



Implementation Plan for Climate Change Adaptation Research: Human Health

April 2012

1. Purpose of Implementation Plan
2. Background
3. Potential sources of research funding
4. Potential sources of research delivery
5. Strategy for national coordination
6. Impediments and risks
7. Monitoring
8. References

Appendix 1: Updated Priority Research Questions for Human Health (2012)

Appendix 2: Current NCCARF (ARGP) / NHMRC Research for Human Health

1. Purpose of Implementation Plan

This Implementation Plan for Human Health (2012) outlines implementation directions for the updated priority research questions for climate change adaptation and human health, as stated in the *Update Report: National Climate Change Adaptation Research Plan for Human Health (2012)* (Update Report; Hanna et al. 2012).

The purpose of this Implementation Plan is to define the most effective way to build (and in some cases initiate) national investments to address the updated priority research questions. The focus is on:

- delivering research to address the objectives of the National Climate Change Adaptation Research Plan for Human Health (Human Health NARP; McMichael et al. 2009);
- facilitating collaborative arrangements;
- maximising resources for priority research; and
- optimising the timing of research investments.

Implementation Plans consider opportunities for implementing research at a specific time, and so are not static documents. NCCARF updates Implementation Plans periodically to ensure that new opportunities are continually identified, developed and harnessed over time. This implementation plan was revisited and updated during 2011 and 2012 using information from relevant organisations and after discussion and input from key stakeholders.

Additional opportunities for research investment may arise in this area over the coming year and in a next Phase of NCCARF. This Implementation Plan will be updated to reflect the development of new opportunities.

2. Background

2.1 Australia's Climate and Human Health

Extreme variability is a characteristic of the Australian climate, and this variability affects human health. Many other health risks arise from changed ambient temperatures and rainfall or combinations of climate conditions, other biophysical factors and individual and community responses to these changes. In southern Australia there are risks from heatwaves, drought and bushfire, and flooding can lead to contamination of water supplies, and in northern Australia to increased risk of vector-borne diseases such as dengue fever. Adverse effects on the physical and mental health of individuals and groups may occur in the workplace, public places and the home.

2.2 The Human Health NARP

The National Climate Change Adaptation Research Facility (NCCARF) developed the Human Health NARP (McMichael et al. 2009) in 2009 to identify high priority research questions to guide research investment for a five to seven year period. The Human Health NARP is one of nine NARPs that address issues arising from the impacts of climate change on key theme areas.

In 2011 NCCARF revisited and updated the Human Health NARP to take account of developments after the original NARP was completed, including:

- research published since 2010,
- changes to stakeholder information needs since 2010, and
- research commissioned after the NARP was completed.

The revisit process resulted in the preparation of an Update Report (Hanna et al. 2012) with an amended list of priority research questions. The amended list of high priority research questions is provided in Appendix 1.

2.3 Preparation of the Implementation Plan

NCCARF has updated the Human Health Implementation Plan in 2012 to take account of changes in:

- the capacity of Australian researchers to undertake climate change adaptation research for human health and

- the capacity of key potential research funding organisations to invest in research to address the updated research priorities in the Human Health research theme.

Australia has a long history of high-quality research that addresses human health, funded by both the public and private sectors. This research provided a good platform for the national focus on climate change adaptation research that resulted from the identification of research priorities in the Human Health NARP and research calls under a joint NHMRC and DCCEE arrangement (see section 3.1.1).

3. Potential sources of research funding

This section outlines potential sources of research funding to address climate change adaptation for human health.

3.1 Key changes since 2009

- Funding from the Adaptation Research Grants Program (ARGP) available for climate change adaptation research for Human Health has been transferred to the NHMRC. Seven research projects have been commissioned using the ARGP funding available for the human health theme and further climate change adaptation research for human health may be funded on a competitive basis through NHMRC's programs using remaining ARGP funding or other NHMRC funding; (see Section 3.2.1).
- All other ARGP funding has been fully allocated (see Section 3.2.1).
- Griffith University, NCCARF and DCCEE are investigating options for further research funding for this theme and for an extension of NCCARF (see Section 3.2.1).
- The NHMRC will continue to fund research about climate change adaptation and human health that meet their funding guidelines and requirements (see Section 3.2.2).

3.2 Australian Government

3.2.1 Department of Climate Change and Energy Efficiency (DCCEE)

In December 2008 the Department of Climate Change and Energy Efficiency (DCCEE) and the National Health and Medical Research Council (NHMRC) formed a collaborative arrangement to direct research investment towards delivering research against the priority research questions identified in the Human Health NARP. Under this arrangement the research priorities identified by the Human Health NARP were coupled with an NHMRC Special Initiative *Health Challenges of Climate Change* under their research support grants program, with DCCEE and NHMRC each contributing \$3 million to create a \$6 million research investment fund. The DCCEE contribution was from the Australian Climate Change Adaptation Research Grants Program (ARGP). Three Special Initiative research calls have resulted in seven research proposals being funded (see Appendix 2).

The \$6 million DCCEE and NHMRC research investment in human health challenges of climate change is one of the largest such investments focussed on climate change

adaptation and climate change globally. However the value of this investment can be achieved only if the three organisations involved, DCCEE, NHMRC and NCCARF, continue to manage the program towards its objectives and communicate its research findings and knowledge to end users. In addition, while the NHMRC research investment pathway is very important, a broader approach to investment is needed to encompass the full scope of the Human Health NARP research priorities and, more widely, the research interest and efforts now being focused on the human health implications of changing climatic conditions.

