adaptation options. Incorporating a social research agenda to examine stakeholder perceptions across the value chain allows for unique insights into opportunities to adapt to climate change impacts, or to overcome barriers, and therefore grow these valuable fisheries in the future.
Community Engagement and Resilience

Poster Number: 513

H. Foster1, J. Hoy1

1Office of the Emergency Services Commissioner

As climate change spurs more frequent, severe and protracted events, the capacity of communities to prepare, respond and adapt to climate hazards is critical. In response to this, the functions of emergency service organisations have evolved and broader responsibilities assumed. In preparing for climate hazards, some agencies have taken on community engagement functions to inform and educate communities about climate hazards. The extent and breadth of engagement differs between agencies and their varying core business.

These issues make it difficult for the Victorian emergency management sector to consistently coordinate, execute and evaluate engagement strategies. This may potentially influence the level of impact the strategies can have in developing community resilience to climate change.

This study examines the engagement initiatives of three emergency agencies in Victoria. The study evaluates the effectiveness of selected engagement strategies in fostering resilience to climate change within their community. The study explores a range of issues, including (1) how the agencies mandate their engagement strategies in agreements or legislation, (2) what engagement strategies are used, (3) the effectiveness of the strategies and what their limitations/barriers are in enhancing community resilience to climate change. The study also explores community expectations of the emergency services in a changing climate.

Moderating factors such as barriers and facilitators of adaption, are considered in the study, including the ability (and/or inability) of agencies to effectively evaluate their engagement strategies.

The outcomes of this research will assist the Victorian emergency management sector in identifying the tools to effectively engage their community about climate change and foster overall resilience to the challenges it presents.
**Learning from Exemplars**

Poster Number: 615

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Much has been said about the barriers and challenges to climate change adaption, but little about those who do make changes and their decision making process. Through this longitudinal project, we seek to learn from the experiences of individuals across primary industries and associated communities who have made significant changes that enhance their ability to respond and adapt to a changing climate. Our case studies include the peanuts, rice and wine industries as well as two rural communities in Australia. Understanding how these individuals adapt and their decision-making processes is arguably critical for informing future adaptation strategies as their experiences can serve as lessons for others.

This paper showcases vignettes of ‘adapters’ who are demonstrating leadership and innovation in preparing for, and pro-actively adapting to, the impacts (direct or indirect) of climate change. These stories are drawn from semi-structured interviews conducted across our case studies. They provide exemplars of ‘adapters’ in the context of adapting agriculture to climate change; and offer valuable insights into what success in adapting and transforming might look like and what is needed to put adaptation into action.
Climate Change Adaptation: Education and Training for Application in Sustainable Land, Water and Natural Resource Management

Poster Number: 309

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There is widespread stakeholder demand for climate change adaptation education in sub-Saharan Africa. In response to this demand, a five-day course that includes a whole day field trip and focuses on Climate Smart Agriculture (CSA) has been developed and delivered by the World Bank Institute in conjunction with the African Institute for Capacity Development (AICAD). The course titled Sustainable Land-Water Management: Towards a Climate-Smart Agriculture aims to enhance participants' knowledge and skills on concepts and practices of CSA and how to achieve this through sustainable land-water management. The course includes updates from Durban COP17 where agriculture became part of the climate negotiation agenda. The course explores the triple wins of CSA – food security and poverty alleviation, adaptation, and mitigation and features case studies, interactive exercises and innovative learning experiences. The five course modules cover: 1) Climate change, variability and impact Assessment Tools, (2) Climate-Smart Agriculture (CSA): Addressing Food Security and Poverty Alleviation, Adaptation, and Mitigation, (3) Climate Resilience, (4) Land Degradation - towards a landscape approach, and, (5) Building Capacity and skills for climate negotiations.

Expected learning outcomes include: increased understanding of the concepts of climate change and climate variability, and tools designed to assess climate risks, improved practical knowledge of CSA policies and practices as well as landscape management approaches, and enhanced capacity to integrate some of the learning modules and materials into academic curricula.

The course is designed for 25-30 participants and attracts mid to high level government officials, trainers, educators, development practitioners and professionals who work at universities, local training institutions in the region of Eastern and Southern Africa, and who deal with climate change issues in agriculture, land and water.

Evaluation results from previous course offerings indicate improved knowledge and skills and an appreciation and greater application of tools useful for climate change adaptation.
**Canute: A Decision Support Tool for Sea-level Change Adaptation**

Poster Number: 201

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¹Antarctic Climate and Ecosystems CRC

The impact of sea-level rise on coastal infrastructure would primarily be dominated by changes in the magnitude of extreme sea-level events. Such events mostly take the form of storm surges, generated by tropical or extra-tropical cyclones, and a change in their number or magnitude would heighten the flood-risk for low-lying coastal regions. An additional impact, attributable to the mean sea-level rise, would lead to increased shoreline erosion.

Engineers and planners build coastal infrastructure to a specified design risk, such that the threat of flooding is minimised over the constructions lifetime. This requires knowledge of the probability of extreme events, which, due to sparsity of data, carries a level of uncertainty. Climate adaptation requires such planning to also incorporate the impacts of predicted sea-level rise. The IPCC predicts global sea-level change for several possible future emission scenarios, and within each of these paths presents significant intra-scenario spread (an additional uncertainty). Hunter (2010) recently published a method to combine these present and future uncertainties, to provide a best estimate of the probability that a given sea-level will be exceeded over a design lifetime.

This method has been incorporated into an online Decision Support Tool which provides data for the whole Australian coastline at a resolution of 2.5km. Where historical tide-gauge data is unavailable, gaps have been supplemented with data from a storm-surge model (forced using 40-years of atmosphere reanalysis fields). The interface is presented in the form of an easily navigable map, with flexible user-options such as the building design lifetime, and IPCC scenario choices. The default output produces plots of exceedance probability for a range sea-levels (perturbed and non-perturbed climate), and also graphs the number of events expected at said levels. Additional tools, incorporating user-input of locally specific data, calculate waverunup/setup and predicted coastal recession.
**Understanding the Pacific’s Adaptive Capacity to Emergencies in the Context of Climate Change**

Poster Number: 118

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There is a critical need to inform policymakers and practitioners of the required measures to improve adaptive capacity to address disasters in the Pacific. In the Pacific, the impacts of climate change are expected to be severe, particularly the possibility of increased frequency / intensity of extreme events. Pacific Island Countries (PICs) are inherently vulnerable to climate change given their small size, insularity, remoteness and limited disaster mitigation capacity. Climate change therefore challenges Australia’s significant existing investment in development in PICs including in supporting response to emergencies.

This NCCARF funded research project seeks to understand the capacity of both PICs and Australia’s emergency response to a potential increase in disasters driven by climate change. Traditionally, disaster management has been reactive. The focus of this research is to assist in the building of long term adaptive capacity by informing policymakers and practitioners on what is needed, and thereby reduce vulnerability to climate driven disasters. With a particular focus on the immediate humanitarian needs post-disaster, including health care; food and nutrition; water and sanitation and psychosocial needs, the primary objectives of the research are:

- To provide recommendations to policy makers and practitioners in the Australian and Pacific disaster and emergency response sectors on current adaptive capacity of PICs to climate related disasters (e.g. tropical cyclones, floods, droughts, storm surge), and what financial and human resources, policies and systems are likely to be needed in the coming years to enhance this capacity

- To inform improved planning and more effective response through analysis of the Australian emergency services and related organisations’ capacity, role and obligations to assist PICs in times of disaster and predicted requirements to service future needs.

This presentation provides an overview of the research and presents preliminary findings from the literature, stakeholder interviews and the project’s multi-stakeholder reference group.
Feeding Management Rules As Adaptation Strategy for Natural Resources and Livestock Systems in Southern Australia

Poster Number: 616

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The GrazPlan modelling tools were applied to simulate potential effects of future projected climate (SRES A2 scenario) on pasture and livestock production of 25 representative farms across Southern Australia running Merino ewe enterprises. We applied projected historical weather data (as reference) of 1970 to 1999 and projected data from four global circulation models. GrazPlan was used to simulate biophysical processes and production of pasture and animals. Future potential ground cover and livestock production were simulated for 2030, 2050 and 2070. Across the 25 locations, simulation results for GFDL-CM2.1 circulation model showed an average change in annual above-ground net primary productivity (ANPP) of -17%, -20% and -29% and mean annual income ($/ha) variation of -27%, -36% and -42% for 2030, 2050, and 2070, respectively. To mitigate negative effect of future climate on pasture and livestock production, confinement feeding rules from 1 December to 31 July have been considered as an adaptation scenario. For designed confinement feeding rules, there were not significant change of ANPP and livestock gross margin, this suggests that confinement feeding rules should be associated with the other adaptation strategies.
Climate Change Impacts on the Water Resources of the Remote Communities of the Alinytjara Wilurara Region, South Australia

Poster Number: 631

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Groundwater from shallow unconfined aquifers provides the main water resource for indigenous communities in the North West of South Australia. For arid regions such as this, the large range of regional rainfall changes indicated by current Global Climate Models (GCMs) leads to difficulties when planning climate change adaptation strategies for water resources. Furthermore, the more commonly reported projections of changes in average annual rainfall provide little insight into the important aspects of rainfall for water resources in the AWNRM Region, where recharge to the groundwater resources is mainly driven by only the largest rainfall events. These difficulties are exacerbated by the limited information available on groundwater in these areas to convert the projected changes in climate to changes in water resource availability.

The Climate Futures Framework has been adopted to select GCMs. Both high (A2) and low (B1) emission scenarios were considered for the time horizons of 2030, 2050 and 2070. A daily scaling downscaling approach was used to produce daily time step rainfall series from the GCM projections and applied to the whole Alinytjara Wilurara Natural Resources Management (AWNRM) Region on a 0.05° grid resolution. The resulting images of approximately 10,000 cells depict the projected changes in months of rainfall above 100 mm and the change in the largest (first percentile) rainfall events. These provide insights into the potential changes in frequency of groundwater recharge under possible future climate scenarios.

The results indicate that in general, the projected reduction in the largest rainfall events is less than the corresponding reduction in the average annual rainfall. However, the projected reduction in the frequency of recharge events is approximately 2.2 times greater than the reduction in the average annual rainfall, averaged across the region. These results will inform adaptation planning of future water supply options in the region.
**Climate-adapted Sanctuaries – Securing Refugia for the Future**

Poster Number: 807

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The protection and management of refugia is increasingly identified as an important adaptive strategy in the face of global change. Yet, they are afforded limited protection under current legislative, regulatory and planning processes.

Terrestrial and freshwater refugia have been defined as places where physical and biological attributes combine to provide an environment that is more resilient to climatic variation than surrounding areas. They can act as refuges from contemporary or future threats and disturbances such as fire, weed invasion, diseases and pests. On the island state of Tasmania the Natural Systems Resilient to Climate Change Project aims to identify potential climate change adaptation actions to enhance the resilience of Tasmanian’s natural systems, and a key focus is refugia. In South East Queensland the establishment and maintenance of biodiversity corridors is seen as a strategic way of securing refugia that can accommodate the latitudinal and altitudinal migration of plant and animal species under changing climatic conditions.

This paper has three purposes. Firstly, to scope the challenges of securing refugia in the face of climatic changes and the resultant patterns of land use at landscape scales. Secondly, to provide a comparison of the ways in which the challenges of managing climate refugia are being addressed in Tasmania and South East Queensland. Thirdly, to propose that dedicating areas (identified by their biophysical characteristics and condition) as climate sanctuaries, is a workable landscape-scale strategy for securing refugia. The concept of sanctuaries is explored in the context of safe havens. Climate sanctuaries are proposed as areas set aside to maintain functioning natural ecosystems and ecological processes and function as refuges. A case is presented that this process could be aided by giving climate-adapted sanctuaries special status as publically and privately funded environmental offsets.
Developing Regionally Specific Conservation Actions Under Climate Change: a Tasmanian Case Study of Temperate Lowland Grasslands

Poster Number: 806

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Tasmania holds some of the Australia’s most iconic and valued ecosystems and landscapes, and has an outstanding record of Protected Area establishment with 44% of public land in reserves and 1% of private land under conservation covenants or agreements. While large tracts of land are protected in the public reserve system, some ecosystems such as lowland temperate grasslands exist mainly on private land, adding complexity to planning future adaptation options.

To identify how nature conservation in Tasmania might need to adapt to a changing climate, we held a structured expert workshop bringing together Tasmanian climate change researchers and policy-makers working in the conservation management of terrestrial and freshwater systems. For a range of different Tasmania ecosystems, the workshop explored climate impacts of greatest conservation concern, the challenges of setting conservation goals in a changing climate, possible management actions required, and knowledge gaps. The barriers and opportunities affecting implementation of adaptation in three administrative regions, and the necessary policies that might be required, were then discussed. This enabled us to identify similarities and differences in the approach to adaptation that might need to be taken in different ecosystems and regions.

We discuss our findings with particular reference to identifying specific adaptation guidelines for the conservation of lowland temperate grasslands (a nationally threatened ecosystem). Lowland native grasslands exist predominantly on private farmed land and are undergoing significant land use change due to irrigation developments to ‘drought-proof’ agricultural production. Increased climate variability provides opportunities and threats to conservation, and effective policies and incentives are needed to support appropriate land management. Competing values from government, community and private landholders all need to be accommodated to ensure the future of these threatened grassland communities, illustrating the importance of considering the social and land ownership context of conservation when identifying actions and policies for adaptation.
**Information, Motivation and Institutions: Exploring Community-level Adaptation Decisions**

Poster Number: 302

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Although knowledge and information services are central to building adaptive capacity and managing climate risks, a more holistic understanding is needed of the cognitive and cultural factors that shape perceptions of information and risk as well as how power, politics and institutions shape these processes and the scope for action. I propose a conceptual framework that provides an integrated and systematic approach to explore the role of information, motivation and institutions in shaping adaptation decisions and practices at the community level. The framework is based on the socio-cognitive Model of Private Proactive Adaptation to Climate Change (MPPACC) by Grothmann and Patt (2005), which links perceived adaptive capacity (determined by perceived risks, self-efficacy, and adaptation benefits and costs) and objective adaptive capacity (available set of natural, financial, physical and human resources) to understand the process that shapes adaptive intentions and behaviour using motivation theory. I incorporate perceptions of information’s credibility, saliency and legitimacy as well as the influence of social identity and processes of social learning to enhance analysis of the knowledge-value-action interface. I also examine how power and institutions influence knowledge production and sharing, cognition, and overall access to resources within the framework. I believe this conceptual framework will prove valuable for researchers and practitioners by facilitating in-depth analysis of the process of community-level adaptation as well as the barriers and enablers of adaptation.
Farmer Climate Change Attitudes, Knowledge and Adaptation Behaviour in Victoria, Australia
Poster Number: 617

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For farmers, managing climate change means adapting to changes in climate, managing carbon emissions and understanding the role of carbon in agriculture. In Australia, opportunities for managing climate change and carbon in farming systems are emerging through government initiatives such as the Clean Energy Future. As such, an understanding of the best ways to encourage farmers to adapt to climate change and manage on-farm carbon is required.

In 2009, a large-scale baseline survey of landholders provided information on how Victorian farmers saw their role in this emerging situation. This information created a benchmark to track changes in both farmer attitudes and actions as programs are developed to educate farmers on the drivers of climate, greenhouse gas emissions and the ramifications of future climates. This survey was carried out during drought conditions thought to be linked to climate change. In contrast, a follow-up survey was conducted in 2011 subsequent to drought breaking rains and floods, a change of government in Victoria, announcement of a carbon tax and a swing towards climate change-scepticism in the media.

The 2011 survey tracked changes in attitudes and knowledge of Victorian farmers towards climate change, climate variability and on-farm greenhouse gas emissions. The results showed that attitudes to climate change shifted significantly since the advent of rain and change in political climate. More farmers feel that changes in climate and recent extreme weather are due to natural variability rather than human-induced climate change. Farmer’s understanding of climate drivers and greenhouse gas emissions increased, yet there is less on-farm adaptation behaviour compared to 2009. These findings suggest that political climate and belief in natural variability reinforced by recent rains influences farmer attitudes. This has implications for the type of approach that will encourage farmers to participate in climate change adaptation and the uptake of climate change initiatives.
Heat and CALD: Barriers to Climate Change Adaptation in Culturally and Linguistically Diverse Communities

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Background: The importance of identifying vulnerable sub-populations is well recognised in planning for climate change adaptation. Overseas evidence has shown that people from culturally and linguistically diverse (CALD) backgrounds may be susceptible to heat-related illnesses. However, there has been little research conducted in Australia to support or refute this claim, despite the fact that more than one quarter of Australian residents were born overseas. With heatwaves projected to increase in intensity and frequency in a changing climate, it is important to identify and address potential barriers to adaptation in the increasing proportion of the population who are from CALD communities.

Methods: A qualitative study was conducted in Adelaide to gain an understanding of how migrants and refugees cope and adapt during periods of extreme heat and the potential implications for climate change adaptation. Focus groups and interviews were conducted with stakeholders including policymakers and service providers to a range of CALD communities including established migrants and new and emerging communities.

Results: In this ongoing study, 17 respondents have so far participated in interviews or focus groups. The emerging findings suggest that people from CALD backgrounds are particularly vulnerable during periods of extreme heat. Those most at risk are from two distinct groups – aging migrants in established communities, and refugees and asylum seekers in new and emerging communities. Despite some issues unique to certain sub-groups, there are common barriers to adaptation, including inequity in access to heat-health messages, and socio-economic issues that influence adaptive behaviours.

Conclusions: Many people from CALD backgrounds face challenges coping with extreme heat in Australia. Culturally appropriate transfer of information regarding the potential severe health impacts of extreme heat, and low cost adaptive behaviours are among the strategies which may assist migrants and refugees in adaptation to a warmer climate.
Climate Change Adaptation in a Small Pacific Island Nation

Poster Number: 119

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The island of South Tarawa in Kiribati has a population of 40,000. It is 26km long and an average of 450m wide but is generally only 3 to 4 m above mean sea level. Adapting to the impacts of climate change on a low lying coral atoll is vital but has unique challenges. The adaptation options available are severely restricted due to the limited availability of space, physical resources and financial constraints. To address the potential effects of climate change the Government of Kiribati, with assistance provided by the World Bank, is undertaking the Kiribati Adaptation Program. This project includes implementation of shoreline protection works involving improved investigation, option analysis, and design and construction methodologies.

The work described in this paper involved establishment of: a means of assessment and prioritisation of risk to public assets affected by coastal impacts; a set of guidelines on how to address erosion and increase the resilience of public assets in the future; and identified improvements to traditional methods of coastal infrastructure design and construction. A number of pilot adaptation projects were funded to assess and refine the above techniques.

Several conclusions have been drawn. Appropriately designed (with an emphasis on practical observations and user-friendly and robust technology), systematic assessment of coastal condition is well within the capability of the local Government staff. The usual suite of coastal management adaption options cannot simply be overlaid in coral atolls, as the preferred softer options are usually not practical. Finally, if structures are required on the coastline, traditional building methods, may be shown to have a lower cost, in present day terms, than the more usual fully engineered options. The success of this project is considered to be the transfer of appropriate technology and the incremental improvements to techniques for coastal infrastructure resilience.
**Adapting Australian Agriculture: The Capacity of Farmers to Change Management Practices in a Changing Climate.**

Poster Number: 618

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Australian farmers operate in a complex and constantly changing environment, subject to the vagaries of weather, markets, social change and local environmental conditions. Climate change presents an additional factor in this complex system that will demand a high degree of adaptive management; that is, actively seeking information and new ways of management, and assessing changes to inform and improve future decision making. Current research with Australian farmers provides some insight into the capacity for adaptive decision making and practice change.

Interviews were conducted with over 2400 farm managers to produce a representative sample of mixed cropping and grazing farms in seven regions across Australia. Overall, farmers reported only a moderate perceived risk of climate change affecting their farming businesses. This was much lower than the perceived risk of other factors such as market or weather fluctuations. They were also highly confident in their abilities to make complex decisions, and had relatively few sources of information and influence in making decisions. Furthermore, those who reported fewer sources of influence tended to rely on their own intuition or experience.

While personal experience is undoubtedly valuable in farm management, a key component of adaptive management is seeking new information and methods of decision making. It also seems that long term climate change may not be seen as different from current climate variability and is therefore not seen as a significant risk or complex factor in decision making. Extension activities need to communicate climate change effects at the personal and immediate level as well as distinguishing these from normal cycles of climate variability. This may be aided by using local networks and demonstration sites and promoting adaptive management by providing decision making tools and support. These possibilities will be discussed in terms of current actions aimed at practice change and improved adaptive management.
**What About Me? Factors Affecting Individual Adaptive Coping in the Agricultural Sector.**

Poster Number: 619

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¹University of Western Australia

The agricultural sector contributes greatly to the economy and resources of many countries (e.g., Australian farmers produce almost 93 per cent of Australia’s domestic food supply) and yet is one of the sectors most vulnerable to climate change. Higher temperatures and reduced rainfall will reduce the yield of certain crops while encouraging the proliferation of weeds and pests. Such negative impacts on the sector affect the entire country, but how are individual farmers adapting and coping to a changing climate?

Our research examines how the goal systems of agricultural workers affect their adaptive coping to climate change responses. First, we identify the relationships between particular goal system patterns and particular coping strategies (both as individuals and in reaction to climate change responses) using interviews and surveys in agricultural communities in south-west Western Australia. For instance, we hypothesise that a positive pattern (one that shows dense, positive connections between the person’s “green” identity/values and their other values, identities and tasks) will be strongly and positively related to adaptive coping while a negative pattern will be strongly and positively related to maladaptive coping.

We will also explore the relationship between organic and non-organic farmers relative to their adoption of pro-environmental behaviors. Building on the goal systems theory (Kruglanski et al., 2002), we will explore the notion of competing goals (e.g., green goals vs. financial goals) and their association with pro-environmental behavior. In conventional farming, for example, green goals may be in competition with financial goals, or production goals. In most cases, multiple goals will be valued, opening up the possibility of competition for motivational resources and for certain goals to be either attended to or neglected. We hypothesise that an environmentally conscious farmer may have less goal competition as green goals are incorporated into business goals thus reducing this goal competition.
Regional Risk Perceptions: Longitudinal Study of Climate Change Adaptation in Coastal Versus Agricultural Areas of the Hunter Valley, NSW

Poster Number: 303

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A longitudinal study compared a random sample of 1162 Hunter Valley coastal and rural residents to assess regional and time differences in climate risk perceptions and adaptation. Telephone interviews were completed in 2008 with equal numbers of “at risk” Lake Macquarie residents (LM-R; sea level/storm inundation), Lake Macquarie “control” residents (LM-C), and Upper Hunter LGA rural residents (UH). Demographically, residents were long term home owners, 60% women, and older. Follow-up interviews in 2011 located 947 of the original sample (81.5%). Interviewees responded to 64 items asking about their observations of climate change (CC) indicators locally, CC concerns, perceived impacts, adaptation actions, and environmental ethics.

Pearson Chi-square test assessed area differences for individual items; the McNemar test for differences between paired proportions evaluated whether individuals’ changed across time ($P < 0.01$). A complex pattern of regional consistencies and differences emerged. For example, 60-70% would be ‘very concerned’ if the 12 climate change indicators occurred over the next 20 years. Yet, significantly more baseline farmland residents felt intense concern about hotter days, arrival of new plants/animals, and changing seasonal patterns; LM residents voiced higher concern about marine life loss and flash floods. At follow up, farmland residents retained concern about drought, but not marine life, while those closest to the lake (LM-R) were significantly more concerned about sea level rise.

