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Aboriginal responses to climate change in arid zone Australia: regional understandings and capacity building for adaptation

Final Report

Paul Memmott, Joseph Reser, Brian Head, James Davidson,
Daphne Nash, Tim O'Rourke, Harshi Gamage,
Samid Suliman, Andrew Lowry, Keith Marshall

ABORIGINAL RESPONSES TO CLIMATE CHANGE IN ARID ZONE AUSTRALIA

Regional understandings and capacity building for adaptation

The University of Queensland

AUTHORS

Paul Memmott (University of Queensland)

Joseph Reser (Griffith University)

Brian Head (University of Queensland)

James Davidson (University of Queensland)

Daphne Nash (University of Queensland)

Tim O'Rourke (University of Queensland)

Harshi Gamage (University of Queensland)

Samid Suliman (University of Queensland)

Andrew Lowry (University of Queensland)

Keith Marshall (University of Queensland)

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The role of NCCARF is to lead the research community in a national interdisciplinary effort to generate the information needed by decision-makers in government, business and in vulnerable sectors and communities to manage the risk of climate change impacts.

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- Dugalunji Aboriginal Corporation, Camooweal
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- Department of Environment and Resource Management, Queensland
- Emergency Management Queensland
- Australian Red Cross
- Desert Channels, Longreach
- Southern Gulf Channels, Mount Isa
- Barkly Shire Council, Tennant Creek
- Mount Isa City Council

Cover image: Georgina River Landscape during an intense wet season © Shirley Macnamara

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ABS	Australian Bureau of Statistics
AK	Aboriginal Knowledge
AMA	Australian Medical Association
BCA	Building Code of Australia
BSSERC	Behavioural and Social Sciences Ethical Review Committee
COAG	Council of Australian Governments
DKCRC	Desert Knowledge Cooperative Research Centre
ENSO	El Niño Southern Oscillation
ILUA	Indigenous Land Use Agreement
ITCZ	Inter Tropical Convergence Zone
IPCC	Intergovernmental Panel on Climate Change
MII	Mount Isa Inlier
MJO	Madden Julian Oscillation
MGD	Mitchell Grass Downs
MOU	Memorandum of Understanding
NCC	National Construction Code
NDRRA	Natural Disaster Relief and Recovery Arrangements
NHMRC	National Health and Medical Research Council
NT	Northern Territory
PDO	Pacific Decadal Oscillation
QDC	Queensland Development Corporation
TAFE	Technical and Further Education
TAN	Tanami
TEK	Traditional Ecological Knowledge
UGR	Upper Georgina River
UGRB	Upper Georgina River Basin

ABSTRACT

Given the broad scale and fundamental transformations occurring to the natural environment due to anthropogenic climate change in the present era, what does the future hold for Aboriginal people in remote arid regions of Australia? In searching for answers to this question, this study takes an interior arid-zone region, the Upper Georgina River Basin in northwest Queensland (Figure 1) as the focus for a scoping study in which to investigate and document Aboriginal perceptions and knowledge of climate change, and the capacity of regional communities to respond and adapt to such change at a number of levels; specifically anticipatory adaptation or preparedness for particular types of climate change, land and riverine management, housing and settlement adaptation as well as enterprise development opportunities arising from new forms of adaptation processes. Based on these findings, a set of Regional Climate Change Adaptation Planning principles and strategies has been generated. The relevance of aspects of this adaptation plan can be extrapolated for use in other arid zone regions where applicable. The study also analyses the implications for climate change adaptation policy relevant to Aboriginal communities at different jurisdictional levels, including across state and local government borders. The study was carried out by a multi-disciplinary team of researchers and local community and business personnel who are already engaged in research projects in the region, led by staff of the Aboriginal Environments Research Centre at University of Queensland and Myuma Pty Ltd, an Aboriginal enterprise and training organisation at Camooweal in north-west Queensland.

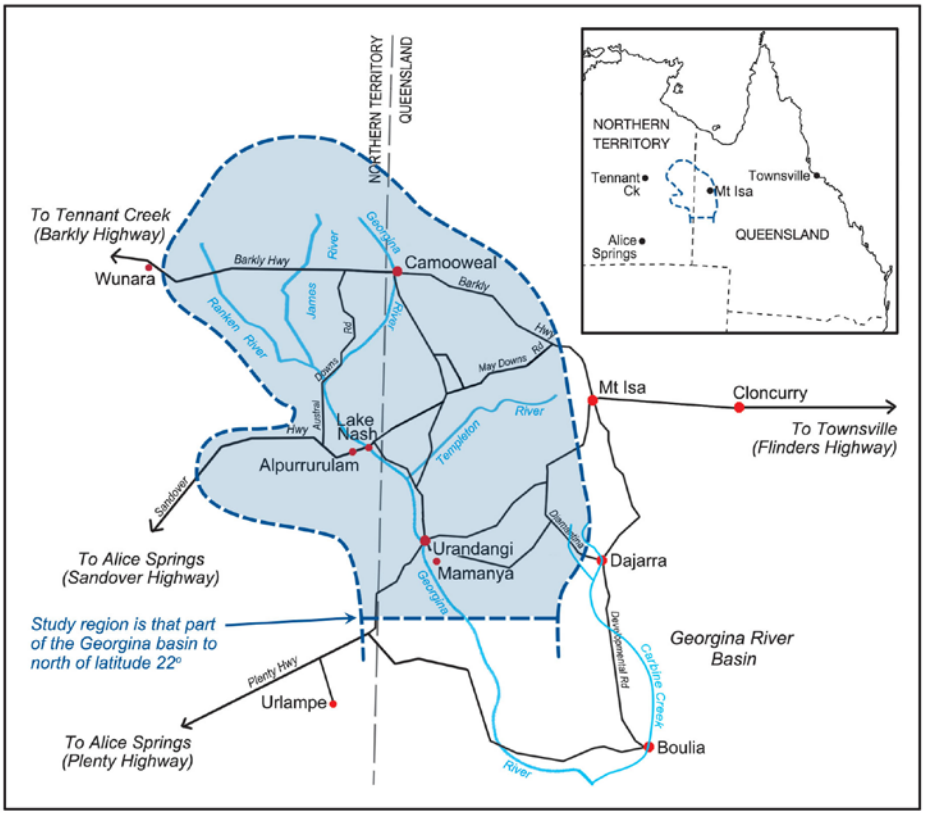

Figure 1: Map of the study region showing the five main communities and extent of the Upper Georgina River Basin. (Source: AERC)

EXECUTIVE SUMMARY

Given the broad scale and fundamental transformations occurring to the natural environment due to anthropogenic climate change in the present era, what does the future hold for Aboriginal people in remote arid regions of Australia? In searching for answers to this question, this study takes an interior arid-zone region, the Upper Georgina River Basin in northwest Queensland as the focus for a scoping study in which to investigate and document Aboriginal perceptions and understandings of climate change, and the capacity of regional communities to respond and adapt to such change at a number of levels; specifically anticipatory adaptation or preparedness for adaptation to the threat of climate change and (currently and prospectively) to broader climatic, landscape and ecosystem changes and impacts, land and riverine management, housing and settlement adaptation as well as enterprise development opportunities arising from new forms of adaptation processes. Based on these findings, a set of Regional Climate Change Adaptation Planning principles and strategies has been generated. The relevance of aspects of this adaptation plan can be extrapolated for use in other arid zone regions where applicable. The study also analyses the implications for climate change adaptation policy relevant to Aboriginal communities at different jurisdictional levels, including across state and local government borders.

Consequently, this study has been carried out by a multi-disciplinary team of researchers and local community and business personnel who are already engaged in research projects in the region. Led by staff of the Aboriginal Environments Research Centre at the University of Queensland and Myuma Pty Ltd, an Aboriginal enterprise and training organisation at Camooweal, the project has utilised existing links with Aboriginal communities and collaborating organisations in the region including the Dugalunji Aboriginal Corporation in Camooweal, the Jimberella Cooperative Society in Dajarra, the Alpurrurulam community of Barkly Shire and the Marmanya Aboriginal community at Urandangi.

The reasons underlying the formation of this research project are founded in the authors' collective experience over many years of research and consultancy practice in the northwest Queensland region. When devising the project framework, the research team felt that most climate change discussion had in the past focussed on coastal communities to the exclusion of arid-zone interior regions of Australia. Furthermore, a literature review at the time showed there to be a dearth of climate change adaptation strategies tailored to Aboriginal communities in such regions. In formulating the research objectives for this project, the research team began the project design framework with the following questions:

- What are Aboriginal perceptions and understandings of climate change from within the interior of Australia?
- What would a climate change adaptation strategy for remote arid-zone Aboriginal communities look like?
- How would a research program be designed and undertaken to inform and address these questions?

- If such a research-informed strategy were to be developed what would be the most significant components to such a plan?

In addition to these questions, our research team was interested in a research program that provided a cross-cultural and comparative window on differing cultural assumptions, meaning systems, future orientation, perceived causal attributions, felt responsibility, looking after country obligations, and those psychological and social impacts which are an integral part and reflection of climate change impacting processes and physical and ecosystem environmental impacts themselves. The resultant research program aimed to document how ways of thinking, doing and preparing may be changing, and the processes which are mediating these changes, and which are central to an adaptation focus. The objective of the baseline data in this report was to provide the necessary research base and platform for future longitudinal research on changing feelings, thoughts and understandings about climate change.

Thus, in building on the research questions above, there are two main research objectives running through this project; the first (Part A) is an overall assessment of Aboriginal risk-perceptions and understandings throughout the region related to climate change, while the second (Part B) is the scoping of a preliminary Regional Climate Change Adaptation Plan designed to develop and foster strategies necessary to deal with longitudinal climate change over subsequent generations of Aboriginal people throughout the study region. To address these objectives a multi-disciplinary teams of researchers was assembled comprising anthropologists, an environmental psychologist, ecologist, climatologist, political scientists and remote architecture and enterprise specialists.

The second component of this report contains a preliminary plan for Aboriginal adaptation responses to climate change, and builds upon a set of observations of climate and environment recorded from Aboriginal people in the region, as well as their past experiences of disaster responses. These observations were further carried out in the study region and developed through several workshops. Consequently, the adaptation response plan outlines a range of strategies and barriers to adaptation as devised in consultation by Aboriginal people from the Upper Georgina River Basin (UGRB). It is the intention that this scoping document will be placed on the websites of the Aboriginal Environments Research Centre (AERC), University of Queensland and of the Myuma Pty Ltd at Camooweal, and distributed as a hard copy to all study communities. It forms a useful practice protocol and guide for others in similar contexts to draw upon with the Adaptation Response Plan organised into four thematic ‘domains’, being:

- Anticipatory adaptation for changes in climate and related weather extremes
- Land and riverine management responses
- Housing and settlement infrastructure adaptation, and
- Enterprise initiative and capacity arising from and contributing to adaptation

In completing the survey analysis, this study has developed a regional database with which to examine similarities and differences with respect to perceptions, understandings, and responses to climate change, with all of these informing and having implications for more psychological and behavioural engagement adaptation

responses. The specific findings regarding similarities and differences are interesting and ground-breaking given that no other study exists that has produced such climate change focused survey findings for Aboriginal communities in Australia. Aboriginal survey respondents were both very similar in many respects to national survey respondents, yet different in other respects. Acceptance of climate change and concern levels were similar, while general understandings and felt self-efficacy were appreciably different, and the threat of climate change was a relatively less salient and immediate issue than more immediate social, health, and economic concerns and challenges.

Key Findings for Climate Change Adaptation in the UGRB Region

The following major findings of our study are relevant to the establishment of an overarching and long-term Adaptation Plan for the UGRB region.

- *Climate is Changing.* Most respondents are experiencing hotter weather but also changeable weather, however, some respondents mentioned that the climate seems cooler in winter; these are not necessarily contradictory responses. Anecdotally, and from the literature, the conditions in the 1960s, for example, were much drier and dustier with less vegetation. Also people are spending less time out in the elements. In the UGRB Aboriginal people spend more time indoors, living in houses, looking after children, in employment, such as office work compared to 1960s when people had very basic housing and were commonly living outdoors in hunting and gathering and droving lifestyles.
- *Predictability of the weather is a real problem.* Aboriginal people are increasingly uncertain about the weather and have responded by changing the way they act on country. For example, some people are hunting when the conditions are likely to be most productive rather than following the previous practice of seasonally based activities.
- *People are unclear and uncertain about climate change.* People admitted uncertainty and also a lack of knowledge about reasons for the changing weather together with certain feelings of powerlessness and vulnerability against natural forces. Big weather events in other parts of the world (as well as in Australia and the region) are now seen as the typical scenario by some. Most people demonstrated belief in normal cycles. For example, bush tucker will come after rain.
- *Country has changed over the decades and culturally important places and significant species are changing.* Both Aboriginal and non-Aboriginal respondents have experienced big weather events and have observed changes. For example, the 1940s and 1960s are identified with the big dust storms. There is some recognition that climate change has influenced the changes, for example, damage from frequent bushfires and the effects of changing climate on hibernation patterns of animals such as goannas and also growth of favoured plant resources.
- *There was limited general or more formal knowledge of the contemporary phenomenon of global climate change, its causes and projected and unfolding global and local consequences.* Knowledge of climate change was clearly related to the age, gender, experience, work, education and other life history considerations. For example, middle-aged stockmen were able to share experiences of noteworthy

human-induced landscape and ecosystem changes, whereas few other people acknowledged human causes for climate change.

- *People are dealing with change in many aspects of life.* Questions about climate change provoked responses about the social and cultural changes that they are currently experiencing. Climate is only one factor that affects how Aboriginal people live especially in remote arid regions and they are worried about how they will live in the future. Aboriginal people have many day to day concerns about costs of living, such as for food, power and fuel, as well as enduring problems associated with health and stress on families from the breakdown of traditional family relationships, particularly in relation to childcare, and the loss of traditional knowledge as old people pass.
- *Living on Country is paramount.* People's knowledge of their country is linked to their cultural obligations, which make it imperative for them to live on their land. As the 'old people' pass on, Aboriginal people are concerned about the transmission of appropriate knowledge to the younger generations. Being on Country is integral to knowledge transmission, cultural maintenance and well-being. There is a strong history in this region of bushfire and rain dreaming with reports of significant people being able to sing the weather; a generation ago, there were significant rainmakers present in the Georgina River basin.
- *Resilience is grounded in cultural values, beliefs and practices.* People expressed commitment to 'traditional ways' and also to continue living in their community. With the exception of interviewees from Camooweal, people believe that they would have community support in an environmental crisis. There are socio-economic barriers for Aboriginal people as they adapt to the impacts of climate change; however, they are most likely to stay on their country as the climate does change.

Recommendations based on Aboriginal Perceptions and Understandings of Climate Change

A clear recommendation here is to initiate a community education and discussion program which could assist interested individuals and the community as a whole better understand the nature of the projected climate change impacts for the region, as well as the nature of what can really be done, both in addressing the additional environmental stressor of the ongoing threat, as well as the actual physical environmental changes and weather and seasonal changes taking place. Clearly perceived understandings and knowledge levels could be greatly improved, with flow on consequences in terms of both individual and collective efficacy, and clearer pathways forward in terms of adaptation and mitigation. The provision, in the community discussion meetings of how their own survey data corresponds to that of mainstream Australia, and other indigenous communities elsewhere in the world would also be very informative and in many ways validating and reassuring.