In 2011 DCCEE (after consultation with NCCARF) and NHMRC agreed that a call for research proposals should be made under the NHMRC *Partnerships for Better Health* program. It was agreed that the *Partnerships* program was more closely aligned to the objectives of the ARGP and the Human Health NARP. The first *Partnerships* program call targeted to climate change adaptation opened in April 2012, with further calls anticipated on a 4-monthly basis.

Climate change adaptation research will continue to be awarded from other NHMRC research programs, where proposals meet NHMRC requirements.

In separate initiatives, DCCEE funds research which contributes to understanding climate change adaptation for human health, such as a report about risks of climate change to Indigenous peoples of the tropical North (Green et al., 2009).

In addition, several research projects funded by the ARGP under other themes also contribute to climate change adaptation research relevant to Human Health (see Hanna et al. 2012 for details). These include:

- 3 projects in the Settlements and Infrastructure theme with ARGP funding of \$1,245,000 and a total cash value of about \$1,500,000 (cash) and about \$3,590,000 (in-kind) for a total research value of about \$2,310,000. These projects will be completed and reported by mid-2013.
- 7 projects in the Social, Economic and Institutional Dimensions theme with ARGP funding of about \$1,970,000 and a total cash value of about \$2,065,000 (cash) and about \$1,920,000 (in-kind) for a total research value of about \$3,985,000. These projects will be completed and reported by mid-2013.
- 2 projects in the Indigenous Communities theme with ARGP funding of about \$730,000 and a total cash value of about \$780,000 (cash) and about \$525,000 (in-kind) for a total research value of about \$1,300,000. These projects will be completed and reported by mid-2013.
- 2 projects in the Emergency Management theme with ARGP funding of about \$400,000 and a total cash value of about \$455,000 (cash) and about \$425,000 (in-kind) for a total research value of about \$880,000. These projects will be completed and reported in 2012.

All ARGP funds have now been allocated to research projects. DCCEE has an ongoing interest in research in the human health theme and may invest in research that addresses the NARP's research priorities as funding becomes available.

Griffith University, NCCARF, the NCCARF Board and DCCEE are looking at options for an extension of NCCARF. No funding for further human health research will be available from an extension of the ARGP until decisions are made about the future of NCCARF.

3.2.2 National Health and Medical Research Council (NHMRC)

The NHMRC is Australia's leading funder for public and individual health research. As discussed in Section 3.1.1, a joint DCCEE (ARGP) – NHMRC research funding allocation has supported seven research proposals from three research calls, with the remaining funding being allocated to the *Partnerships for Better Health* program. The Partnerships program, represents a major new focus for NHMRC: *[Partnerships] aim to lead to more effective connections between decision makers who design policy and researchers, and to improve the availability and quality of research evidence to help inform the policy process.*

The Partnership program has two parts.

- a. NHMRC Partnership Projects part supports collaboration on specific projects between researchers and policy or practice agencies. The remaining joint DCCEE (ARGP) – NHMRC funding has been allocated to this part.
- b. NHMRC Partnership Centres for Research Excellence will be established, most likely for a five-year period, as leaders in scientific research relevant to policy and practice. Members of the Health Adaptation Research Network are seeking opportunities to participate in Centres, such as through a potential Centre of Excellence in Climate Change Adaptation.

3.2.3 Other Commonwealth Departments

Many Commonwealth Government departments have specific interests in the effects of changing climatic conditions on human health.

- Department of Health and Aging: the impacts of extreme weather events and prolonged heatwaves on aging populations. This department sees its research needs being fulfilled primarily through the NHMRC.
- Department of Agriculture, Fisheries and Forestry (DAFF): the health of rural communities and mental health of people working in the agricultural sector.
- Attorney-General's Department:
 - extreme events and demands for emergency management provision;
 - legal capabilities of local governments and understanding of liabilities under changing climatic conditions; and
 - risk analysis and prioritisation of climate change in the context of other stresses and risks which have implications for human health.
- Department of Defence: heat impacts on personnel, water-borne vectors and mosquito distribution, especially in tropical and sub-tropical training areas.
- Department of Education, Employment and Workplace Relations: potential work place implications and capacity building to address climate-related health issues.
- Department of Sustainability, Environment, Water, Population and Communities (SEWPaC): the management of national parks and world heritage areas, assessing projects and water resources.

- Department of Families, Housing Community Services and Indigenous Affairs (FaHCSIA): climate change adaptation generally as part of a wider consideration of multiple stresses affecting the lives of Australians. For example, FaHCSIA supported the National Rural Women's Summit in 2009 which explored issues around climate change and set out priority recommendations for action.
- Department of Infrastructure and Transport: a wide spectrum of portfolio interests have embedded concerns over health implications of climate change.
- Department of Innovation, Industry, Science and Research and Tertiary Education (DIISRTE): improving tools and capacity and the role of innovation for climate change adaptation decision-making by state and local government, business owners and local groups, research integration and good international engagement, all in relation to human health implications.
- Department of Regional Australia, Local Government, Arts and Sport: Regional Australia works in partnership with communities, government and the private sector to foster the development of self-reliant communities and regions, and assists local governments to provide essential services and develop effective planning initiatives; the Office for Sport has targeted programs relating to safety and other matters.
- Department of Veterans Affairs (DVA): the health and welfare of personnel who have served or are serving overseas, including physical and mental health, homecare and support. DVA's dedicated research and development area may be able to collaborate in research activities into health implications of climate change adaptation on core areas of departmental interest.
- Department of Resources, Energy and Tourism (DRET): health impacts for tourism operators in coastal areas and around eco-tourism, including the effects of increased incidence of extreme events and time to recovery. DRET is also concerned about possible negative images of Australia overseas, such as arising from increases in health and safety incidents arising from climate change-related disasters.