The longitudinal data suggest a marked decline in observations of climate change indicators (except hotter days), while concerns and expectations of future impacts, though somewhat reduced, remained elevated. Several adaptation actions under one’s own control are well established, but activism is still rare. More people are willing to disagree with ideals of environmental equity, but most maintain an ethical stance. Discussion examines actual weather conditions, deeply held environmental beliefs (e.g., natural cycles), item specificity, intentional versus conservation impact action, and changes in political context.
Using the Most Effective Communication Tools and Techniques to Reach Primary Producers with Outcomes of Adaptation Research

Poster Number: 310

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¹Sefton & Associates

Communication agency Sefton & Associates is currently implementing a communication program on behalf of the Department of Agriculture, Fisheries and Forestry (DAFF) Climate Change Research Program (CCRP).

The CCRP is a significant research effort and marks a new emphasis on providing practical solutions for agriculture to adapt and respond to a changing climate. Priority research areas include reducing greenhouse pollution, better soil management and climate change adaptation. The CCRP focuses on encouraging information and experience to flow both ways between producers and scientists.

The Australian Government has contributed $46 million over the past three years to this program and an equivalent level of matching funds has been raised through research agencies and rural industries research and development corporations, resulting in strong collaborative partnerships.

To engage primary producers Sefton and Associates and DAFF developed a comprehensive communication plan. The plan aims to raise awareness of the research among primary producers and their influencers and to demonstrate how the outcomes can assist primary industries to mitigate and adapt to climate change.

The communication is tailored to have the most impact on producers and influencers, and is using particular language, style and tone to ensure effectiveness.

The tools and techniques being used include large producer and influencer events, smaller producer events, videos, media material and proactive and targeted media relations, newsletters, websites and channelling information through existing networks. The effectiveness of each of these communication channels is assessed on an ongoing basis and will be summarised at the conclusion of the Program (June 2012). These insights into communication effectiveness can be shared at the 2012 Climate Adaption in Action conference.
How Adaptation-ready Are Resource Extraction Industries?

Poster Number: 102

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Mining and fisheries industries are involved in resource extraction, but are at opposite ends of the mobility spectrum. Mining takes place in a fixed location restricted spatially by the geological location of minerals. Fishing is the last of the major hunting industries and despite having somewhat fixed bases, fishers chase mobile animals across the ocean. Both industries are subject to environmental variability that impacts on their direct activities, and those of their production chain, yet typically they consider themselves to be resilient to such variability: “we cope - it’s always been that way”. Recent evidence suggests that climate variability does impact performance, and that climate change will have large impacts on these industries both by intensification of previously experienced hazards and by the challenge of coping with new hazards. Therefore, we suggest that climate adaptation in both industries is likely to lead to improved business performance. In this paper we aim to compare examples of adaptation practice that are taking place in both industries. Using these examples, from apparently disparate primary industries, we are able to generalize lessons learned regarding perceptions of risk, engagement approaches with industries, barriers to behavior change, and the role of recent extreme events in facilitating climate change adaptation behavior. These findings provide insights for industry, policy and researchers with an interest in facilitating climate change adaptation to build resilience across primary industries.
Climate Change Projections: What Information and Data Do People Need?
Poster Number: 311

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Climate change projections provide the best information available on likely future climate conditions. CSIRO and the Bureau of Meteorology produce national climate projections, based on climate modelling under different emissions scenarios. The last projections were released in 2007. They were supported by brochures, a detailed technical report and a web site: 

www.climatechangeinaustralia.gov.au

The information has been used extensively, with 120,000 page views to the site in October 2007 following release of the projections. Since then there have been around 40,000 page views each month, with no sign of a decline.

In 2011, CSIRO commissioned LCubed, a web communication company, to undertake a comprehensive survey of almost 900 Australians who were site subscribers or who had participated in climate change events. The objective was to learn what improvements are needed for the site and the best way of supporting the next Australian projections, planned for 2014.

The overwhelming majority of respondents thought that CSIRO and Bureau of Meteorology being responsible for the site was essential for its credibility. Most users wanted to be able to download data, a facility not currently provided.

Recommendations from the survey include a redesigned interface, incorporating 'infographics' and adding resources for laypeople. The site needs to be better publicised, with organisational branding more prominent. Video and on-line presentations would be helpful, as would expert commentary and presentation material. There should be greater interactivity, and more links to background information, such as climate science, FAQs, and a user guide.

Making the information as accessible as possible to end users is an important aim of the upcoming projections. There is an ongoing process for eliciting the needs and views of government and industry users.
Retrospective Evidence-Informed Policy and Corporate Climate Change Mitigation: Can It Be Prospective in Case of Climate Change Adaptation?

Poster Number: 211

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It has been observed that the focus on ‘corporate environmental strategy’ and ‘corporate climate change strategy’ are overlapped largely in the area of corporate harms on environment or ‘inside-out effects’ of corporate activities on environment. Any related corporate activities to reduce that harm fall within the domain of climate change mitigation. Although policies have been formulated in different countries to ensure corporate climate change mitigation, many of the policy making processes were retrospective in nature on the basis of actual evidence and after harms are resulted; undermining the ‘precautionary principle’ for environmental protection. However, it has been also observed that corporations are facing the effects of climate change in their business operations and have to address those ‘outside-in effects’ through a different set of corporate climate change strategies. While a considerable amount of evidence-informed policies are focused on ‘inside-out’ impact related corporate strategies, a negligible focus is on the ‘outside-in’ impact related corporate strategies or corporate climate change ‘adaptation’ strategy. This strategy could be defined as the adjustment in business strategy to avert risks along with exploiting beneficial opportunities created by climate change impacts. However, the negligible focus on the issue as a whole has created the possibility of corporate activities that may be beneficial for corporations within the definition of climate change adaptation while bringing no disadvantageous consequences for society. As ‘maladaptation’ is observed as the actions which increase vulnerability rather than resilience, it is therefore imperative to take measures so that legitimate, democratic and accountable corporate governance in relation to climate change adaptation strategy could be ensured. Bearing this in mind, through presenting some current debates around corporate climate change strategy and likelihoods of maladaptation, this paper presents a framework of prospective evidence-informed policy making process to be adopted through respecting the ‘precautionary principle’.
Thinking Globally, Acting Regionally – Victoria’s Greenhouse Alliances

Poster Number: 514

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There are some who claim Australia is over-governed with MPs and councillors of national, state and local governments clamouring variously for funds, responsibility and relevance. The national government includes in its responsibilities oversight for Australia’s international agreements and treaties and it funds national research. Among the many roles of state government is legislation for and administration of environmental management and planning law. Local government, within its municipal boundaries, does much much more than the much touted roles of rates, roads and rubbish. Among the many responsibilities of councils are the implementation of planning schemes, constructing and maintaining adequate drainage systems and the provision of a range of community services.

Climate change is a challenge to this arrangement. Typically, local government only works for its own communities, when climate change impacts are clearly broader than that. Regional groupings of councils, bringing the deep knowledge that they have of their own communities to the efficiencies that derive from working across a number of communities, are an extremely effective way of responding to climate change.

Victoria’s greenhouse alliances are successful examples of local government collaboration. These associations are more than just occasional meetings of interested councils though – they are formal entities with strong governance, mature strategies for dealing with diversity and a range of ways of working to respond to the breadth and depth of the climate change challenge.

In this paper, two alliances will be examined for the structures that they have, the processes that they follow and the operations that they conduct. The authors, executive officers of their respective alliances, will argue that the regional level is particularly effective for a comprehensive climate change response.
Climate Change Coping and the Effect of Social Norms and Message Framing on Those with Extreme Worldviews

Poster Number: 312

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Acceptance of climate science is a basic requirement for commitment to action to reduce global climate change. However, previous research has shown that support for a laissez-faire ‘free-market’ ideology predicts the rejection of climate science, as well as decreased willingness to take action to reduce climate change (Heath & Gifford, 2006). Here, we explore whether social norming information can mitigate the effect of extreme worldviews on attitudes towards policy action to reduce carbon emissions. People with low and high support for the ‘free-market’ will be recruited from a large pre-tested sample. They will be given information about carbon emissions in three different scenarios. One scenario (control condition) will provide solely descriptive information about Australia’s carbon emission, with no comparative data. The second scenario will provide (true) social norming data that places Australia among the most-polluting nations of the world (4th out of 141 based on CO2/kWh). A third scenario will provide information only about Australia’s position relative to the average. Subsequently, people will be asked in a hypothetical referendum scenario to indicate their support for various extents of carbon emission cuts. Sometimes, the loss of future personal income associated with committing to the different policy options will be framed as an ‘opportunity cost’, whilst sometimes the future loss will be framed as a ‘foregone gain’—where income still stands to increase in the future, but not by as much as without emission cuts. Previous research has shown that people express a greater willingness to act to reduce climate change when policy options are conveyed using a ‘foregone gain’ framing (Hatfield-Dodds & Morrison, 2011). We predict that the provision of rank-based social norming information and ‘foregone gain’ framing of the future losses associated with committing to climate change alleviation policies will mitigate the effect of extreme ‘free-market’ worldviews on adaptive coping.
Predictability of Global Crop Yield Variations Using Seasonal Climate Forecasts

Poster Number: 620

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An increased volatility of the world’s food supply induced by climate extremes under changing climate and anticipated rise in food prices are concerns for food-importing countries, specifically people living in poverty. Seasonal climate forecast offers prediction information for the mean state of climate on a seasonal time scale (e.g. 3-month average) with various lead times up to one year. Translating such climate information into food production in major exporting countries is useful for food-importing countries to ensure food security. Additionally, applications of seasonal climate forecasts offer the test bed to utilize climate information to adapt climate risks in a more practical manner; this offers help to stakeholders regarding adaptation to long-term climate change.

This study assessed the predictive skill of crop yield variations for maize, soybean, rice, and winter wheat over the world’s harvested areas using the seasonal climate forecasts performed by the atmosphere-ocean coupled general circulation model SINTEX-F. First, we specified the single driving climatic factor that governs the interannual yield variation (represented by the NOAA/AVHRR-derived net primary production during the whole growing period) from the reproductive growing season-mean temperature (T), vapor pressure deficit (VPD), and solar radiation (SR).

With one-month read time, the SINTEX-F model showed the predictive skill of the mean summer (June, July, and August) temperature in many terrestrial areas except for high latitudes by means of Pearson’s correlation between the nine-member ensemble-mean forecast and JRA25 reanalysis data. However, almost no skill was found for the mean summer VPD and SR with exceptions such as Australia. If we combined the driving climatic factors and predictive skill of climate, the areas where the prediction of crop yield variation is skillful could be specified.
Climate Change and Dengue Fever: Vulnerability and Potential Adaptation Responses in Urban Settings of Bangladesh

Poster Number: 410

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Natural phenomena, such as the geographical location and geo-morphological conditions of Bangladesh have made the country exceptionally vulnerable to climate change. Climate change impacts including health are already being felt in Bangladesh and they threaten to pose a significant economic burden on the country, and hinder its development in the medium to long term. The nation’s vulnerability to floods, tropical cyclones, storm surge and droughts pose threats to health in direct and indirect ways. Of these health impacts, vector borne diseases, and in particular, dengue fever threatens a large population at risk. There is an urgent need to manage this vector borne disease considering the country’s economic burden, and its public health importance. As a first step, there is an unmet need to better assess vulnerability in order to develop effective health adaptation strategies. Thus it is essential to know the climate change vulnerability to dengue fever considering its disease pattern, influencing factors, mechanism, vulnerable populations and locations. This study is doing an assessment of vulnerability in Dhaka and Chittagong, two locations in Bangladesh where dengue is currently endemic and rates predicted to rise by exploring Bangladeshi stakeholders' knowledge and understanding of climate change vulnerability to dengue fever on which to develop health adaptation responses.
Identification and Characterization of Freshwater Refugia in the Face of Climate Change

Poster Number: 808

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Freshwater ecosystems have very high biodiversity relative to their areal extent. They are particularly vulnerable to climate change because of their limited extent, their limited connectivity and, in much of Australia, their susceptibility to drying resulting from the high variability of temperature and rainfall. The possible impacts of climate change on fresh waters must be assessed in relation to changes in both temperature and riverine networks (e.g. flow and linear connectivity) and their interactions with existing stressors (e.g. impoundments, agriculture, urbanisation) and the surrounding landscape (e.g. topographic features and riparian vegetation). Identifying, characterising and mapping the biophysical environments that will enhance the persistence of freshwater biodiversity across Australia will provide an invaluable resource to better inform climate change adaptation actions and, inform the selection and implementation of appropriate adaptation actions for the protection of freshwater refugia. In this presentation we will introduce the National Adaptation Research Plan project on Freshwater Refugia the key objectives of which are to: define a typology of refugia for freshwater ecosystems, identify the spatiotemporal extent and quality of freshwater refugia under a range of future climate scenarios and inform the selection and implementation of appropriate adaptation actions for the protection of freshwater refugia. We will discuss some of the initial challenges facing the project (for example understanding changes in river flow regimes under climate change, the availability of spatial datasets for freshwater biota) and present some of our preliminary findings.
Building the Resilience of Communities and Ecosystems to the Impacts of Climate Change in the Pacific: Lessons from a Project Partnership

Poster Number: 120

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¹The Nature Conservancy

Many community-based adaptation activities are initiated and implemented through projects, facilitated by NGO’s, development agencies, with various partners, contractors and collaborators. Many aid projects typically have a short timeframe (less than three years); detailed upfront logframe; fixed budgets and schedules, and compliance and reporting requirements. All of these characteristics can be constraints and compounded when addressing a long-term and very real issue for communities in the countries where we work.

In 2010, The Nature Conservancy-led AusAID funded project “building the resilience of communities and their ecosystems to the impacts of climate change in the Pacific” commenced, with a short first phase timeframe of less than two years.

This first phase of the project, March 2012, highlighted key successes and shortcomings in a project-based approach to community-based adaptation in Pacific Island countries.

Successes included:

- Focus on participatory tools and evaluation of each stage of CBA planning and implementation
- Willingness of partners and donors to work at the pace and capacity of communities and local civil society groups
- Flexibility in direction and prioritising / weighting of project interventions
- Focus on supporting capacity and motivating local action, rather than outputs and achieving short-term outcomes
- Connection to governance structures, policy and government planning processes at local, sub-national and national levels

Lessons included:

- Over-ambitious design and complex structure of the project proposal
- Some level of assumption that external technologies and science would provide answers and solve problems
- Project timeframes are rarely appropriate to ‘implement’ CBA

Through participatory evaluation, project partners and AusAID’s International Climate Change Adaptation Initiative are working on a 6-month design phase to ensure continuation of the project is taken into account in Phase II.
Leadership in Uncertain Times - Decision Making Beyond Business As Usual

G. Johnston¹, K. Harris¹

¹Future Ready

Leadership in stable secure times is very different from times of uncertainty. Responding as a leader to climate variability and adaptation challenges requires a distinct range of skills and values. Kate Harris has developed a range of values based metrics to support leadership in climate adaptation and resilience. An experienced executive leadership coach, Kate is director of Learning, Culture Change and Leadership with Future Ready and a director of the Centre for Sustainability Leadership. Her work with leaders from Federal, State and local government, leading ASX corporations and community activists gives her a unique insight into leadership qualities. Social ecology methodologies, applied science and participatory processes support this research. Gareth Johnston has contributed through research from Climate Adaptation in the Boardroom funded by NCCARF and other corporate engagements.
Science for Decision Makers - Improving Adaptation Communication

Poster Number: 313

G. Johnston\textsuperscript{1}, D. Burton\textsuperscript{2}

\textsuperscript{1}Future Ready
\textsuperscript{2}Climate Planning

The science community and the climate science communities as subsets have struggled to have their findings clearly understood. A range of barriers including cultural, education, political and complexity are limiting effectiveness of communications. As adaptation pressures build, good policy responses and timely decision making becomes more imperative.

Citing case studies from environmental, corporate, aid organisations and government sectors, the authors Burton and Johnston assert that the adaptation science community must do more to make itself heard, the messages understood and to support decision making.
The Power of Local - Empowering Local Adaptation Responses

Poster Number: 515

G. Johnston¹, K. Harris¹

¹Future Ready

Future Ready has been engaged by capital city and other local governments to develop community adaptation capacity at local levels. Building support networks for voluntary leadership, enhancing capacity and developing better government-community linkages have proven critical. NGO, Government and business sectors have been brought together to co-develop responses.

Kate Harris will present iterative findings from these programs and highlight opportunities for improvement. Gareth Johnston as Director of Live Local will also supplement this presentation.
A Preliminary Economic Geography of Impacts and Adaptation for Australia

Poster Number: 212

R. Jones

Victoria University

The economics of adaptation is a micro-economic issue most often considered on a project by project basis, making it hard to gain a regional, multi-sectoral or national perspective. One way to assess this is to assess income across the total range of economic activities at regional, state and national scales according to their climate sensitivity. Total income for 2005–06 from ABS data is assessed for 169 activities and rated as having high, moderate, low or negligible sensitivity to climate change across 59 statistical divisions (SD). The first pass rates different activities without any geographical weighting for spatial variation within hazards. The breakdown of the national economy subject to high, moderate, low and negligible sensitivity to climate is 16%, 6%, 59% and 20%. This sensitivity is very unevenly distributed as a proportion of total income by SD. Highly agricultural regions are the most sensitive and the capital cities the least sensitive. The addition of regional risk weighting for hazards such as tropical cyclones will alter this mix somewhat, but rural and remote SDs remain the most vulnerable. Results incorporating geographic variations in climate risk will be presented. Regions with a few high value–high sensitivity climate sensitive activities will need to act very strategically in order to remain viable. Adaptation will map onto this geography quite differently; knowledge industries and service sectors will feature highly. Mapping adaptation onto the low carbon economy in some regional areas will also need to be done very strategically. Finally, two very high value sectors are poorly represented in the conventional economy: the invisible economies of water and biodiversity. This is a timely reminder that adaptation is as much about preserving both monetary and non-monetary values as it is about avoiding costs.
**Analysis of Spatial Rainfall Patterns in South Australia Between 2000 and 2010**

Poster Number: 516

**M. Kamruzzaman**¹, S. Beecham¹, A. Metcalfe²

¹University of South Australia  
²University of Adelaide

The aim of this study is to use geographical information system (GIS) tools to investigate the effect of topography on the spatial relationship of rainfall time series. We discuss three spatial statistical techniques, Kriging, rainfall oriented by a directional distribution model, and a graphical regression model for understanding rainfall behaviour in the context of the Adelaide Plain and the Mount Lofty Ranges. The spatial properties of the rainfall time series and their distributional features are investigated and related to topographical features. The time series is adjusted by removing seasonal and orographic effects so that they can be considered as individually stationary series on a plane. The standard deviational ellipse is calculated and this indicates directional trends in the time series. Variograms are calculated and their suitability is assessed. The anisotropy of the spatial field is also considered.
State and local government, and industry peak bodies and business associations, face important decisions regarding climate change adaptation. There appears to be a preference from these decision-makers for concrete dollar values on the economic impact (costs, benefits and distribution) of climate change adaptation options that proprot to represent the overall benefit of an initiative. This situation leads to a perceived need for economic impact assessments yielding precise dollar values. Such assessments are in fact rarely precise and costly to carry out.

Economists have a variety of tools at their disposal for these economic impact assessments, each with their own potential and limitations. Estimates on the costs, benefits and distribution of climate change impacts and adaptation options are hampered by limited availability of data. Assessments are also often imprecise for two key reasons: a) ascribing a dollar value to environmental and social impacts is difficult and costly, and is rarely undertaken, and b) the interactions of society, technological innovation, government policy and climatic conditions are immensely complex and hence difficult to predict the further into the future one looks. Treatment of uncertainty and sensitivity analysis further complicate assessments. Extensive economic impact assessments are not always utilised to their full capacity because of the reality of public policy and industry decision-making in which economic efficiency considerations are only one factor behind final decisions; this further calls into question the perceived need for resource-intensive precise estimates.

Communication between decision-makers and economists is essential for the selection of the right assessment method and appropriate interpretation of results. Qualitative assessments, order of magnitude or partial estimates would in many cases serve just as well as reportedly precise, single-figure assessments, if communicated clearly by economists and well-understood by decision-makers.
Barriers to Climate Change Adaptation: Quantifying the Disconnect Between Available Climate Information and the Needs of Rural Community End Users

Poster Number: 103

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1University of Newcastle

A number of limits and barriers impede the adaptation process, preventing well documented facts, key themes and recommendations from being effectively implemented. This presentation summarises recent research which focused on one of these many barriers – the disconnect between available climate information and the needs of rural community end users. Rural communities were the focus as they are particularly vulnerable to climate change as they are largely reliant on agriculture which is strongly dependent on weather and climate. While previous research, and anecdotal evidence, qualitatively establishes that a disconnect does exist, this research provided a “first-pass” quantification of the causes and magnitude of the disconnect. An online survey asked researchers, industry representatives and government representatives from both a climate science and climate adaptation background the following questions:

- Is the information that currently exists with which to inform climate change adaptation useful? If so, why? If not, why not?
- What information relating to climate impacts is required for successful adaptation?
- What do climate scientists do well? What do climate scientists do poorly?
- What do adaptation practitioners do well? What do adaptation practitioners do poorly?

Findings from the survey identified a lack of detail, format and legitimacy as causes of the disconnect. Additionally and of concern, one quarter of all survey respondents believed that climate information did not meet their needs. These findings are indicative of the extent to which the disconnect prevents the translation of climate information into action. Further effort toward robustly quantifying the causes and magnitude of the disconnect is necessary in order to achieve the considerable task of finding a solution to this barrier to adaptation.
Port Phillip Bay Coastal Adaptation Pathways Project (a Department of Climate Change and Energy Efficiency Coastal Adaptation Decision Pathways Project)

Poster Number: 209

A. Klindworth¹, L. Johnstone²

¹AECOM
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Climate change increases the risk to the coastal zone from more frequent inundation, accelerated beach erosion, loss of public land and private property and threats to natural ecosystems. Adaptation to these risks requires significant effort and investment in activities such as protective works, asset strengthening and planning responses. Consequently, the pressure to have clear and transparent decision making in response to coastal impacts will continue to increase due to aspects such as legal challenges, irregular and insecure planning, insurance and political conditions and community dissatisfaction or fracture.

Adaptation decision making is challenging due to the likelihood of conflicting stakeholder objectives, the limitations of available information and the inherent uncertainty associated with decision-making for long time horizons.

To assist decision making in the coastal zone, the Port Phillip Bay Coastal Adaptation Pathways Project created a framework to develop, assess and identify preferred adaptation pathways. The framework is underpinned by mapping of hazard areas, economic analysis of impacts and benefits and stakeholder consultation. Four case studies were undertaken to test the framework, focussing on inundation risks from marine flooding and local catchment flooding in the following municipalities; City of Melbourne, City of Port Phillip, City of Kingston and Shire of Mornington Peninsula.

The case studies enabled the framework to be tested on areas with a mix of land use types, geographic characteristics and development densities.