Another key recommendation stems from the importance and value of refining the survey protocol and procedure on the basis of our findings, and endeavouring to establish a biannual monitoring program for this catchment region, and possibly several other catchment regions, to document and further examine the kinds of adaptation changes and impacts that are currently taking place, and to utilise this research platform and survey protocol to also monitor and evaluate the effectiveness of

particular climate change adaptation initiatives which are under way or in the planning stage.

One further key finding is that the research and workshops have no doubt been very reactive in a positive way in that the communities involved have been engaged in a protracted consideration of climate change, its causes and implications, what their own collective views are, how these seem to compare with mainstream Australia, etc. Therefore, this has been a very educational engagement with the issue, and people's thoughts and feelings about climate change are undoubtedly changing, resulting in psychological and social adaptation.

Key Strategies of the UGRB Adaptation Plan

The key strategies, actions and outcomes necessary for the successful implementation of the UGRB Adaptation Plan are as follows:

- The formation of a UGRB Climate Change Adaptation Group comprising representatives from the five Aboriginal communities of the region;
- Establish an on-going and longitudinal climate change adaptation research program to support the Aboriginal communities in the region;
- Implement appropriate regional and local education programs dedicated to climate change adaptation strategies;
- Utilise Aboriginal knowledge and skill in environmental resource management;
- Involve Aboriginal people in community planning and housing design processes;
- Improve the adaptive capacity of Aboriginal people in the UGRB through the implementation of appropriate local training programs dedicated to enterprise development opportunities arising from the various climate adaptation strategies identified in this research report; and
- Utilise Aboriginal knowledge and skill, thus generating meaningful employment opportunities in ecosystem rehabilitation works which include environmental disaster clean up, mining land rehabilitation, weed and feral animal eradication in addition to patchwork burning regimes.

Political Implications for the UGRB Region: Governance Reform

In responding to substantive future climate change challenges, there is a need to develop enhanced governance responses which are vital for improved adaptation outcomes. The first dimension of such governance reform is to identify and enhance the amount and nature of the resources available for local communities to manage their individual, group and collective purposes. These resources include the level of skills that are available locally plus those readily accessible from neighbours and partners; the financial resources available for maintaining human and physical capital and for investment in new enterprises; the availability of accurate and sufficient information on key issues; and the participation and influence of local people in planning and decision-making processes that affect their future.

The second dimension is the benefits which flow from clarification of key roles and responsibilities between the local, regional and higher levels of government, along with better coordination between these levels of public authority within the state of

Queensland and across jurisdictional boundaries. In parallel with improving the responsibilities and capacities of existing public sector agencies, reconsideration of the potential role of local community organisations is warranted. Indigenous organisations could not only provide a focal point for coordination with the three levels of government, but could also be empowered to take a more active role in a wide range of issues – social, economic, ecological, physical infrastructure, communications, and so on. The lack of investment funds, and the fragmented nature of funding sources, suggests there could be advantages in exploring some options for pooled funding processes to accelerate innovative solutions.

The third dimension of governance reform is to reconsider the regulatory environment which shapes, constrains and facilitates economic and social behaviour. Questions arise concerning the suitability of regulatory systems and service systems which allow or even encourage inefficient or ineffective forms of energy use, building design, local enterprise on collective tenures, and so on. Clearly there is a need for further collective and collaborative work to guide the redesign of how these planning and services regimes operate in relation to business enterprises and human settlements in remote areas.

Signficance of Findings

This study has generated information that is vital for building a national model of Arid Zone response and adaptation to climate change, notwithstanding the heterogeneity in understandings and response capacities in different regions and communities. It is recognised that other important research projects have also been addressing the climate change challenge for Indigenous communities in Australia and internationally. Capacity to extrapolate findings partly rests on the observation that since the advent of independent Aboriginal corporations in the early 1970s, a number of good-practice corporations have demonstrated proven capacity to survive and adapt to shifting government policy in multiple jurisdictions and associated economies, sustained in part by intermittent project funding. It is argued that such stable and resilient corporations have on-going viability to take a major role in climate change management in rural and remote Australia. This will have significance in protecting Australia's future. Maintaining an interconnected decentralized settlement system in the arid interior of Australia will become increasingly difficult with climate change threats, but such a settlement and communications infrastructure is believed necessary not only for land and riverine management but also for national security given that global warming may greatly increase the illicit arrival of 'climate refugees' from overseas (refugees fleeing from ecological catastrophes in their home countries).

Aboriginal people, as regional environmental managers will have an increasingly important role to play in maintaining their land and country as well as their communities. It will be important to link these roles to the responsibilities of the three levels of government for various aspects of service planning, infrastructure provision and emergency management. The study has also identified relevant issues of cross-jurisdictional response to climate change impacts and the inherent difficulties of coordinated responses to climate events and natural disasters which cross Local and State Government boundaries. The unique evidence available from this project can

make important contributions to evidence-informed policy and planning. Adaptation to climate change encompasses more than preparedness, and involves adaptive capacity, anticipatory coping, and other intra-individual and individual and collective behavioural adjustments, and community and social and cultural processes, not just to the environmental impacts and manifestations of climate change (including extreme weather events) but to the ongoing threat, stress, and implications of climate change. As well the very visible and ongoing manifestation of climate change is that of environmental and landscape change, not typically or exclusively sporadic, and acute extreme weather events.

In response to the original research questions, the authors have provided a better knowledge of Aboriginal perceptions and understandings of climate change from within the interior of Australia, most notably the UGRB study region. While it needs further work and much greater financial input and commitment from Government, NGOs and the private sector to become a reality, a skeletal framework for a climate change adaptation strategy for remote arid-zone communities has been developed. In addition, a research program was designed and implemented that addressed the key issues of an adaptation plan and showed that such a plan requires the critical and crucial input of Aboriginal people if such communities are to successfully adapt to the increasing effects of climate change. The next step is to begin implementing the findings from this report. Only time will tell if there is enough political will to support the project's Aboriginal collaborators who are themselves the change agents needed to fulfil the broader aims of this study.

1. INTRODUCTION

This scoping study had two principal aims. The first was to take an interior arid-zone region, the Upper Georgina River Basin located in far northwest Queensland, as the location for a pilot study in which to investigate and document Aboriginal perceptions and understandings of climate change. 'Understandings' includes Traditional Ecological Knowledge (TEK), ecological knowledge, and knowledge of climate change science accounts, but is also more than these in terms of individual and cultural conceptual and emotional responses and meanings. The second aim was to study the capacity of these communities to respond and adapt to the threat of climate change and (currently and prospectively) to broader climatic, landscape and ecosystem changes and impacts, land and riverine management, housing and settlement adaptation and enterprise development responses.

1.1 Research Objectives

Based on the research findings, a set of regional adaptation planning principles and strategies has been generated, which can be extrapolated for use in other arid zone regions across Australia. The study also analyses the implications for climate change adaptation policy relevant to Aboriginal communities at different jurisdictional levels, including across state and local government borders.

Consequently, this study has been carried out by a multi-disciplinary team of researchers and local community and business personnel who are already engaged in research projects in the region. Led by staff of the Aboriginal Environments Research Centre at the University of Queensland and Myuma Pty Ltd, an Aboriginal enterprise and training organisation at Camooweal, the project has utilised existing links with Aboriginal communities and collaborating organisations in the region including the Dugalunji Aboriginal Corporation in Camooweal, the Jimberella Cooperative Society in Dajarra, the Alpurrurulam community of Barkly Shire and the Marmanya Aboriginal community at Urandangi.

The reasons underlying the formation of this research project are founded in the current authors' collective experience over many years of research and consultancy practice in the northwest Queensland region. When devising the project framework, the research team felt that most climate change discussion had in the past focussed on coastal communities to the exclusion of arid-zone interior regions of Australia. Furthermore, a literature review at the time showed there to be a dearth of climate change adaptation strategies tailored to Aboriginal communities in such regions. In this literature review a number of crucial epistemic gaps are identified, specifically with regard to people-environment relations and the cultural/perceptual frames through which Aboriginal people perceive and understand climate change. In contemplating the research objectives for this project, the research team began the project design framework with the following questions:

- What are Aboriginal perceptions and understandings of climate change from within the interior of Australia?
- What would a climate change adaptation strategy for remote arid-zone Aboriginal communities look like?

- How would a research program be designed and undertaken to inform and address these questions?
- If such a research-informed strategy were to be developed what would be the most significant components to such a plan?

In addition to these questions, the research team was interested in a research program that provided a cross-cultural and comparative window on differing cultural assumptions, meaning systems, future orientation, perceived causal attributions, felt responsibility, looking after country obligations, and an arguably different set of psychological and social impacts which are an integral part and reflection of climate change impacting processes and impacts themselves. The resultant research program aimed to document possibly changing ways of thinking, responding and preparing, and those underlying processes and dynamics which are mediating these changes, and which are central to an adaptation focus. The objective of establishing baseline data in this research was to provide the necessary research base and platform for future longitudinal research documenting and monitoring changing psychological and behavioural responses to, and impacts of, climate change, including changing feelings, thoughts, and understandings about climate change.

Thus, building on the research questions above, there are two main research objectives running through this project; the first (Part A) is an overall assessment of Aboriginal risk-perceptions and understandings throughout the region related to climate change, while the second (Part B) is the scoping of a preliminary Regional Climate Change Adaptation Plan designed to develop and foster strategies necessary to deal with longitudinal climate change over subsequent generations of Aboriginal people throughout the study region. To address these objectives a multi-disciplinary team of researchers was assembled comprising anthropologists, political scientists, an environmental psychologist, ecologist, climatologist, and remote architecture and enterprise specialists.

1.1.1 Part A – Aboriginal Risk Perceptions and Understandings

In terms of the theoretical framework underpinning Part A, the first stage of this study proceeded on the hypothesis that rural and remote Aboriginal people in the study region were likely to have at least some different constructs, vocabulary and causal understandings of climate change compared with metropolitan Australians, as well as particular views about the nature of environmental threats, different risk domains, and also the nature and extent of human agency and involvement in causation of, and response to, climate change as land custodians.

1.1.2 Part B – Preliminary Climate Change Adaptation Response Plan

The second component of this report contains a preliminary plan for Aboriginal adaptation responses to climate change, and builds upon a set of observations of climate and environment recorded from Aboriginal people in the region, as well as their past experiences of disaster responses. These observations were further carried out in the study region and developed through several workshops. Consequently, the adaptation response plan outlines a range of strategies and barriers to adaptation as devised in consultation by Aboriginal people from the Upper Georgina River Basin (UGRB). It is the intention that this scoping document will be placed on the websites of

the Aboriginal Environments Research Centre (AERC), University of Queensland and of the Myuma Pty Ltd at Camooweal, and distributed as a hard copy to all study communities. It forms a useful practice protocol and guide for others in similar contexts to draw upon with the Adaptation Response Plan organised into four thematic 'domains', being:

1. Anticipatory adaptation for the threat of climate change and broader climatic and ecosystem changes;
2. Land and riverine management responses;
3. Housing and settlement infrastructure adaptation; and
4. Enterprise initiative and capacity arising from and contributing to adaptation.

These four streams are explained in greater detail below.

1.1.3 Anticipatory adaptation for climate and weather extremes

Stream 1 of the Adaptation Response Plan investigates how well Aboriginal communities in the study region are prepared for the effects of changing climate and the resultant weather extremes. In the context of this report, the term 'preparedness' or 'anticipatory adaptation' is defined as a set of physical, psychological and social precautionary measures taken to prepare communities of the Upper Georgina River Basin for the occurrence of climate change and related extreme weather events. In evaluating preparedness, two broad categories of climate change are considered: incremental changes and extreme event changes. Incremental changes (also known as 'chronic') are those that will vary gradually over one's lifetime such as increasing mean temperatures and evaporation rates, whilst changes in extremes (known as 'acute') include changes in the frequency and intensity of cyclones, floods, heat waves and droughts, and indirect extremes such as bushfires. Discussion centres on the relationship between adaptation and its interface with preparedness for events having occurred in the recent past within the study region (e.g. Cyclone Yasi, the flood-induced Inca Creek acid spill, large bushfires), as well as to Aboriginal response findings outside the study region, e.g. Cyclone Tracy (Reser 2011), rising Torres Strait sea levels (Green et al 2010). The recommendations arising out of this section of the report are the result of intensive workshop discussions between Aboriginal people of the Georgina River Basin in conjunction with preparedness experts in Government (Emergency Management Queensland and the State Emergency Service) and non-Government (Australian Red Cross) agencies.

1.1.4 Land and riverine management response

This section of the report builds upon baseline data collected specifically on plant and animal communities in the grasslands and riverine corridor and an ethno-botanical study. It is also informed by data from recent wildfires and managed burns by Aboriginal groups in the area, as well as Indigenous Land Use Agreement (ILUA) prospects of patchwork burns for pastoral properties and national parks. The need for more in-depth study of plant and animal community richness for longitudinal monitoring and response is outlined. Research findings also include a recognition and validation of traditional Aboriginal roles as land and climate risk managers, and the further application and extension of such roles in the national interest.

1.1.5 Housing and settlement infrastructure adaptation

This research builds on previous regional surveys of energy and water use (Long 2007) and investigations of infrastructure and service delivery in the study region (O'Rourke 2011) across a period of severe drought (2007 to 2009), which identified chronic problems with sub-standard infrastructure, poorly designed housing for the extreme arid climates, inappropriate household technologies, and unnecessarily high demand for utilities. These factors reduced the resilience of arid-zone settlements and their capacity to respond to climatic extremes. The combination of larger scale infrastructure development, smaller scale technical interventions, and changes in patterns of demand require an integrated approach to planning that engages with Aboriginal communities and individuals. This section also examines the relationship between climate and uses of buildings, energy (off-grid generators) and water. This component uses data from actual household surveys to measure awareness of energy and water consumption in relation to household behaviour across different seasons. The survey data is combined with case studies of existing households to document existing infrastructure and technologies and measure consumption patterns. From these results, a range of adaptive technology responses are proposed across the survey group.

1.1.6 Economic enterprise opportunities

Investigation in this section focuses on how climate change impacts influence the hybrid economies (Altman 2012) being practised by the Myuma Group in Camooweal and other organisations in neighbouring Aboriginal communities, for example, the local combinations of subsistence, enterprise and mainstream employment economies. Relevant economic practices already being anticipated by local Aboriginal groups in the study area are carbon trading, road re-construction and maintenance, building re-construction and maintenance, emergency evacuation, emergency sheltering and catering, retro-fitting of energy-saving technologies. Enterprise preparedness and response capacity of local Aboriginal corporations are also critical outcomes of this section of the report.

1.2 Climate Change and Variability

The Intergovernmental Panel on Climate Change (IPCC) has defined 'climate change' to be "any change in climate over time, whether due to natural variability or as a result of human activity" (IPCC 2007: 2). In the context of natural variability there are many factors that influence the climate of Australia and the Upper Georgina River Basin (UGRB). The following description details the overarching weather patterns influencing Australia's climate. A more localised description of UGRB climate specifics is found in section 5.1 of this report.

The tropical Pacific Ocean is the source of much of the climate variability affecting the north east of Australia with the El Niño-La Niña phenomena being the most significant. During El Niño there is an eastward shift of the Walker circulation as shown in Figure 2 and the resulting conditions in northern and eastern Australia are cooler and drier than average. Conversely under La Niña there is a westward shift of the Walker circulation, as shown in Figure 3, resulting in warmer and wetter than average conditions in northern and eastern Australia. These circulations typically start in autumn and last between 6 to 18 months. The atmospheric response to El Niño is the negative phase of

the Southern Oscillation and combined are referred to as ENSO. ENSO events result in less monsoon rainfall and therefore drier conditions in the UGRB while La Niña enhances the monsoon and rainfall over the UGRB.