3.2.3.1 National data provision

Empirical research is dependent on data, and there are two main providers to underpin research around climate change and human health. Each has statutory obligations with respect to data quality, providing a level of assurance for researchers drawing on national scale datasets.

- The Australian Institute for Health and Welfare is Australia's national agency for health and welfare statistics and information.
- Australian Bureau of Statistics (ABS) has as its vision statement: *'We assist and encourage informed decision making, research and discussion within governments and the community, by leading a high quality, objective and responsive national statistical service'*.

3.3 State and Territory Government Organisations

All state and territory governments have departments and research capacity concerned with human health. These encompass primary health care and the provision of hard and soft infrastructure to support wide ranging health services. There is demonstrated awareness of the potential impacts of extreme weather conditions and climate change on vulnerable cohorts: the very young, the aged and people receiving institutional and at-home health care services. While these departments are interested in collaborative research activities, no new immediate and easily accessible sources of funding have been identified.

3.4 CSIRO Climate Adaptation Flagship

CSIRO established a Climate and Health Cluster to bring together scientists and researchers from a range of disciplines to develop adaptation strategies for safeguarding the health of urban populations in the face of a variable and changing climate. The Cluster is a \$3.5 million collaboration between eight partner institutions and the CSIRO Flagship Collaboration Fund. The Climate and Health Cluster's research program focuses on heat stress, food security and safety, air quality, and the changing risk posed by vector-borne diseases such as dengue fever due to climate change.

3.5 Australian Research Council (ARC)

The Australian Research Council (ARC) is a statutory authority within the Australian Government's Industry, Innovation, Science, Research and Tertiary Education (IIS RTE) portfolio. The ARC's mission is to deliver policy and programs that advance Australian research and innovation globally and benefit the community.

In seeking to achieve its mission, the ARC supports the highest-quality fundamental and applied research and research training through national competition across all disciplines, with the exception of clinical medicine and dentistry. However, the ARC will invest in research that relates to health and medical policy. The ARC will also broker partnerships between researchers and industry, government, community organisations and the international community.

Current ARC research relevant to climate change and human health includes: a) the functional genomic analysis of exported DnaJ molecules in the malaria parasite *Plasmodium falciparum*; and b) extreme weather and population health in Australia with particular interest in risk assessment, prediction of health impacts and disease burden, and adaptive strategy exploration. There is every reason to expect that further sound proposals about climate change adaptation research about health and medical policy will be funded.

ARC funding programs come under the umbrella of the National Competitive Grants Program.

ARC *Discovery* programs fund individual researchers and projects.

ARC *Linkage* programs help to broker partnerships between researchers and industry, government and community organisations as well as the international community.

ARC *Future Fellowships* program promotes research in areas of critical national importance by giving outstanding researchers incentives to conduct their research in Australia. The aim of *ARC Future Fellowships* is to attract and retain the best and brightest mid-career researchers and significantly boost Australia's research and innovation capacity in areas of

national importance. Preference is given to researchers who can demonstrate a capacity to build collaboration across industry and/or research institutions and/or with other disciplines.

Over a five-year period (2009-2013), *ARC Future Fellowships* offer four-year fellowships to 1,000 outstanding Australian and international researchers in the middle of their career. In addition, each researcher's Administering Organisation will receive funding of up to \$50,000 per year to support related infrastructure, equipment, travel and relocation costs. The first 200 *Future Fellowships* were announced in September 2009.

Opportunities for funding human health climate research also exist at ARC within the *Centres of Excellence* scheme. Examples of existing Centres with relevance are:

- ARC Centres for Excellence for Climate System Science (UNSW);
 - The objective of this CoE is to resolve uncertainties in regional climate science to support for impacts and adaptation research, and thereby to deliver economic, social and environmental benefits by improving advice to all levels of Government and the broader community on the scale, speed and timing of regional climate change.
- ARC Centre of Excellence for Environmental Decisions (UQ)
 - The objective of this CoE is to generate the fundamental knowledge and tools needed to make the best use of available resources for conservation and provide new techniques for assessing what resources are required and innovative ways for learning from investment decisions.
- ARC Centre of Excellence for Cognition and its Disorders (UWA)
 - The objective of this CoE is to undertake research to inform the diagnosis and treatment of a range of cognitive disorders, that would, among other benefits, support better communication of climate change risks and adaptation options to affected individuals and their families and thus improve the resilience of this vulnerable component of Australia's community.
- ARC Centre of Excellence for the History of Emotions (UWA)
 - The objective of this CoE is to provide greatly enhanced understandings of how to improve emotional health among modern Australians.
- ARC Centre of Excellence for Population Ageing Research (UNSW)
 - The objective of this CoE is to transform thinking about population ageing, inform private and public sector policy and yield outcomes that improve the well-being of the aged and their social and economic environment.

3.6 Private Sector and Non-Government Organisations

A wide range of peak bodies for industry sectors, non-government organisations and advisory bodies are aware of the need to adapt to climate change. For example, insurance companies are addressing the human health implications of extreme weather and changing climatic conditions, as in the Insurance Council of Australia policy paper '*Improving Community Resilience to Extreme Weather Events*'.