The decision making framework will be presented with a discussion of the case study learning outcomes and resources developed to support the framework’s application by the ten Port Phillip Bay councils and more broadly. These case studies challenge current thinking about adaptation in intensely developed areas, where a proactive design led response can address questions about ‘who pays’ and leverage private development to transform vulnerable areas.
Marine Protected Areas and Transboundary Governance

Poster Number: 216

L. Kriwoken¹, Julie Davidson¹, M. Lockwood¹

¹University of Tasmania

Australia’s marine ecosystems and resources are facing unprecedented climate variability and extreme events. The east coast of Australia is logging record high sea temperatures that will have a range of biophysical, social and economic impacts. Marine protected areas (MPAs) are a widely accepted management tool that protect marine biodiversity and support the sustainable use of marine resources. Australia is considered one of the international leaders in developing a representative MPA system. The Commonwealth of Australia and the states and territories broadly support the development of a national system of MPAs with the designation of representative samples of Australia’s marine ecosystems. The legal and policy framework that underpins the national system of MPAs means that in many cases cooperative and transboundary management arrangements must be implemented. This is especially the case for those MPAs that straddle the three nautical mile boundary between Commonwealth and state marine jurisdictions. The aim of this chapter is to explore the role of transboundary adaptive marine biodiversity conservation governance in the context of MPAs. Transboundary issues associated with MPAs are examined and their capacity for cooperative management assessed. Cooperative federalism in the marine environment is first introduced, followed by an examination of federal, state, local and non-state governance arrangements, the regional marine planning process and the National Representative System of Marine Protected Areas. Case studies are used to illustrate the types of challenges facing transboundary governance arrangements for MPAs in a changing climate. Issues of transboundary MPA management are then discussed and lessons drawn. The chapter argues for a broadening of the concept of transboundary issues in the context of MPAs and the need for wider formal and informal arrangements to enhance adaptive capacity and effective marine biodiversity governance and management.
Adaptation to Climate Change in the Pacific: Enhanced Seasonal Prediction of Climate Extremes

Poster Number: 121

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Climate change and climate extremes have a major impact on Australia and Pacific Island countries. Of particular concern are tropical cyclones and extreme ocean temperatures. As a practical response to adaptation to climate change, under the Pacific-Australia Climate Change Science and Adaptation Planning program (PACCSAP), we are developing enhanced web-based information tools for providing seasonal forecasts for climatic extremes in the Pacific.

Tropical cyclones are the most destructive weather systems that impact on coastal areas. Interannual variability in the intensity and distribution of tropical cyclones is large, and presently greater than any trends that are ascribable to climate change. In the warming environment, predicting tropical cyclone occurrence based on historical relationships, with predictors such as sea surface temperatures (SSTs) now frequently lying outside of the range of past variability meaning that it is not possible to find historical analogues for the seasonal conditions often faced by Pacific countries.

Elevated SSTs are the primary trigger for mass coral bleaching events, which can lead to widespread damage and mortality on reef systems. Degraded coral reefs present many problems, including long-term loss of tourism and potential loss or degradation of fisheries. Monitoring and prediction of thermal stress events enables the support of a range of adaptive and management activities that could improve reef resilience to extreme conditions.

Using the climate model POAMA, we aim to improve accuracy of seasonal forecasts of tropical cyclone activity and extreme SSTs for the regions of Western Pacific. Improved knowledge of extreme climatic events, with the assistance of tailored forecast tools, will help enhance the resilience and adaptive capacity of Australia and Pacific Island Countries under climate change.
Uncertainties in Flood Risk Projections: Support for Risk-based Decision-making

Poster Number: 203

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Uncertainty about magnitude and timing of future climate-driven changes in flood risk and socio-economic development represents significant challenges for flood risk management. The current decision-making context often demands a single best estimate of current and future flood risk to justify any responses that could limit development in areas at risk. However, a single best estimate focus ignores the range of alternative futures and can thus result in a maladaptive focus on enhancing protection and a false sense of security.

A more nuanced, risk-based approach to managing future changes in flood risk requires consideration of a wide range of alternative scenarios, but this is often constrained by the high cost and complexity of modelling. Here we demonstrate a simplified approach for evaluating uncertainty in future changes in flood risk, using the Hutt River in New Zealand’s lower North Island as case study. We applied a simple algorithm to estimate future changes in rainfall extremes, calibrated to a regional climate model and tuned to a range of emissions scenarios and global climate models and show that the probability of a current 1percent Annual Exceedance Probability (AEP) event could have increased by the 2090s to anywhere between a 1.5percent and more than a 10percent event.

We argue that using the full range of uncertainty strongly encourages more flexible risk management approaches, whereas focusing on best estimates promotes a protection-focused response to flood risk that could prove maladaptive given uncertainties in future changes. Flood risk managers using this more dynamic approach for an initial screening assessment may be able to more readily scope response options suited to changing flood risk and that can incorporate protection, accommodation, spatial planning and potentially retreat. Such simple to use tools are more likely to be taken up where councils are resource constrained.
The Role of Climate Change Adaptation Intelligence System (CCAIS) for Communication and Integration of Information Related to Climate Change Adaptation.

Poster Number: 122

E. Lee¹, M-J. Lee¹, S. Park¹, Y. Lee¹

¹Korea Environment Institute

At present, climate change is the most significant environmental issue globally. From its inception, the international effort for climate change has focused on mitigation of greenhouse gases (GHGs). But, according to IPCC, even if the level of GHGs remains at the level they were in 2000, the gases released prior to then will still effect global warming. This is why the international effort for climate change must deal with adaptation. Recently, integration of climate change information has become crucial in regards to climate change adaptation at the policy development level. Currently, however, such adaptation information is based on different sources from many governmental departments and institutions. So, an integration of adaptation information stemmed from various sources and systems through the integrated information system is needed. For this reason, Korea Adaptation Center for Climate Change (KACCC) has constructed CCAIS (Climate Change Adaptation Intelligence Delivery System) in 2011.

The purpose of this study is to introduce of overall CCAIS utilization in the adaptation step and to examine the configuration of the CCAIS. CCAIS’s primary sources are documents, statistics, and geo-information based on Web-GIS. All data collected from 157 sites related to climate change and reclassified to increase user convenience. Also, this system provides advanced search function about the structured metadata and real time news through conjunction with and external sites. So, through this system, climate change and climate change adaptation trends can be identified at a given time.

CCAIS is highly accessible and convenient because users can utilize the system by simply connecting to the internet without the need to install any programs. So that it is a very effective tool to collect, generate, manage and share data and information on climate change adaptation.
Assessing the Climate Vulnerability of Australia’s Threatened Species
Poster Number: 802

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Species’ distributions are determined by many non-climatic factors such as dispersal ability, life history traits, interspecific interactions or genetic factors, therefore hampering accurate predictions about their future distributions under climate change. As part of an NCCARF-funded project we are currently working to integrate these factors into a vulnerability index for threatened Australian species and to determine which species are particularly affected by climate change as a consequence of non-climatic factors. Here we (i) document the potential non-climatic limitations to the distributions of threatened species in Australia, (ii) present a climate vulnerability index for Australia’s threatened flora and fauna listed by the EPBC Act (1999), and (iii) compare values of this index with recent conservation status of species to look for evidence of climate change impacts on threatened species.
What is Everyone Else Thinking? Pluralistic Ignorance and False Consensus About Community Acceptance of Anthropogenic Climate Change.

Poster Number: 304

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\textsuperscript{1}CSIRO Australia
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What do people think others think about the causes of climate change? Generally, people exhibit a range of mental biases when estimating the prevalence of others’ opinions, attitudes and beliefs. These biases include a tendency to overestimate how common one’s own opinion is (false consensus), to underestimate majority opinion, and to overestimate unfavourable or ‘deviant’ opinions (pluralistic ignorance). These biases are important to understand because, if left unchallenged, they can influence actual opinions. We sought to establish the extent to which these biases manifest in people’s estimates of community consensus about the causes of climate change.

In two surveys conducted 12 months apart (n=5036; n=5030), respondents were asked to select one of four belief statements that most accorded with their view: that climate change was not happening, that they didn’t know, that it was occurring but due to natural processes, or that it was occurring and mainly human-induced. Respondents were then asked to estimate levels of agreement with each belief statement among the general population. Every belief group displayed false consensus; that is, estimates of consensus with their own view were higher than estimates made by other belief groups. Every belief group overestimated the prevalence of climate change denial in the general population. For those who thought climate change was happening but a natural process, high levels of false consensus were associated with reduced levels of pro-environmental behaviour, reduced levels of individual responsibility to act, and reduced perceived efficacy of acting. Those with high levels of false consensus were less likely to change their mind about the causes of climate change 12 months later. The results support the notion that false consensus and pluralistic ignorance about climate change beliefs serve a social support function for unfavourable viewpoints and inaction. Implications for climate change communication are discussed.
**Measuring the Adaptive Capacity of Registered Nurses in Global Green and Healthy Hospitals**

Poster Number: 403

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Purpose: The presentation will inform health professionals of the need to benchmark the adaptive capacity of registered nurses as changes within Australian health systems adapt to climate change.

Methodology: A critical analysis of literature related to the above was undertaken as part of a PhD research program. This analysis focussed on global changes that are occurring in global health systems as part of restructuring to reduce environmental footprints.

Findings: In 2009 a draft paper for global attention was written by the World Health Organisation and Healthcare without Harm. The paper contained seven key elements regarding what constituted a ‘Climate-friendly’ hospital. A percentage of global countries responded by creating either super hospitals, sustainable hospitals or by remodelling already established health systems. In 2012 Healthcare without Harm will launch ‘The Global Green and Healthy Hospitals Agenda’. This new agenda contains ten action goals which will support sustainability promotion in hospitals.

Originality/value: There is a paucity of research within this area pertaining to the measurement of the adaptive capacity of registered nurses working within this new environment. Information analysed regarding Global Green and Healthy Hospitals remains in contention. Anecdotal information from various healthcare systems have been both confusing and conflicting, and is often dichotomous in position when addressing health in a changing world. Lack of research especially within the area of adaptive capacity of registered nurses contributes to this. This paper will highlight the current state of play in Australia in adaptive strategies and will outline the need for further research within these areas as they pertain to registered nurses adapting to work in a changing environmental health system.
From GCM/RCM Raw Data to User Experience: Towards an Extendable Decision Support System for Urban Planning

Poster Number: 204

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Population and development pressures will, in all likelihood, continue to grow at a rapid rate, especially for urban areas. This process could result in unprecedented risks to urban areas from climate change impacts, such as sea level rise, storm surge, extreme rainfall and temperature events, and cascading secondary effects. To face these challenges, a prototype toolkit, called GENIES, was developed as a climate change decision support system for urban areas, to include the climate change impact and risk assessment, and potentially extends to the major sectors: climate related hazards resilience, water, transport, and health. A series of climate change impact models (flood, storm surge, heat waves and other impact models as raised during the project), economic models and multiple criteria decision analysis tools will be developed and incorporated into GENIES. The flexibility of the system will be obtained by establishing standard model and data libraries or modules that provide the building blocks for a number of similar applications by deploying system dynamics approach. The system is multi-layered while the core of the system provides the fundamental scientific understanding of the climate change issue and the universal graphic user interface and model development environment. The interactive layer should allow the efficient and effective interaction between model developer and end user. The policy making layer facilitates the policy making processes and provides support in various formats, including, guidance, graphs, maps, and technical information. The participatory assessment approach will be applied through working with urban policy makers and planners from targeted cities.
How to Build Soil Carbon with Sub-tropical Pastures on Marginal Crop Lands for Climate Change Adaptation

Poster Number: 621

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Well-managed grass pastures build soil carbon slowly through microbial processes. Legume pastures that fix N and drive higher biomass production of associated grasses, drive a more rapid carbon accretion. In legume swards, organic carbon accretion has been in the order of 12-15% of the biomass produced/annum. Enhanced soil carbon is beneficial because it enables greater infiltration and retention of rainfall and this compensates for expected increases in temperature and more uncertain rainfall.

Marginal cropping lands in the sub-tropics are usually in poor condition with soils having reduced organic matter, low N fertility, and poor structure. They are constrained by limited infiltration, water holding capacity, and associated with higher erodibility. They are more vulnerable to the expected impacts of climate change concerning increased aridity and/or increased rainfall intensity. Establishment of pastures on these lands is often desirable but difficult because of the significant challenges from the climatically variable environment and the relative short-term profitability of grain growing versus grazing in good seasons.

This paper reviews progress over the past 50 years regarding appropriate methods for transforming marginal cropping lands to permanent or ley pastures. This reveals: (a) significant progress in the release of productive, well adapted grass and legume cultivars, (b) improved land preparation and sowing methods to achieve successful establishment, (c) improved risk management practices through increased knowledge of weather systems and climatic phenomena such as El Nino and La Nina, (d) variable rates of soil carbon accretion between 450-650 kg/ha/yr until reaching equilibrium, depending on season. We recommend that incentives are needed with accompanying education programs that include longer-term economic analysis by: (a) continued accelerating adoption of improved pastures to build soil carbon, (b) developing ‘best-management’ practice manuals on managing climate risk, and (c) measuring carbon fluxes in grazed grass/legume pastures to demonstrate how to maximise soil carbon accretion.
Adaptation Strategies for Apple Orchards Dealing with Climate Challenges in the Goulburn Valley

Poster Number: 622

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The Goulburn Valley in Victoria is the most significant apple producing region in Australia, however, apples in this region rely on the availability of irrigation water and are growing close to the upper limit of their ideal temperature for commercial production. Current climate challenges in the Goulburn Valley include reduced availability of irrigation water, increased sunburn damage of fruit, reduced winter chill and increased frost damage, with associated reductions in potential yield. Apple growers in the Goulburn Valley have already begun adapting to these challenges with more appropriate varieties, improved water management and infrastructure upgrades that include spray-on sun protection, shade netting and evaporative cooling.

A possible adaptation strategy for the industry is to relocate further south. This would be a major transformational change and may be limited due to lack of suitable land, water and infrastructure.

Options for incremental change to adapt the industry to a warmer climate are currently being used by innovative fruit growers. Under current climate change scenarios for the region, wider and more sophisticated use of these options can most likely maintain an economic apple industry in the Goulburn Valley for the foreseeable future, especially if the market is willing to pay for the extra costs of production and/or provided growers can find further innovative adaptation strategies and productivity gains.
Responding to Climate Change: How Older People Cope with Heat Extremes

Poster Number: 517

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Recent heatwave experiences in Australia have indicated that older people are at greater risk of heat related ill health. Older people have responded to heat waves for many years prior to the introduction of air-conditioning. However not all communities are adversely impacted to the same degree. The aim of this study was to explore the heatwave experiences of older people in a community from north western Victoria regularly exposed to heat extremes. This project involves several stages, with the results of the focus group discussion and household interviews reported here.

Fourteen people attended a focus group to discuss knowledge and behaviours related to hot weather. Participants were asked to comment on heat adaptive behaviours used prior to air-conditioning and those used recently. These included sleeping in cooler places with breezes, wetting clothing, blocking heat by shading house/windows, rescheduling daily activities to the morning, and changing eating patterns. Participants were not aware of specific heat health alerts, but based decisions on temperature forecast. Participants were generally sceptical of climate change, believing that the changes were cyclic and could be adapted to, but raised concerns about electricity cost, water insecurity, and infectious diseases.

Household interviews were conducted in 20 households with 26 participants (Mean age 72.5 years (range 55-90); 11 female, 15 male; 32% from single person households). Overall, respondents did not feel vulnerable to heat, but some reported specific heat-related health concerns or knowing ‘others’ who were vulnerable. High levels of physical and social activity were reported. All houses had at least one air-conditioner and most had adaptations to provide shade. Houses differed with respect to age, construction and location within the town.

The outcomes of this project will provide critical information to older people and the general public about preparing and responding to heat-events.
The Use of Global Climate Model Output in Climate Change Impact Assessments: A Case Study of Wheat Yields in New South Wales

I. Macadam¹, D-L. Liu², A. Pitman¹, P. Whetton³, H-P. Zuo⁴

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Assessments of the potential impact of climate change are one source of information available to support decisions on climate adaptation. Many of these assessments make use of the output from Global Climate Models (GCMs). However, GCMs are not capable of realistically representing the local climate conditions that are important to many impact assessments. Therefore, GCM output is usually “downscaled” and “bias-corrected” in some way to derive data that provide a more realistic representation of local climate conditions. A common finding of climate change impact assessments that use downscaled GCM output is that different GCMs yield different impact projections. Further uncertainty can arise from the use of multiple downscaling and/or bias-correction methods.

This presentation uses the case study of future wheat yields for New South Wales (NSW), Australia to illustrate how differences in downscaled climate projections can lead to differences in impact projections. The APSIM agricultural model is used to simulate wheat yields for the 2059-2098 period for a selection of sites in NSW. APSIM simulations are performed forced with climate data downscaled from simulations of different GCMs. Although all of the GCM simulations are forced with the same scenario for greenhouse gas and sulphate aerosol emissions, total wheat yields for the 2059-2098 period show substantial differences between the different GCM-forced APSIM simulations. Implications for climate change impact assessments are discussed.
A Simplified Scale for Assessing Current Impact of Climate Change in the Pacific Region

Poster Number: 314

M. Macfarlane¹

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Climate change is regarded as one of the greatest policy challenges ever faced by governments and policymakers. To understand and compare the impact of climate change between regions requires a clear and consistent measure. To date there is no one simplified scale for measuring climate change impact for policymakers and the general public. This paper highlights the need for a simplified impact scale to improve clarity and reduce complexity in communicating climate change impacts to a broader audience.

Further, the paper presents a simplified prototype scale option for measuring and communicating climate change impacts. Subsequently, the scale was trialled by 18 Pacific Islands states and a survey was undertaken. The paper analyses the results of the Pacific trial and provides a synopsis on the findings.
Climate Justice: Gaps and Opportunities in Government Policy

Poster Number: 411

M. Maloney

Griffith Climate Change Response Program

The impacts of climate change will affect different communities differently. As noted by Garnaut, "the most vulnerable in our community would be the most affected by climate change ... people who are well off will be able to insulate themselves from the effects of climate change ... poorer people in society won't be able to". As a society, if we are to adapt successfully to the impacts of climate change, we must ensure that everyone can participate equally.

This paper argues that ‘climate justice’ presents significant risks and opportunities to government policy, but Australian governments (Federal, State and Territory) have so far failed to address the issues or create a framework for response.

This paper explores what ‘climate injustice’ looks like, drawing on examples in Queensland and around Australia. It argues that climate justice is an increasingly complex element within the broader field of ‘environmental justice’ and the absence of environmental justice policy frameworks in Australian government have contributed to the inability of government to grapple with climate justice.

Using the term ‘environmental equity’ to capture both climate justice and the more traditional aspects of ‘environmental justice’, this paper draws attention to the lack of existing government policy on environmental equity, and why this is problematic. It argues that achieving environmental equity is a particular challenge to governments because it cuts across existing policy ‘silos’: health, environment, communities, housing, employment and transport. It then examines some of the initiatives undertaken in the US and UK and presents a framework for Australian governments to address environmental equity and utilise it as a new paradigm for empowering civil society and achieving healthy and sustainable communities.
Adapting to Uncertainty

Poster Number: 205

M. Manning¹

¹New Zealand Climate Change Research Institute

Climate change science, and its assessment by the IPCC, have an increasing focus on uncertainty in both understanding of processes and the ability to quantify future changes. However, this can create a barrier for effective communication because uncertainty about the future is often interpreted as a reason for delaying response. However, risk management combines uncertainties with the associated values or damages and is broadly accepted in contexts such as engineering and economics.

While quantifying damages associated with potential climate events or trends can be very dependent on circumstances and value judgments, it can be shown that a risk management approach provides similar perspectives whether considering either high or low damages. Thus risk can be used as an effective way of communicating objectively about uncertainty.

As shifts in the frequency distribution for climate events become more obvious, it is clear that the risks caused by extremes are changing much more rapidly than average climate conditions so there is a need for rapid adaptation to storms, flooding, and drought. Projections for future sea level rise also show a need to deal with accelerating changes in low-lying coastal areas, because the dominant cause being loss of glaciers and ice sheets means that the rate will increase with global temperature. Thus anticipating rapid changes in risk is becoming essential for resilience.

Dealing with rates of change in risk also needs to be extended so as to deal with the growing evidence for “regime shifts”, rather than smooth trends in climate change. Furthermore limits to scientific understanding must be dealt with in ways that enable management of risks associated with both epistemic uncertainty (IPCC’s “confidence”) and aleatory uncertainty (IPCC’s “likelihood”). A generalisation of Bayesian inference, as used in complex engineering systems, provides a basis for this and is now becoming increasingly relevant for climate science.
Gold Coast Urban Agriculture and Food Supply Chain Redevelopment Project

Poster Number: 524

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The project investigates the re-establishment of local food production, sale and purchase opportunities within the city. The project’s key objective is to identify suitable processes and strategies to successfully reinstate a local food supply industry on the Gold Coast. The project identifies the changes required to the existing situation in order to reinstate this supply chain.

The project was an outcome of the Gold Coast City Council’s Climate Change Strategy. The project focused on methods of reducing peak oil consumption and carbon emissions through a revision of the methodologies associated with growing, processing, distribution and sale of food. And what impact that localising these activities would have on the overall carbon emissions and peak oil usage.

The project investigates closing the food production and supply loop, ensuring a complete lifecycle from production to waste, and enabling the reuse of suitable waste products back into the growing system. Although the basis of the project was the issue of climate change and the role that urban agriculture can have on adapting city's to cope with the effect of climate change. The project also identifies the environmental, social and economic benefits of a project that emerged as a climate change adaptation tool. The emphasis that such projects can have multiple associated benefits is crucial to its success, longevity and sustainability within a growing city.

The presentation whilst identifying the content, objectives and outcomes of the project will also identify the project history including the obstacles to the development and acceptance of the project to date. The discussion also includes the methodology in realising the project including the strengths, weaknesses and suitability of the concept.

The presentation will also discuss the need for the dissolving of cross border competition and deal with this issue as a regional response to a global issue.
Adaptation Insights from Extreme Weather Impacts on Great Barrier Reef Industries

Poster Number: 504

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Understanding vulnerability is an important first step in minimising the impacts of climate change on social systems. By providing knowledge of the vulnerability of resource-dependent industries and communities and the people within them, decision-makers can prioritise their efforts, identify options for building resilience and can provide a basis for early engagement. We consolidate learnings across scales and present a modification to the IPCC framework for assessing vulnerability that specifically targets the individual scale. An understanding of how individuals respond and adapt to change is pivotal to understanding the extent and nature of adaptation potential in communities and other groups of people. We use the modified IPCC framework to describe and assess the vulnerability of commercial fishers and marine-based tourism operators in the Great Barrier Reef region to recent extreme weather events. Using the framework allowed us to understand the nature of vulnerability and make predictions about who was more likely to be vulnerable than whom. We tested predictions with interview data from 145 commercial fishers and 62 tourism operators. Our results suggested that fishers and tourism operators that were more resource dependent (climate sensitive) and had less adaptive capacity were more likely to be impacted (directly and indirectly) by the climate events. We show how the framework can inform climate adaptation planning through identifying specific barriers to adaptation that exist at the individual scale.
**Connectedness to Nature: is a Sane Mind Resilient to the Psychological Impacts of Climate Change?**

Poster Number: 405

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**Background:** Research suggests a relationship between a person’s connectedness to nature and their health. Increased connectedness to nature may decrease negative behaviours and states such as aggression, anxiety and depression and increase health, positive behaviours and cognitive capacity. Exposure to nature may lead to many desirable health outcomes.