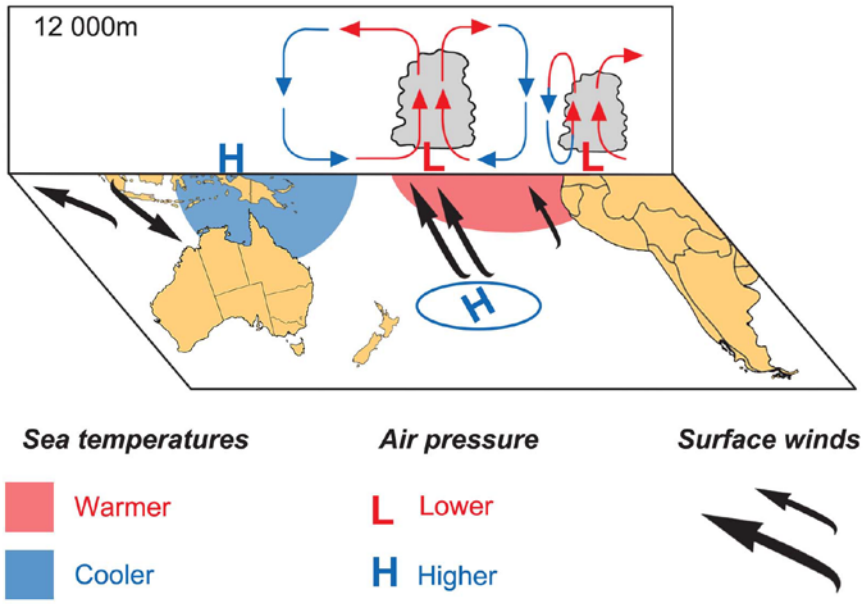

Figure 2: The Walker Circulation under El Niño conditions (Adapted from The Long Paddock 2010, 'El Niño and the southern oscillation', Queensland Government.)

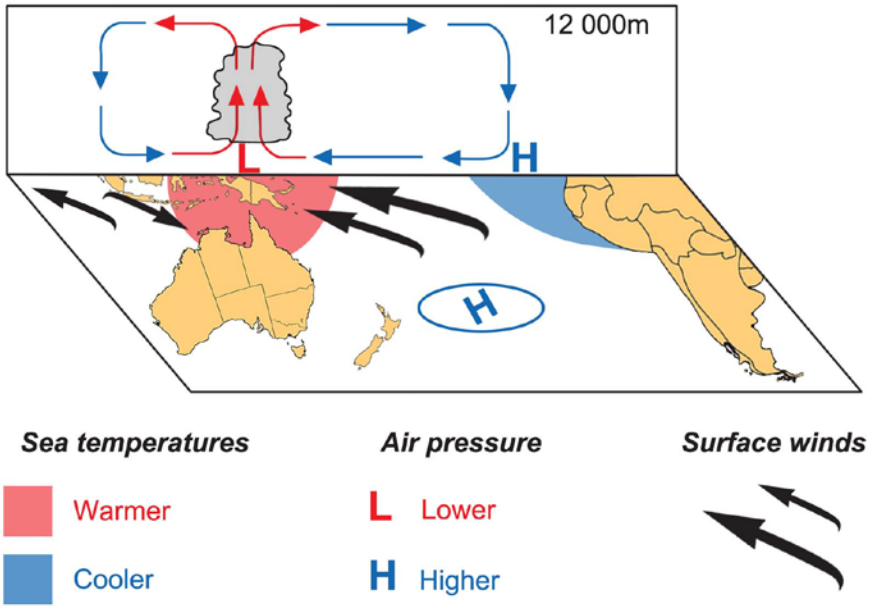

Figure 3: The Walker Circulation under La Niña conditions (Adapted from The Long Paddock 2010, 'El Niño and the southern oscillation', Queensland Government.)

Underpinning the inter-annual fluctuations of ENSO, are decadal timescale variations; the Inter-Decadal Pacific Oscillation and the Pacific Decadal Oscillation respectively (PDO). The PDO is a variation in sea surface temperature and pressure between the tropical Pacific Ocean and the west coast of North America. The warm (positive) phase of these oscillations shows temperatures in eastern Australia to be warmer and drier than normal. Conversely the cool (negative) phase shows temperatures in eastern Australia to be cooler and wetter than normal. Positive phases of the PDO tend to weaken the effect of ENSO on monsoon rainfall, while negative phases of the PDO show strong correlations with La Niña and increased rainfall over northern Australia and the UGRB as experienced in the 2010 and 2011 wet seasons.

The UGRB's climate is strongly influenced by ENSO. The rainfall and temperature variations for the period 1907 to 2011 are shown in Figures 4 and 5 and illustrate that the climate varies from season to season. Figure 6 shows the variations in ENSO for the period 1907 to 2011. Comparing the observations with ENSO shows that there can be a correlation between the observed climate and the variations in ENSO. However in the case of 1994, which was one of the strongest El Niños on record, there was minimal effect on the rainfall for the period particularly the summer monsoon which was about normal. It has been suggested that the cause of this was that the PDO was in a positive phase (see Figure 7), and thus weakened the effect of ENSO on observed rainfall. Accordingly, while ENSO is the major cause of inter-annual variability in the basin's climate, its influence will change from event to event.

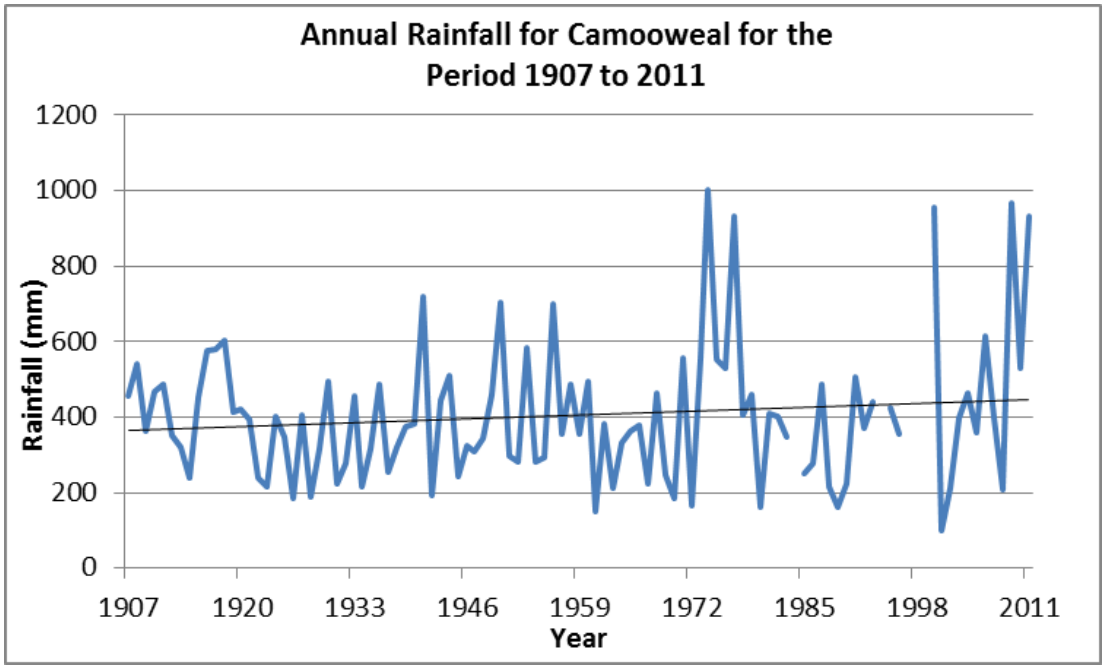

Figure 4: Annual Rainfall for the Bureau of Meteorology station at Camooweal for the period 1907 to 2011.
(Source: Data from the Bureau of Meteorology 2013)

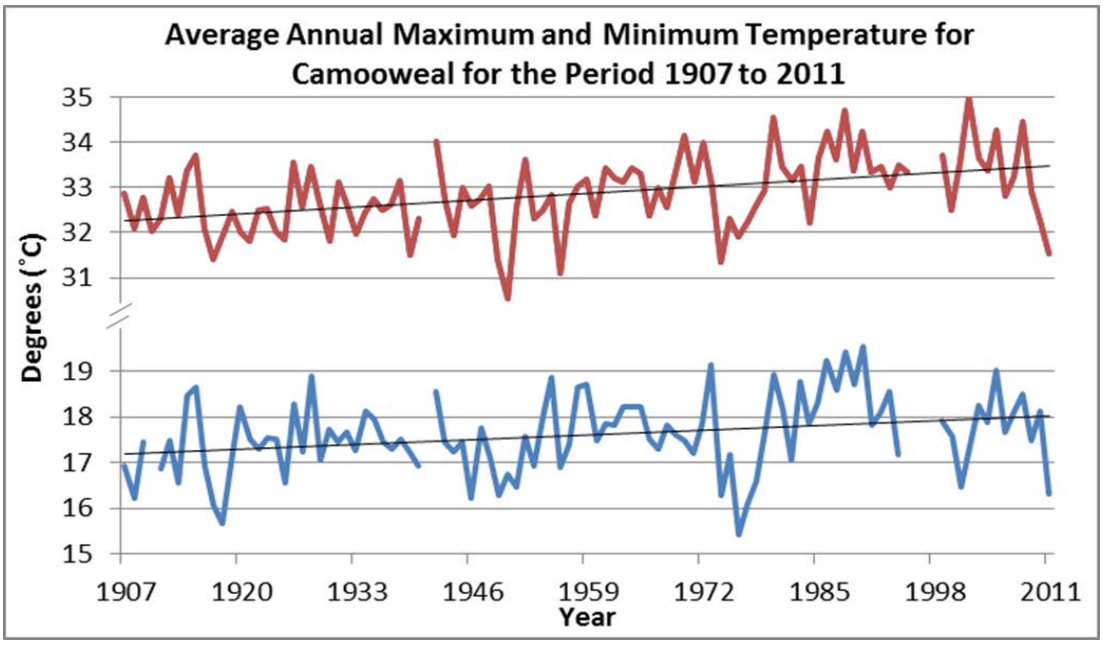

Figure 5: Average Annual Maximum and Minimum Temperature for the Bureau of Meteorology station at Camooweal for the period 1907 to 2011.
(Source: Data from the Bureau of Meteorology 2013)

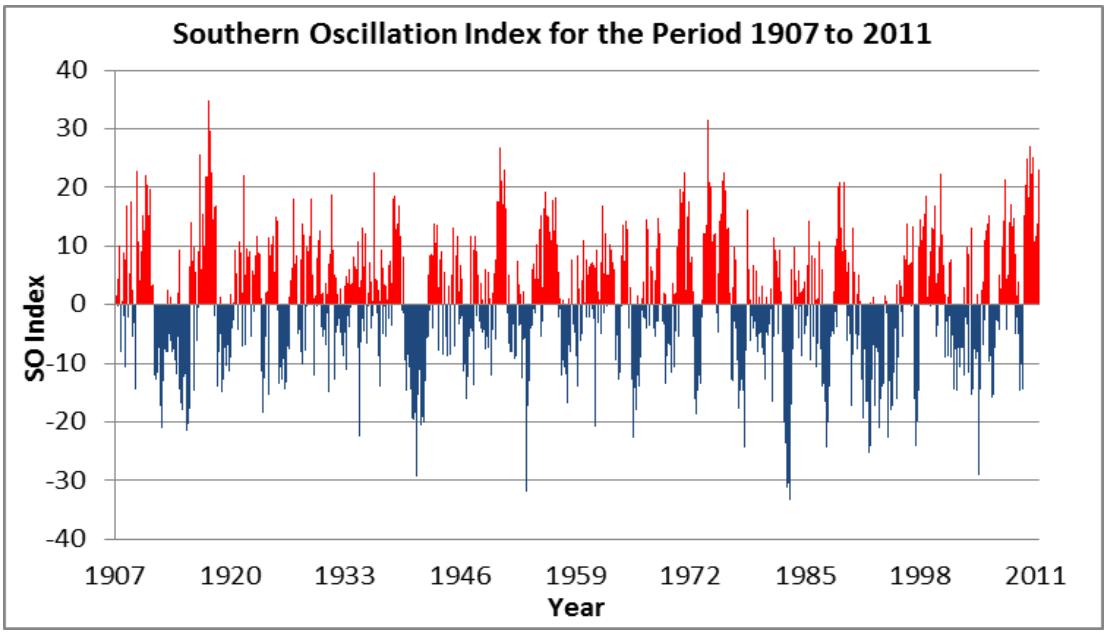

Figure 6: Southern Oscillation Index for the Period 1907 to 2011.
(Source: Data from the Bureau of Meteorology 2013)

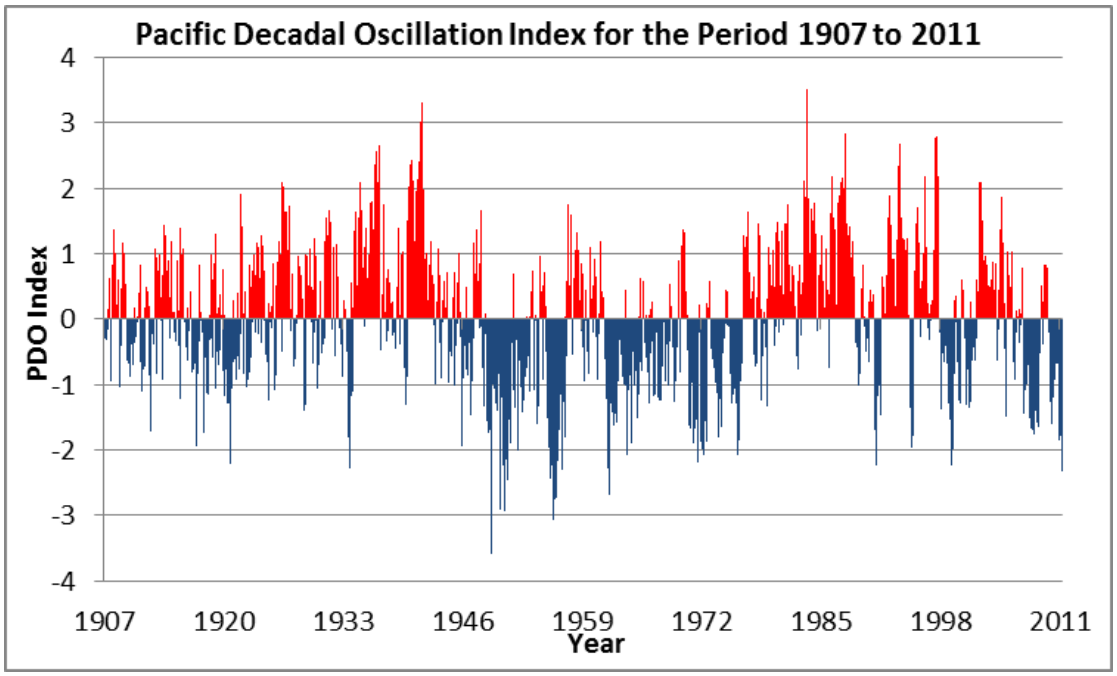

Figure 7: Pacific Decadal Oscillation Index for the Period 1907 to 2011. (Source: Data from the Joint Institute for the Study of the Atmosphere and Ocean 2013)

1.3 Anthropogenic Climate Change

Anthropogenic climate change is caused by increased concentrations of greenhouse gases (e.g. CO_2) in the atmosphere and the ability of these gases to absorb thermal radiation emitted from the Earth's surface, increases in aerosol concentration (e.g. black carbon) in the atmosphere and change of land use and land type as a result of human activity. Since 1750 the concentration of CO_2 has increased from 280 (±5) parts per million (ppm) to 391 ppm in 2012 (World Bank 2012). The effect of the increase of CO_2 and other radiatively important gasses has been to contribute to a global increase in air temperature of 0.8˚C since the pre-industrial era (World Bank 2012). Figure 8 illustrates the process of how radiatively important gasses affect the climate.