Peak organisations representing public and environmental health professionals and private sector health care providers are well aware of the human health dimensions of changing

climatic conditions in broad terms and the need for ongoing research. These organisation are able to aid the Health ARN in communicating to their members about both research calls, collaborations and results, including encouraging national and state/territory based non-government responses to research calls.

NCCARF will continue dialogue with bodies such as:

- The Public Health Association of Australia, regarding its involvement in promoting more innovative climate change and human health research and in helping to lever research funding;
- UnitingCare regarding research funding into climate adaptive hospitals and home care services, the latter being a particular interest of BlueCare as the nursing arm of UnitingCare;
- The Royal Australasian College of Physicians, that is already collaborating with the Health ARN;
- The Australian Local Government Association and state based Local Government Associations regarding the human health dimensions of climate;
- Regional Development Australia, an emerging on-the-ground initiative of the DITRDLG and specific regions, such as the Kimberly, Goldfields-Esperance and South West in WA and the Sunshine Coast in Queensland, regarding research into the human health dimensions of climate change for regional Australia;
- National Seniors Australia regarding potential research partnerships into the impacts of climate change on aging populations;
- The Insurance Council of Australia regarding collaborative research into the human health impacts of extreme weather involving NCCARF and Health ARN partners; and
- The National Farmers Federation regarding collaborative and co- funding for research into the mental health dimension of extreme weather events and their impacts.

3.7 International

There is significant national and international awareness of impacts and risks to human health posed by climate change and the need to prepare health systems and protect vulnerable groups from the impacts of climate change. Many international organisations could interface with research in Australia to address the research priorities in the Human Health NARP as indicated by the World Health Organisation (WHO) Collaborating Centre for Environmental Health Impacts at Curtin University. However, it is difficult to ascertain the current international investment in health adaptation research.

Ebi et al. (2009) identified significant research funding shortfalls in the USA into human health and climate change, and suggested that funding in the order of US\$200 million was required as opposed to an estimated US\$3 million per year then being invested.

On a global scale, the 'Hothaps' or 'high occupational temperature health and productivity suppression' program is a multicentre health research and prevention initiative investigating workplace heat impacts on worker health and productivity (Kjellstrom *et al.* 2009; Mathee *et al.* 2010).

While other international research will often be relevant to Australian conditions, it is likely to require interpretation to Australian circumstances, and this requires local research. There are also possibilities for collaborative work with individual overseas research organisations, such as universities.

3.8 Summary

Funding for climate change adaptation research about human health is available from several NHMRC programs, including the Partnership and the Special Initiative under the Partnerships for Better Health program the immediately available potential sources of funding to address climate change adaptation for human health include Commonwealth programs, including from the DCCEE, the NHMRC and the Australian Research Council (ARC). CSIRO research often provides opportunities for collaborative activities. States and territories may be interested in funding research that closely aligns with their priorities.

Additional funding for climate change-related health research (with a more distinct jurisdictional and regional focus) may come from state, territory and local governments, state and territory health-related agencies, where researcher interests and capacities align with agency priorities. Research funding could also be generated through strategic partnerships with non-government organisations, the private sector, charities and philanthropies. With respect to the prospects for collaboration and support from the private sector, there is increasing interest in this general topic of impacts and risks from climate change in particular from the private hospital and insurance sectors.

4. Potential sources of research delivery

4.1 Key changes since 2010

- New CRCs about health matters have the capacity to contribute to research relevant to climate change adaptation (see Section 4.5).
- EnHealth is taking a greater interest in the health risks associated with climate change and in possible climate change adaptation research activities (see Section 4.6).
- The membership of the Adaptation Research Network for Human Health has increased from about 150 members to about 300 members, with 20 partner institutions; the ARN has held several activities to promote research capacity and collaboration (see Section 4.7).

4.2 Background

Australia has a long history of human health research but relatively limited research about the effect of climate change on Australia's human health. Similarly, there has been only limited synthesis of regional and jurisdictional clinical and public health data to produce national scale perspectives. This situation is being addressed to some extent through integration and synthesis work being undertaken by NCCARF partners and some of the

projects awarded under the ARGP-NHMRC jointly funded Special Initiative described in Section 3.1.1.

To date, consideration of the human health dimensions of climate change adaptation has been mainly recognised by research centres within universities, by individual researchers and by focused private sector groups (eg Insurance Group Australia). Research capacity in climate change adaptation for human health is distributed sparsely across Australia in relatively small research groups housed within various university centres and departments or in specific groups within government health departments and agencies.

4.3 Universities

Universities employ researchers with wide ranging capabilities for research across disciplines relevant to human health - from highly theoretical approaches which challenge the ways we frame problems through to practical problem solving.

There is also the opportunity for large groups of researchers across universities to tackle complex multi-faceted problems. Universities generally welcome partnership arrangements such as those with CRCs, other research groups (including those overseas) and agencies, but need to consider carefully costs and benefits on a case-by-case basis. The work encompasses highly theoretical questions that challenge the ways in which problems are framed through to policy formulation and decision making processes for practical problem solving. The operational arrangements that focus the research effort within and between universities range from formal institutes and centres through to project-by-project collaborative activities between institutions and individual researchers. The scope of participation of the university sector in this research space is illustrated by the membership of the Health ARN.