Research into the psychological impacts of climate change tends to be event-focused; framed in terms of disasters (bushfires, floods, cyclones etc.). However, there is a growing awareness and body of research on the longer term psycho-social implications of climate driven phenomenon including as they relate to mental health.

How does the relationship a person has with their natural world influence resilience to adversities such as climate driven phenomena and climate change?

**Aims:** The aim of the research is to determine the relationship between connectedness to nature and resilience to the psychological impacts of climate change; develop a comprehensive understanding of the factors and interactions outlined in a conceptualisation and to document personal experiences of connectedness to the nature; climate driven phenomenon; and the relationship between these two and psychological health impacts.

**Methods:** The research will use mixed methods to measure correlation between participant’s connectedness to nature and their trait anxiety and ‘climate change’ state anxiety. It will then provide an opportunity for participants to give a ‘face’ to their experiences of climate change through the telling of their climate witness story.

**Findings:** Concepts of environmental connectedness, direct and indirect experiences of climate driven phenomenon and cumulative psychological health impacts of climate change will be presented. Preliminary findings and their potential application for developing community-based programs to build psychological health resilience will also be discussed.

**Conclusion:** Understanding the relationship between connectedness to nature and the psychological impacts of climate change will provide opportunities to create and expand knowledge of resilience.
Assessing the Transferability of the Integrated Systems Method for Building Capacity in Adapting to Extreme Events and Climate Change in Fiji

Poster Number: 123

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This article reports on a pilot project used to test the transferability and effectiveness of the participatory systems method to assist coastal tourism operators in Fiji and other countries in the Asia-Pacific Region in building capacity to adapt to impacts of extreme events, climate change and anthropogenic (man-made) pressures and hazards.

Half day workshops trialed a successful Australian method, format and procedure, where staff from two differing Fijian coastal resorts were provided with a brief background on the causes of climate change and the likely impacts of extreme events and climate change in the future. The Vensim computer program was trialed for recording participants’ responses and representing the data generated through a participatory data gathering and decision making approach.

The systems method and approach successfully revealed how resort staff conceptualised the drivers and impacts of climate change and effectively identified a broad range of barriers and opportunities to adaptive capacity of the participants from both resorts. The method was effective in identifying generic and context-specific adaptive capacity constraints. Generic constraints were related to a lack of understanding of climate change issues, while context-specific constraints related to dependency on supply chains, infrastructure and access: issues external to the core functions of the tourism businesses. The workshops also highlighted specific local strengths and weaknesses with regard to building future capacity. The participatory systems method appears transferable and effective as a process for improving understanding of the perceived adaptive capacity in the South Pacific tourism industry to respond to extreme events and climate change impacts.
Costs and Benefits of Adaptation to Coastal Inundation to Protect Appreciating Assets

Poster Number: 214

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Coastal inundation is a feature of current urban life, and is predicted to get worse as cities grow and climates change. Adaptation options exist to partially ameliorate the impacts of inundation, including the construction of sea walls, changed building codes, and staged retreat. To choose the mix of adaptations that can optimally protect a given area requires frameworks that can estimate the relative costs and benefits of the various options available. To be effective these techniques must account for all relevant costs of inundation and benefits of adaptation.

Many previous studies of the costs and benefits of adaptation to inundation have considered damage to infrastructure, but few have considered damage to land values. In contrast, the housing economics literature has estimated inundation damage to land values, but rarely considered adaptations to prevent damage in the future, nor how climate change may affect future inundation events. Incorporating damage to land values into forward-looking climate change studies is vital because cost-benefit tools place more importance on appreciating assets, like land, than depreciating assets, like infrastructure. Ignoring land assets risks substantial undervaluation of the benefits of adaptation.

We incorporate the results of a hedonic analysis of the value of inundation security to residential house prices in three case studies in Queensland, Australia, into a simulation model of coastal inundation to estimate the costs of inundation events under future climate change scenarios. We estimate the costs of implementing three adaptation options available to local councils and simulate accumulated damages to 2100 to calculate the net present benefits attributable to these adaptations. We find that all adaptations achieve greater benefits than their cost of implementation by 2100, and show that including appreciating lost land values as well as infrastructure damage is vital to accurately assess potential benefits of adapting to coastal inundation.
**Tropical Perennial Grasses and Hardseeded Legumes—Examples of Using Species Adaptation in a Changing Climate**

Poster Number: 624

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Historic rainfall in northern New South Wales (NSW) has been highly variable between years, decades and centuries and with climate change these extremes are predicted to be greater resulting in:

- Variable climate/rainfall with a trend in 2000-10 towards drier periods in autumn and late winter and increased rainfall in October–December
- Anticipated climate change may increase variability, with hotter and wetter summers predicted for northern NSW
- A need for adaptive and responsive pasture species. Tropical perennial grasses have demonstrated that they are a productive and persistent option.

As a result there has been an estimated 300 000 ha of tropical perennial grasses sown in northern NSW over the past 10 years. This rapid increase in tropical perennial grass sowings is not only attributed to the changes in climate and their adaptability, but also an increased research and extension effort to support their adoption.

These drier autumns and springs have also meant our traditional reliance on annual Trifolium subterraneum (subterranean clover) has had to change, providing opportunities for new legume species. The potential of a range of hardseeded temperate annual legumes, temperate and tropical perennial legumes, and tropical shrubby legumes that are under evaluation, is also discussed.
Building Knowledge and Capacity for Climate Change Adaptation

Poster Number: 224

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Sound climate change adaptation decisions need high quality information. While some relevant information is available, considerable new knowledge, well targeted at end users, needs to be developed. The Australian National Climate Change Adaptation Research Facility’s (NCCARF’s) Thematic Research Program was established to deliver new research and information to support effective climate change adaptation decisions, investments and initiatives in Australia. The Thematic program comprises 6 steps:

1. Identify key information needs of decision-makers;
2. Identify the knowledge and information available;
3. Determine key information gaps and priority research questions;
4. Commission research projects;
5. Ensure decision-makers and other research users are involved throughout research activities;
6. Deliver research findings in a timely and accessible manner.

NCCARF’s Thematic Research Program has now commissioned 96 research projects, covering nine key themes (Emergency Management, Human Health, Settlements and Infrastructure, Marine Biodiversity and Resources, Terrestrial Biodiversity, Freshwater Biodiversity, Primary Industries, Social Economic and Institutional Dimensions, and Indigenous Communities). Further cross-themes have emerged, such as heat waves and heat stress, coastal adaptation and local government adaptation.

The current research program will be completed by April 2013. Stakeholder engagement and communication about projects and their results occurs throughout each project life cycle. More comprehensive communication of findings will occur once research is completed, including reports, fact sheets and journal publication.

This research program has several enduring objectives:

1. Moving research and adaptation decision-making beyond ‘impacts’ and ‘vulnerability’ to ‘adaptation’ – that is, action to reduce detrimental and increase beneficial outcomes from climate change;
2. Increasing understanding by researchers and decision-makers about the needs, capacities and limitations of the other party – that is, what information is most critical to decision-makers, and what information can researchers realistically deliver;
3. Building Australia’s capacity to do and use climate change adaptation research.
Thermal Stress, Outdoor Public Space Use and Climate Adaptation - a Western Sydney Case Study

Poster Number: 525

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Outdoor public space use is key to human health and integrating physical activity, social interaction and connections with nature into urban lifestyles. Thermal stress significantly affects human behaviour in outdoor environments. This research explores everyday use of outdoor public space, and related influences on health of climatic conditions, especially urban heat, reflecting on microclimatic and climate change adaptation. Focus is given to communities vulnerable to heat-health impacts.

Few studies explore relationships between thermal stress, public space use and human health. Studies investigating the climate sensitivity of human health are mainly concerned with mortality, reflecting only extremes. However, thermal environments also impact on morbidity and an individual’s ability to perform everyday activities, particularly those activities requiring use of outdoor public spaces.

Anticipated climate change scenarios for temperate Australian cities include significant increases in temperature and frequency of extreme heat events, with major heat-health impacts, and have serious implications for healthy urban planning in general and microclimatic adaptation of public space specifically. Yet, urban heat is given marginal consideration when planning and designing cities due to poor interdisciplinary understanding between urban climatology, health and built environment sectors.

Population vulnerability and adaptive capacity differ substantially across and within regions, requiring assessment of individual regions and communities to inform climate change adaptation strategies. This research explores the vulnerability and adaptive capacity of a community within Fairfield City, the most disadvantaged Local Government Area in Sydney, with regard to thermal stress and influences of physical, social, cultural and political environs on the use of a main civic park.

Fundamental to this current research doctorate commenced in 2006, methodology development is multi-disciplinary, aligning meteorological measurements, heat-health variables and warnings, behavioural mapping, landscape analysis and heuristic inquiry. Suggested relations between climate and public space use are presented. Final analysis and results are yet to be undertaken.
Adaptation Begins with Four-hour Work Day

Poster Number: 406

R. McLean

Beneath the Wisteria

Adaptation to climate change is simple, but strangely complex in the extreme. Neoliberal enthusiasts addicted to profit and growth will shudder at the thought that our only real opportunity to limit the damage of climate change and yet enhance the overall wellbeing of people is to introduce a rather strict, and therefore enforceable four-hour work day, no overtime, no double shifts.

Subsequently people will be poorer and therefore much less able to consume and accumulate “stuff” and so use a vastly reduced amount of energy, most of which is provided for civilization by fossil fuels, the real villain in the emergence of climate change.

I will explain what is meant by a four-hour work day, although I don’t see it needs much explaining; I will talk about the complications that those who see life through the existing economic paradigm; I will explain the immense improvement individual health and wellbeing such a change will bring; I will explain the massive benefits such a change will bring to neighbourhoods and beyond that broader community; I will talk about how our chance to adapt to climate change has largely been eroded and now the issue has become so urgent that we need action rather than rhetoric;

The time has passed when we could have worked at a system that would have maintained the status quo (sort of) and now we need to act quickly and dramatically to reduce human impact on our atmosphere and a four-hour work day will crack open the dramatic adaptation we need, urgently.
Feeling Committed or Making Progress? Examining the Rebound Effect in Adjusting to Climate Change

Poster Number: 305

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¹University of Western Australia

A growing number of researchers are focusing on ways to increase people’s individual adaptive behaviors to climate change by influencing their green motives and goals. However, motivating behavior change can come with an unwanted side-effect, namely the rebound effect; this occurs when a person’s increased target behavior (e.g., green behavior A) results in them decreasing other behaviors that serve the same goal (e.g., green behavior B), or increasing behaviors that are detrimental to the goal (e.g., environmentally unfriendly behavior C). For example, people who buy solar panels might in turn save less energy, or buy a bigger, pollution heavy car. Past research on health behaviors and academic success has found that whether or not this rebound effect occurs is influenced by whether the performance vs. non-performance of the target behavior is interpreted in terms of progress (e.g., ‘I’ve done my portion of green behaviors’ vs. ‘I should be doing more’) or in terms of commitment (e.g., ‘I’m clearly committed to being green vs. ‘I’m clearly not very committed to being green’), with the ‘sufficient progress made’ interpretation being more likely to lead to a rebound effect. We will test whether this also applies to adaptive behaviors relating to climate change. Furthermore, we will aim to unravel the underlying process. We hypothesize that the rebound effect is mediated by deactivation of the goal attached to the target behavior when the current situation signals that enough progress has been made (i.e., target behavior has been performed sufficiently). However, when the situation is interpreted in terms of commitment the effect of performance vs. non-performance of the target behavior will be opposite; with goal activation and thus goal-serving behaviors dropping in case of underperformance, as this signals that there is little commitment to the goal. These hypotheses will be tested in an experimental setting.
Climate Change Adaptation in Coastal Communities: A Blueprint for Investigation and Assessment

Poster Number: 505

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Climate change may have many and varied impacts on coastal communities. In particular, marine-related industries such as fisheries, aquaculture and ecotourism could be impacted by changes in water temperature, reproductive capacity and disease. Adaptation to these changes, and the long term social and economic effects on society and the economy, will depend on the communities’ vulnerability and resilience. Using three communities of differing size and structure around Australia, we will investigate how adaptation might occur and how different interconnections and attributes may make one community better placed to adapt than another. The results of this study will include a blueprint for assisting community adaptation in the future.

Data collection and modelling has been undertaken using information gathered from community members from SE Australia, the fastest warming region in the southern hemisphere. Integrative methods are being developed based on qualitative modelling, social network analysis and bio-economic modelling. The qualitative models were used to link climate forcing factors, key biological factors and key human sectors within the community. Specific factors and interactions were objectively prioritised for further investigation and sub-models were produced to allow detailed investigation of high priority variables. Social network analysis, demographic surveys and bio-economic models were also produced to assess the impacts of marine-related climate change on the local economy and the relationship between community structure and adaptability. The remaining case studies will be undertaken in fishing communities in northern and western Australia. These case studies reflect communities of differing size, differing marine and non-marine resource bases and differing climate change exposures. A comparison of case studies will underpin development of a generic blueprint for the assessment of adaptation mechanisms in coastal communities in Australia.
Cross-Scale Barriers to Adaptation in Local Government, Australia

Poster Number: 105

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Local Governments across Australia are confronted with an ever increasing exposure to climate change impacts from drought to flooding, sea level rise and heat waves. However, even with the best intentions there are significant barriers that restrict or prevent good adaptation planning and management in the local government context. To build on the good work that is being done, this study aims to synthesise a set of critical cross-scale barriers to adaptation planning and implementation by local government in Australia thereby defining the adaptation interventions to move to a climate resilient delivery of local government services. It also examines the underlying processes that give rise to the barriers.

By breaking the analysis of barriers into three stages, viz. climate change knowledge and understanding, strategy planning and project implementation, the cross-scale causes will be better understood. The study adopts theories from multi-level governance to examine networked and multi-scale jurisdictional nature of policy making. Preliminary results will be presented, informed by strong end-user engagement in the form of workshops and key-informant interviews.
Beyond Risk Management - Adaptation to Extreme Weather in Victorian Parks

Poster Number: 206

J. Mumford¹

¹Parks Victoria

More variable and extreme weather events of storms, fires and floods over the past decade are placing increased stress on the ability of the natural environment to provide the ecosystem, societal and recreational services communities depend upon. Existing park management systems and tools, while providing a sound basis for identifying risk, are not sufficient for adaptation to climate change impacts. There is need for decision support across a suite of disciplines to research, identify and develop adaptation measures and responses. It is recognised that climate change adaptation is needed in Parks Victoria’s normal business process to build capacity to respond to extreme weather impacts on parks of bushfires, drought, flood and storms, and the long-term adaptation to climate change impacts such as warming, permanent shifts in rainfall and sea level rise. We will highlight the knowledge and research gaps that link applied research and operational management that emerged from Parks Victoria using its established risk based management approach to identify and prioritise climate change responses. Major parks including Wilsons Promontory, Grampians and along the Murray River have experienced several extreme weather events over 2010 and 2011. These parks will be used as examples to assess current decision making process and response and to discuss why decision support tools such as vulnerability assessment and multi-criteria analysis are needed for park and public land management. Climate change adaptation will require changes in park planning and operations, biodiversity management, emergency response, fire and flood recovery and infrastructure for visitors. We will discuss the current work being undertaken by Victorian agencies and opportunities for practical research and development of decision support tools for application in the parks system.
Climate Change Vulnerability and Children in the Pacific: Challenges and Opportunities for Adaptation

Poster Number: 124

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This paper examines the diversity of risks faced by children from climate change related impacts and associated planned adaptation policies in the Pacific. Based on empirical research from Kiribati and Vanuatu, we explore the confluence of challenges that children face. These challenges are likely to be exacerbated by both the physical effects of climate change and subsequent policies, which, if not designed to consider child rights, could have unintended negative consequences for children. The results show that limited consideration of children is evident in Pacific Island adaptation plans, baseline data of climate-specific impacts on children is not widely collated, and that spaces for children’s participation in adaptation policy activities are very limited. Recommendations include further research to explore the alignment of donor funding with climate variability, integrating child participation components into policy development processes, an inclusion of climate change in UNICEF sentinel monitoring and increased donor funding to help foster climate champions.
Engaging Community for Climate Change Adaptation: Key Determinants for Effective Engagement

Poster Number: 113

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¹Griffith University

This paper reports on its findings on the key determinants found in the climate change literature for effective community participation for climate change adaptation. This follows on from the same literature that effective and inclusive community participation is a vital aspect for successful climate change adaptation, as located in the broader envelope of environmental management and sustainable development literature and practices. Preliminary analysis shows that there are at least 28 aspects or determinants for effective community participation exist. First, of approximately 100 articles on community participation in the environmental management literature, the aspects most mentioned for effective community participation were ‘local knowledge’, ‘social capital and cohesion’, and ‘institutional change’. These aspects, renamed ‘determinants’, were also found dominant with regard to community participation within the sustainable development and climate change adaptation literatures. Local knowledge was found important because it enables the active participation of local people using their local knowledges to address an environmental problem through formulating what they consider to be locally appropriate solutions. In turn, a high level of social capital and cohesion contributed to strong social interaction in communities that leads to effective community participation. The active inclusion of community in decision-making process was also found important; an aspect that most often requires institutional change in overly top-down decision-making approaches in conjunction with the formulation of appropriate institutions at the local level. Outcomes of placing more emphasis on these three aspects (or determinants for effective decision-making) have been evidenced in both developed and developing countries where community participation demonstrates a positive contemporary approach to decision-making process. Such evidences makes it clear that inclusive community participation especially based on fostering local knowledge, social capital and cohesion and institutional change is important for effective climate change adaptation.
Can Words Save Us? An Exploratory Investigation of Climate Change Communication in Australia

Poster Number: 315

C. Naum

1James Cook University

Global climate change is cited as being one of society’s greatest challenges. Despite mounting evidence for anthropogenic climate change and corresponding empirical evidence to support degradation of valuable ecosystems in Australia, public concern for climate change has been on the decline. This may in part be attributed to communication of the phenomenon by science communication practitioners.

Climate change communication is an emerging area of empirical science communication research. Strategic climate change communication is widely acknowledged as critical for informed decision making and for fostering public engagement with the issue, including mitigation and adaptation strategies. The growing body of literature identifies a number of unique challenges and opportunities for communicating about climate change strategically and effectively. Yet, much remains to be understood about the role of the communication practitioners’ workplace experiences and personal perceptions in shaping such communication initiatives.

Therefore, this paper examines climate change communication from the perspective and experiences of Queensland-based science communication practitioners employed within government or non-government. The paper presents the preliminary findings of qualitative, mixed method interviews that reveal important insights into personal, educational and professional factors influencing their approach to strategic climate change communication.
Durability of Housing Materials in a Changing Climate

Poster Number: 526

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¹CSIRO Australia

Durability is one of the most important issues in the use of materials in the construction of buildings and infrastructure. Billions of dollars are spent annually on new construction and maintaining the existing infrastructure against material degradation, which is governed strongly by the surrounding environment and climate. However, climate change science has projected a different climate in the future to the one that we experience today. These climate changes are likely to affect the rate and extent of degradation in materials commonly used in construction, with huge implications for society.

This presentation gives an overview of the durability issues of housing materials and then outlines a quantitative approach for assessing the trends of climate change impacts on durability performance of construction materials that are commonly used in housing. The types of material degradation that have been considered are: corrosion of steel components; the decay of timber above ground and in-ground; and the corrosion of reinforced concrete due to either carbonation or chloride-penetration.

The assessments are made using available durability models developed for structural engineering purposes. Climate change projections are developed using the emission scenario A1FI and nine different Global Circulation Models. For each assessment, the degradation model is presented first, then the possible effects on the degradation due to changes in the climate are identified and incorporated into the degradation model. To demonstrate the approach, assessments are made of possible future changes in the degradation rate of materials using the climate projections for four Australian cities covering a range of different climates: Melbourne, Sydney, Brisbane and Townsville.

The implications of this research and the opportunities for progressively incorporating climate change adaptation into the mainstream risk management and business planning of organisations responsible for the construction of new housing and for those managing large housing portfolios are discussed.
Adapting to climate change: a risk assessment and decision framework for managing groundwater dependent ecosystems with declining water levels

Poster Number: 632

J. Chambers¹ and G. Nugent¹

¹Murdoch University

One of the key gaps in climate change adaptation research is translating relevant science into tools useful for management. In many regions, competition for water resources between humans and the environment presents a challenge for environmental managers. This project will develop and test a risk assessment and decision-making tool for managing groundwater dependent wetlands and caves with declining water levels due to climate change and other stressors.

The tool will be tested in south-western Australia, a global biodiversity hotspot and one of the earliest regions impacted by climate change. A key element of this research is to determine the capacity for species, communities and ecosystems to adapt to changes in environmental variables, particularly water. Habitat requirements (the hydrological and water quality conditions under which biota will persist) will be identified from long-term datasets. This will be based on the relationship between surface and groundwater levels and quality, rainfall recharge processes and biota requirements. Multivariate statistics and Bayesian networks will be used to identify hydrological thresholds for functional groups of biota in wetlands and caves. Current distribution of these hydrological habitats will be mapped and compared to predicted future distribution of these habitats based on groundwater levels modelled by different climate change or anthropogenic extraction scenarios.

Maps will illustrate the distribution of risk to wetlands and caves across specific catchments, resulting from present and future climate change, and from water resource use by humans. It will help environmental managers adapt to climate change at the local, landscape and catchment scales by identifying sites of high ecosystem value, including species and communities at risk. It will then be modified to help manage groundwater dependent ecosystems across Australia.
Fire Management for Healthy Communities and Landscapes

Poster Number: 316

W. Parker¹, A. Miehs¹, G. Banks¹

¹Nature Conservation Council of NSW

The frequency, intensity and severity of bushfires is predicted to increase under a changing Australian climate. These altered fire regimes will require human adaptation and careful management for improved biodiversity and risk outcomes. There are often demands for an increase in prescribed burning to protect communities following bushfires. However, research shows that the willingness of communities to take responsibility for bushfire preparation is critical to mitigate bushfire risk. This presents a challenge in a society where people have become increasingly disconnected from the natural environment and where there is an expectation that emergency management agencies are responsible for community protection.

The Nature Conservation Council of NSW has a proven history in successful delivery of fire focused community engagement programs which result in behavioural change. These programs enrich people’s understanding of, and increase their participation, in managing their natural environment.

Our approach is to target areas of high conservation value and build strategies to increase community and ecological resilience by integrating: peer-reviewed science, the best operational knowledge, existing planning tools, local land management knowledge and the different community values, into a landscape planning framework. Three case studies are presented:

1. The Preparing for Fire workshops: aimed at peri urban communities located near areas of bushland.

2. The nationally awarded Hotspots workshop series: a fire management training program that focuses on achieving biodiversity, cultural and risk outcomes for rural landholders.

3. The consortium resilience program: a regional stakeholder fire management program that draws together strategies to holistically manage natural resources across landscapes.

This unique and proven model provides additional opportunities to create new benchmarks in sustainable fire management, and other areas of land management. It drives research as well as informs policy to ultimately increase ecosystem and community resilience through adaptation in the face of climate change.
The Role of NCCARF’s Networks in Information Exchange for Climate Change Adaptation

Poster Number: 317

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²Adaptation Research Network for Terrestrial Biodiversity

The National Climate Change Adaptation Research Facility’s Adaptation Research Networks are a community of researchers and practitioners working together to progress and share climate change adaptation knowledge across Australia. Established in 2008, there are eight Networks representing various themes. This presentation will review the roles, methods and effectiveness of the Networks in supporting multi-disciplinary research, building research capacity, promoting and supporting information exchange and engaging with stakeholders and industry.