Aerosol concentration in the atmosphere has both a direct and an indirect effect on climate. Aerosols both scatter and absorb short and long wave radiation; that is, they intercept radiation in the atmosphere as it is received. Indirectly, aerosols in the atmosphere act as condensation nuclei for the formation and longevity of clouds, which reflect solar radiation. Figure 9 illustrates the processes of how aerosols affect the climate. The consequence of this absorption of radiation and increase in cloud formation is a net negative effect on the radiative forcing on the atmosphere.

Land cover and land use change in the context of climate change is the modification of a land surface, such that it affects the climate of a region. Symptomatic of land cover change is a reduction in surface water, a reduction in substrate moisture content, higher soil erosion and desolation of native vegetation. Land cover change alters the climate by increasing the surface albedo, reducing the canopy cover and reducing surface roughness. These changes alter the distribution between soil runoff and

evapotranspiration, and thus soil moisture content and precipitation. The resultant effect on the surface energy balance, for example from land clearing, is a decrease in latent heat (evaporation) and an increase in sensible heat. In essence land clearing contributes to a warmer and drier climate.

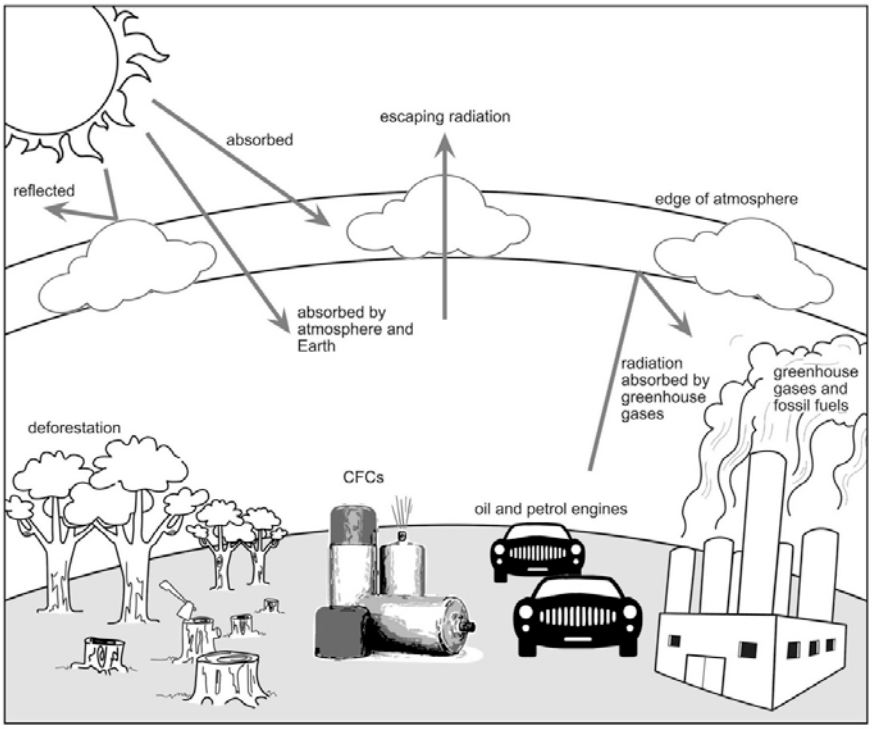

Figure 8: The Greenhouse Effect. (Source: AERC)

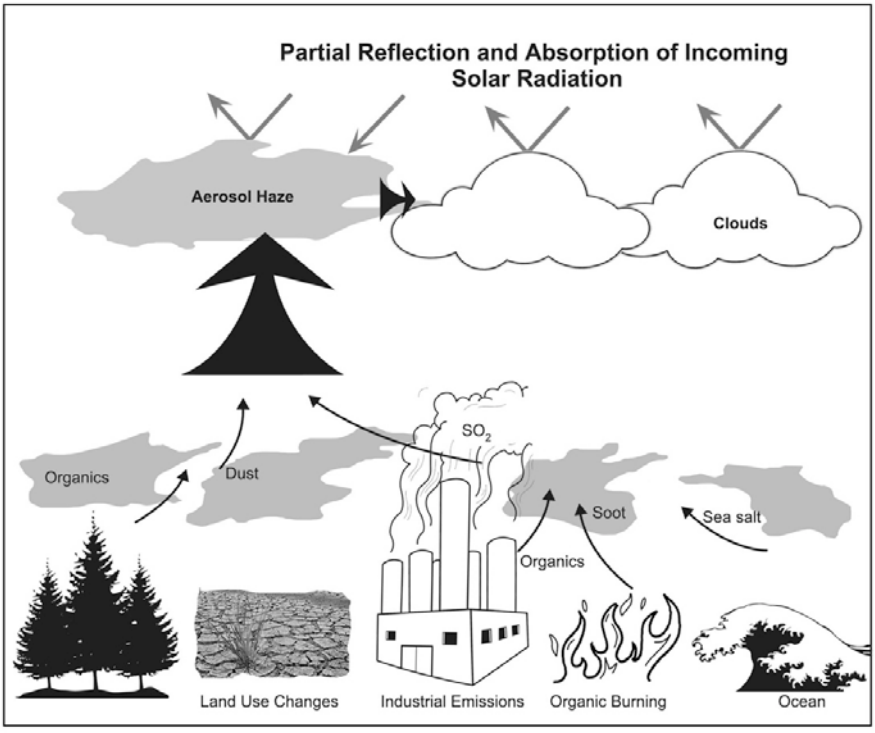

Figure 9: Atmospheric Aerosols. (Source: AERC)

Human modification of global climate has caused mean average air temperature to rise by 0.8˚C since 1750 (World Bank 2012). In addition to this increase approximately 93% of the additional heat is stored in the oceans, which have warmed by 0.09˚C since 1955 (World Bank 2012). These changes correspond to an increase in the extreme daily maximum and minimum air temperatures. In Australia, the average maximum air temperature rose 0.6˚C and the average minimum temperature rose 1.2˚C from 1910 to 2004 (Suppiah et al. 2007). This is highlighted in Figure 5, which shows an increasing trend of daily maximum and minimum temperatures. Since 1950 the number of hot days (≥35˚C) rose by 0.1 days per year and hot nights (≥20˚C) rose by 0.18 nights per year; similarly the number of cold days (≤15˚C) fell by 0.14 days per year and cold nights (≤5˚C) fell by 0.15 nights per year (Deo et al. 2009).

A more detailed description of local climate is found in section 5.1 of this report.

1.4 Policy Implication Analysis

This scoping study also generates viable ideas central to building a national model of arid zone response and adaptation to climate change, notwithstanding the likely heterogeneity in understandings and response capacities in different regions and communities. Full account is taken of other such exercises addressing the climate change challenge for Indigenous communities in Australia and internationally (e.g. Ford et al 2010 and Green et al 2012). Capacity to extrapolate findings partly rests on the observation that since the advent of independent Aboriginal corporations in the early 1970s, a number of good-practice corporations have demonstrated proven capacity to survive and adapt to shifting government policy in multiple jurisdictions and associated economies, sustained in part by intermittent project funding. It is argued that such stable and resilient corporations have on-going viability to take a major role in climate change management in rural and remote Australia. This has significance in protecting Australia's future while maintaining an interconnected decentralized settlement system in the arid interior of Australia, which can itself withstand the difficulties associated with climate change.

It is the report authors' contention that such a settlement and communications infrastructure is believed necessary not only for land and riverine management, but also for national security given that the effects of change climate may greatly increase the illicit arrival of overseas 'climate refugees'. Aboriginal people who wish to maintain their land as environmental managers will have an increasingly important role to play. Thus, it is important to link these roles to the responsibilities of the three levels of government for various aspects of service planning, infrastructure provision and emergency management. This study is also strategically designed to elicit relevant issues of cross-jurisdictional response to climate change impacts and the inherent difficulties of coordinated responses to climate events and natural disasters which cross governance boundaries. The unique evidence available from this project makes an important contribution to evidence-informed policy and planning (Head 2010).

1.5 Relevance to the NARP

This research project makes important contributions to *The National Climate Change Adaptation Research Plan: Indigenous Communities* (hereafter: 'the NARP'). The

NARP identifies core research priorities that are required to increase knowledge of the adaptation needs of Aboriginal communities as they face climate change and increasing extreme weather events. A commentary on how the design, implementation and findings of this research project contribute to the NARP Priority Research Topics is presented in the concluding section of this report.

1.6 Summary of the Introduction

This introductory section has presented a range of social, cultural, historical and ecological factors that need to be considered when embarking upon the process of understanding and operationalizing Aboriginal perspectives on climate change and climate change adaptation. It is clear that the challenges and risks posed by climate change are not only confined to the natural environment, but that the environmental changes that are forecast in the Upper Georgina River Basin will likely render significant social and cultural changes to its inhabitants. As we have outlined, both research and policy engagements with climate change adaptation in Aboriginal communities could and should take an inclusive approach, one that has not been articulated to date in the academic sphere.

The literature review highlighted the importance of understanding climate change and climate change adaptation in the context of specific, place-based people-environment relations. This review also highlighted the importance of closing 'epistemic' gaps that exist between Western, scientific knowledge systems (including the social sciences) and Aboriginal knowledge systems. The latter, it has been suggested, may have an important role to play in both forming baselines against which to gauge the scope and depth of environmental change (such as bio-diversity loss), as well as in developing place-specific and culturally relevant adaptation strategies that ensure the successful adaptation of people, places and country. The need for such a 'trans-epistemic' perspective on research and policy is evident in light of changes to fire regimes. The breakdown of traditional Aboriginal burning practices, though cultural and geographical dislocation and the contestations over land use by traditional owners and pastoralists, have led to significant threats to species biodiversity which, in turn, may threaten Aboriginal social, cultural and economic practices as anticipated changes become manifest. Likewise, reinstatement of Aboriginal mosaic burning practices may indeed present an opportunity to minimize biodiversity loss through catastrophic wildfire and also present opportunities for Aboriginal communities to develop emergent carbon-reduction industries, utilizing both Aboriginal and Western knowledge about the landscape and the changes that are looming. There is clearly a need to further investigate these challenges and opportunities in a contexualized and culturally specific fashion.

This chapter has identified important research gaps, most notably a lack of knowledge about the social-cultural-ecological nexus in the study region, in addition to the ways that Aboriginal people in the study region perceive and understand climate change, and the extent to which traditional knowledge and practice may be utilized to allow the region's communities to successfully adapt. In addressing these gaps, this project responds directly to the 'National Climate Change Adaptation Research Plan: Indigenous communities', and specifically to the Priority Research Topics outlined in the NARP. The research project has been dedicated to developing a more

comprehensive understanding of the challenges and opportunities that Aboriginal people in the UGRB face as they adapt to a changing climate and landscape.

2. RESEARCH ACTIVITIES AND METHODS

In studying Aboriginal perceptions and knowledge of climate and climate change in the UGRB, three members of the research team carried out qualitative field interviews, using a modified national survey protocol, with 72 respondents in the study region, carried out both data collection and analysis (see Appendices 1 and 2). Out of this original work, our team invited 35 Aboriginal people to attend two successive workshops held at the Dugalunji Aboriginal Corporation headquarters in Camooweal. The intention of the workshops were to firstly review and comment on the data collected to that point in time during fieldwork and secondly, discuss the implications of these findings in the context of the four research streams (preparedness, land and riverine management, housing and infrastructure, and enterprise development). Workshop 1 (August 2012) was devoted to the land and riverine management stream and the housing and infrastructure stream, while Workshop 2 (November 2012) related to enterprise development and preparedness for climate extremes. In addition, both workshops were filmed using a digital video camera as a permanent record of the discussions that took place at the time. This evidence has proved vital to later analyses and understandings and will be made available from the Aboriginal Environments Research Centre at the University of Queensland upon request. During the course of this data collection, a photographic analysis of climate and country as a visual reference datum was carried out by the Aboriginal Research Assistant, Mr Keith Marshall of Dajarra, which will also be placed on the AERC website and made available through NCCARF networks.

In preparing the draft modules for the final report, our analysis has shown that the field survey and workshop processes resulted in good quality research outcomes which not only have relevance for the current study, but will continue to have relevance to those communities in our study region moving forward. A secondary motivation for bringing people together from the five communities was to promote the benefits of organising a regional collective action whereby members of these communities collaboratively establish an Upper Georgina River Basin (UGRB) climate adaptation group which aims to mutually support each community in adapting to future climate change in the region. It is envisaged that both individuals and communities will find strength in collective action rather than attempting to address climate change adaptation on their own.

The innovative and creative design of this project is shaped around a longstanding set of collaborative relationships between the Aboriginal communities of the Upper Georgina River Basin (UGRB) and the Team Leader, Professor Paul Memmott and certain members of his research team. In particular the Aboriginal leader of the Myuma Group in Camooweal, Colin Saltmere, is an Adjunct Associate Professor with the University of Queensland and thus in an already existing Industry Partner role. There are a variety of baseline studies in place arising from this relationship including ethno-botanical research (Dugalunji and Wallis 2010), Native Title of study groups (Memmott and Sackett 2005; Memmott et al 2007; Memmott 2010A), regional service delivery research (Moran et al 2009, Fisher et al 2010 Memmott 2010B, O'Rourke 2011, Long 2007), regional mobility study (Long and Memmott 2007, 2009), cultural landscape study (Long 2005), current capacities of Aboriginal Corporations (Memmott 2007, 2010C: Stafford Smith and Moran 2008; Moran 2008, 2010), and grassland research

(Gamage et al 2010, 2011A, B, Memmott et al 2009). The Myuma Group are collaborative partners in this study and have both a vision and an already operationalized capacity to respond to adverse environmental events and impacts which occur in the UGRB.

2.1 Baseline data set on Aboriginal risk perceptions and understandings of climate change – Interviews

This component of the research proceeded on the assumption that Aboriginal people of the study region were likely to have different constructs, vocabulary and causal framings and understandings of climate change from metropolitan Australians. We expected some mention of cosmological explanations with particular views about what constituted environmental threats, different risk domains, as well as alternate ideas about human involvement in causation and response as land custodians. A survey and semi-structured interview process was designed, piloted and administered to a sample of adults in the study region based on a framework of psychometric variables developed by the project social and environmental psychologist, Professor Joseph Reser for mainstream Australia (Reser et al 2012a,b), but adapted for local Aboriginal contexts and cognitive frames. These variables included self-reported knowledge of climate change, acceptance of climate change, concern, risk perception, distress, self-efficacy and adaptation. A further related cognitive domain that was included, given the prospect of changing weather patterns, concerned the Aboriginal constructs of household energy and energy use behaviours.

The combined survey administration and semi-structured interview ensured the completion of structured survey items and scales, but also provided scope and opportunity for more extended discussion by respondents, reflecting cultural assumptions, individual and collective sense making, and more personal thoughts, feelings, and concerns. The survey was administered face to face, allowing for assistance and qualitative discussion, to add value and depth to the findings, and ensure that any limitations were addressed and minimised. Seventy-two interviews were carried out in Camooweal, Alpurrurulam, Urandangi, Dajarra, Mt Isa and Wunara settlements distributed on and around the Upper Georgina River Basin, which straddles two state government jurisdictions (Queensland/Northern Territory).