4.4 Commonwealth Scientific and Industrial Research Organisation (CSIRO)

The CSIRO Climate Adaptation Flagship is the primary CSIRO focus for climate adaptation research in response to the Human Health NARP. This involvement is most directly evident through the Urbanism, Climate Adaptation and Health Collaboration Cluster of the Flagship. The overall goal of this Cluster is to safeguard the health of our urban populations in the face of a variable and changing climate. Key research objectives include:

- a fuller understanding of climate-related risks to health
- evaluation of early warning systems for stressful climate-related exposure
- evaluation of occupational and environmental standards and public health practices
- development of decision support tools for policy makers, urban planners, developers and households.

CSIRO researchers also apply for funding under other programs.

The Cluster's research program focuses on heat stress, food security and safety, air quality, and the changing risk posed by vector-borne diseases such as dengue fever due to climate change.

The CSIRO Health Cluster is already involved in researching the human health dimensions of climate change adaptation through the Health ARN and this avenue for collaboration and partnership is expected to be enhanced in the coming years.

4.5 Cooperative Research Centres (CRCs)

Cooperative Research Centres (CRCs) bring together researchers from universities, CSIRO, other Australian and state government research organisations, private industry, and/or public sector agencies in long-term collaborative research arrangements. CRCs are funded to support research, development, and education activities to achieve real outcomes of national economic and social importance. Some relevant CRCs are listed below.

4.5.1 Bushfire CRC *(From 2010/11 for 3 years)*

The Bushfire CRC is a partnership between major fire and land management research agencies and research institutions to reduce bushfire risk to the community. The Australian Government has approved additional funding (over the period 2010/11 to 2012/13) for the Bushfire CRC to address issues arising from the Victorian bushfires in February 2009. This supplementary program is designed to take fire research into the next decade with a focus on the interplay between fire and the main demographic, environmental and technological changes in Australia and New Zealand, with strong links to international fire research and management.

Risk assessment is one of four research areas for this CRC, with a considerable emphasis on modelling and future scenarios of climate change.

4.5.2 CRC for Mental Health *(From 2010/11 for 7 years)*

The CRC for Mental Health will develop early detection and treatment of neurodegenerative disorders and psychoses and work with partner end users to integrate the research findings into medical and health care practices. This will enable potentially affected individuals to retain their inherent resilience and so reduce their vulnerability to climate change impacts and risks.

4.5.3 Smart Services CRC *(From 2007/08 for 7 years)*

Smart Services CRC develops means for to enable industry to deliver affordable and personalised continuous services to customers.

4.5.4 Wound Management Innovation CRC *(From 2010/11 for 8 years)*

The Wound Management Innovation CRC examines key challenges in improving wound healing and improved wound management through the evaluation and implementation of evidence-based wound care, new preventative and treatment strategies and improved clinical care pathways.

4.5.5 Young and Well CRC *(From 2009/10 for 5 years)*

The Young and Well CRC seeks to apply information communication technologies to improve the mental health and wellbeing of young people aged 12 to 25 years, with a view to reducing youth suicide, suicide attempts, self-harm, depression, anxiety, substance use and social isolation and a consequent improvement in quality of life for young people, their families and their communities..

4.5.6 CRC for Aboriginal and Torres Strait Islander Health *(From 2009/10 for 4.5 years)*

The CRC for Aboriginal and Torres Strait Islander Health is addressing the key challenges of closing the Indigenous health gap, including chronic illness risk, early intervention and chronic illness management; local community and organisational capacity to develop appropriate interventions policy and programs reform.

4.5.7 CRC for Asthma and Airways (From 2005/06 for 7 years)

The CRC for Asthma and Airways is seeking to discover and develop novel therapeutic and diagnostic products for the benefit of all asthmatics and improve indoor, urban and regional air quality standards to reduce the risk of exposure to the triggers of chronic airway conditions.

NCCARF will explore opportunities for collaboration with relevant CRCs, as a part of the overall research investment strategy.

4.6 State and Territory Government Departments and Agencies

Each state and territory government has a health department. While these have different research awareness and capacity about climate change adaptation, all have become more aware of the potential health impacts of climate change as a result of recent extreme climate events.

NCCARF has discussed future climate change adaptation research programs with enHealth, a national committee having responsibility for providing health policy advice, implementing the *National Environmental Health Strategy 2007-2012*, consulting with key stakeholders, and the developing and coordinating research, information and practical resources on environmental health matters at a national level, with a strong emphasis on collaboration and consultation.

NCCARF also consults state and territory agencies through the Forum for NCCARF Interaction with States and Territories (FORNSAT).

Much of the emerging research effort focusing on climate change adaptation in the States and Territories is being delivered in collaboration with universities and other partners in the Health ARN. An example is research into the human health implications of the impacts of extreme weather events, leading to the development of adaptive strategies and on-the-ground responses, in Victoria, South Australia and Tasmania. This focused area of research effort has been given considerable impetus by the southern heatwaves of 2009.

The concerns of States and Territories around climate change adaptation and human health are different depending on geographical location: heatwaves and bush fire are important issues for southern States are around while managing impacts of cyclones and floods for states and territories that extend into the tropical North. For all, the climate change-related risks for human health are associated with changes in the intensity and frequency of such extreme events. NCCARF will continue to explore options for agency participate in climate change adaptation.