Each Network is convened at an Australian university, chosen through a competitive bidding process. In under four years, they have made a significant and growing contribution towards the advancement of climate change adaptation knowledge across the nation. With over 5000 members, they have the ability to effectively and rapidly communicate with, and connect, researchers and research end users in government, and in vulnerable sectors and communities.

Although the Networks have a common purpose, and seek to fulfil a set of agreed roles, they differ substantially in their focus, approach, funding, structure, management and governance arrangements. Networks have had the flexibility to develop their own set of activities and individual work programs, which has encouraged innovation and allowed Networks to tailor activities that are best suited to their particular sector.

Prior to NCCARF, there were no Australian networks to link the research and practitioner communities in climate change adaptation. The strategic significance of this cannot be overstated: governments, civil society and businesses will increasingly be required to make decisions about responses to future climate risks, and these networks provide a strong foundation for these decision-makers to access information about adaptation, and to share knowledge and build relationships.
**Climate Change and Fisheries Partnership – Tackling Barriers and Limitations to Adaptation**

Poster Number: 106

**E. Perez**, R. Owens, N. Marshall

1Queensland Seafood Industry Association
2GBRMPA
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The Queensland seafood industry amongst many must deal with the financial, social and environmental implications of climate change. The Queensland Seafood Industry Association (QSIA) and the Great Barrier Reef Marine Park Authority (GBRMPA) have understood the need for greater strategic and operational cooperation between government and industry and have implemented a Climate Change and Fisheries Partnership.

Strategies that can build the resilience of the GBR to climate change and help fishers adjust to changing conditions are essential for the long-term sustainability and economic viability of fishing. These strategies are key to effectively maintaining the resilience of the GBR in the face of climate change and increasing multiple use pressures.

Government and industry invest considerable time and energy scoping scenarios around projected biophysical and economic changes. With change coming in the form of climate change fishers in the GBR must adapt at the business level which assumes:

* Acceptance of change by industry.
* The capacity to effect change at the business level.
* Proactive work towards achieving adaptive capacity.

Enabling legislation at present is an inflexible tool to foster adaptive capacity, is slow to respond and is almost the antithesis of adaptability. It is not just industry that has to adapt; hence the crucial need for partnership approaches.

Recent research suggests that there are a number of actions that can enhance the adaptive capacity of fishers, including developing strategic skills, providing information to manage the risks associated with change, and encouraging an interest in the long-term future. Research has also suggested that fishers that are better networked (informally and formally), have a financial buffer and have greater environmental awareness are more likely to be successful in the future. The QSIA and GBRMPA have committed themselves to incremental change to ensure the longevity of industry and stewardship within the GBR.

Poster Number: 904

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High ambient temperature or short periods of hot weather have been shown to be positively associated with the excess heat-related mortality and mobility in many countries and regions. Heat health impacts are also greater in urban areas. Changes in temperature and extreme heat events (EHEs) are predicted to increase by 2030, increasing the likelihood of adverse health effects from heat related conditions. Nevertheless, previous studies have shown the risks of heat-related illness and mortality to be preventable and risk can be minimised by implementing heat-health warning systems and promoting adaptation strategies. One of the crucial parts of heat-related risk management plans is to identify the determinants of heat-related vulnerability. As a part of an Australian National project to identify spatial vulnerability of urban population in EHEs, we developed a heat-related vulnerability index framework to identify spatial vulnerability of urban populations to EHEs for Australian capital cities deriving from published literature. It incorporates land cover, socio-demographic measures, and accessibility to public health care service variables. To determine how well the index predicts population at risk during heat events the index is tested against known adverse health outcomes and emergency responses (i.e. emergency hospital admissions or ambulance callouts) during heat events. This paper presents results of validating heat vulnerability index for urban populations in Australian capital cities using morbidity datasets between 2000 and 2011. Once the heat related vulnerability variables to predict the risk of urban population to heatwaves are determined, spatial heat vulnerability index of urban populations are mapped using geographical information systems (GIS). Such information can be used to advise emergency managers about heatwave preparedness and response as well as to be used as baseline information for predicting of climate changes on heat vulnerability.
Impact of Climate Change on Tasmanian Agricultural Enterprises: Communicating Science to the Broader Community

Poster Number: 625

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Projected changes to the climate of Tasmania resulting from global climate change will have profound impacts on agricultural enterprises at farm, industry and regional scales. This will lead to substantial changes in farm management, choice of crops and pastures and land use.

Communicating climate change and variability is a challenge as the climate system is complex. However, farmers are acutely aware of climate variability and are generally confident in their ability to adjust their farm enterprise mix to relatively short-term climate signals.

The Tasmanian Government and the Tasmanian Institute of Agriculture have developed a series of information sheets to better inform the wider community of potential impacts and adaptation options under projected climate change to 2100.

Climate change projections for Tasmania, sourced from the Climate Futures for Tasmania (CFT) project, were used to assess the impacts of a changing climate. The fine resolution (0.1° grid) of the dynamical downscaled model outputs allows for changes in climate, and therefore impacts, to be differentiated across the agricultural regions of Tasmania over the period 1961-2100. The CFT projections were used to assess the likely productivity of cereal crops, vegetables (potatoes), pastures, and wine grapes for different regions.

A total of seven information sheets have been developed outlining potential impacts of a changing climate on crop and pasture production at a regional scale, and listing adaptation options currently available to farmers. While several of the information sheets outlined potential impacts and adaptation strategies for existing land use, one sheet focused on a catchment-scale, State-funded project ‘Wealth from Water’ (WfW) The WfW project modelled the production potential of alternative crops for the Meander Valley region, extending the capacity of farmers, industry and government to better adapt to a changing climate.
Modelling the Responses of Perennial Ryegrass and a Sub-tropical Pasture Species to Future Climate Scenarios in Tasmania

Poster Number: 626

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Production and consumption of high quality pastures underpin the competitiveness of the Tasmanian dairy and pastoral industries. Climate change projections for Tasmania, sourced from the Climate Futures for Tasmania project, were used to assess the impacts of a changing climate on aspects of pasture production across Tasmania. The fine resolution (0.1° grid) of the dynamical downscaled model outputs allows for changes in climate, and therefore impacts, to be differentiated across the agricultural regions of Tasmania over the period 1971-2100.

Under the A2 emission scenario, Tasmania is projected to experience a rise in mean temperatures of 2.6 to 3.3°C from the baseline period (1971–2000) to 2085 (2071–2100). Mean annual rainfall across Tasmania from the baseline to 2085 is projected to remain relatively unchanged.

The biophysical model DairyMod was used to simulate the growth of perennial ryegrass (Lolium perenne L.) in a monoculture and in a mixture with a sub-tropical summer-active pasture species, under rainfed and irrigated conditions at four sites across Tasmania. The four sites represented the dairying and pastoral regions of the north-west (Flowerdale), the northern Midlands (Cressy), the north-east (Ringarooma) and the south (Ouse). The simulations were nutrient non-limited and identical soil physical and chemical parameters were used for each site.

By 2085, perennial ryegrass yields under rainfed conditions are projected to increase above the baseline by 81% at Ringarooma and 137% at Ouse. However, greater yields (99% and 171% respectively) are projected with the adaptation option of including a sub-tropical pasture species in the sward. Annual irrigated perennial ryegrass yields are projected to increase at Flowerdale and Cressy until mid-century, then decrease by 2085 as a result of increasing daily maximum temperatures. With the addition of the sub-tropical pasture species at these sites, an increase in mean pasture yields is projected (35% and 46% respectively).
Indigenous Climate Change Adaption in the Port Philip Bay Region: A Longitudinal Investigation into the Physical and Cultural Transformation of the Bay from an Indigenous and Landscape Architectural Perspective

Poster Number: 409

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¹Deakin University

Currently there is a dearth of research into Australian Indigenous knowledge and their understanding of climate change especially in regard to how it fits into their world view. Recent discussions by the National Climate Change Adaptation Research Facility (NCCARF) have highlighted this deficiency but also the need to source relevant research projects that may address this knowledge and perspective, and enable the incorporation of Traditional ecological Knowledge into the planning of climate change adaption strategies in the Port Phillip Bay region thereby increasing their engagement in this discussion. Within this context, this paper examines the use and understanding of landscape, both urban and regional, surrounding Port Phillip Bay and the risks and opportunities climate change adaption brings to the local Indigenous communities. It synthesises focused interviews with the (Wurundjeri (Yarra Valley), Wathaurong Geelong-Bellarine Peninsula) & Boon Wurrung (Mornington Peninsula) to elicit a contemporary and local response to issues raised by NCCARF but importantly to articulate a possible Indigenous position about the formation, change and direction that Port Phillip Bay and its environs should take from their perspectives. Research draws upon how these communities have adapted to climate change physically, mentally and spiritually over their long habitation of a shared geological asset and their perceptions of climate change in respect to forecasting and adapting to climate change for this century. The project looks to uncover a longitudinal perspective of change and adaptation focused upon Indigenous views of ‘country’ and traditional custodial obligations to ‘country’ including accumulated cultural and environmental histories.
The iClimate Framework, from Climate Drivers to Adaptation Responses
Poster Number: 318
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Under the NCCARF iClimate project, we were challenged to define a framework to synthesise the climate change impacts and adaptation literature across three major sections: natural and managed systems, human health and well-being and human built environments, industry and structure. We modified the DPSEEA/DPSIR framework, previously applied for health and environmental impact assessments. The modified framework describes a causal chain from drivers (D) to impacts (I) and through to adaptation responses (R). The framework also provides a support framework for decision making (where can policy actions break the chain?) and establishes a basis to develop policy relevant indicators. Under the iClimate project, we synthesised 781 studies into 47 DPSIR statements and these are available from the project website in a searchable database. We present the iClimate framework and a summary of the impacts and adaptation responses across sectors within iClimate. We compare the complexity of the DPSIR chains among sectors and discuss the implications for adaptation.
Space-for-time Substitution to Assess Likely Response of Aquatic Ecosystems to Future Climate-related Change

Poster Number: 809

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Predicting and managing ecological response to a changing climate is often limited by an incomplete understanding of response thresholds and biogeographic differences. For example, step changes in rainfall and runoff, and threshold dynamics and hysteresis in ecological response make projection of future conditions difficult. To combat these constraints we propose that biophysical data across existing climatic gradients can be used in a space-for-time substitution to predict climate-related ecological response elsewhere. This method builds on previous attempts at space-for-time substitution by using patterns in physical and physicochemical data to explain biological differences across the spatial gradient, then using those patterns to formulate hypotheses of temporal ecological response and finally testing those hypotheses on temporal data available in a second, similar region of interest.

As an example application of the method, we use existing biophysical data from across a known longitudinal gradient in rainfall and runoff in south-western Australian estuaries to quantify trajectories of ecological response to differences in freshwater flow and estuarine conditions. Based on these trajectories, hypotheses are established for likely climate-related responses in other southern Australian estuaries of similar latitude. Available temporal physicochemical and ecological data for a subset of those estuaries were then explored for evidence in support of those hypotheses, using Victorian estuaries in the first instance.

In this way, we are able to identify the susceptibility of a range of southern Australian estuaries to climate-related changes in freshwater flows. By assessing the evidence of similar response across regions, we gain an understanding of the transferability of ecological risk and so the transferability of management strategies across estuary types and geographic boundaries. This can then form the basis of a regional framework, enabling identification of strategic management options that aim to increase estuarine resilience at multiple spatial scales.
The Protective Role of Cytokinins During Water Stress in Sugarcane

Poster Number: 627

P. Punpee\textsuperscript{1,2}

\begin{itemize}
\item \textsuperscript{1}University of Queensland
\item \textsuperscript{2}BSES Limited
\end{itemize}

Water stress affecting crop production is predicted to increase with a changing climate due to decreased rainfall, increased evaporation, lower ground water tables, longer and more frequent droughts and increased mean annual temperatures. Water deficiency-induced stress dramatically reduces sugarcane yields. Water stress results in a dramatic reduction in plant height, an increase in leaf senescence and associated reduction in green leaf area. Combined with decreasing stomatal conductance (gs), these responses to water stress cause a reduction in photosynthetic capacity, biomass and sugar yield. Recent field-based evaluation of sugarcane germplasm to discern genetic variation of physiological traits and has identified genotypes with contrasting tolerance to water stress. Glasshouse and field observations collectively point toward a links between water availability, nutrient status, gs, and cytokinins (CKs) in regulating leaf growth, senescence and crop yield. There is evidence that CKs stimulate plant growth and increase the resilience of photosynthesis during water deficiency and other stresses and CKs may be instrumental for improving the water use efficiency (WUE) of sugarcane. The research proposed here will investigate the effects of lower water availability on growth and yield of contrasting genotypes in context of CKs with an integrated physiological and molecular experimental strategy. Two experimental approaches are taken (i) glasshouse-based controlled experiments to assess the response of sugarcane to externally-supplied CKs, and (ii) evaluation of CK up-regulating transgenic sugarcane.
Climate Change Adaptation: Developing Metrics to Evaluate Effective Adaptation

Poster Number: 114

A. Rance

EcoLogical Water

With climate change and its impacts accepted by the scientific community and majority of society alike (Clark 2011; Mummery 2011; Philp et al. 2011; Nelson et al. 2007), focus is now shifting towards response mechanisms (Hedger et al. 2008). One approach to attenuating the impacts of climatic change is through ‘adaptation’ and the development of policies that facilitate this. With awareness of our vulnerability to climate change impacts increasing, Australian coastal communities are attempting to take action through various adaptation strategies and management plans. Yet means to evaluate effectiveness of adaptation action is not yet present on any scale; a significant gap in knowledge has been identified (Preston et al. 2010; Preston & Kay 2010).

This paper/presentation discusses findings from an honours thesis (Rance 2011) entitled, ‘Climate Change Adaptation: Measuring Individual Community Response in Coastal Australia’, a first pass attempt at quantifying adaptation compliance at a coastal community scale. The next step in research is what we can learn and how to move forward in effectively evaluating adaptation to climate change impacts. Research under a PhD is proposed to develop further an evaluation matrix to act as a baseline, and further as an auditing tool to effectively monitor adaptation progress throughout coastal Australia.
Targeted Restoration Will Help Some Functional Plant Types Avoid Extinction in Fragmented Landscapes As Climate Changes

Poster Number: 803

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In the next century, global climate change is predicted to have large influences on the distributions of many species, including plants. Most research in this area to date has focused on predicting the areas where future conditions will be suitable for species of interest, and thus the potential distribution of the species. However, it is just as important to predict whether species will be able to migrate into new suitable areas as conditions shift. Such prediction must account for dynamic processes such as dispersal, maturation, mortality and reproduction, as well as landscape characteristics such as level of habitat fragmentation and connectivity. We present a spatially-explicit individual-based model that addresses these factors, and explain how the model was used to investigate how and to what extent the functional traits of plant species affect their ability to move with climate change across landscapes with various levels of fragmentation. We then tested the efficacy of strategic restoration such as planting corridors to increase connectivity among fragments. Our results show that strategic restoration aimed at building corridors linking habitat fragments could help avoid species extinction, but intervention techniques such as assisted migration might be required to prevent losses of some functional types, such as trees.
Daily Climate Projections Data for Australia Now Available Through the Queensland Government’s SILO Climate Database

Poster Number: 528


Queensland Climate Change Centre of Excellence

The SILO climate database managed by the Queensland Climate Change Centre of Excellence (QCCCE) has been the main source of ready-to-use climate data for agricultural modelling in Australia since 1998. SILO provides historical (1889 to present) daily weather data for any location in Australia. Data is provided in ready-to-use formats for common pasture and crop models. Variables provided include maximum and minimum temperature, rainfall, solar radiation and a water vapour and evaporation variable.

A project funded by the Department of Agriculture, Fisheries and Forestry (DAFF) under the Australia’s Farming Future – Climate Change Research Program (AFF-CCRP) has supported the development of daily climate projections based on historical SILO data and IPCC Fourth Assessment Report (AR4) Global Climate Model (GCM) projections.

As a result of this project, known as the Consistent Climate Scenarios Project (CCSP), a uniform process for developing daily climate projections data has been applied across a set of AR4 GCMs guided by an expert panel. Daily projections data centred on 2030 and 2050 are now available nationally, in two model-ready formats (GRASP and APSIM) from the enhanced QCCCE SILO portal. The data is available for 17 AR4 models and a range of SRES warming scenarios and climate sensitivities. Projections data based on either the ‘change factor’ or ‘quantile matching’ approach are supplied together with the historical baseline data, other ancillary data and a User Guide. As data for any one location may consist of up to 150 data files, online orders restricted to up 12 locations delivered via FTP. Larger orders are processed manually.

Use of the enhanced climate projections data provided through SILO will significantly improve the ability of the primary production sector to adapt to a changing climate. The presentation will demonstrate the new SILO interface and some sample applications.
Research to Support Decision Making: Australia’s National Climate Change Adaptation Research Facility’s Synthesis and Integrative Research Program

Poster Number: 225

D. Rissik\textsuperscript{1}, J. Palutikof\textsuperscript{1}, R. McKellar\textsuperscript{1}, S. Boulter\textsuperscript{1}, D. George\textsuperscript{1}, F. Stadler\textsuperscript{1}, D. Stock\textsuperscript{1}

\textsuperscript{1}NCCARF

Delivering high quality, useful research results to end users such as decision makers in government and industry is a major challenge for research management organisations. NCCARF runs a Synthesis and Integrative Research Program focussed on providing end users with the information needed to underpin successful decision making for climate change adaptation. The program recognises the massive amount of literature being produced in Australia and globally; it aims to synthesise and integrate this information to generate new, user-focussed knowledge and tools.

Our approach is based on substantial end user engagement. Preliminary steps include canvassing end users to identify their research needs and working with end users and researchers to determine feasible research pathways to address those needs. Following a call for proposals, successful projects are required to have substantial end user engagement and involvement. Our experience shows that by including or strongly involving end users in project teams and processes it is much more likely that outputs will be useful and adopted. Nevertheless, challenges exist in (a) encouraging participation of busy end users and (b) identifying appropriate delivery formats for research outputs that engage and inform end users.

We unapologetically push for research products to focus on end user needs rather than traditional research pathways of publish first and communicate to end users afterwards. We encourage researchers to publish in journals, but only after research outputs have been provided to end users.

A major challenge for our approach is to pull projects into a cohesive group of strategic research products rather than having a “scatter gun” portfolio. To address this, we focus on a three pronged approach:

- Identifying the characteristics of a well adapting Australia in 30-40 years;
- Identifying barriers that prevent Australia from adapting well; and,
- developing tools and approaches to help Australians adapt to climate change.
The Role of Conservation Agriculture in Climate Change Adaptation of Grain Production in Australia

Poster Number: 628

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The Australian Grains industry generates approximately 45 million metric tonnes of grain depending on seasonal conditions. They do this within the 300mm to 800mm rainfall zone from Central Queensland to Western Australia. Much of this production occurs on light soils with limited water holding capacity. Grain production is directly reliant on rainfall and the industry is vulnerable to climate changes trending towards a reduction in rainfall. Farmers have been adapting to drought conditions by applying conservation agriculture to maintain production since the late 1980s. In 2011 over 80% of Australian grain farmers practice some form of reduced tillage, maintain ground cover and apply crop rotations. The efficiency gains have convince farmers to go beyond reduced tillage and stubble retention and start applying digital technology to reduce soil compaction, improve fertiliser application, reduce herbicide volumes and use moisture probes to better manage water use efficiency. Australian farmers are taking up technology and redefining conservation agriculture to further reduce limited resources for economic reasons, but in the process developing an adaptive management process for improve water use efficiency.

Examples of this technology uptake include using Global Navigation Satellite System (GNSS) and correction technology such as Real Time Kinematic (RTK) or Continuously Operating Reference Stations (CORS) that allows centimetre accuracy. This allows farmers to precisely establish set machinery traffic lanes to minimise compaction; deliver seed fertiliser and chemicals only where it is needed. Make use of Variable Rate Technology to manage nutrient across different soil types, weed sensors that only apply chemicals to detected weeds. Other sensor based functions include data transmission of subsoil moisture using moisture probes and Normalised Difference Vegetation Index (NDVI) to determine crop health.
**Great Ocean Road Region – Alternative Adaptation Pathways for the Connectivity of Coastal Towns Under Future Climate Effects**

Poster Number: 117

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The Great Ocean Road Region is Victoria’s most popular visitor destination outside Melbourne, and one of the most publicly accessible coasts in the world. Stretching from Warrnambool to Torquay, the landscape provides a place of infinite visual and ecological diversity with thriving coastal towns amongst rugged mountain ranges, coastal scenery and estuaries, rainforests and extensive productive farmlands in the hinterlands. These attractions, with their proximity to Melbourne, make the region a popular visitor destination while the seaside lifestyle in the area is attracting more full time residents, mirroring the ‘sea change’ phenomena. Key to the economic survival of this region is its accessibility, the connectivity of the coastal towns and the hinterland to the outside world, the availability of a diverse interconnected transport infrastructure. Change these attributes and qualities and you have a dramatic effect upon the region’s survival, its context, economic, social and environmental attributes and values. Drawing upon recent literature on coastal planning and management, the Great Ocean Road Region Strategy (2004), and recent findings of the Surf Coast Climate Change Vulnerability and Adaptation Project (2011), backed by the third Victorian Coastal Strategy (2008) this paper reviews and critiques the potential climate impact effects of these settlements and its related transport infrastructure, identifies best practice methods for the evaluation of alternative adaptation pathways in treating risks from sea level rise and associated coastal recession, classifies and charts a transport infrastructure asset model relevant for this location having regard to the unique spatial and temporal risk circumstances, and offers a connectivity-informed climate change adaptation model on how this region possesses specific resilience and urban design answers.
Public Health Emergency Response in Disasters – a Case Study of the 2010/2011 Queensland Summer of Disasters

Poster Number: 905

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Large scale disasters continue to be on display in the world’s media capturing emergency responses in action and showing their impact on affected communities. The lessons are clear: with the predicted increases in scale and intensity of extreme events associated with climate change, the world’s communities at risk must adapt and strengthen their capacity in emergency management. Hence, it is both urgent and useful to learn and share good practices from experienced response teams. The 2010/11 summer of disasters in Queensland was the worst in Queensland’s history in terms of duration and scale of impact, stretching the capacity of its emergency management system. However, there appeared to be a good public health outcome with relatively few deaths and injuries nor any disease outbreaks.

Public health is an important part of emergency management yet it is often unseen, unheard and unexamined, and thus the general community including both the scientific body and the media tend not to understand its roles and functions and most importantly the key factors for successful public health emergency management of disasters.

The primary purpose of this research is to analyse and share with the national and international public health and disaster management community the factors contributing to a successful public health disaster response using an example grounded in reality. A secondary purpose, through the production of a documentary for a TV and internet audience is to showcase the relatively unrecognised work of public health in disasters.