It should be noted that the principal objective of the quantitative data we collected was for the purposes of comparison and contrast with comparable national survey data, and to provide baseline data for future monitoring of changing views. Few of the quantitative survey items actually referred to matters of objective knowledge, and matters of emic understanding and accounts for this catchment region based on qualitative open ended responses and interview data have been considered and interpreted sensitively and cautiously, but with an appreciation that many of these respondents are in fact bicultural, reasonably educated, and very able to shift frames of reference in discussion of a threat and phenomenon such as ‘climate change’.

Previous long-term engagement with Aboriginal people in the study region by members of the UQ research team allowed for an efficient link-up with prospective survey respondents. All communities were advised that the surveys would be taking place, and that they were part of the larger research exercise as set out in the information

page on the first workshop. UQ researchers contacted the Jimberalla Housing Coop at Dajarra, the NT Barkly Shire Office at Alpurrurulam, the Dugalunji Camp at Camooweal and also various Aboriginal community members were contacted in Mt Isa, Urandangi and Wunara. The project was also fully explained at the workshops and through the participant information flyers given to each respondent.

After the initial formal consultation between the UQ team and relevant Aboriginal organizations in the study communities, the team relied heavily on Keith Marshall the local Aboriginal team member. Keith travelled with the other two researchers when required, liaising with individuals and generally facilitating cross-cultural communication. Sampling for the survey-based interviews was based on Keith Marshall's social connections in all locations. Also in Alpurrurulam, Daphne Nash interviewed people from families she knew previously. The survey interviews took place in three time periods: 16th to 22nd May 2012 in Dajarra, Urandangi, Alpurrurulam and Camooweal; 1st to 3rd August 2102 in Mt Isa; and 17th to 19th September 2012 in Camooweal.

Two members of the research team with disciplinary expertise in anthropology and architecture, and extensive cross-cultural fieldwork experience, conducted the interviews and themselves completed the survey protocol for respondents, as is routinely the case in telephone surveys. The number of individuals who completed the survey was 72, including 42 male respondents and 30 female respondents. Three of these (2 male and 1 female) were non-Aboriginal people who had long-term experience of living close to the land – while the information they gave was useful for comparative purposes, their responses have not been included in the Aboriginal data. The age of respondents ranged from 17 to 81, with the average age being 52. The number of individuals who were asked but declined to participate in the survey was minimal, reflecting in all likelihood the fact that most were approached by Keith Marshall a member of their community whom they knew and trusted. A $30 cash payment was made to all interviewees in return for their participation.

2.2 Climate Change Service Provision Workshops

This part of the study focused on the potential role of a good-practice Aboriginal corporation (Myuma Pty Ltd, see Memmott 2010c) already engaged in enterprise and training to act as a regional Aboriginal service provider and to coordinate other Aboriginal community corporations and manage climate change response for both Aboriginal and non-Aboriginal people in an arid region. An important objective of the workshop was to address and evaluate existing Aboriginal preparedness and adaptive capacity within the region to known and anticipated future changes, both by way of chronic and on-going natural disasters and extreme weather events, and with respect to both rapid and gradual environmental changes and impacts. A working model of the Aboriginal region was developed based on existing demography, cultural groups, corporations, settlements, mobility patterns, economy, employment and environment. Much of this information had already been gathered and modelled by the applicants in prior research, allowing an accelerated commencement of the project.

Five research fellows (anthropologist, climatologist, ecologist, two architects) assembled relevant findings from prior consultations with Aboriginal people in the

region as well as propositions and hypothetical types of responses based on these findings with conceptual input and guidance from the C.I.s. This material was used where relevant in the successive workshops. A set of two exploratory Focus Group Workshops with Aboriginal representatives of the region's settlements (including Camooweal, Alpurrurulam, Urandangi and Dajarra) then explored the likely scenarios of increases in average temperatures, evaporative rates, cyclonic depressions, heat waves, bushfires, droughts and flooding 'wets' as well as other risks identified by the Aboriginal consultants. Workshops were used to focus on the four research streams.

Both short-term and long-term adaptation strategies were discussed with differentiation between psychological, behavioural, environmental and governance adjustments with workshop facilitators aiming to elicit both Aboriginal knowledge and western scientific knowledge that would be useful for informing adaptation responses. Bridges were sought between individual and household adaptations and community development initiatives, thus increasing capacity both at the individual, household and community levels.

The participants in the workshop process firstly devised and then refined the stated strategies, ensuring that the objectives of the regional planning process were based on practicalities founded in the realities of changing and adapting life-ways in the Upper Georgina River Basin. Recommendations arising from this work encompass sustainable targeted industry collaborations, e.g. with pastoralists and miners, with University technology researchers, and with government nodes across several jurisdictions (NT/Qld, Mt Isa/Tennant Creek). A set of prospective partnerships will be later outlined to pursue shared goals in climate change adaptation and response. Recommendations are also likely to encompass appropriate educational strategies for increasing capacity, such as ranger training, TAFE training, and training by Myuma Pty Ltd in its new training centre at Camooweal.

2.3 Ethics Review Process

As part of the design process for any research project involving human subjects or human-related materials, University of Queensland researchers must obtain ethical clearance when required. As such, and in accordance with the National Health and Medical Research Council's (NHMRC) *National Statement on Ethical Conduct in Human Research*, the University of Queensland's Behavioural and Social Sciences Ethical Review Committee (BSSERC) approved the ethical position and conduct of this project on 1 May 2012. Information supplied to the BSSERC at the time involved Participant Consent Forms, Participant Information Sheets, Questionnaire Templates and Gatekeeper Permission Forms.

2.4 Literature Review and Research Context

Of particular interest in the context of this report is the 'state of the field' of research that is dedicated to understanding how remote Aboriginal communities understand climate changes, and how such understandings are related to their capacity to adapt to the changes over the next century. The focus and objective of this literature review is to identify and take into account what is known of existing approaches to climate change adaptation in remote Aboriginal communities, in order to develop a robust

approach in our study region to developing concrete and contextualized responses that are appropriate for communities and for country, whilst augmenting existing adaptation responses by local, state and federal governments.

2.4.1 The challenge for remote Aboriginal communities

A core puzzle that much present research on climate change deals with is the stark contradiction between the historical resilience of Aboriginal people and the heightened vulnerability to which Aboriginal people are exposed, compared to the general population. On the one hand, Aboriginal people are known to be extremely resilient, having successfully adapted to changing climatic and meteorological conditions over millennia (see Green 2009; McLachlan 2003). On the other hand, however, Aboriginal people, especially those residing in remote settlements, are consistently described as the groups most vulnerable to the effects of global climate change (Hennessey *et al*. 2007; Green *et al*. 2009; Langton *et al* 2012: 6; Crate and Nuttall 2009). Despite the rapid increase of research dedicated to the social, economic and cultural impacts of climate variability associated with climate change there remain some significant gaps in the literature dedicated to making sense of this contradiction. It is necessary to identify such gaps so as to fully utilise the insights from extant critical analysis to imagine and pursue alternative futures for Aboriginal people in a variety of local contexts.

The specific risks and vulnerabilities faced by remote Aboriginal communities can, in part, be contextualised with reference to the broader challenges faced by rural and remote regions across Australia. Indeed, remote and regional communities face great challenges that arise from the prospect of a changing climate and increases in extreme weather events. A recent study has concluded that inland settlements—especially remote Aboriginal settlements—face the greatest climate change risks nationwide (Beer *et al*. 2012: v). Given the predictions of chronic and acute climatic changes across the continent, it seems likely that all regions and communities will need to invest social and financial capital into adaptive strategies. Moreover, all regions and communities will need to base such adaptation strategies on clear and comprehensive assessments of the risks and vulnerabilities that they face because of the anticipated changes.

To date, the majority of research into the barriers to, and strategies for, successful climate change adaptation has been focused upon coastal and more intensely urban areas. The preoccupation with these regions has meant that the risks and vulnerabilities faced by remote communities remain under-researched. This is problematic because while ‘climate change’ constitutes a suite of issues that will likely affect all parts of Australia, it is also likely to affect various regions very differently, with geographical, political, economic, demographic, social, cultural and ecological factors combining in a range of different ways and contexts. So while there has been a surge of research dedicated to understanding the challenges of climate change adaptation at a broad national level, there are still significant research gaps when it comes to understanding and explaining the variability and particularity of climate change risks and vulnerabilities in different regions across the continent.

As a result of these lacunae, the adaptation prospects of remote and regional Australia, including Aboriginal settlements, have received scant attention in public debates and

policy fora. Moreover, the specific risks and vulnerabilities faced by remote Aboriginal communities are supplanted by a public policy discourse that frames climate change as a predominantly coastal phenomenon (rising sea levels, powerful cyclonic storm systems, coastal river flooding) that may have devastating effects upon high-capital/high-value assets that are situated in more densely populated coastal/urban centres. The preponderant representations of vulnerability and risk in the face of coastal/urban climate change tend to rely upon a highly scientific and economic calculus, which leaves little room for an appreciation of culture, socio-environmental relations and alternative forms of knowledge that will likely be important in informing adaptive responses to climate change in remote Aboriginal communities.

There is a clear need to identify and examine the combinations of climatic, ecological, meteorological, social, psychological, cultural and economic factors that are peculiar to Aboriginal communities, as identified in the National Climate Change Adaptation Research Plan for Indigenous Communities (Langton *et al*. 2012; see also Bardsley and Wiseman 2012), as there is a need to understand the threats posed by climate change in remote and rural Australia (Nelson *et al*. 2010).

2.4.2 Public Perceptions of Climate Change

The impulse to gauge and understand the ways that public perceptions of risk intermingle with formal political responses to climate change has certainly become stronger in recent years. In the past decade, there have been important theoretical and conceptual developments that point to the importance of understanding how understanding the social and systemic nature of vulnerability faced by communities (see, for example, Adger 2006; Smit and Wandell 2006; Gallopin 2006). In this context, there has been a stronger focus on understanding the ways that members of communities themselves perceive and experience climate change, in order to develop adaptation strategies that will deliver tangible, beneficial outcomes.

According to a recent NCCARF-funded study on public risk perceptions, the authors note that in recent years, there has been a growing need for "sensitive measures and appropriate methodologies for documenting and monitoring important impacts and changes in the human landscape over time" (Reser *et al.* 2012: 19). One aspect of such innovative methodological approaches into the social aspects of climate change has been an engagement with the ways that people perceive the changing climatic and meteorological conditions, which may not be reflected in the scientific approaches advanced by climate scientists, or the official representations and statements about climate change advanced by political leaders and wealthy elites. Thus, understanding and evaluating *public* perceptions and understandings of climate change have become central to developing a more complete picture of the psychological and social dimensions of a changing climate.

In this regard, it is important to note that perceptions of risk, vulnerability and resilience are place-based. Data that are ultimately phenomenological in nature are likely to be anchored to the lived experiences of individual groups *in situ*, and will be likely be informed by a range of different factors including the natural environment, the built environment and human relationships. It is important, then, to anchor the study of complex challenges posed by climate change – including their social, political,

economic, cultural and ecological dimensions – in local contexts. In this research context, the importance of personal experience of climate change and the local contexts of such experience are not to be understated. According to Akerlof *et al*. (2013: 89), personal experiences are of equal or greater importance to exposure to broader social constructions and media representations in perceiving climate change risks. Perceptions – invariably informed by experiences – are also an important window to understand transformations in political agency and political communities with regard to climate change and environmental activism in specific regional contexts (Connor 2012, 2010).

One particular aspect of perception to critically explore is the relationship between perceptions of risks and the vulnerabilities that may be posed by environmental change and broader dynamics that may be physical, social or political in nature. Reviewing the relevant literature, Cutter *et al*. (2008: 599) explain that despite the diversity of theoretical and practical approaches to assessing vulnerability, these various approaches contain a number of common elements, including highlighting the salience of place-based studies in assessing a community's vulnerability to climate change. They also note that for analysts of vulnerability and resilience,

> *Challenges in moving from single stressors (hazards) to multiple stressors (global change), understanding how cross-scalar dynamics influence the vulnerability of a place, incorporating the dynamic nature of vulnerability (spatially and temporally), including perceptions of vulnerable populations, and providing a theoretically sound conceptualization that can be applied to local problems hamper our understanding of disaster vulnerability and its link to resilience (Cutter et al. 2008: 599.)*

The task of addressing public perceptions and understandings, then, is associated with the imperative to develop an account of risk that is embedded in society, or, more specifically, in social relations. It is to understand how publics and citizens make sense of changes in the natural world, and how these changes may impact their own life-worlds and their capacity to adapt to a changing environment. It is also to develop a comprehensive account of the context in which individuals and groups perceive and make sense of the environmental and social changes that are occurring. There are, however, certain tendencies in current research that may actually impede such goals. These will be discussed below.

2.4.3 Continental versus regional perspectives

One such tendency is to approach questions of perceptions of climate change risk by taking the national perspective as the starting point. Such an approach hinges upon a highly territorialised conception of the public that is bounded by the nation-state. Such research is undoubtedly important, and feeds into a broader field of research concerned with national public policy. However, it is also important to recognize a core limitation of nationally oriented research: the tendency to smooth over regional differences and elide the more complex social and cultural factors that influence the framing of individual perceptions of climate change. This tendency may have negative consequences, such as concealing the fact that different regions and communities

within Australia may be exposed to more risk and greater vulnerability, which will adversely impact their capacity to adapt at the local level:

> *According to all the national-scale metrics, Australia is well positioned to combat the impacts of climate change, with the Intergovernmental Panel on Climate Change (IPCC) categorizing it as having "high adaptive capacity" […] Yet this national-level assessment masks a high level of sub-national heterogeneity. Australia is predominantly a relatively wealthy urban society; however, remote northern Indigenous communities have been described as "fourth world" societies, with significant disparities between them and mainstream Australia clearly evident from most social and economic indicators. (Green et al. 2012: 1.)*

Relying upon the national perspective as the unit of analysis for understanding the implications and possibilities for managing climate change may have important methodological implications, which need to be overcome to develop a more fine-grained account of climate change preparedness and adaptive capacity. As Eriksen and Kelly (2007: 518) have noted in their discussion of vulnerability indicators, "The need to aggregate up to, say, the national scale can lead to the loss of information about pockets of vulnerability and may distort overall conclusions as detail is lost in the process of averaging or accumulation".