4.7 Adaptation Research Network for Human Health

The NCCARF Adaptation Research Network for Human Health (Health ARN) is hosted by the National Centre for Epidemiology and Population Health at the Australian National University. The Health ARN is working to *'improve Australian knowledge about climate change adaptation and human health to enable decision-making by government, industry and communities. This will be achieved by fostering interdisciplinary research, building research and decision-making capacity, facilitating collaboration between all stakeholders and communicating research findings broadly'*. The main aims of the Health ARN are (to quote):

- *To foster interdisciplinary research and emerging research methods (time-series methods, spatial analyses, systems-based modelling of complex ecological relationships and processes, and scenario-based modelling of future health risks).*
- *To build research and decision-making capacity by attracting and leveraging new funding, and focusing on mentoring and support for early career researchers and policymakers.*
- *To facilitate collaboration between researchers, policymakers and practitioners, including regional conditions to strengthen Australia's capacity to anticipate and mitigate the human health consequences of climate change.*

Currently the Health ARN has a membership of 20 partner institutions and about 300 members comprising researchers from universities, government research institutions and industry and stakeholders from government, business and the community. Collectively, the researcher members have access to a wide range of field and laboratory research facilities and have knowledge of the pathways to public and private sector research investment funds, while stakeholder members include key policy developers. The Health ARN is thus an effective vehicle to lever cash and in-kind research investment and ensure research uptake and application

Examples of current collaborative research activities through the Health ARN are:

- Developing a collection of State of the Science and Policy papers on priority themes, to inform research planning within the Health ARN's thematic nodes.
- Funding climate change adaptation research planning workshops on mental health and vector-borne disease, and contributing to a national workshop on thermal impacts, hosted by the Victorian Government.
- Hosting annual science writing workshops for PhD students who are members of the Health ARN, jointly with the Royal Australasian College of Physician's Faculty of Public Health Medicine.
- Engaging with relevant initiatives led by other Adaptation Research Networks, such as the initiative on Climate Change and the Urban Environment led by the Australian Academy of Technological Sciences and Engineering and supported by the Adaptation Research Network for Settlements and Infrastructure.
- Organising and sponsoring special issue publications relating to climate change adaptation and human health in Australia.
- Organising and holding workshops to ensure researchers are aware of the new opportunities resulting from the reallocation of funds to NHMRC's Partnership program.

The Health ARN is a key vehicle for extending the breadth and depth of the research agenda.

4.8 Regional Strategic Partnerships

Currently there are a number of emerging regional partnerships between universities, state, and national agencies with research interests in the climate change dimensions of human health. The geographic spread of these partner groups potentially provides a rich resource to address national-scale research questions in the health sector. Some cross-institutional arrangements exist and many of the researchers in these partner groups are active members of the Health ARN. A number of these partnerships have expressed keen desire to connect into the national research agenda and work with NCCARF in the delivery of the Human Health NARP (e.g., the Centre for Rural and Remote Mental Health Queensland, based in Cairns).

Regional Development Australia provides another example of an emerging strategic partnership base. Effort should be focused into harnessing regional linkages to obtain national perspectives. This could entail low cost 'action research' and utilise the integration and synthesis component of internally funded NCCARF activities.

4.9 Private sector funding

Funding through the private sector, philanthropic bodies and non-government organisations also needs to be further explored. This will entail maximising the involvement of current partners in the Health ARN and fostering new and innovative collaborations. A key focus should be on the benefits to be gained from supporting targeted research that will help to better inform investment and resource allocation. For example, the human health dimension of climate change adaptation is of considerable importance to:

- the insurance and financial security sectors;
- primary industry (agriculture, forestry and fisheries);
- mineral extraction and processing;
- tourism facility and activity operators;
- private hospital and health care providers,
- the industrial, trade and professional components of the union movement;
- community service organisations; and
- sporting and recreation bodies.

5. Strategy for National Coordination

There is a broad recognition that adaptation to climate change will become an increasingly important factor in government, industry, business and community planning and decision-making. Seven research projects been commissioned using the ARGP / NHMRC funding since the original Human Health NARP was completed (see Section 3.1 and Appendix 2). Research is also being funded and / or conducted by a variety of other providers (e.g. ARC), research organisations (e.g. CSIRO), and Commonwealth and state agencies.

5.1. Immediate investment (2012-2013)

Funding from the ARGP available for climate change adaptation research for Human Health has been transferred to the NHMRC. Climate change adaptation research for human health may be funded on a competitive basis through NHMRC's programs using this funding or other NHMRC funding.

Similarly, climate change adaptation research for health and medical policy can be funded on a competitive basis through the ARC's programs. There is every reason to presume that sound research proposals are likely to be successful.

The CSIRO remains interested in collaborative research opportunities, and states and territories have more or less limited resources available for research that is pertinent to their knowledge priorities.

NCCARF, with support from the Health ARN, will continue to discuss with the NHMRC, ARC and state and territory governments and agencies how climate change adaptation research for human health can be promoted within their research portfolios and how collaborations might be formed that will expand and extend research opportunities.

NCCARF is also developing an on-line hyperlinked source-page of potential climate change adaptation funding sources available to Australian researchers. When this page is live it will be announced at www.nccarf.edu.au and all Adaptation Research Network members will be advised.

5.2 Building future programs

A next Phase of NCCARF is being proposed to commence from 2013. NCCARF is seeking to establish a new round of core funding for further climate change adaptation research, with additional funds available for the human health theme.