The study focuses on 5 key thematic areas of leadership, risk communication, multi-sectoral collaboration, community participation and preparedness. It uses a case-study methodology involving multiple methods of data collection. As knowledge sharing is a critical component of the project, the findings will be provided in a variety of forms to meet the needs of multiple users.
Mainstreaming Climate Change Adaptation Through Technology Transfer in Developing Countries: A Case in Bangladesh

Poster Number: 125

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Countries in the South-Asian region are extremely vulnerable to the impacts of climate change for a number of reasons. These include extreme weather events such as tropical cyclones and monsoons. Rapid and unplanned human settlements also aggravate the degradation of its natural environment. Furthermore, countries in the South-Asian region often suffer from limited financial resources, extreme poverty, and inadequate technology. This study explores the technological solutions for climate change adaptation in the coastal areas of Bangladesh in four highly vulnerable sectors including water resources, coastal protection, livelihood and health. The study suggests that using innovative and cost-effective technology could help minimize the climate change induced vulnerability of these sectors. The study also highlights the importance of coordinated trans-country cooperation to minimise conflicts in sharing water resources in the region and preventing saline intrusion in the coastal region, by using the adaptation fund declared for the developed countries in COP 15. The study provides some solutions to the economic and policy barriers to technology transfer and implementation in order to draw conclusion on how to create a stable platform to mainstream climate change adaptation in the region.
Reflections on the Practical Application of a Hybrid Risk / Vulnerability Assessment Approach to Inform Organisational Climate Change Adaptation

For organisations wishing to undertake climate change adaptation planning, there are already a number of guides and tools to assist with this process, with more emerging all the time. However, the practical implementation of adaptation assessment and planning is still relatively new, and reflections on how well organisations are adopting adaptation processes are just beginning to emerge. Anecdotal evidence appears to indicate that the private sector in Australia prefers to align with a risk management approach to climate change adaptation planning, while public entities, such as local governments, are ‘blending’ risk assessment with local vulnerability assessment approaches. To date, there has been little analysis of the effectiveness of these new hybrid approaches, the organisational and external constraints involved, and whether they are meeting the needs of the stakeholders involved.

This presentation will attempt to address this knowledge gap by reflecting upon current applied research activity (2011-2012) that is supporting the development of a climate risk management framework for RMIT University, based on such a hybrid assessment approach. Adaptation as a ‘learning process’ underpins the analysis, including creative engagement with both functional and academic staff in order to meet expectations from different areas / disciplines of the University within a limited time-frame. The discussion will be framed according to an elaboration of the hybrid approach used, consideration of the competing objectives of the key stakeholders in the process, the challenges and opportunities of generating engagement, how institutional and external barriers were identified and addressed, and finally how findings are intended to be mainstreamed across different university strategic policies. The research findings from this case study will have wider implications for how organisations assess climate risk and ensure informed adaptation responses.
**Sustainable Water Management in Australian Industries**

Poster Number: 115

I. Senaratne¹

¹Australian Bureau of Statistics

This study investigates the water use efficiency and water management practices in Australian industries. The results are based on a number of Australian Bureau of Statistics (ABS) data collections focusing on business and agricultural economic activity associated with water use. These collections include Energy, Water and Environment Survey (EWES) 2008-09; the ABS Water Accounts; the Agricultural Commodity Survey (ACS) 2008-09.

Water availability has declined in the major agricultural production since 2000-01, particularly within the Murray-Darling Basin. However, the impact upon agricultural production (in volume and $value terms) is not commensurate with reduced water availability. Switching between agricultural products and changes in irrigation practices have sustained the value of irrigated agricultural production during the period of reduced water availability. Over 50% of agricultural businesses have changed their irrigation practices in order to better manage water use.

Urban industrial water use has also declined during the same period. The results of the EWES showed that 22% of all Australian businesses undertook water management practices in 2008-09. Large businesses (over 200 employees) were more likely to undertake water management practices (60% of large businesses). Queensland businesses recorded the highest proportion of water management practices among all states and territories. About 2% of all businesses invested in research and development in water efficiency methods. A binary logistic regression model with EWES data showed that the likelihood of a business becoming water efficient was higher in large businesses; in the Accommodation and Food industry; and in Queensland.
Photovoice: a Photographic Exploration of Attitudes to Climate Change and Adaptation
Poster Number: 319

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¹WAMSI
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Commercial fishers in the south west of Australia have experienced changes in the marine environment including sea level rise of more than double the global average and an increasing sea temperature of between 0.6 and 1 degree over the past 50 years. Settlement of rock lobster larvae (puerulus) has declined significantly and a ‘marine heat wave’ early last year resulted in extensive fish and invertebrate kills in a highly productive area for rock lobster: the Abrolhos Islands, a regionally isolated group of low-lying islands, 420 km north-northwest of Perth. Despite these well documented trends and events, fishers appear reluctant to connect changes in the marine environment to climate change. As fishers are considered ‘traditionally resistant’ to change, new and innovative methods are needed to facilitate the uptake of climate change science and adaptation strategies. This project builds on a visual research method (Photovoice) to investigate the impacts of a warming ocean and rising sea levels on the Abrolhos Islands, which produce a significant volume of the highly valued Western Rock Lobster. Photovoice was successfully used to give rock lobster fishers a voice through their own photographs. Fishers developed a shared understanding of the values of their fishing community, coupled with a greater knowledge of climate change science and an increased capacity to adapt to a changing environment.
Taking a Participatory Systems Approach to Understanding Climate Adaptation Needs: a South-East Queensland Case Study

Poster Number: 325

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Our research addresses climate change impacts across South-East Queensland. Taking a social-ecological systems approach, the study, conducted in three SEQ regions, provides a place-specific analysis of adaptation and resilience strategies, highlighting ways that people deal with climate variability and climate change risks and opportunities in uncertain times. It integrates social-ecological dimensions through a series of deliberative participatory processes to engage local stakeholders and user groups in ‘climate conversations’, to enable anticipation of climate variabilities to be incorporated into a regional-wide adaptive management system encompassing Moreton Bay, urban/peri-urban, and rural areas in the Bay’s river catchments. Literature on climate change adaptation observes the neglect of systems understandings and a shortage of comprehensive mitigation analyses. These shortcomings carry the risk of fragmented effort, and maladaptation where a planned adaptation for one set of requirements may prove detrimental to others. This paper presents initial results from research designed to develop and test a participatory approach to gathering and integrating local professional and personal knowledge towards understanding what happens under climate change: how the range of possible climate impacts in one local area influences the span of interconnected biophysical, social and economic factors within that locality and across the region as a whole. Each area and issue links to affect and receive effects from others. Our study encompasses terrestrial, riverine, coastal and marine environments, rural and urban areas, across water bodies and islands. ‘Climate Roundtables’ involving approximately 120 people are being held to combine organisations’ and community members’ knowledge into a ‘picture of influences’, to assist integrated planning and management across interested sectors and communities. It is supported by a multi-sectoral collaboration between scientists, social scientists, Traditional Owners and community in planning and implementing the Roundtables, drawing on diverse skills, experiences and networks to provide a comprehensive ability to deal with complex systems.
**Mississippi: The Inevitable Next Shift of Old Man River**

Poster Number: 110

**J. Sieweke**

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The Mississippi is about to make the next periodic geomorphologic shift within the delta-fan that resembles Southern Louisiana. All land of Southern Louisiana has been constructed by a frequent shift of the course of the River, this has been not the exception, but the rule. The next shift is only held back by the “Old River Control Structure”. Without it maintaining a 70/30 flow ratio, the larger portion of the stream would already divert along the shorter path through the Atchafalaya and would eventually abandon the Port of Louisiana and New Orleans. In a case of a failure this unintended accelerated shift would be rapid and not reversible. Within days the largest chemical industry and the “Big Easy” would be left at a salty tidal creek without a source of fresh water. Consequently the Port of Louisiana with its petrochemical industry would be without navigation and without process water – it be shut down within days. The city of New Orleans would be left in the intruding saltwater of the gulf without a source of freshwater supply.

In the spring of 2011 a historic record of river stage was funneled through the “plumbing system” as the ACOE refers to the lower Mississippi. In their minds - they won the “flood-fight 2011”. It seems questionable how much longer this system may be maintained at all costs of maintaining the mechanical control-systems against all natural dynamics. In the favor of navigation the “levees only policy” cuts of all diversions. This channelization is directly linked to the massive land loss of Louisiana due to delta starvation. The excess sediment carried by the Mississippi is intentionally washed of the continental shelf and its nutrient discharge causes a growing area of hypoxia along the gulf coast. Can we outengineer the delta?
Drawing Lessons for Climate Change Adaptation: a Framework for Analysing Cross-Border Institutional Arrangements

I. Sporne

Griffith University

Many socioeconomic and environmental issues have already transcended existing administrative boundaries. Emergence of cross-border management agendas has lead to the development of various institutional arrangements operating at different governance levels. In the context of climate change these arrangements offer learning opportunities for addressing emerging cross-border adaptation challenges.

Nevertheless, the diversity of cross-border institutional arrangements presents several analytical challenges. Evolution of the arrangements has been influenced by different contextual factors and involved institutional actors. They have been developed for various purposes and different management scopes and scales. As a result, it is crucial to develop an understanding of different variables that have affected the development and implementation of these institutional arrangements. Identification of these variables and their interactions is important to structure analysis, organise findings and accumulate knowledge.

To address this analytical challenge this presentation offers a general framework for the analysis of cross-border institutional arrangements. The framework has been developed based on the synthesis of several frameworks existing in the literature. We argue that the framework can be applied in the analysis of various cross-border institutional arrangements in Australia to identify opportunities and challenges for climate change adaptation.
Learning from Cross-border Governance Mechanisms to Support and Promote Climate Change Adaption in Australia

Poster Number: 220

W. Steele¹

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The impacts of climate change do not adhere to conventional governance boundaries. Floods for example do not stop at the state border, nor are storm surges contained within local government jurisdictions. Whilst this may appear self-evident, this 'inconvenient institutional truth' poses considerable challenges to existing and deeply embedded governance frameworks. This paper focuses on communicating the key findings from Stage 1 of a recently funded NCCARF SEI project. The overall focus of this project is what might be learnt from existing cross-border regulatory mechanisms to strengthen and improve climate change adaptation practices in Australia. There are significant implications for the evolving national role in climate change adaptation, as well as the relationship to cross-border issues at the local and state level that this paper highlights.
The Development of Hazard Lines for Coastal Flood Adaptation

Poster Number: 506

H. Stevens¹, A. S. Kiem¹

¹University of Newcastle

The coastal zone is one of the most vulnerable to changes in climate. Traditional methods of flood planning have relied on exceedance probabilities such as the 1 in 100-year flood level. These flood estimates have implications for coastal planning as well as economic and legal ramifications – if the flood risk is underestimated decision makers could be at risk of liability if property and/or livelihoods are impacted. However if they are overestimated, it can negatively affect economic development due to the restrictions that it imposes. Exceedance statistics are based on the assumption of a ‘stationary’ climate, that is the chance of an extreme event occurring is the same from one time period to the next. However in light of natural and human induced climate change, this assumption is no longer valid. This paper reviews a new method of approaching coastal flood risk through the development of hazard lines – multiple lines that incorporate current risk with sea level rise benchmarks and development asset life. Based on a case study from a Lake Macquarie, this paper outlines the steps, assumptions and key complexities that arrive when developing hazard lines as well as argues the opportunities and limitations to this approach. The outcomes of this study are a better understanding of when hazard lines are appropriate and how to work towards developing hazard lines that accurately reflect the risk. This research would be of interest to any coastal stakeholders who are either working on or using coastal flood risk estimations.
The ‘Risk Matrix’ Workbook: a Facilitation Tool to Assist Adaptation to a More Variable and Changing Climate

Poster Number: 207

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Identifying and analysing risk and opportunities using the Climate Change Risk Management Matrix can help to plan responses to climate variability and climate change and can enable organisations to be proactive and more effective in adapting to future climate uncertainty. To help facilitate wider use of the ‘risk matrix’ process, a paper based workbook and electronic workbook (eWorkbook) have been developed to assist extension activities with organisations and individuals.

The ‘Risk Matrix’ was developed by the Queensland Climate Change Centre of Excellence (QCCCE), in association with Agri-Science Queensland, based on Australian and New Zealand Risk Management Standards. The workbook provides a simple and structured stepwise process which identifies:

- Impacts imposed by a more variable and changing climate in the context of an organisation or situation.
- The level of risk or vulnerability associated with a more variable and changing climate.
- Possible adaptation responses.
- How to communicate the key risks and vulnerabilities to others.
- How to develop an action plan to address the key risks and vulnerabilities.

The eWorkbook is an electronic version of the risk and vulnerability assessment section of the Risk Matrix Workbook. It is a self explanatory stand-alone program that enables users to complete a 3x3 risk and vulnerability assessment in digital form with automated recall and dropdown functions. The assessment process can be repeated using different climate variables and organisational elements. Each assessment can be saved and recalled for future reference. Report statements and action plans can also be saved in various formats (i.e. pdf, Word).

The presentation will describe the various components of the eWorkbook and how it can be used to plan for and develop adaptation opportunities in our changing climate for a range of end-users.

To download the Risk Matrix Workbook and eWorkbook described above, visit the QCCCE website http://www.longpaddock.qld.gov.au/.
A Comparative Study on the Decision Making Process of the Coastal Climate Adaptation of Central and Western Coastal District of Bangladesh

Poster Number: 507

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Bangladesh has a coastline of 710 km along the Bay of Bengal, which will be extremely exposed to climatic hazards over the coming decades. At present, the improvement of people’s livelihoods of this zone largely depends on the climate adaptation approaches adopted in the water management and agricultural practice. Although the cross-sectoral dimension of ICZM process encourages stakeholder engagement during the preparation of the plans, subsequent steps tend to be top-down in nature, which creates critical gaps between national and local level governance. For this reason the outputs (policy, strategies, programmes etc.) of ICZM, and its adaptation action plans, are ineffective in implementing, monitoring and evaluating the processes of achieving sustainable livelihood in the coastal zone. Therefore the aim of this paper is to understand how different stakeholders make decisions about adaptation and coastal management. It will also examine how they develop adaptation options suited to specific coastal regions, and the effectiveness of these policies and strategies in enhancing people’s adaptive capacity to climate change. A comparative study is conducted between a central coastal island (Bhola district) and a western coastal estuarine (Shatkhira district) by analysing adaptive approaches through different variables (geophysical, socio-economic, governance) and examining decision making processes in different scales (national, district, local). Operating a ‘sustainability decision support system’ on both a vertical and horizontal scales of ICZM can help to overcome the institutional gaps by focusing on risks related to climate change. Considering the barriers to adoption and effective implementation of the system, it is hoped that these case studies will evaluate the successes and failings of the system, and its relevance for similar regions in other developing countries of the world.
Protected Area Management in the Face of Climate Change

Poster Number: 810

S. Tanner-McAllister

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Protected areas face a suite of impacts and changes from anthropogenic climate change and current management may not conserve these areas adequately. Climate change impacts on surrounding lands have implications for protected area management and vice versa. How do we adapt protected area management at the site level under climate change? A survey and interviews were conducted within the Scenic Rim, South-East Queensland, Australia to gain an understanding of the public’s and natural resource manager’s values and perceptions of climate change, its impact on the local natural environment and protected areas and their management. The study showed QPWS were significantly more concerned about an increase in fire frequency and intensity than the community and neighbours and an improvement and/or change to park fire management strategies will be required. This may influence adaption of prescribed burning to predicted higher temperatures, reduced rainfall and more severe droughts. Neighbours were considerably higher concerned about feral animals than QPWS and the general local community and all were generally highly concerned about the potential increase in the impact of weeds. This may support better introduced species management, an area identified by QPWS as needing improvement to ensure higher park resilience. Neighbours and QPWS were highly concerned about native animals and believed threatened species are not well managed; a concern considering QPWS identified substantial lack of monitoring on parks. Community/public education was a perceived barrier to climate change adaptation by QPWS; however they believe an increase in community engagement is necessary. QPWS were significantly more concerned about recreational impacts, residential/commercial development and surrounding land-use than the community and neighbours, which may influence local planning, possibly placing additional pressure on the protected areas. This study will contribute to development of a socio-ecological model to assist protected area managers in adapting park management as future climate alters.
Helping Queensland’s Primary Producers Adapt to Climate Change Through Regional Climate Change Impact and Adaptation Fact Sheets

Poster Number: 320

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Climate factsheets were published in 2009 for each of Queensland’s 13 regions as part of the Queensland Government’s ClimateQ climate change strategy.

These factsheets outline historical trends and projections for 2030, 2050 and 2070 for different emissions scenarios. They are available online and on CD and have been a useful introduction to the climate ‘risk matrix’ workshops that identify impacts, risk, vulnerability and adaptive responses.

A key initiative of the strategy is the Helping Primary Producers Adapt to Climate Change which is helping the primary producers to plan for and adapt to a changing climate.

In response to industry requests for more targeted and local information the Queensland Climate Change Centre of Excellence has taken these regional projections a step further, and enhanced each of the factsheets to describe the key primary industries in each region, the specific impacts resulting from a changing climate and practical adaptation responses. The factsheets also provide information on the impacts and adaptation options in the areas of human well-being and biodiversity.

For some regions there are seven industries described including grazing, dairy, cropping, horticulture, sugar, fisheries and aquaculture. Within each of these industries, the factsheets describe the potential impacts of major variables of climate change relevant to the region including changes in temperature, rainfall, CO2 concentration, and intensity and frequency of extreme events.

All information included in the factsheets is based on the latest scientific literature, published work and expert opinion. They are available in a range of media formats for distribution to rural industries, landholders and their advisors.

The presentation will introduce the content of the factsheets, including examples of potential impacts and their associated adaptation responses, and discuss how the factsheets will be used in the climate risk management component within the Helping Primary Producers Adapt to Climate Change project.
**Projecting the Impact of Climate Change on the Transmission of Ross River Virus Disease: Methodological Challenges and Possible Solutions**

Poster Number: 407

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\(^5\)Curtin University

The processes influencing the pattern of Ross River virus (RRV) transmission are complex. The interannual cycles and intensity of RRV transmission are primarily determined by the dynamics and interactions between the pathogen, vector, vertebrate hosts, and environment. Climatic variability is one process that can influence RRV transmission. Queensland has a relatively long RRV surveillance data where consistent climate and disease relationships have been identified. However, there are many methodological challenges in projecting the impact of climate change on the transmission of RRV disease. For example, how accurate are the RRV surveillance data over time and place? What roles can non-climatic factors play in the interannual cycles and intensity of RRV transmission? What is an interactive effect between rainfall and temperature on RRV transmission? These issues need to be addressed when we forecast the possible impact of climate change on the transmission of RRV disease. An improved understanding of disease ecology and transmission dynamics may help anticipate and mitigate the future impact of climate change on RRV and other mosquito-borne diseases in Australia.
Alternative Communication Pathways for the Dissemination of Climate Change and Adaptation Science for Community Education and Empowerment

Poster Number: 321

A. Travers¹, Z. Whitton¹

¹University of Queensland

Community engagement and education is essential to the success of many projects, including climate change adaptation projects. The utilisation of alternative and grassroots communication systems has the capacity to increase community engagement and program acceptance. The use of peer to peer guided discussion and digital media has the capacity to increase a project, or information, acceptance, whilst allowing for flexible learning and genuine community feedback. Such alternative methods may also allow for direct contact with the intended audience, avoiding filtering by mainstream media and potentially maintaining better information accuracy in communication. An increase in reliable information sources alongside the development of networking throughout the system may increase community resilience and adaptability in the face of change. These factors may increase ownership of change on behalf of communities, increasing project sustainability and increasing the capacity for further project deployment and growth.

The growing impact of grassroots organisations such as AVAAZ, GetUp and 38Degrees demonstrates how alternate engagement methods can increase awareness, direct policy and generate individual and collective action. The methods used by these groups, amongst others, can be directly applied to climate change adaptation projects. They also have the potential to be applied to the communication of climate science and can be utilised to enhance the quality and scientific accuracy of the discussion.

This paper will discuss potential information pathways and methods for communicating with a broader audience base through digital and alternative media. It will also demonstrate the value of supplementing traditional media communication with alternate information dissemination and networking methods. This will be shown in relation to climate change adaptation management strategies both within Australia and abroad and will aid the development and implementation of such strategies into the future.
Portrayal of Climate Change in the Mass Media and Associated Consumer Responses

Poster Number: 322

A. Travers

1University of Queensland

The media has the capacity to shape events, stories and ideas within the public sphere, this happens on a daily basis throughout Australia and the World. For many Australians online news outlets are one of the primary sources of news, particularly scientific news. The media has played a significant role in the communication of numerous scientific stories, including the discussion of climate change, pollution impacts and daily health science stories. How these stories are treated in the media can have significant ramifications for the interpretation of the science at an individual level, and at a community level. This paper investigates the nature of climate science reporting as compared to the reporting of the scientific impact of plastics in the marine environment, within four news outlets. The nature of the user generated comments following these stories is also analysed. It was found that there are distinct trends between the news outlets in their reporting of different science stories, and not all science is framed in the same way. It was also found that the nature of a story, whether in support of the peer reviewed literature or in disagreement with it had a significant impact on the nature of the reader comments following the story. These findings have significant impacts for scientists wishing to portray their science through the mass media. In particular the portrayal of climate science in the media, and associated reader acceptance of the science, may have significant implications for the communication, and acceptance, of adaptation strategies. This paper helps to develop an understanding of how such strategies and information is portrayed to increase scientists understanding of information dissemination patterns throughout the Australian online mass media.
Water-based Communities in the Tonlé Sap Region, Cambodia: Spatial Patterns and Climate Change Vulnerability

Poster Number: 126

A. Travers¹, D. Neil¹

¹University of Queensland

Tonlé Sap is an extensive, complex hydrological system in which the lake area varies seasonally by a factor of 3 or more, water depth by an order of magnitude and river flows reverse direction. It has high biodiversity and is a key to Cambodian food supply through large fish catches and extensive floodplain agriculture. Water-based (stilt and floating) housing and associated infrastructure is widely distributed along river banks and lake shores in this system and is vulnerable to climate change. The poster presents the changing characteristics of the environment and associated water-based housing along a river and lake transect from Phnom Penh to Siam Reap. The vulnerability of these communities to climate change is reviewed in the context of the spatial patterns of those characteristics.

Communities in the Tonlé Sap region differ greatly according to their location within the river-lake system, from Phnom Penh, along Tonlé Sap River, to Siam Reap on Tonlé Sap Lake. Communities include floating and stilt housing, often in close association. Systematic variation occurs in relation to fishing methods, settlement morphology and adaptations to seasonal water level fluctuations and spatial variations in bank height and gradient.