2.4.4 On vulnerability to climate change

However, a targeted focus on regions or localities may not overcome some of the problems associated with decontextualized approaches. Further examples of decontextualized approaches are those that, despite a more specific geographical focus, tend to displace some important contextual features out of assessments of risk, vulnerability and adaptive capacity. Scientific accounts of climate change vulnerability have been noted, in some contexts, to portray climate change vulnerability as an observable natural risk. While this clearly obtains within a Western scientific discourse, the implication is that other ways of making sense of the risks of climate change, that are based upon different social, cultural and epistemological considerations, may be excluded from risk calculations (Green, Niall and Morrison 2012). Similarly, technocratic and economic perceptions of risk are preponderant in policy discourses surrounding climate change: these approaches, it may be observed, reflect a very specific understanding of risk that is abstracted from the more complex set of social, political, historical and economic relations. For instance, regional disaster management plans often incorporate risk assessments for Local Government Areas, such as is the case in the study area. The definition deployed in the Mt Isa District Disaster Management Plan portrays risk as:

> *Expected losses (of lives, persons injured, property damaged, and economic activity disrupted) due to a particular hazard for a given area and reference period. Based on mathematical calculations, risk is the product of hazard and vulnerability. (Mt Isa DDMG 2011: 14.)*

While this definition seems largely incontrovertible, the problematic nature of technocratic conceptions of risk is revealed when they are exposed to critical engagements with questions of risk, vulnerability and adaptive capacity. From a

research perspective, it is crucial to be reflexive about how and why certain conceptions of risk are constructed because differing conceptions of risk may lead to different forms of response planning. For instance, Green *et al*. (2012: 296) identify two ways of framing risk and vulnerability. The first is endpoint framing, which:

> *…starts by identifying the biophysical impacts on a system from a set of green house gas emissions projections. The process then considers the system's adaptive capacity with respect to these defined impacts. The residual consequence of after adaptive capacity is considered as the 'system's vulnerability'. This highly linear approach does not easily accommodate socio-political considerations.*

Whilst this approach predominates in policy discourses, it may not accurately reflect different perspectives of risk and vulnerability that posit the risk landscape as external to the social, cultural and political realms of communities being assessed; nor does it address the contextual factors that may enable or inhibit certain communities to adapt to the risks that they face. Instead, Green *et al.* suggest that a different approach is more appropriate:

> *The second approach, starting-point analysis, embeds vulnerability in the present social context. By considering vulnerability as a starting point (or the contextual vulnerability), this framing is better able to explain the diversity of experiences, coping abilities and resilience in human systems observed at a national and subnational level. (Green et al. 2012: 296-7.)*

Such alternate approaches have begun to emerge in recent research on climate change risk and vulnerability in the Australian context (e.g. Gleeson and Steele 2010). As noted earlier, much scholarly and policy attention is paid to understanding how climate change risk may affect urban and coastal regions. To correct this bias, there have been recent attempts to shift the geographical focus towards inland Australia. Nelson *et al*. (2010) and Beer *et al*. (2012) have explored the ways that geographic, demographic, ecological and social factors may pose unique challenges to remote and rural areas. Meanwhile, Raymond *et al*. (2012) have noted there is a disconnect between rural communities and the formal institutions that set climate change policy, highlighting a lack of communication and engagement procedures surrounding climate change policy. This, they argue, presents a major barrier to successful adaptation in agricultural regions in the South Australian context. A common theme amongst such interventions is that the unique challenges faced by rural and remote regions are not fully absorbed into policy-making institutions, which are largely anchored in metropolitan centres. Thus, the basis for this study.

There is also a further tranche of literature that seeks to develop a more textured and multi-dimensional account of vulnerability. For instance, Adger (2000, 1999) explores the social constitution of vulnerability in coastal communities in Vietnam, and considers the relationship between the individual, the social and the ecological both in terms of vulnerability to climate change risks and resilience in the face of such risks. In this approach, climate change vulnerability and resilience are understood with reference to the social, environmental and political/institutional determinants.

Closer to home, several authors have highlighted the specific, and heightened forms of climate change vulnerability faced by Aboriginal people in rural and remote areas, providing a contextual account that acknowledges historical and contemporary disadvantage, remoteness, and differential forms of political and economic inclusion in the national community (Altman and Jordan 2008; Green, Jackson *et al*. 2009). Acknowledging the multi-dimensionality of climate change vulnerability allows us to account for the complex determinants of vulnerability that are faced by Aboriginal people. Drawing upon a vulnerability framework developed by the Allen Consulting Group (2005), Green *et al.* (2009: 12-13) examine some important factors that increase vulnerability in the Aboriginal and Torres Strait Islander context. These include, the increasing rate of climatic change, and its deleterious impacts upon social and cultural resilience arising from socio-economic disadvantage, lower life expectancy, higher rates of chronic illness and drug and alcohol dependence (see also McMichael 2002; Green 2009; Macchi *et al.* 2008). Adding to these, we can also identify the historicity of Aboriginal disadvantage as an important determinant of vulnerability. Indeed, Green (2009: 219) has argued, "widespread social ills have their roots in indigenous Australian's forced dispossession from their country and the past active suppression of their cultural practices" (see also Rose 1996).

In addition to these historical factors, some interventions have also highlighted the discursive determinants of increased climate change vulnerability. Marike *et al*. (2009) have argued that rural spaces have been represented as 'white', thereby eliding the fact that Aboriginal people have deep connections with remote landscapes, as well as suffering dislocation from these places throughout the settlement history of Australia. Additionally, McIntyre-Tamwoy *et al*. (2012) warn against viewing Aboriginal and Torres Strait Islander spaces as homogenous; they argue that specific regions and localities require fine-grained, textured and contextualized assessments of Aboriginal people-environment relations as well as their vulnerabilities.

2.4.5 Alternative epistemological perspectives

The above concerns are also reflected in a recent study by Veland *et al*. (2012), who contend that there is a widespread tendency to ignore or exclude Aboriginal conceptions of risk, which are overridden by a Western scientific account of risk and vulnerability. Their paper draws attention to the importance of developing a broader conception of risk and vulnerability by recognizing that: 1) Aboriginal peoples have been historically disadvantaged through dispossession; 2) the physical dispossession has also led to cultural and epistemological dissimilation as the social structures of Aboriginal peoples and their bio-physical foundations were radically transformed. To this end, the authors identify "a procedural vulnerability to *climate change research*, where perceptions of change and their meaning have their context in Dreaming that supersedes and parallels Western scientific discourses of hazard and risk, but that are marginalised in studies and policies on climate change" (Veland *et al*. 2012: 1, emphasis added). This important study draws attention not only to the cultural dimensions of social responses to climate change, but also the ways in which knowledge about climate change and climate change adaptation may in fact emerge from specific cultural and even cosmological contexts.

Such recent interventions into understanding the cultural dimensions of climate change adaptation in Australian contexts reflect a growing trend in the anthropological literature to place culture and cultural change at the heart of climate change research globally, particularly with regard to indigenous peoples (McIntosh *et al.* 2000; Strauss and Orlove 2003; Krupnik and Jolly 2002; Sherratt *et al*. 2005; Adger *et al*. 2006; Orlove *et al*. 2008; Cruikshank 2005; Berkes 2008). In the introduction to their landmark volume, *Anthropology and Climate Change*, Susan A. Crate and Mark Nuttall argue:

> *The effects of climate change are not just about communities' or populations' capacity to adapt and exercise their resilience in the face of unprecedented change. Climate change is also about the relocations of human, animal, and plant populations to adjust to change and to cope with its implications. Such relocations, both actual and projected, entail a loss of intimate human-environmental relationships that not only ground and substantiate indigenous worldviews, but also work to maintain and steward local landscapes. (Crate and Nuttall 2009: 12.)*

Such a concern has also animated other recent studies into the ways that Aboriginal people in Australia perceive, experience and understand environmental and climatic changes and challenges. For example, Petheram *et al.* (2010) have documented the perceptions of climate change of the Yolngu people in Northeast Arnhem Land. They note that such perceptions of the global phenomenon of climate change are closely linked to perceptions of other forms of environmental change that stem from what is considered to be inappropriate use of natural resources. Such perceptions stem from a particular way of understanding the nature of human agency in relation to the natural world, and forms of human activity that disrupt traditional conceptions of ecological balance are blamed for the kinds of changes (such as changing weather patterns) that scientists attribute to global climate change. Furthermore, their article documents the ways by which respondents perceived the *barriers* to climate change as being external in nature, and thus desired a community oriented approach based on ideas of self-sufficiency. Similarly, Leonard *et al*. (2013) have noted in their study of the Miriwoong people of Kununurra (W.A.) that:

> *…it is difficult to separate climate from other drivers of change both in a material sense (dams, mines, and land-use changes) and in a cosmological sense (it is not just the climate but also people who cause these changes). These results raise important questions about how indigenous and non-indigenous groups' [sic] not only perceive and respond to the impacts of climate change, but also the acceptability and effectiveness of climate change adaptation strategies. (Leonard et al. 2013: 8.)*

Given the documented disparity between the responsibility for climate change (understood simply in terms of emissions) and the effects of climate change (increased vulnerability and adverse outcomes) in indigenous communities worldwide (see Crate and Nuttall 2009), the perceptions of social and political barriers –themselves historically determined – may be just as important as material barriers. As Petheram *et al*. further note:

> *…adaptive capacity is defined not only by a community's capacity, but also their opportunity, motivation and preferences to adapt. Greater local involvement in adaptation planning is likely to reveal insight into policy and structures that may enable communities to adapt in ways suited to their context. For this involvement there needs to be a greater attention placed on local engagement. (Petheram et al. 2010: 689.)*

Cumulatively, these studies also highlight a further significant barrier to climate change adaptation, namely the tension between *climate change as a scientifically observable natural phenomenon*, and *climate change as lived experiences*. Obviously they are not mutually exclusive foci of research, but it is clear that much social scientific research on adaptation does not sufficiently countenance the cultural dimensions of climate change, and consider whether attention to these might be as important as attending to material aspects in order to strive for the sustainability of remote Aboriginal (and other) communities. Moreover, as Gregory Bankoff has argued, the very concept of vulnerability itself has emerged in the context of a broader historical trajectory of development, whereby large portions of the world have been essentialized as being inherently prone to disease, poverty and disaster. These representations, he further contends, shape technocratic approaches to dealing with vulnerability, which in turn comprise a "wider historical and cultural geography of risk that both creates and maintains a particular depiction of large parts of the world (mainly non-Western countries) as dangerous places for *us* and *ours*" (Bankoff 2001: 27).

The epistemic context in which dominant conceptions of risk are framed, and the exclusion of alternative conceptions of risk, might foreclose the insights offered by worldviews that do not lie within the bounds of scientific or economic discourses. O'Neill *et al*. (2012) describe the ways in which culturally-embedded conceptions of risk have been overlooked by scientific researchers, and the ways that a scientific approach to assessing climate change risk has been imbricated with top-down policy responses that often clash with the social and cultural imperatives of communities in the Torres Strait. For instance, researchers and policy makers have not necessarily taken on board the priorities of Torres Strait Islander peoples when deploying (or not) resources to combat some of the effects of climate change, such as increasing coastal erosion.

In this context, coastal erosion has been associated with *cultural erosion* for Torres Strait Islanders, whereby sacred sites and other culturally important features of the natural environment are damaged due to a lack of recognition of their salience in climate change adaptation. According to O'Neill *et al:*

> *[…] Islanders are likely to prioritise the preservation of sacred sites. Areas containing rain stones or culturally significant trees, for example, are locations likely to remain unrecognized as important by western scientists. This prioritisation of cultural artefacts and locations does not deny the very real problem Islanders can see with maintaining basic sewerage. It does, however, imply there is a recognition that physical infrastructure can be rebuilt, which is not the case for damage to sacred sites or change to the lifecycle of totemic animals. (O'Neill et al. 2012: 1107.)*

The implication here is that remote Aboriginal communities may perceive greatly different risks, vulnerabilities and pressures in the face of climate change, and thus may be stressed by climate change adaptation plans that do not properly account for threats to cultural aspects of Aboriginal life. Both perceptions and responses to climate change in remote Aboriginal communities will likely be influenced by specific cultural markers and cosmologically-derived meaning systems, and thus perceptions and responses will likely be different vis-à-vis urban populations and the nation as a whole. Moreover, the perceptual frames employed by people in these regions may be markedly different, and be influenced by specific positionality with regard to cosmology, culture, the economy and substantive political and economic status. These issues have certainly been noted in relation to Aboriginal perspectives on human health with it being closely interconnected with the health of country (Green, King and Morrison 2009).

This research draws out attention to the need to engage directly with the 'epistemic gaps' that pervade scholarly and policy engagements with climate change adaptation in remote Aboriginal communities. By 'epistemic gap', we refer to the disjuncture between modern, techno-scientific representations of climate change and culturally embedded perceptions of climate change. The privileging of the former (and thus silencing of the latter), according to Veland *et al*. (2012), constitutes a form of "procedural vulnerability" that itself further entrenches the epistemological violence inherent to colonial relations. Furthermore, the exclusion of indigenous knowledge may also further compound systemic and material vulnerabilities and thus lead to maladaptation (Howitt *et* al. 2012). To overcome such complex vulnerabilities it is crucial to deal with this 'epistemic gap' through contextually specific, place-based, and culturally sensitive research:

> *Modern scientific and Indigenous Dreaming narratives are not best approached as simply either 'right' or 'wrong' perspectives, but as realities that co-exist in the meeting of different knowledge cultures, and therefore need to be accounted for in efforts to, for instance, adapt to climate change (Veland et al. 2012:11).*

2.4.6 Alternative conceptions of risk

One further implication of the absence of culturally and phenomenologically grounded understandings of the way inland Aboriginal communities understand climate change is the danger that important cultural and cosmological differences – especially with regard to social-ecological relations – may be subsumed under a technocratic conception of risk (as discussed earlier) in a policy context. The policy implications of this common manoeuver are rarely examined in relation to culture, or in the context of inter-cultural relations and processes of cultural change. Moreover, it is scarcely acknowledged that the dominant conception of risk may in fact reflect a certain set of social and cultural assumptions may not all apply across different cultural contexts.

The perils of this latter issue become starkly apparent when considering how specific discourses about climate change risks form the basis of governance and public policy, in a range of different contexts. In the international context, questions about the effects of climate change upon indigenous and First Nations peoples have centred upon discrepant accounts of agency and responsibility vis-à-vis climate change policy:

> *Some indigenous people see themselves as 'climate change victims', with little agency to effect positive change. Other case studies depict indigenous people as 'empowered' to manage environmental change by developing culturally appropriate responses. (Buhrich 2010: 4.)*

Furthermore, tensions have been evident in island communities that face extreme vulnerability from rising sea levels and articulated in international climate change negotiation contexts. In her studies on climate change vulnerability in Tuvalu, Carol Farbotko (2010, 2005) has argued that many accounts of vulnerability exclude the agency of those affected, reducing them to patients who require intervention and remediation from more powerful and capable actors:

> *Island people, long marginalized, are denied their own agency in the climate change crisis. They are fictionalized in to victim populations, fleeing inundation, desperate for dry land, even drowned. (Farbotko 2010: 58.)*

Though inland Australian Aboriginal communities may not face the same existential threats from climate change as island nations, there are complex risks and vulnerabilities that are not captured by analytical frameworks and policy approaches that presume that Western, scientific knowledge and rationalist policy approaches offer all the answers. Many authors have pointed to the importance of attending to the exclusion of indigenous knowledge in international and Australian contexts (Agrawal 1995; Berkes 2008; Muir *et al*. 2010; Smith and Sharp 2012; Woodward *et al*. 2012), and given the acute challenges faced by historically marginalized and disadvantaged indigenous peoples all over the world, there are calls to develop a framework that accounts for a multiplicity of perspectives, knowledge systems and world views (e.g. see Mercer *et al*. 2007).