NCCARF will continue to investigate with all potential research investors how further coordinated research programs could be developed to advance Australia's capacity to respond effectively to climate change adaptation challenges and opportunities.

The NCCARF Adaptation Research Network for Human Health will continue to monitor the interests of stakeholders with a view to developing and enhancing opportunities for research investment and collaboration.

6. Impediments and Risks

6.1 Impediments

Australia's climate change adaptation research community has increased during the 2008 – 2012 period, but remains small in comparison with the national research program required to address the updated research priorities for human health.

Implementing the research program set out in updated research priorities will require several research phases over a decade or more. This research agenda will need considerable funding over an extended period, and research focussed on the updated research priorities for human health will need to be integrated with research commissioned under other themes, such as SEID, Settlements and Infrastructure and Emergency Management.

6.2 Risks

The DCCEE and NHMRC have jointly invested \$6 million in the NHMRC Special Initiative *Health Challenges of Climate Change*. Other research investments are also contributing knowledge in this area. If adaptation around human health needs in Australia is to be well-informed, this program must deliver world-class and relevant research outcomes, well-

tailored to the needs of decision- and policy-makers. To achieve this goal, the three organisations involved, DCCEE, NHMRC and NCCARF, must collaborate closely to ensure that the outcomes from the research are managed and communicated so that Australian human health practices and institutions are able to effectively adapt to the challenges and opportunities that arise from climate change.

7. Monitoring

NCCARF monitors research being conducted across Australia that implements the research plan and reports annually on this research and remaining research gaps. NCCARF also reports regularly on the progress of research investments from the ARGP.

The Human Health NARP and Implementation Plan will be updated periodically to take account of changes in the information base available, current research being undertaken and changes in stakeholder information needs.

NCCARF, through a dedicated research program, also synthesises research outcomes as these evolve.

The Adaptation Research Network for Human Health is a useful partner in many of these NCCARF activities, and also develops independent reports and collaborations.

NCCARF undertakes a yearly survey of stakeholders which obtains feedback about a variety of issues including stakeholder engagement in projects and the delivery of useful information to end users.

8.0 References

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Appendix 1

Priority Research Questions in the *National Climate Change Adaptation Research Plan: Human Health*

Heat
<ul style="list-style-type: none"> • Which categories of people are most vulnerable to short-term extremes of heat? Do levels of understanding of the nature of the risks, and personal / household-level ways of ameliorating them, vary between these population subgroups? Are changes needed to public health policy in order to manage heat wave impacts? • Do early warning systems (EWSs) for heat waves and other extreme weather events reduce adverse health impacts? Which types of EWS are most effective and for what locations? • Are current occupational health and safety standards in relation to climate change-induced health risks (e.g., extremes of workplace heat exposure) adequate?
Short-duration extreme weather events
<ul style="list-style-type: none"> • Does public education about the risks of short-duration extreme events, and their avoidability, alter people's knowledge and behaviour?
Vector-borne disease
<ul style="list-style-type: none"> • What are the future increased risks of arbovirus diseases arising from climate change? Does climate-driven predictive modelling of any particular vector-borne infectious disease outbreak reduce the occurrence of such outbreaks? How would existing public health systems cope with increased levels of vector-borne disease infections? • Can meteorological forecasts of impending seasonal weather conditions provide useful advance warning of altered risks of vector-borne infectious disease outbreaks? Does such usefulness differ between human-only and zoonotic VBDs? Are such forecasts enhanced by the inclusion of information about changes in environmental indicators (e.g., surface water, vegetation levels, etc)? Will the implementation of such early warning systems result in reductions in outbreaks or infection rates?
Food, air and water quality
<ul style="list-style-type: none"> • Where will the likely climate change impacts on food safety and quality be observed, and what measures/practices can be implemented to reduce the risk of food-borne disease outbreaks? • How can the effects of climate change on air quality and aeroallergens be addressed? • How can water security be ensured in the management of climate change impacts and what is the role of the existing water authorities?
Mental health
<ul style="list-style-type: none"> • What interventions are required to minimise the potential harmful mental health effects of natural disasters (such as drought, windstorms or floods)?
Community health
<ul style="list-style-type: none"> • Which types of intervention most effectively increase the level of community resilience? What key characteristics of Indigenous, rural and urban communities determine their level of resilience to the stress of long-term changes in climatic and environmental conditions • How might climate change and climatic extremes affect aspects of Indigenous culture and living conditions that affect health?
Health care system and infrastructure issues
<ul style="list-style-type: none"> • Are health care and public health (health protection) systems adequately structured, staffed and resourced to handle increased demands from (i) extreme weather events and (ii) climate-related outbreaks of infectious diseases? What improvements are needed, feasible and effective? • What policies/ service guidelines and models of integrating the entire health sector's adaptive responses best support the coordination of adaptive activities? • What models of linkage and knowledge exchange between climate change researchers and policy-makers best provide relevant decision support in planning health sector responses. • What role should the primary health care sector play as part of a broader public health adaptive response to climate change? • What forms of in-career training of health care and related professionals best prepare them to identify and respond to climate-related health impacts? • What integrated responses are required between the health, transport, water, energy and other service provider sectors, including NGOs, to minimise impacts on vulnerable individuals during extreme heat events and other extreme events?