Climate change impacts on the Tonlé Sap region are likely to include: changing patterns of sedimentation, altered volumes and timing of water flows, changing fish production and extent of floodplain agricultural lands. Changes to the vegetation communities around the lake may impact on fish stocks, availability of cooking fuel and building materials. These changes are likely to occur in association with significant impacts on the hydrological regime in response to increased impoundment and diversion of water in the upper Mekong catchment as well as local pressures such as vegetation clearing and fishing pressure. Through the spatial patterns identified, the poster examines the vulnerability of these communities to climate change impacts.
What About Me? Influencing a Person’s Adaptative Behaviours
Through Priming Goals

Poster Number: 306

K. Unsworth^1, J. Heath^1, I. McNeill^1

^1University of Western Australia

Much of the social science research examining adaptation to climate change has examined how organisations, industry sectors, or societies as a whole will adapt to climate change: There is much less research examining how people themselves will adapt. The premise for our research comes from the realization that adapting to climate change is only one of many goals that an individual may have (alongside, for example, their work goals and other life goals). We know that people differ in their responses to climate change depending on their prior beliefs, attitudes, or values but we do not know why. This is particularly important when dealing with populations who may hold identities that potentially conflict with an adaptation goal (e.g., “farmer” or “battler”). We hypothesise that a person’s overall goal hierarchy will affect his/her behaviour and adaptive capacity. We will report on an experimental study which examines the effects of priming in altering an individual’s goal hierarchy and subsequent effects on behaviour. Participants are asked to complete survey questions on a computer program: one-quarter see a subtle, non-invasive image related to climate change as they answer the questions; one-quarter are asked explicitly about the relationships of ‘green goals’ within their goal hierarchy; one-quarter are asked explicitly to create relationships between green goals and their other goals; and one-quarter will not be primed. Participants are then asked whether they wish to volunteer their time on a sustainability working party or further research and whether they wish to donate some of their incentive payment to a green charity. We hypothesise that those in the priming conditions will be more likely to have denser hierarchies and more likely to choose to engage in adaptive coping behaviours than those in the control condition. These results will provide a solid foundation for recommendations for improving individual-level adaptation.
Accessing Regional Capacities for Climate Change Adaptability: A Suggested Methodology

Poster Number: 412

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This paper starts with the premise that the cultural environment of a region—how people communicate with each other, and how local media represents the immediate social and natural environment—provides clues to a region's normative values, which underpin potential capacities for climate change adaptability.

We explore this premise with a comparison of letters to the editor of two newspapers, both published by Australian Publishing Newspapers (APN): The Northern Star (printed in Lismore, northern NSW) and The Queensland Times (printed in Ipswich, SE Qld). Contrary to the accepted view, regional newspapers are experiencing growth, rather than decline. Furthermore, these newspapers serve distinctly different communities, with Northern Rivers, also known as the Rainbow Region, having a reputation for environmental awareness, while Ipswich in south east Queensland is a more conservative community where mining interests have long been an important part of the local economy.

We focus specifically on reader responses to the introduction of The Gillard Government’s Carbon Tax. We demonstrate that letters to the Queensland Times are more antagonistic towards the Carbon Tax, compared to the Northern Star. Although this method is limited in its ability to ‘read’ a community’s environmental values, it is one of a suite of indicators that we suggest provides evidence of the willingness of local communities to accept strategic measures towards climate change adaption.
**Bridging the Gap Between End User Needs and Science Capability: Dealing with Uncertainty in Future Scenarios**

Poster Number: 323

**D. Verdon-Kidd¹, A. Kiem¹, E. Austin¹**

¹University of Newcastle

Currently a fundamental barrier exists to successful adaptation, namely the disconnect between information that climate science can currently provide and the information that is practically useful for end users and decision makers. This disconnect is emphasised within the water resource management and agricultural sectors (due to high uncertainty surrounding precipitation projections) and has been identified as a major barrier preventing well documented facts, themes and recommendations from being translated into successful adaptation outcomes. It is not currently clear whether this disconnect is a communication issue, an education issue, a technological issue, or a fundamental philosophical issue (i.e. that scientists think about things differently to practitioners, decision makers and/or end-users).

In this presentation results will be presented from an extensive survey aimed at gaining a better understanding of these limits or barriers to adaptation, by clearly identifying and quantifying, the disconnects between what science can currently provide and what is needed by end users of climate information. In addition, the outcomes of a workshop held with a number of high level decision makers and climate scientists will be discussed. The aim of the workshop was to give both groups (i.e. climate scientists and end users) ‘a voice’ where long held concerns, issues and beliefs could be raised and discussed in an organised forum. We will demonstrate how this medium improved climate scientists understanding about what climate information is required by decision makers and what format the information needs to be provided in. This will help focus future research efforts on the scientific questions that would have the biggest impact on the adaptation community and aid climate scientists in providing research outputs that are of maximum relevance and usefulness to end-users – hence increasing the chance that insights emerging from climate science will be translated into positive adaptation strategies.
Working Together Today for a Healthier Reef Tomorrow: Climate Change Adaptation Through Community and Industry Engagement

Poster Number: 703

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While the Great Barrier Reef continues to be recognised as one of the world’s healthiest coral reef ecosystems; it's no surprise that climate change impacts dominate predictions about its future health. With limited regulatory and legislative influence over activities which drive environmental impacts on the Reef; the GBRMPA recognized that a hands-on approach at a community level was essential to help address these issues and preserve the Reef’s immense social, economic and environmental value. This community based collaboration is a crucial element in securing a healthier future for the Great Barrier Reef. Individuals and organisations that use and enjoy the Reef are demonstrating their commitment and taking practical steps every day to help safeguard its future. The Great Barrier Reef Marine Park Authority’s Reef Guardian program demonstrates the effectiveness of building these relationships and the value of sharing responsibility for these desired environmental outcomes. The program encourages the sharing of information as a platform for the voluntary uptake of practices to improve the economic and environmental sustainability of the industries and community sectors involved and the health of the Reef itself. The community-based Reef Guardian stewardship programs are playing a critical role in ensuring the Reef is well placed to meet the challenges ahead. This presentation highlights the successes and challenges of the Reef Guardian stewardship program since its inception; it showcases the journey of developing the program and demonstrates how we are all working together today for a healthier reef tomorrow, in the face of a changing climate.
**Measuring the Mass & Energy Exchange of Australian Irrigated Agriculture: Pathways for Adaption to a Changing Climate**

Poster Number: 629

C. Vote¹, M. Hafeez¹, P. Charlton¹, A. Hall¹

¹Charles Sturt University

With respect to the mass and energy balance, there has been an extensive amount of research done to investigate the carbon sequestration potential of various terrestrial ecosystems world-wide; however, very little has been done to quantify water, carbon and energy fluxes of irrigated broad-acre crops across spatio-temporal scales for common Australian conditions and soil types. This study focuses on the use of eddy covariance methodologies to determine the empirical relationship between these fluxes for three of the major crops grown in a gravity-fed irrigation system in Australia; maize, rice and wheat. Here we present the uptake or release of carbon dioxide in relation to water use (evapotranspiration) at different phenological stages of the crop at the field scale; and the extrapolation of these to provide an estimate of fluxes at the regional scale based on similar soil types. The results of this study will be used to upscale eddy covariance measurements through the application of a biophysical diagnostic model in order to bridge the gap between ground-based observations and satellite-derived information. This will ultimately provide a useful tool to estimate water, carbon and energy fluxes at different spatio-temporal scales and assist in the closing of regional and global water and carbon budgets.
What Role for Systemic and Adaptive Governance in a Climate-Changing World?
Poster Number: 217

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Climate change adaptation can be framed in at least three different ways: (1) adaptation 'to'; (2) adapting 'with'; and (3) systemic and adaptive governance. In the first, and most widely adopted position, climate change is an external force that society needs to respond to by changing its ways, with the exclusion of changing the human-induced causes of the external force (considered to be mitigation). This framing envisages a stable end-point where society is adapted. In the second, mitigation is an element of adaptation, so society changes its ways, tries to reduce the external force, and responds to the new situation that is created. In this case, adaptation isn't a single end point, but is bounded by a range of states that are considered to be successfully adaptive. In the third, society engages in a dynamic and co-evolutionary performance with climate-changing situations. Such situations are not bounded by disciplinary topics (e.g. infrastructure, freshwater biodiversity, health), but are systemically inter-connected, messy, complex and uncertain. Preference is given to relational capital – that is, the ability of people to learn and interact with each other and other (natural and constructed) elements of socio-ecological systems. Governance is not restricted to 'government', but relates to the process of steering and managing a new trajectory that is systemically viable in a climate-changing situation. Processes of social, continuous learning underpin these trajectories, and the act of 'knowing' replaces concepts of 'knowledge' that can be created, transferred or used. What is successfully adaptive is continuously co-constructed from a range of different perspectives. Examples are given from a series of research inquiries on water governance and climate change decision-making.
Food Security, Social Justice, Environmental Justice and Climate Change: Points of Adaptation in Food-systems
Poster Number: 630

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Balancing human and environmental needs is urgent where food security and sustainability are under pressure from population increases and changing climates (UK Government Office for Science 2011; PMSEIC 2010). Viability of the Australian rural economy is intrinsically linked to food production and food security requiring systematic evaluation of climate change adaptation strategies for agricultural productivity. This paper, draws on a review of literature exploring the risks of climate change and existing institutional frameworks that support food-systems. We conclude that a vertically linked food-system model (Islam, Nath and Wardell-Johnson, 2011) identifying points of risk and intervention may provide a useful conceptual framework to apply in the rapidly changing agricultural landscapes of the SW-WA and SE-QLD. By identifying points of adaptation and risk this model provides the basis for developing a comparative understanding of the attitudes of stakeholders on climate change mitigation and adaptation for drawing a balance between economic, social and environmental needs.
Refugia in Flat, Drying Landscapes
Poster Number: 811

G. Wardell-Johnson¹, G. Keppel¹.

¹Curtin University

Refugia are habitats that can retain relatively stable local climatic conditions when the regional climate changes. Therefore they have great potential for facilitating the in-situ persistence of biodiversity under anthropogenic climate change, and are critically important for biodiversity conservation in climate change adaptation management. The identification of refugia is problematic but especially important in landscapes undergoing a continuing trend of reduced rainfall or having limited topographic complexity. The South-western Australian Global Biodiversity Hotspot exemplifies this dilemma. In the landscapes of this region, refugia must provide protection against three increasing environmental stressors: reduced moisture availability, increased fire intensity and more frequent extreme temperature events. Using multiple data sources, we demonstrate how particular swamps, granite outcrops, high rainfall forest ecosystems and a few mountain ranges of limited extent provide such refugia. We then ask ‘What is the resilience of these refugia?’ and ‘What management options do we have to assist their continued persistence?’ We show that in order to effectively utilise refugia for climate change adaptation management, we not only need to identify refugia but also determine their resilience. We show that under projected climate change, the ability of refugia to provide biodiversity benefits will increasingly be stressed, a trend exacerbated by existing land-use threats and change. There is an urgent need to obtain adequate understanding of how refugia respond to regional climate change and how much biodiversity they could potentially protect. This will enable assessment of their role in climate change adaptation to achieve effective prioritization in management plans. Mitigating the effects for climate change refugia will likely include reducing the impacts of existing land-use threats and reducing the impacts of increasing fire frequencies and intensities, through more targeted fire management.
Beach and Surf Tourism and Recreation in Australia: Vulnerability and Adaptation

Poster Number: 508

D. Ware¹, M. Raybould², N. Lazarow¹, D. Anning²

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There is a substantial and growing body of knowledge on the physical impacts of climate change on coastal resources. What is less clear is the way in which beach visitors and coastal societies will be affected by these changes. This is a serious knowledge deficit, as decisions about the management of these resources may have wide ranging implications. In Seachange locations, coastal features are, by very definition, assumed to be drivers of residential development and regional economies. Work by the authors has highlighted the social and economic importance of beaches for tourism and recreation in Australian coastal cities which is in turn reliant upon the character and natural state of assets.

This research project aims to improve the understanding of current beach recreation values and how these might be altered by climate change over the remainder of this century. Further, it aims to develop tools that will assist coastal planners and decision makers to assess the economic impacts of climate change on recreational use values in their area and make informed planning decisions.

This project will provide estimates of the value of the recreational and tourism assets in key 'seachange' locations. Combined with a national classification framework of beach and surf assets, this information will be useful to all councils considering their coastal climate change adaptation options. Understanding the economic streams emanating from tourism and recreation linked to these assets, and how changes in resource quality and accessibility will impact on these streams at various time horizons and under different climate change projections will allow communities, industry and decisionmakers to make better informed adaptation decisions.
**Reflecting on the Lessons Learnt from Consultation in the Pacific Islands**

Poster Number: 108

E. Warry\(^1\)

\(^1\)AECOM

Three work-paid trips to Vanuatu sounds ideal, but in reality the paradise became a culture shock for a Brisbane-based climate change consultant. Competing with the Government priorities of food security and improving the quality of life for local ni-Vanuatu, the issue of climate change adaptation seems relegated to donor-funded aid projects and a one-person climate change office. The purpose of the stakeholder and community consultation was to determine what projects were considered critical for implementation to improve the climate change resilience of upland agricultural and coastal communities from $5.7 million of World Bank funding.

The poster will outline the lessons learnt from stakeholder and community consultation in Vanuatu. These include the importance of relating the projects back to Government priorities to get engagement and acknowledging that every new project will be started with consulting with Government officials who have been asked all of your questions before. The more practically focused lessons learnt from community consultation includes the necessity of engaging effective translators and that the ability to drive in heavy rain while avoiding road pot holes is essential.

The poster will also canvas issues around the utility of community consultation: how does it inform project development, does it set up a sense of entitlement among those communities which are consulted and how can a invariably small number of consultations provide representative input to projects that will be national in scope.

These experiences will allow individuals participating in donor-funded projects for climate change adaptation to better understand and be prepared to undertake consultation in the Pacific Islands.
Leading Adaptation Practices, Products and Tools for Australia

Poster Number: 208

B. Webb¹, J-L. Beh¹

¹Australian National University

The presentation describes the outcomes to date of an NCCARF-funded project that is distilling leading adaptation practices, reviewing the range of products that currently support adaptation initiatives and capabilities (including international and Australian developed web-based tools), and recommending an appropriate strategy to further develop and deliver such capabilities in the Australian context.

Increasing investment in adaptation initiatives over the last decade has generated significant experience and learning. However, much of this emerging knowledge is fragmented and difficult to access. Adaptation practitioners, sponsors and decision-makers face a sometimes confusing array of research findings, advice and tools to support their efforts.

The project is identifying the needs of Australian practitioners and stakeholders including governments (local, state and national); regional organisations (e.g. regional development authorities, regional organisations of councils, and catchment management authorities); NGOs; businesses and industry bodies; and researchers, consultants and other practitioners.

Categories of end-user need include

- Guidance on typical end-to-end adaptation processes from initial framing, through planning, assessment, decision-making, implementation and review
- Next level down tools, methods and models to assist in various stages of the overall process, sometimes very specific to sector and context
- Relevant socio-economic-environmental scenario development and use (including historical and projected climate information and impacts)
- Knowledge bases for distilling and sharing information (e.g. research studies, emerging good practices, potential adaptation responses, education and skilling, networks)

The project is confirming relevant products and tools currently available internationally and in Australia, mapping these to validated end-user needs, and (through widespread engagement with end-users and providers) establishing the criteria against which their applicability and utility can be assessed. Based on this the project is recommending the most appropriate strategy to deliver suitable products to Australian users, and to assist end-users choose approaches and products that are most likely to match their own need and context.
Local Governments’ Risk-based Approach to Climate Change Adaptation: a Missed Opportunity for Resilience in New South Wales

Poster Number: 111

N. White¹

¹Southern Cross University

Parts of New South Wales (NSW) have experienced warming of 1.5 to 2.0 degrees Celsius in the period 1960 to 2009, indicating that the impacts of climate change are already being felt. Immediate, effective adaptation to potential impacts is crucial in reducing vulnerability to climate change. All three levels of government in Australia have a role in adaptation planning however it is local government that is at the ‘coal face’ of the outcomes of imminent climatic changes. This empirical research seeks to discover whether the existing institutional and cultural environment of local governments in NSW facilitates or impedes effective adaptation. Interviews were conducted with personnel from NSW local governments to discuss any adaptation processes undertaken, and the success of the outcomes. These interviews have been critically analysed by applying resilience and adaptive management theories.

The research has uncovered a pattern of predominantly risk-based approaches to climate change adaptation by NSW local governments. The factors that have lead to this dominance of risk-based approaches include: direct intervention of the Australian federal government; State based regulatory governance influences; local governments’ existing competences in risk management and hazard reduction; and organisational culture. The analysis of these factors suggests that leadership, resources and values are critical influences on adaptation decision-making processes. It is argued that risk-based approaches, which are often localised and site-specific, restrict the suite of adaptive responses that can contribute to enhancing total system resilience. This, paradoxically, can limit the capacity of socio-ecological systems within the local government jurisdiction, as well as neighbouring systems, to adapt to change, thus leading to maladaptation. Ameliorating NSW local governments’ risk-based approach to adaptation would be complex, due to the factors and influences identified in this research, and because resilience is not a normative concept and does not conform to established principles of government policy.
There have been significant efforts over the past few decades to better incorporate gender considerations into development policy and practice. This is based on a growing recognition of women’s empowerment as central to positive development outcomes and the contribution that gender equality can make to the achievement of the other Millennium Development Goals (MDGs). Community Based Adaptation (CBA) involves the joint application of objectives and strategies relating to development and natural resource management. It is incumbent on CBA practitioners to integrate gender considerations into CBA projects and programs, in order to ensure that CBA activities benefit men and women equally, and do not inadvertently amplify existing social inequalities.

Phase I of The Nature Conservancy-led AusAID funded project “Building the resilience of communities and their ecosystems to the impacts of climate change in the Pacific” commenced in 2010 (focused on Papua New Guinea, Solomon Islands and Marshall Islands), and the design of Phase II is currently underway. As part of this design process, a systematic assessment of the extent to which Phase I incorporated gender considerations was undertaken. This included assessment of the extent to which men and women were included in project activities, including participatory 3D modelling and participatory video, as well as in tangible adaptation actions. Importantly, the gender balance in planning and decision making aspects of the project were examined. As part of the assessment, partnerships with other organisations focused on gender issues within the context of CBA work were established, as well as with organisations with strong content knowledge and experience in gender assessments. Lessons to help inform future project design, as well as broader organisational gender policy, were extracted and discussed.
How Do Heatwaves Affect Older People? A Survey of Aged Care Facility Staff Knowledge

Poster Number: 408

L. Wilson¹, C. Veitch¹, D. Black¹

¹University of Sydney

Introduction: Older people are vulnerable to the effects of extreme heat. Those who are frail, over 85 years, have limited mobility or co-existing illness are most vulnerable. This group of older people more often reside in Aged Care Facilities. The knowledge of staff on heatwave effects on the elderly and the way these staff care for older residents during heatwaves has never been systematically studied in Australia. This paper presents the results of a study investigating the heatwave effects knowledge of 200 clinical and administrative staff in ACFs in three Australian states.

Method: Clinical and administrative Aged Care Facilities staff in NSW, Qld and SA were invited to participate in a 15 minute telephone interview. The interview used a semi-structured validated questionnaire to identify the knowledge of staff about the effects of heatwaves on the elderly. The study was funded by NCCARF and approved by the Ethics Committee of the University of Sydney and the organisational Ethics Review Boards or Management Committees of the participating institutions.

Results: This paper presents the results of responses from 200 ACF clinical staff and compares them to those of 200 ACF administrative staff enrolled in the study. The majority ACF staff were able to identify at least one effect heatwaves had on older people. Many were unable to outline in detail the specific health impacts of heatwaves on older people.

Discussion and Conclusion: Until now, the knowledge of ACF staff about the effects of heat on the elderly institutionalised has never been systematically studied in Australia. These results provide an insight into ACF staff knowledge and highlight the strengths and weaknesses of current knowledge. The results provide a platform for the future development of heat health awareness educational training in Aged Care.
Assessing the Threats to Beach-nesting Birds from Predicted Sea-level Rises and Strategies for the Conservation and Management of Breeding Habitat

Poster Number: 509

E. Woehler¹, O. Carter², F. Faulkner², L. Gilfedder², A. McCuaig³, P. Park¹, V. Ruoppolo³, C. Sharples¹, L. Sparrow³, L. Znidersic¹

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The potential impacts to beach-nesting shorebirds and seabirds on sandy beaches on the Tasmanian coastline were assessed by combining GPS data on nest sites and breeding territories and colonies with projected high-water marks based on a range of predicted rises in sea-level. Extensive contemporary nesting data for three species of shorebird (hooded and red-capped plovers, pied oystercatchers) and for two seabird species (fairy and little terns) were combined with projected mean high-water marks for a range of predicted sea levels of 60, 80 and 100cm. Some high-resolution LiDAR data were available, and incorporated for the beaches where bird data were available. Variables such as beach width and slope will influence the potential loss of breeding habitat for these species from the rises in sea level. The study provides a number of alternative strategies for the conservation and management of breeding habitat for coastal birds, by incorporating the current conservation status of the species and the predicted rate of loss of critical breeding beaches. The inter-disciplinary approach provides a foundation for proactive policy and adaptive management strategies in minimising sea-level rise impacts on coastal fauna by providing a range of conservation priorities through a transparent assessment process.
Evaluating Collaborative Adaptation: The Case of Connectivity Conservation
Poster Number: 226

C. Wyborn

Fenner School of Environment and Society, Australian National University

Current approaches to conservation policy and management will be fundamentally challenged by the impact of climate change on species and ecosystems. Protecting and enhancing landscape-scale ecological connectivity has been proposed as a key approach to manage these changes, and is being implemented in a number of large-to-very large-scale initiatives in Australia and elsewhere. Motivated by the science of conservation biology, these initiatives use innovative models of collaborative governance to connect landscape-scale science with local-scale action. These arrangements intend to be flexible and responsive to local context while maintaining coherence and alignment across vertical (jurisdictions) and horizontal (land tenures) scales. In Australia, we have seen countless attempts to manage environments and landscapes across spatial and intellectual borders, however none as grand in scope and scale as these. Despite the promise of integrated conservation management across multiple tenures, connectivity initiatives face significant challenges of collaboration and communication across diverse landscapes, communities and agendas.

Connectivity conservation provides a unique and powerful lens through which to explore the policy and institutional challenges of climate change adaptation actions that require collaborative and cross-scale coordination. These challenges are common to many adaptation responses. Improving ecological connectivity at a large landscape-scale requires social and institutional integration that crosses spatial and temporal scales, land tenures and jurisdictions. Integrated cross-tenure management requires collaboration between stakeholders who have jurisdiction over different parcels of the landscape. Moreover, institutions to facilitate climate change adaptation will be most effective when flexible and adaptive to local context while maintaining coherence and alignment across vertical and horizontal scales. Thus the lessons drawn from emerging connectivity conservation initiatives can apply more broadly to other areas of climate change adaptation. Drawing on existing theory and emerging practice, this paper will highlight the challenges and opportunities of a collaborative approach to managing the cross-scale dimensions of climate adaptation.
Communicating Adaptation Effectively
Poster Number: 324

C. Young

1VCCCAR

Communication in the field of adaptation is a pivotal part of obtaining effective outcomes with adaptation and presents a particular challenge to all actors in the adaptation field. Because of the diversity of stakeholders and the need for research in many cases to be applied practically across diverse sectors and requires a combination of different types of knowledge, a multi-tiered and flexible model that uses a number of different forms of communication and types of language is necessary. It is important to understand what the barriers are to effective communication and how to overcome them in a practical way.

This presentation would examine what is working and why by presenting the different mediums and their effective use through current case studies and research. It will also show a model I have developed through my extensive experience of acting as a communicator/connector in this area between research bodies and government, industry and communities.
Total City Adaptation 1. Infrastructure
Poster Number: 414

G. Zellmer¹

¹AIA, Architecture Planning Research Development

Adaptation requires a new prototype to be sufficiently prepared for future climate changes. Existing cities will never be able to fully adapt! Both approaches will be necessary, the difference is like comparing a car adapted to float to the efficiency of a boat.