The present research consideration of Aboriginal risk perceptions, understandings, and responses to climate change reflects a convergence of interdisciplinary vantage points, including ethnographic, human ecological, sustainable resource management, health and well being, risk perception and appraisal, environmental stress, and disaster preparedness and response perspectives, to name but some. An important social science perspective and methodology within the context of climate change has been the use of national surveys to examine public risk perceptions, understandings, beliefs, values, policy preferences, and impacts (e.g., Brechin, 2010; Brechin and Bhandari, 2011; Leiserowitz et al., 2012a,b; Lever-Tracy, 2010Nisbet and Myers, 2007). A virtue of these surveys is that there is typically a much stronger focus on psychological variables and outcomes, and individual level psychological and behavioural adaptation responses, and the efficiencies of such a methodology allows for the capturing of robust national and regional data sets. A limitation of such surveys is that they typically provide a somewhat cursory and shallow examination of underlying psychological, social, and situational factors and putative determinants of adaptation responses and impacts. A number of such social science based national surveys have been undertaken in Australia (e.g., Ashworth, 2011; Leviston and Walker 2010, 2011; Leviston, Leitch, Greenhill, Leonard and Walker, 2011; Reser et al., 2012a,b). However none of these Australian surveys have been able to include or provide either

a national or regional pictures of indigenous Australian responses to the threat of climate change.

Moreover, there are of course clear challenges both in using such a typically on line methodology to survey more remote Aboriginal communities, and in undertaking a survey within such regions where the cultural and geographic contexts of these communities pose multiple problems of distance, access, language, and clarity of purpose. Nonetheless such research is possible, and of crucial importance, and the present research has been undertaken in part to demonstrate the feasibility and value of such an undertaking, and the multiple ways in which such comparative, quantitative and qualitative survey data from Aboriginal communities can be used in documenting adaptation challenges and capacities, and in monitoring individual, community-level, regional, and cultural adaptation adjustments and changes. The larger compass, historical data base and research investment, and multi-faceted focus of the research, also provides an excellent context for establishing the validity and values of such information when addressing regional understandings and capacity building for climate change.

2.4.7 Ontology in the Upper Georgina River Basin (UGRB)

Aboriginal perceptions and understandings of climate change in the Upper Georgina River Basin are likely to be influenced, to some extent, by the traditional ontological belief system. However, due to cultural change processes, the perceptions are more accurately described as intercultural, likely being a mix or syncretism of Aboriginal and Anglo-Australian as well as media-based, globally derived beliefs. We shall later elaborate (section 4) the point that there have been cultural change processes within the settlement populations of the region for many generations. So it is particularly in Alpurrurulam, as well as amongst some Camooweal families in the western part of the UGRB, that more complete traditional beliefs are maintained and valued in a more systematic and coherent way (a 'system of laws and customs' to use the terminology of Native Title evidence). This more traditional ontological system involves individuals knowing their Dreamings, which gives them a place-based identity linking them to particular sacred sites and to the knowledge that the reproduction of ritual actions at sites can change the environment in particular ways, including aspects of the climate such as wind, rain and lightning. This brings into focus the importance of understanding the cultural contours of perceptions and responses to climate change:

> *There are some striking cultural contrasts between Indigenous models of people-environment relations and those of Western science. For example, most groups believe that their land and marine systems were shaped and installed with resources by their ancestral heroes displaying supernatural powers. The explanation of Western science is in terms of geomorphology, and does not involve the influence of humans. In the Aboriginal explanation, the country was shaped by people; in the Western one, by nature. Aboriginal groups also believe that they can influence the weather and the reproductivity of plants and animals with special songs and actions at places – whereas Western science provides explanations which, again, do not involve the human influence. (Memmott and Long 2002: 43.)*

For those groups who have undergone a greater depth of cultural change, such as many of the residents of Dajarra and Mt Isa in the east of the UGRB, there may not be the same holistic belief systems as in the west. However, it is likely that they still believe in the presence of spiritual entities in the landscape and the idea that inappropriate human behaviour in the environment can, from time to time, precipitate retaliatory actions by such entities, which can be manifested as extreme weather events. What these more multicultural groups have in common with the former groups is also an attention to environmental detail and ecological inter-relationships in those cases where they make regular excursions into the country for purposes of hunting, resource gathering, recreation, and land and riverine management.

The idea that Aboriginal peoples are embedded within a different cosmology, and that their cultural heritage may shape contemporary perception of climate change is thus an important one to attend to in this context (see Veland *et al*. 2012). It remains to be seen whether specific place-based perceptions and understandings of climate change and extreme weather events will, perhaps, have some sort of role in allowing Aboriginal communities to adapt successfully to climate change. At stake is the relationship between indigenous knowledge(s) and the Western scientific episteme. Furthermore, an important question that arises from the tension between these two knowledge systems is whether a deeper and more comprehensive understanding of the relationship between them may assist the communities in the UGRB to become more resilient and improve their adaptive capacities. Such an understanding will also acknowledge the relationship between Aboriginal people and their environment, and the inter-relationships with different aspects of social, cultural, political and economic life that are put under threat by changes in the natural environment over time.

Such an understanding may also redress some deep-seated fatalism surrounding the future of remote Aboriginal settlements. One important theme of anthropological research into Aboriginal social systems, as previously noted, is centrality of the environment to an understanding of society (Berkes 2008; Memmott 2010; cf. Peace *et al.* 2012). Instead of understanding social systems and eco-systems as related, but mutually exclusive entities (this has been a strong tendency in the Western tradition), Aboriginal perspectives are more often than not grounded in a cosmology that involves the close integration of people and country at its heart. Thus:

> *Climate change adaptation efforts in remote indigenous communities need to recognize the multiple and interacting drivers of socio-ecological systems in a holistic manner if they are to have any success in reducing climate change vulnerability. Rather than being a cause for despair, an acknowledgement of these drivers and interactions can yield innovative and successful ways of managing natural resources, and more generally, of living in desert regions. (Wiseman and Bardlsey 2013: 19.)*

2.4.8 Closing the 'epistemic gaps' in current research

Finally, this review acknowledges recent, innovative research that seeks to close the 'epistemic gaps' that persist in both policy and academic fora when it comes to the climate change research. In relation to disaster management, it is being increasingly acknowledged that despite the smooth functioning of disaster management policies

and procedures in coastal and urban areas (Arkley 2012), there remains a lack of capacity in remote areas, which in turn increases vulnerability and risk sensitivity. Indeed, recent research suggests that disaster management ought to be integrated within a climate change adaptation framework (Howes *et al.* 2013). Though there is little substantive research on this point, an anecdotal report about a mass evacuation of Kiwirrkurra (a remote desert community in Western Australia near the N.T. border) following widespread flooding reveals important lessons to be learned in emergency contexts in remote Aboriginal settlements:

> *It is important that emergency managers working with Indigenous communities understand the historical and current context of the community they are working with. This knowledge makes it easier to negotiate and communicate with community members. Additionally it can help avoid awkward misunderstandings and embarrassing trip ups over cultural and/or historical sensitivities and issues that may damage trusted relationships. (Brinkley 2009: 69.)*

Such a case-study reveals important lessons for both researchers and policy-makers for not only the challenges that remote regions face, but also the barriers to smooth disaster management procedures that may arise from not countenancing important cultural and socio-economic factors. Understanding these factors may also help pave the way for novel cross-border arrangements that have purchase across the region, thus overcoming some of the barriers cultural and jurisdictional barriers that are built into extant governance mechanisms (Griggs *et al*. 2012; Steele *et al.* 2013). The cross-border context of the UGRB will be discussed further in later sections.

Studies of the governance of natural resource management, and land and riverine management, have suggested that indigenous perspectives, based on a specific socio-ecological framing of environmental change, have been excluded or marginalized within regulative and consultative settings (e.g. Petheram 2010; Ayre and McIntyre 2012; Davies and Holcombe 2009). Similarly, a socially and culturally embedded methodology for vulnerability assessments, that accounts for the close relationships between people and their environments, is seen to be a crucial aspect of assisting Aboriginal and Torres Strait Islander communities to prepare for successful climate change adaptation, in a way that is commensurate with the ways of organizing their social and economic lives (Green, Billy and Tapim 2010; Green and Raygorodetsky 2012). Moreover, Prober *et al* (2011) suggest that Aboriginal knowledge has an important role to play in land and natural resource management, both directly (though traditional methods of land care, such as controlled burning of country) and indirectly (by deploying traditional knowledge of country to monitor and evaluate climate change effects over time). Utilising traditional knowledges and practices may also give rise to novel and contextually specific governance arrangements, as has been demonstrated by Griggs *et al*. (2012) and Bardsley and Wiseman (2012).

Of course, the immense challenges presented by climate change for remote Aboriginal communities have also been examined for their potential. A few recent contributions have explored the ways in which climate change adaptation may also provide fruitful avenues for enterprise development in remote areas (Altman 2012; Godden 2012; Hewitt 2012). Furthermore, such enterprise possibilities that emerge from traditional

knowledge and practice may be at once instrumental in redressing historical disadvantage and improving adaptive capacity and resilience through innovative and culturally sound methods that have multi-dimensional 'knock on' effects. Munang *et al.* (2013) have recently suggested that "ecosystem services" may have an important role to play in adapting to regions and livelihoods to climate change. Such approaches will likely have positive public policy implications:

> *Rather than tackling climate change, biodiversity, health and social inclusion challenges separately, we must put effort into funding projects that tackle these problems simultaneously. Based on the Australian experience so far, we are likely to find that it is better value for money than trying to solve them in isolation. (Green and Minchen 2012: 643.)*

2.4.9 Literature Review Summary

As demonstrated above, the marginalization of Aboriginal perceptions, understandings, and indigenous knowledge systems have thus been documented in recent but limited scholarly literature. The current authors' research seeks to contribute to these efforts by foregrounding and understanding the barriers and challenges to climate changes in the Upper Georgina River Basin, which has received scant attention in terms of concrete policy and planning. In doing so we seek to develop a contextualized and place-specific understanding of both vulnerabilities and capacities to adapt to climate change in the UGRB. We also seek to better understand the peculiar configurations of the determinants of risk, and the ways that sensitivity to these risks might be overcome. A general aim of this study is to bring knowledge, culture and an Aboriginal understanding of the perceived implications of climate change to the centre of enquiry in order to fill these epistemic gaps, and thereby help Aboriginal communities reduce their risk exposure, redefine their risk landscapes, reduce vulnerability and increase adaptive capacity and economic sustainability. To this end, a people-environment study of vulnerability is developed herein that examines the linkages between social, cultural, economic and climatic factors. Moreover, this study seeks to examine the potentials for deploying local knowledge in conjunction with public resources, to achieve these goals.

3. THE GEORGINA RIVER FRONTIER HISTORY[1]

In the mid-nineteenth century the Indjalandji-Dhidhanu people occupied the most upper part of the Georgina River basin and surrounding Barkly Tableland in far north-west Queensland, extending from the O'Shannassy and Seymour Rivers in the north to the Templeton River in the south, and from the James River in the west (Northern Territory) across the upper Georgina River to encompass its eastern tributaries (including the Buckley River). Wakaya clan groups were located on the upper Ranken River in the north-west of the basin. These English place names were not in use at this time; rather, there was an original cultural geography and Aboriginal system of place naming in existence. Downstream were the Bularnu on the lower Ranken River and on the reach of the Georgina where Headingly Station now is, and then the Waluwarra on the next lower reach and its tributaries, Moonah Creek, Jayah Creek, Split Creek, Bull Creek and Mudgeegoolla Creek (see Figure 14 for the group territories map).

The traditional society and lifestyle of these peoples was not impacted by the British invasion of Australia until after the continental crossing by Burke and Wills in 1861–1862. As a result of the search effort for the lost Burke and Wills expedition, the colonial explorer William Landsborough, in 1862, encountered and re-named three sacred Indjalandji lakes as Lakes Mary, Francis and Canellan. These lakes on the upper Georgina River were of central significance in regional law and custom, being both sacred sites and the sites for inter-tribal trade markets and ceremonial festivals, situated on the north–south continental trade route (Flinders Range – Lake Eyre – Georgina – Southern Gulf of Carpentaria). Landsborough also reported on the surrounding grasslands, and these discoveries (water and grass) triggered several waves of pastoral occupation by colonists.

The first wave of pastoral settlement occurred from 1864 to 1869, establishing the pastoral runs of Rocklands, Avon Downs, Soudan, Alroy Downs and Lake Nash stations in the study region (see Figure 10), but all withdrew after severe drought. The second wave occurred from 1876–1885 and brought permanent settlement. During this early period, the socioeconomic and religious significance of the Georgina waterholes would have been paramount to the local Aboriginal groups. Conflict arose during the droughts when the local pastoralists were trapped with large numbers of stock needing water and fodder. Tense relations would have been exacerbated by the establishment of a stock route beside the river, the destruction of edible riparian flora by the stock, the pollution by the cattle and sheep of the waterholes which were sacred sites, and such stock becoming bogged in drought-stricken waterholes and remaining there as rotting dead carcasses.

Pastoral settlement of the Georgina's upper tributaries in Queensland – the Buckley, Inca, Wooroona, Mingera and Upper Templeton river and creeks – spread in the 1880s and early 1890s and was consolidated between 1895 and 1919 with the establishment of Barkly Downs, Morstone, Yelvertoft, Undilla, Flora Downs, May Downs, Wooroona

[1] This entire section is extracted and summarized from a much longer historical analysis prepared by one of the authors (Memmott 2010A).

and Thorntonia stations. The Aboriginal groups maintained a connection with all of these pastoral areas through visitation, pastoral employment, and residence. The township of Camooweal was established beside Lake Francis in 1884 and was to flourish as a border customs post, a pastoral industry service town and a droving stop for the cattle barons who quickly became established across the Barkly Tableland and west to the Kimberley. Cattle from this vast northern area had to be brought back via the Queensland border-dipping centre to the eastern coastal markets.

Stock roads soon linked Camooweal to Cloncurry, Urandangi, Boulia, Burketown, Borroloola and Tennant Creek. Aboriginal Town Campers provided a labour pool of stockmen and domestics. These frontier roads had many functions. The cattle stations were all without exception formed at the most reliable waterholes, and so too did each and every traveller rely on the same water sources. The waterholes had for many centuries been the sites of Aboriginal camps, and ceremonial centres, and many continued to be used as such where there was no resistance from the pastorialists. Similarly, the roads between the major water sources were previously the trunk trade routes of the Aborigines, linking into a continental network of such Aboriginal trading routes (McCarthy 1939; Memmott 1985).

Decimation of the Aboriginal groups of the Georgina and its tributaries occurred during the late nineteenth century and was largely attributable to frontier violence, especially conflict at the hands of the Native Police, as well as multiple infectious and contagious diseases (influenza, measles, dysentery, venereal diseases). Bad droughts between 1891-92 and 1901-02 exacerbated circumstances (Murray 1932, Upton 1938 and Australian Met Bureau 1957). Only a limited number of families survived in the region. Partly in response to the widespread demographic collapse that occurred in this and other parts of the State by the end of the nineteenth century, the Queensland Government introduced the *Aboriginals Protection and Restriction of the Sale of Opium Act 1897*. 'The Act' regulated the labour of Aboriginal people in the pastoral industry. Its administrators were able to punish those who did not or could not please their employers and the local police, by sending them to institutionalized penal settlements in the east of the state such as Cherbourg, Woorabinda and Palm Island.

In later decades (1920s to 1940s), various people in the next descending generation were sent to Palm Island. Due to the forced separation under the State's Aboriginal 'removal' policy, the offspring of these Palm Islanders were still re-establishing links with descendants who remained on the Georgina in the early 2000s. Another consequence of the 1890s droughts was the introduction of the new bore technology to the Barkly Tableland stations, first at Rocklands, then in 1894 at Alexandria ('Northern Territory Times' 24/10/90, 7/9/94). Eventually, some 100s of bores were sunk across the upper Georgina region and many were operated by steam engines. Aboriginal laborers had to fell and cart gidgea and other acacia wood over many decades to run these engines, creating an environmental impact (albeit unmeasured) to the alluvial riverine land system. (Figures 11, 12 and 13 below).