Appendix 2: Current NCCARF (ARGP / NHMRC Research for Human Health

Project Title	Lead Organisation	Lead Investigator
Changing Heat: direct impacts of temperature on health and productivity - current risks and climate change projections	Australian National University	Keith Dear
<p>We know that heatwaves kill people - some 50,000 died in the 2003 European heatwave - but little is known of the details. This project will discover those details, in three important dimensions: WHO is at risk, and where do they live; HOW are people at risk, e.g. from kidney failure; and just WHAT is it about heat that is most dangerous? We will then build mathematical models of the future risks, and explore what public health measures will best protect Australians in a warming climate.</p>		
Climate Change and Rural Communities: Integrated study of physical and social impacts, health risks and adaptive options	Australian National University	Anthony McMichael
<p>Rural Australia has begun to experience climate change impacts - which will increase in future. Losses in farm yields, water supplies, property, community morale and family incomes have diverse health effects. This project will study the separate and joint effects of climate change and associated extreme events (e.g., bushfires) on selected health outcomes. Using integrative methods, it will clarify the main influences on health risks, their future projections, and how best to intervene to lessen risks.</p>		
Dengue transmission under climate change in Northern Australia: linking ecological and population based models to develop adaptive strategies	Australian National University	David Harley
<p>Dengue is a mosquito-borne Flavivirus. The health impact in Australia is increasing. Epidemics have become more frequent in North Queensland with over 1,000 cases and one death in the most recent epidemic. There is no generally accepted model of the relation between climate, other determinants, and dengue for Australia. We will develop such a model. The principal aims are: 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; and 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: Collect and link data to develop new statistical models for the relationship between climatic and related variables and the occurrence of dengue in North Queensland; Assess the validity of an existing model (DENSIM , i.e. Dengue Simulation Model) of that relationship, for use in North</p>		

Project Title	Lead Organisation	Lead Investigator
Queensland; and Determine which of the above models (1. or 2.) is the most accurate tool for predicting future dengue incidence, in relation to projected climatic conditions, by comparing their 'back-casting' performance (i.e. validity) against past climate data and dengue incidence (for Cairns and Townsville, 1990-2010).		
Projection of the impact of climate change on the transmission of Ross River virus disease	Queensland University of Technology	Shilu Tong
<p>Human pathogens transmitted by mosquitoes pose a significant threat to population health. Ross River virus (RRV) is the most common and wide-spread mosquito-borne disease (MBD) in Australia, with over four thousands of clinical cases reported each year. Although there have been a number of studies of the relation between climatic variability and RRV, no research has been conducted to examine the possible impact of future climate change on this disease. The central aims of this study are to: establish baseline relations between climate variables and RRV at a local government area (LGA) level across Queensland; determine the impact of projected temperature, humidity and rainfall changes on the transmission of RRV in each LGA; and use the projected impacts to align climate change and public health policies for RRV surveillance and risk management programs.</p>		
Health impacts of climate change on Indigenous Australians: identifying climate thresholds to enable the development of informed adaptation strategies	University of New South Wales	Donna Green
<p>This project aims to provide decision-makers with clear and robust policy-relevant evidence that identifies the connections between climate, and the health and well-being of Indigenous people in the tropical north of Australia. The literature in this area is limited, even though a number of studies indicate that Indigenous people are likely to be disproportionately vulnerable to the future impacts of climate change. This project is significant in that it is the first major comparative study to fill this research gap: that is to test the hypothesis of disproportionate climate impacts on health, through two separate but related projects in urban and remote Indigenous communities. The study disaggregates data by indigeneity for past climate-morbidity and mortality relationships in order to identify thresholds in the urban setting. These identified thresholds would then be used to project mortality and morbidity of Indigenous people to future climate change, assuming no acclimatisation or adaptive strategies occur. In the remote community sites, in addition to the quantitative analysis, the project will also perform a qualitative study to assess the psychosocial impacts of climate change through the use of semi-structured interviews. The nominated communities have already collaborated with the CIA on related research, and AIA and AIB are Indigenous community leaders from the study sites who will be able to provide valuable intellectual guidance as well as local support</p>		

Project Title	Lead Organisation	Lead Investigator
Climate Change impacts on Workplace Heat Extremes: Health Risk Estimates and Adaptive Options	Australian National University	Elizabeth Hanna
<p>This project will study the relationship between occupational heat exposure and physiological parameters, especially dehydration, indicative of health risks. Heat-imposed limits on productivity will be estimated, and workplace heat policies, protocols and practices will be evaluated. We will assess workers' heat exposure by measuring temperature and humidity and calculate effective on-site thermal load. We will calculate trends in exposure since 1980, and model future workplace heat exposures and their health impacts under projected climate change with, and without adaptation strategies.</p>		
Displaced twice? Investigating the impact of Queensland floods on the wellbeing and settlement of a cohort of men from refugee backgrounds living in Brisbane and Toowoomba	La Trobe University	Ignacio Correa-Velez
<p>In December 2010, the first ever longitudinal study of health and settlement among refugee men (SettleMEN project) was completed. Findings for this cohort of 233 men revealed increasing levels of wellbeing after arrival in Australia, satisfaction with health services, improvement in family functioning, and greater social support. These men, however, face significant social exclusion that can seriously impact their successful integration into the Australian community; high levels of unemployment, low income, and increasing discrimination. The challenges for those men resettled in regional areas are even greater. At least 40% of the SettleMEN participants live in or close to areas affected by the floods that devastated Southeast Queensland in January 2011. As we have recent pre-disaster measures of health and settlement, this proposed follow-up study offers a rare opportunity to investigate the impact of an extreme weather disaster on a resettled refugee population.</p>		