Basic physical requirements are clear. Climate adaptation involves everything. It would be negligent not to re-evaluate everything. It must allow flexibility, easily updated with newest technologies for changing climate. It must offer vertical evacuation from floods or brushfires. This proposal does that, and can be built today.

It offers better opportunities for all conference themes. There’re too many features, so two abstracts are submitted (see: 2-Human Factors). Arrangements improve every stage of life and reduce mortgage risk. This solution is ready for evaluation by conference attendees and construction of prototypes.

Highlights: Its basic arrangement offers flexibility to adapt to any climate with costs similar to comparable current housing. At suburban density 80% of land is open space. Surrounding farms enhance near total recycling. Its permanent infrastructure offers 1000+ years “continual-use,” reducing future housing replacement costs by 70%. Long-term infrastructure financing lowers initial cost. Amazing advantages, for investors is like money in the bank, it has permanent value. It can be built in new areas or phased gradually in old to keep neighborhoods intact. Owners can build homes with local materials without reducing the city’s comprehensive near zero-energy efficiency. (See: www.sprawlsolutions.com) For the first time in history necessity and technology offer, actually demand, a new prototype for cities. As soon as possible, 100-unit prototypes need to be built around the world for testing and refinement. It’s necessary, ...almost urgent!

... Flexible as nature fully adapts, old concepts cannot.
Two trees in each backyard hide this town’s structure.
Intense human activities are contained inside.
Private backyard, tree-shaded hill, countryside view.
**Total City Adaptation 2. Human Factors**

Poster Number: 519

G. Zellmer

1 AIA, Architecture Planning Research Development

Why adapt? It’s about human survival. For the first time in history, a combination of necessity and technology offer an amazing opportunity to solve human problems with cities. Cities are not designed primarily for people; streets are planned first. Forget you’ve ever seen a city. This prototype offers greater efficiency for every detail. Major feature: 70% lower environmental impacts and housing costs for 1000+ years, “Continual Use.” (See 1.Infrastructure)

Compact efficiency improves adaptation: Utility runs are shorter. Everything is within a short walk, including each transit stop. No car is needed, including big savings and benefits for non-drivers. Elevators and sloped paths, like hill towns in Europe, connect every home. Multi-story stair-stepped home-site lots with the roof of one being the backyard of the one above and 3-D subdivisions offering unique possibilities. Totally private home-sites allow any use: from 1 or 4 units to light industry without negative effect on neighbors and adaptable to future challenges. This almost eliminates mortgage risk. The poor can start small; with sweat equity to grow out of poverty. An incredible advantage not possible in other developments. Two best suburban and urban features: productive private backyards (for gardens, chickens, or even a goat) overlook the countryside. Front porches overlook the convenient Main Street which makes density desirable and more secure. (See: www.sprawlsolutions.com)

In extreme hot or cold climates, backyards have air-supported solar collecting enclosures with trees and gardens inside. The interior shopping Main Street can be covered and insulated from outside temperatures by surrounding homes which adapts easily. Neighborhoods are visually, socially and functionally connected. Main Street offers space for temporarily displaced people. Entire paradigm allows physical and human factors a better chance to adapt, especially to climate change.

... Midrise combines best of urban and suburban features. The waving distance increases sense of community. Start with 100-units, gradually phase into old city. Main Street connects towers as community grows.
Author Index

A
Abal, E................................................................. 51
Addai, D............................................................. 288
Adeyinka, A......................................................... 289
Akompab, D......................................................... 52, 290
Aldunce, P......................................................... 53, 54, 55, 291
Alexandra, J......................................................... 56
Anderson, G........................................................ 57
Anthony, K........................................................ 58
Argent, S............................................................. 292
Arora, M.............................................................. 293
Asamoah, D......................................................... 59, 294, 295
Aitchison, J......................................................... 296
Audas, D.............................................................. 60
Ayre, M................................................................. 297
Azam, M.............................................................. 217

B
Bai, L................................................................. 298
Bainbridge, M.................................................... 61
Baker-Jones, M.................................................... 62
Balston, J......................................................... 63, 299, 300
Barmuta, L.......................................................... 64
Barnett, G........................................................... 65
Barnett, J............................................................. 263
Battle, C.............................................................. 301
Beaty, M.............................................................. 66
Becken, S............................................................ 67
Beecham, S......................................................... 302
Beeden, R........................................................... 68
Beggs, P............................................................. 69
Bell, E................................................................. 70, 71
Bell, J................................................................. 303
Bell, M................................................................. 304
Bell, W................................................................. 305
Belusko, M........................................................ 72
Berry, H.............................................................. 73
Bhathal, A........................................................... 74
Bi, P................................................................. 264, 265
Biggs, C.............................................................. 306
Bird, D............................................................... 75, 277
Black, D............................................................. 266, 307
Bohensky, E....................................................... 308
Boland, J............................................................ 309
Bonnitcha, J....................................................... 76
Boon, H............................................................. 310
Booth, P............................................................. 77

Boschetti, F......................................................... 78
Bosomworth, K................................................... 79
Boulter, S.......................................................... 80
Box, P................................................................. 311
Brown, P............................................................ 312, 313
Burton, A........................................................... 314
Burton, D........................................................... 81, 315
Burton, P............................................................ 82

C
Capon, T............................................................. 83
Carey, M............................................................ 84
Chambers, L....................................................... 85, 316
Chaplin, S........................................................ 86
Chapman, S...................................................... 317
Cheng, X........................................................... 318
Clewett, J........................................................... 87
Cliffe, N............................................................ 88
Clifton, C.......................................................... 319
Cobden, S........................................................ 320
Cobon, D........................................................... 89
Coiacetto, E....................................................... 267
Cole, S............................................................... 321
Corkill, D........................................................... 90
Coulter, L.......................................................... 322
Cox, T................................................................. 323
Coy, D............................................................... 324
Creighton, C..................................................... 91
Crick, F............................................................. 92
Crompton, R..................................................... 181, 280
Cullen, B........................................................... 325

D
Dale, A............................................................... 326
Dany, V............................................................. 93
Daryanto, S....................................................... 327
Davidson, James................................................. 281
Davidson, Julie................................................... 95
Day, K............................................................... 261
De Sousa, D...................................................... 97
Dobes, L........................................................... 98, 99, 148
Doerr, V........................................................... 328
Doogue, J........................................................ 100
Dunlop, M......................................................... 101
Dunn, M............................................................ 102

E
Eady, S............................................................. 103
### Author Index

<table>
<thead>
<tr>
<th>Name</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eburn, M.</td>
<td>104</td>
</tr>
<tr>
<td>Ehmke, G.</td>
<td>329</td>
</tr>
<tr>
<td>Elemide, O.</td>
<td>330</td>
</tr>
<tr>
<td>Elsawah, S.</td>
<td>105</td>
</tr>
<tr>
<td>Enright, R.</td>
<td>331</td>
</tr>
<tr>
<td>Fabricius, K.</td>
<td>106</td>
</tr>
<tr>
<td>Fallon, D.</td>
<td>332</td>
</tr>
<tr>
<td>Farmer, N.</td>
<td>333</td>
</tr>
<tr>
<td>Farquharson, R.</td>
<td>107</td>
</tr>
<tr>
<td>Fidelman, P.</td>
<td>108</td>
</tr>
<tr>
<td>Finlay, K.</td>
<td>335</td>
</tr>
<tr>
<td>Finlayson, M.</td>
<td>109</td>
</tr>
<tr>
<td>Fisher, J.</td>
<td>110</td>
</tr>
<tr>
<td>Fleming, A.</td>
<td>112, 336</td>
</tr>
<tr>
<td>Foster, H.</td>
<td>337</td>
</tr>
<tr>
<td>Fuenfgeld, H.</td>
<td>113</td>
</tr>
<tr>
<td>Fuller, R.</td>
<td>114</td>
</tr>
<tr>
<td>Fyffe, T.</td>
<td>228</td>
</tr>
<tr>
<td>Gaillard, E.</td>
<td>338</td>
</tr>
<tr>
<td>Game, E.</td>
<td>115</td>
</tr>
<tr>
<td>Gardner, J.</td>
<td>116</td>
</tr>
<tr>
<td>George, D.</td>
<td>117, 339</td>
</tr>
<tr>
<td>George, S.</td>
<td>340</td>
</tr>
<tr>
<td>Gero, A.</td>
<td>341</td>
</tr>
<tr>
<td>Gerrard, E.</td>
<td>118</td>
</tr>
<tr>
<td>Ghahramani, A.</td>
<td>342</td>
</tr>
<tr>
<td>Gibbs, M.</td>
<td>343</td>
</tr>
<tr>
<td>Gilfedder, L.</td>
<td>344, 345</td>
</tr>
<tr>
<td>Goldie, C.</td>
<td>119</td>
</tr>
<tr>
<td>Granderson, A.</td>
<td>346</td>
</tr>
<tr>
<td>Graymore, M.</td>
<td>347</td>
</tr>
<tr>
<td>Grigg, N.</td>
<td>120</td>
</tr>
<tr>
<td>Griggs, D.</td>
<td>121, 269</td>
</tr>
<tr>
<td>H</td>
<td></td>
</tr>
<tr>
<td>Hamden, R.</td>
<td>122</td>
</tr>
<tr>
<td>Hand, D.</td>
<td>123</td>
</tr>
<tr>
<td>Hanna, L.</td>
<td>124</td>
</tr>
<tr>
<td>Hansen, A.</td>
<td>125, 348</td>
</tr>
<tr>
<td>Hardwick, L.</td>
<td>349</td>
</tr>
<tr>
<td>Harkin, J.</td>
<td>126</td>
</tr>
<tr>
<td>Hayman, P.</td>
<td>129</td>
</tr>
<tr>
<td>Head, B.</td>
<td>130</td>
</tr>
<tr>
<td>Head, L.</td>
<td>131</td>
</tr>
<tr>
<td>Healy, D.</td>
<td>350</td>
</tr>
<tr>
<td>Heath, J.</td>
<td>351</td>
</tr>
<tr>
<td>Higginbotham, N.</td>
<td>352</td>
</tr>
<tr>
<td>Hilbert, D.</td>
<td>133</td>
</tr>
<tr>
<td>Hillsdon, A.</td>
<td>353</td>
</tr>
<tr>
<td>Hobday, A.</td>
<td>134</td>
</tr>
<tr>
<td>Holper, P.</td>
<td>355</td>
</tr>
<tr>
<td>Horne, R.</td>
<td>270</td>
</tr>
<tr>
<td>Hosseinioon, S.</td>
<td>135</td>
</tr>
<tr>
<td>Howes, M.</td>
<td>136</td>
</tr>
<tr>
<td>Huang, C.</td>
<td>137</td>
</tr>
<tr>
<td>Hunt, G.</td>
<td>138, 357</td>
</tr>
<tr>
<td>Hurlstone, M.</td>
<td>139, 358</td>
</tr>
<tr>
<td>Hussey, K.</td>
<td>140, 272</td>
</tr>
<tr>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Iizumi, T.</td>
<td>359</td>
</tr>
<tr>
<td>Islam, M.</td>
<td>360</td>
</tr>
<tr>
<td>J</td>
<td></td>
</tr>
<tr>
<td>J. Paschen</td>
<td>198</td>
</tr>
<tr>
<td>James, C.</td>
<td>361</td>
</tr>
<tr>
<td>James, R.</td>
<td>142, 143, 144, 362</td>
</tr>
<tr>
<td>Johnston, G.</td>
<td>145, 363, 364, 365</td>
</tr>
<tr>
<td>Jones, D.</td>
<td>146, 147</td>
</tr>
<tr>
<td>Jones, R.</td>
<td>274, 366</td>
</tr>
<tr>
<td>K</td>
<td></td>
</tr>
<tr>
<td>K. Olsson</td>
<td>196</td>
</tr>
<tr>
<td>Kamruzzaman, M.</td>
<td>367</td>
</tr>
<tr>
<td>Keating, A.</td>
<td>368</td>
</tr>
<tr>
<td>Kiem, A.</td>
<td>149, 369, 429</td>
</tr>
<tr>
<td>Klinworth, A.</td>
<td>370</td>
</tr>
<tr>
<td>Kriwoken, L.</td>
<td>371</td>
</tr>
<tr>
<td>Kuleshov, Y.</td>
<td>372</td>
</tr>
<tr>
<td>Kuruppu, N.</td>
<td>150, 276</td>
</tr>
<tr>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Lankester, A.</td>
<td>151</td>
</tr>
<tr>
<td>Lawrence, A.</td>
<td>152</td>
</tr>
<tr>
<td>Lawrence, J.</td>
<td>153, 373</td>
</tr>
<tr>
<td>Lee, C.</td>
<td>154</td>
</tr>
<tr>
<td>Lee, E.</td>
<td>374</td>
</tr>
<tr>
<td>Lee, J.</td>
<td>375</td>
</tr>
<tr>
<td>Lehn, H.</td>
<td>225</td>
</tr>
<tr>
<td>Leitch, A.</td>
<td>157, 158, 159</td>
</tr>
<tr>
<td>Leith, P.</td>
<td>160</td>
</tr>
<tr>
<td>Leveston, Z.</td>
<td>376</td>
</tr>
<tr>
<td>Lewis, T.</td>
<td>377</td>
</tr>
<tr>
<td>Li, Y.</td>
<td>378</td>
</tr>
<tr>
<td>Lim-Camacho, L.</td>
<td>161</td>
</tr>
<tr>
<td>Author</td>
<td>Pages</td>
</tr>
<tr>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>Ling, S.</td>
<td>162</td>
</tr>
<tr>
<td>Lissner, T.</td>
<td>163, 164</td>
</tr>
<tr>
<td>Liu, X.</td>
<td>165</td>
</tr>
<tr>
<td>Lloyd, D.</td>
<td>379</td>
</tr>
<tr>
<td>Loch, A.</td>
<td>166</td>
</tr>
<tr>
<td>Lochhead, H.</td>
<td>156</td>
</tr>
<tr>
<td>Lockwood, M.</td>
<td>96</td>
</tr>
<tr>
<td>Loechel, B.</td>
<td>167</td>
</tr>
<tr>
<td>Lolicato, S.</td>
<td>380</td>
</tr>
<tr>
<td>Lorenz, D.</td>
<td>168</td>
</tr>
<tr>
<td>Loughnan, M.</td>
<td>169, 381</td>
</tr>
<tr>
<td>Low Choy, D.</td>
<td>278</td>
</tr>
<tr>
<td>Lynam, T.</td>
<td>170, 171</td>
</tr>
<tr>
<td>Maani, K.</td>
<td>172</td>
</tr>
<tr>
<td>Macadam, I.</td>
<td>382</td>
</tr>
<tr>
<td>Macfarlane, M.</td>
<td>383</td>
</tr>
<tr>
<td>Mackenzie, T.</td>
<td>173</td>
</tr>
<tr>
<td>Mackey, B.</td>
<td>174</td>
</tr>
<tr>
<td>Maggini, R.</td>
<td>175</td>
</tr>
<tr>
<td>Mallon, K.</td>
<td>176</td>
</tr>
<tr>
<td>Maloney, M.</td>
<td>384</td>
</tr>
<tr>
<td>Manning, M.</td>
<td>385</td>
</tr>
<tr>
<td>Marshall, K.</td>
<td>386</td>
</tr>
<tr>
<td>Marshall, N.</td>
<td>177, 387</td>
</tr>
<tr>
<td>Marshall, P.</td>
<td>178</td>
</tr>
<tr>
<td>Materia, C.</td>
<td>388</td>
</tr>
<tr>
<td>Mayes, G.</td>
<td>389</td>
</tr>
<tr>
<td>McAllister, R.</td>
<td>279</td>
</tr>
<tr>
<td>McAllister, R.</td>
<td>180, 390</td>
</tr>
<tr>
<td>McCormick, L.</td>
<td>391</td>
</tr>
<tr>
<td>McDonald-Madden, E.</td>
<td>182</td>
</tr>
<tr>
<td>McInnes, J.</td>
<td>183</td>
</tr>
<tr>
<td>McIvor, L.</td>
<td>184</td>
</tr>
<tr>
<td>McKellar, R.</td>
<td>392</td>
</tr>
<tr>
<td>McKenzie, L.</td>
<td>393</td>
</tr>
<tr>
<td>Mclachlan, B.</td>
<td>186</td>
</tr>
<tr>
<td>McLean, R.</td>
<td>394</td>
</tr>
<tr>
<td>McNaught, R.</td>
<td>187</td>
</tr>
<tr>
<td>McNeill, I.</td>
<td>395</td>
</tr>
<tr>
<td>Metcalf, S.</td>
<td>396</td>
</tr>
<tr>
<td>Morely, P.</td>
<td>238</td>
</tr>
<tr>
<td>Morley, P.</td>
<td>189</td>
</tr>
<tr>
<td>Mukheibir, P.</td>
<td>190, 397</td>
</tr>
<tr>
<td>Mullett, J.</td>
<td>191</td>
</tr>
<tr>
<td>Mumby, P.</td>
<td>192</td>
</tr>
<tr>
<td>Mumford, J.</td>
<td>398</td>
</tr>
<tr>
<td>Mustelin, J.</td>
<td>193, 399</td>
</tr>
</tbody>
</table>

N
<table>
<thead>
<tr>
<th>Author</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>N. Rogers</td>
<td>210</td>
</tr>
<tr>
<td>Naim, M.</td>
<td>400</td>
</tr>
<tr>
<td>Naum, C.</td>
<td>401</td>
</tr>
<tr>
<td>Nguyen, M.</td>
<td>402</td>
</tr>
<tr>
<td>Norman, B.</td>
<td>194</td>
</tr>
<tr>
<td>Nugent, G.</td>
<td>403</td>
</tr>
<tr>
<td>Nursey-Bray, M.</td>
<td>282</td>
</tr>
</tbody>
</table>

O
<table>
<thead>
<tr>
<th>Author</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>O’Hagan, R.</td>
<td>195</td>
</tr>
</tbody>
</table>

P
<table>
<thead>
<tr>
<th>Author</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmer, J.</td>
<td>141, 273</td>
</tr>
<tr>
<td>Parker, W.</td>
<td>404</td>
</tr>
<tr>
<td>Parsons, M.</td>
<td>197, 283</td>
</tr>
<tr>
<td>Patinson, K.</td>
<td>275</td>
</tr>
<tr>
<td>Pecl, G.</td>
<td>199, 200</td>
</tr>
<tr>
<td>Penny, A.</td>
<td>405</td>
</tr>
<tr>
<td>Perez, E.</td>
<td>406</td>
</tr>
<tr>
<td>Petersen, L.</td>
<td>201</td>
</tr>
<tr>
<td>Petheram, L.</td>
<td>202, 268</td>
</tr>
<tr>
<td>Phan, T.</td>
<td>407</td>
</tr>
<tr>
<td>Phelan, D.</td>
<td>408, 409</td>
</tr>
<tr>
<td>Pocock, G.</td>
<td>410</td>
</tr>
<tr>
<td>Poloczanska, E.</td>
<td>411</td>
</tr>
<tr>
<td>Pope, A.</td>
<td>412</td>
</tr>
<tr>
<td>Possingham, H.</td>
<td>203</td>
</tr>
<tr>
<td>Post, D.</td>
<td>204</td>
</tr>
<tr>
<td>Pratchett, M.</td>
<td>205</td>
</tr>
<tr>
<td>Punpee, P.</td>
<td>413</td>
</tr>
</tbody>
</table>

R
<table>
<thead>
<tr>
<th>Author</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rance, A.</td>
<td>206, 414</td>
</tr>
<tr>
<td>Reisinger, A.</td>
<td>128</td>
</tr>
<tr>
<td>Renton, M.</td>
<td>415</td>
</tr>
<tr>
<td>Reser, J.</td>
<td>207</td>
</tr>
<tr>
<td>Reside, A.</td>
<td>208</td>
</tr>
<tr>
<td>Rhodes, B.</td>
<td>185</td>
</tr>
<tr>
<td>Rickards, L.</td>
<td>209</td>
</tr>
<tr>
<td>Rickett, J.</td>
<td>416</td>
</tr>
<tr>
<td>Rissik, D.</td>
<td>417, 425</td>
</tr>
<tr>
<td>Rochecouste, J.</td>
<td>418</td>
</tr>
<tr>
<td>Roger, E.</td>
<td>155</td>
</tr>
<tr>
<td>Roos, P.</td>
<td>419</td>
</tr>
<tr>
<td>Roper, T.</td>
<td>211</td>
</tr>
<tr>
<td>Russell, S.</td>
<td>212</td>
</tr>
<tr>
<td>Rutherford, S.</td>
<td>420</td>
</tr>
</tbody>
</table>
Author Index

<table>
<thead>
<tr>
<th>S</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salardini, A</td>
<td>Van Vuuren, K.</td>
</tr>
<tr>
<td>Salinger, J.</td>
<td>VanDerWal, J.</td>
</tr>
<tr>
<td>Sandall, J.</td>
<td>Vardoulakis, S.</td>
</tr>
<tr>
<td>Sapiains, R.</td>
<td>Verdon-Kidd, D.</td>
</tr>
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<td>Sarker, T.</td>
<td>Ves, P.</td>
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<tr>
<td>Schandl, H.</td>
<td>Vienet, E.</td>
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<td>Scott, H.</td>
<td>Vohland, K.</td>
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<td>Senaratne, I.</td>
<td>Vote, C.</td>
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<td>Walker, I.</td>
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<td>Shearer, S.</td>
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<tr>
<td>Shears, I.</td>
<td>Wardell-Johnson, A.</td>
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<tr>
<td>Sheaves, M.</td>
<td>Wardell-Johnson, G.</td>
</tr>
<tr>
<td>Siebentritt, M.</td>
<td>Warry, E.</td>
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<td>Sieweke, J.</td>
<td>Watkins, A.</td>
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<td>Soste, L.</td>
<td>Webb, B.</td>
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<tr>
<td>Sporne, I.</td>
<td>Webb, L.</td>
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<td>Steele, W.</td>
<td>Webster-Mannison, M.</td>
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<td>Stocker, L.</td>
<td>Weeks, A.</td>
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<td>Stone, G.</td>
<td>West, J.</td>
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<td>Stubbs, T.</td>
<td>Wheeler, S.</td>
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<td>Sullivan, A.</td>
<td>Whetton, P.</td>
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<td>Sullivan, J.</td>
<td>White, N.</td>
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<td>Sultana, N.</td>
<td>Whitford, L.</td>
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<td>Summers, D.</td>
<td>Williams, D.</td>
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<td>Sweeney, S.</td>
<td>Williams, K.</td>
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<td>T</td>
<td>Wilson, L.</td>
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<td>Tanner-McAllister, S.</td>
<td>Wintle, B.</td>
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<td>Wise, Y.</td>
</tr>
<tr>
<td>Taylor, M.</td>
<td>Woehler, E.</td>
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<td>Terwijn, M.</td>
<td>Woolf, M.</td>
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<tr>
<td>Thorburn, P.</td>
<td>Woolford, C.</td>
</tr>
<tr>
<td>Tong, S.</td>
<td>Wyborn, C.</td>
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<td>Tran, T.</td>
<td></td>
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<td>Travers, A.</td>
<td>Y</td>
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<td>Truong, C.</td>
<td>Young, C.</td>
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<td>U</td>
<td>Young, C.</td>
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<td>Unsworth, K.</td>
<td>Yuen, E.</td>
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</tbody>
</table>

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