The construction of the state border on the Georgina basin and the emergence of differential frontier conditions for Aboriginal people in Queensland and the Northern Territory underlay the eastward migrations of various neighbouring NT Aboriginal

groups such as the Wakaya, Eastern Arrernte and Alyawarr into Camooweal and the Georgina River border stations, especially during the 1920s and 1930s, enabling the maintenance of a cultural law bloc of affiliated tribes with associated inter-marriage and ceremony between groups. The Alyawarr eventually established a succession claim of the Bularnu country around Lake Nash Station (Georgina-junction).

During the early 1920s, many northern Alyawarr made a decision to migrate east with their children across the Wakaya Desert arriving at Soudan to escape the violence occurring in their homelands in the Davenport Murchison Ranges where pastoralists had been consolidating their holdings with force. Other individuals travelled to Lake Nash via the Elkedra-Sandover route. A major influx of 150 people into the Lake Nash pastoral camp occurred from the west in late 1923. A set of regional Aboriginal town camps and pastoral camps were established on the Georgina basin in Queensland and used for up to 100 years in which the remnant Aboriginal population maintained a distinctive lifestyle. Collectively they marked out a cultural region encompassing such groups as the Indjalandji-Dhidhanu, Wakaya, western Kalkadungu, Waanyi, Waluwarra, Bularnu and eastern Alyawarr. The descendants lived in these camps as they worked under 'the Act' and inter-married with spouses from these other language or tribal groups.

In the early 1920s the Georgina pastoralists were, for the first time, linked effectively to the east coast of Australia by the establishment of a new railhead across the Queensland border. Over the decades a railway line had been slowly creeping westwards from Townsville. It had reached Cloncurry in c.1907 ('N.T. Times', 27/12/07), and was extended in c.1922 as far as a siding on Sulieman Creek, called Dajarra, 125kms to the east of Urandangi. Station supplies and foodstuffs could be brought into the district at reduced prices, and much more quickly and frequently; but most important, the distance for droving cattle was vastly reduced. Dajarra was to become one of the largest cattle trucking centres in the world over the following thirty years. Two distinct Aboriginal social groupings immigrated to Dajarra at different times. The first migration came from the border town of Urandangi both before and after World War II, but culminated when the Police Station closed (c1950s), together with the departure of the Policeman who was the agent of the State's Aboriginal Welfare legislation. This group of immigrants comprised the Georgina River tribespeople, Warluwarra, Pankarra, Wakaya, Indjiladji and Pita Pita.

The second migration comprised Wangkamanha/Eastern Arrernte people who came from the Northern Territory via Urandangi, catalysed by the Equal Wages ruling for Aboriginal stockmen which resulted in the sacking of many workers and the eviction of their families from the Cattle Station Camps which they had occupied for upwards of a century. Despite the above forces of demographic and cultural change at a regional level, opportunities for social interaction and the transmission of traditional laws and customs occurred for the Georgina people in pastoral camps (e.g. on Barkly Downs, May Downs, Yelvertoft, Rocklands), and at Urandangi, Dajarra and Camooweal throughout the twentieth century. Working in decentralised Aboriginal stock teams and living on pastoral outstations facilitated a connection to country and sacred sites, as well as enabling customary resource collection and the transmission of customary knowledge from older stockmen and domestic labourers to the younger generations. A

sense of a Georgina River culture and community has survived. Ruby Saltmere sums this up by saying, “And as for the country part of it, well we know the country because we been here all our life and worked on it” (Memmott 2012: 222).

Due to their diminished population, all of these groups have depended upon the wider cultural bloc of the upper Georgina Basin for the maintenance of initiation ceremonies and related Law matters. Relaxation of the Act after 1970 brought more widespread freedom of movement of people within the North-west Queensland region. Combined with the advent of welfare payments, pensions and unemployment benefits Aboriginal people participated more centrally in the mainstream economy. Aboriginal families purchased second hand cars for local travel and hunting. People were able to exempt themselves from the Act much more readily but this was not always taken advantage of.

Dajarra’s Aboriginal people formed the Jimberella Co-op in 1974 and its first application to DAA was for a truck with which to transport food stuffs from Mt Isa for the predominantly Aboriginal population in the town who were said to be “generally enraged by the exorbitant prices charged at the local store operated by a European.” The Society also aimed to act as a Co-operative Housing Society, and to establish a community centre for social activities. (Memmott 1974:1.)

In 1976, Camooweal’s Indjalandji and Bularnu people were joined by 50 Alyawarr originally from the Sandover River but who had had intermittent employment on Soudan and Lake Nash prior to being on Avon Downs. They had become important members of the Georgina basin Aboriginal Law community. Some still reside in Camooweal whilst others are at Alpurrurulam. European contact and settlement inevitably forced the Georgina society to undergo adaptation and change. However, the senior members of the group have responsibly maintained law and culture by passing down the knowledge of the traditional system of law and custom through successive generations; and by activating linkages with neighbouring groups, especially the Alyawarr and East Arrerntic groups at Alpurrurulam, so as to participate in the regional Law bloc.

Overall, there is some cultural diversity amongst the Georgina River communities due to the differences in contact history. The Queensland people in Dajarra and Camooweal have had the greatest time depth of cultural change and adaption into the pastoral industry whereas Alpurrurulam and Urandangi people were largely from Northern Territory groups who have had a shallower depth of cultural change and are more traditionally oriented in many of their customs.

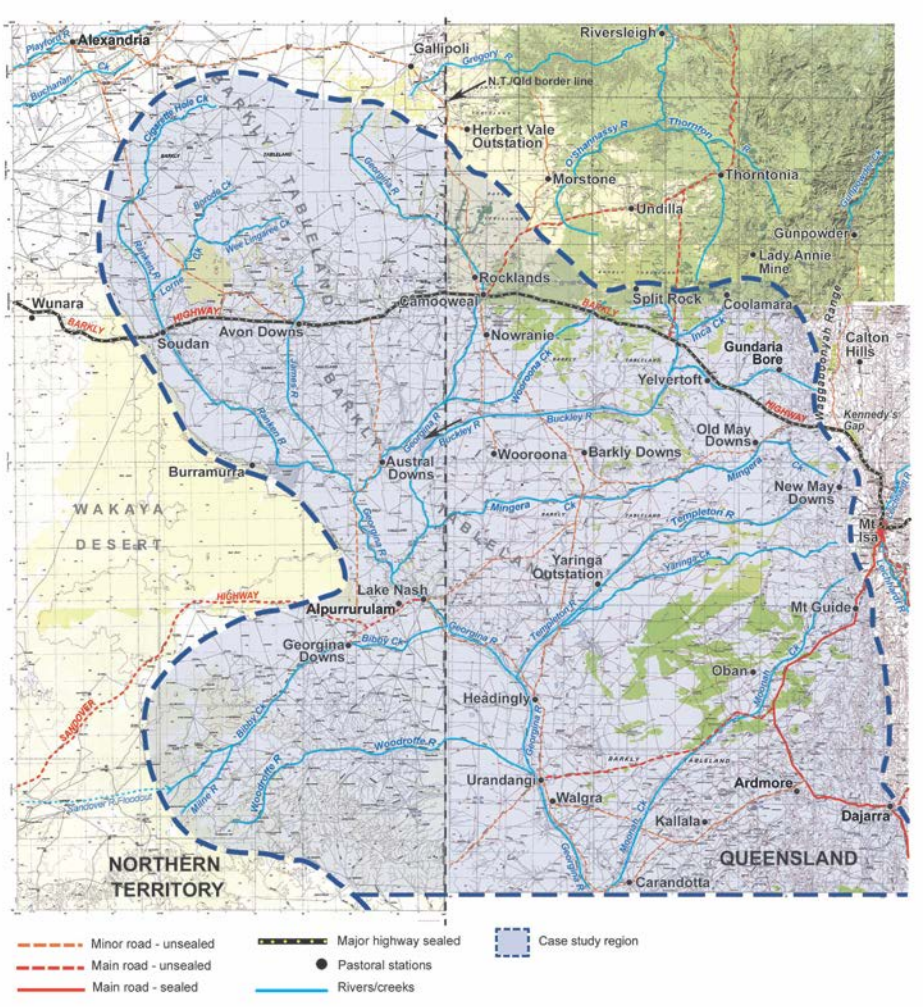

Figure 10: Towns and pastoral stations on the Upper Georgina Basin. (Source: AERC)

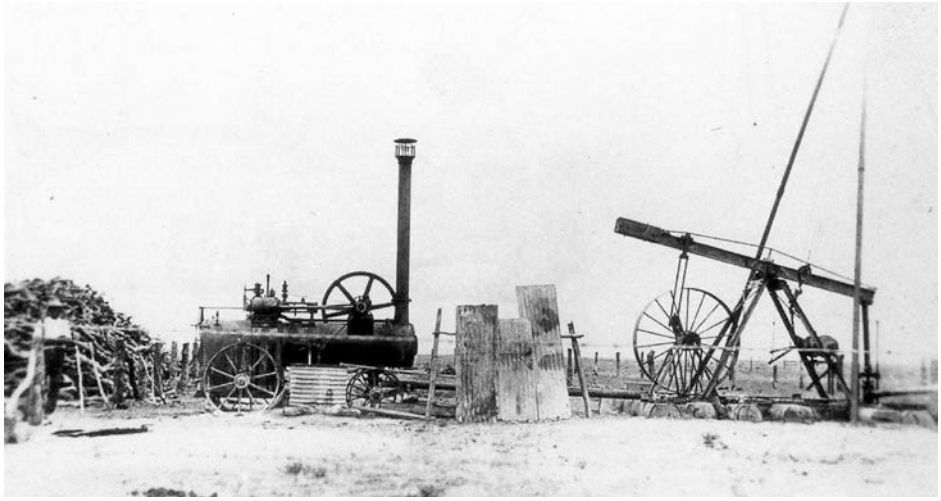

Figure 11: No. 18 Bore, Alexandria, 1920s.
(Source: Kowald and Johnstone1992: 37)

Figure 12: No. 6 Wagon Team carting firewood for the steam engines at the bores, Alexandria, 1920s.
(Source: Kowald and Johnstone 1992: 40)

Figure 13: Aboriginal labourers' quarters, Alexandria, 1920s.
(Source: Kowald and Johnstone 1992: 67)

3.1 Rainmaking on the Upper Georgina River Basin

The economic history of pastoralism on the UGRB involved a reliance on Aboriginal labour over 100 years. In the late 1800s a form of slave labour was employed. If an Aboriginal person did not belong to a station labour pool, the likelihood of their being shot by the Native Police. Labour was then institutionalized under the 1897 Aboriginal Act; but nevertheless remained as a form of forced labour with wages held in perpetuity by the State under the administration of the Police, Non-compliance to work resulted in deportation to Cherbourg or Palm Island. Under these circumstances of enforced cultural change, Aboriginal culture had to be adapted to pastoral lifestyle and interestingly Rain-making ceremonies survived.

In the 1890s the ethnographer Dr Walter Roth (1903 Bulletin 5:9,10) recorded some brief details about rainmaking on the mid-reaches of the Georgina River at Roxborough (his 'Roxborough Downs'). It was a period of bad droughts on the Georgina through to the early 1900s. In the traditional Aboriginal religious belief system, it was believed that rain could be induced into dry country through the performance of Rain-making

ceremonies at Rain sacred sites by highly initiated men who were themselves of the Rain Dreaming. These rain sacred sites were distributed in particular customary estates across the upper Georgina basin, which were identified as Rain estates created in the Dreamtime.

Anthropological research by one of the authors (P.M) has identified four well known rain-makers who carried out Rain ceremonies across the upper Georgina River basin in the mid 20th century and whose skills were sought out by pastoralists in times of severe drought. Three of them died in the 1970s, *Dijeru* Jack, Leichhardt Toby and Avon Willy. *Dijeru* Jack held primary responsibility for maintaining the rain-making rituals of the Indjalandji-Dhidhanu group, and its link to the important Rain-making site of *Dagalanji* on Calton Hills. Long-time Camooweal resident Paddy Lloyd (now deceased) in c1985 recalled that *Dijeru* Jack use to "pray for rain" (i.e. carry out rituals) at such places as the Crocodile Hole and the Lima Yard on Calton Hills. Tom and Ned Saville recalled and verified that *Dijeru* Jack and the Kalkadungu Elder Leichhardt Toby used to make rain together on Calton Hills and that the focal Rain site was *Dagalanji* on Battle Creek. It was said that Bob Johnstone, the Manager, asked them to make rain when it was dry. These two men, *Dijeru* Jack and Leichhardt Toby (Indjaladji and Kalkadungu respectively), carried out Rain ceremonies together. Dijeru Jack was thus the ceremonial 'boss' for Indjalandji Rain estates on the Buckley River and the upper Georgina River.

The third regional Rain-maker was Avon Willy (aka Willy Clegg) who was a Wakaya Elder from the rain making estate of Lorne Creek, an upper tributary of the Ranken River. A fourth regional Rain-maker was Alyawarr Elder Paddy Woodman who died in 2010 at age c.105. Lake Nash Elder Nugget Smith provided an account of *Dijeru* Jack making rain with both Leichhardt Toby (Kalkadungu) and Paddy Woodman at Shady Hole near Headingly, in the late 1920s or early 1930s. This was during Joe Patch's time as manager on Lake Nash. Paddy's country was on Elkedra Station well to the east of the Georgina basin, but as a young man he had been one of those Alyawarr who had fled east across the Wakaya Desert in the early 1920s to escape the violence in their homeland, and he had spent most of his adult life on the Georgina basin cattle stations.

The contemporary Indjalandji-Dhidhanu Elder Ruby Saltmere has explained the close ritual link between the *Dagalanji* Rain and Cloud site on Battle Creek (a tributary of Gunpowder Creek) on Calton Hills, which was held by her grandfather *Dijeru*, and then by his son *Dijeru* Jack, and certain sites on the upper Georgina River. The Dreamings at *Dagalanji* comprise Rain and Cloud, but also Mussel Fish and Mussel Shell. *Dagalanji* is a cloud in the shape of a mussel shell. Ruby said the Rain Dreaming was travelling from *Dagalanji* Spring to Rocklands...[and that this] gave uncle [*Dijeru* Jack] the right to talk for Georgina River." Ruby has explained that the sacred site of Lake Mary, near Rocklands station homestead, was commonly referred to as *Kurruku*, literally 'head', meaning the head of the Rainbow Serpent or *Thuwani karinya kurruku* meaning 'Rainbow Serpent's turning head'. The back and body is believed to extend down the Georgina River to Lake Canellan. ("Head at Lake Mary; tail at Lake Canellan".) Associated Dreamings with rain on the Georgina proper are Rainbow

Serpent, Hailstone, Lightning (including chain lightning), strong winds, and rolling thunder.

As well as rituals to make rain, there were also rituals to stop or abate inclement weather. Ruby thus explained there is a song taught to her by her mother and uncle which is said to break the storm's power down, so that the hail does not do any damage – "break its back, so won't do damage…the song starts at Rocklands."

Rain-making ceremonies have not been carried out in the UGRB for several decades and it would appear this ceremonial capacity is on the verge of being lost. Nevertheless, it will be shown in latter sections of this report that contemporary Aboriginal knowledge of weather and weather change incorporates historical references and beliefs about traditional Aboriginal Rain-making and weather control.

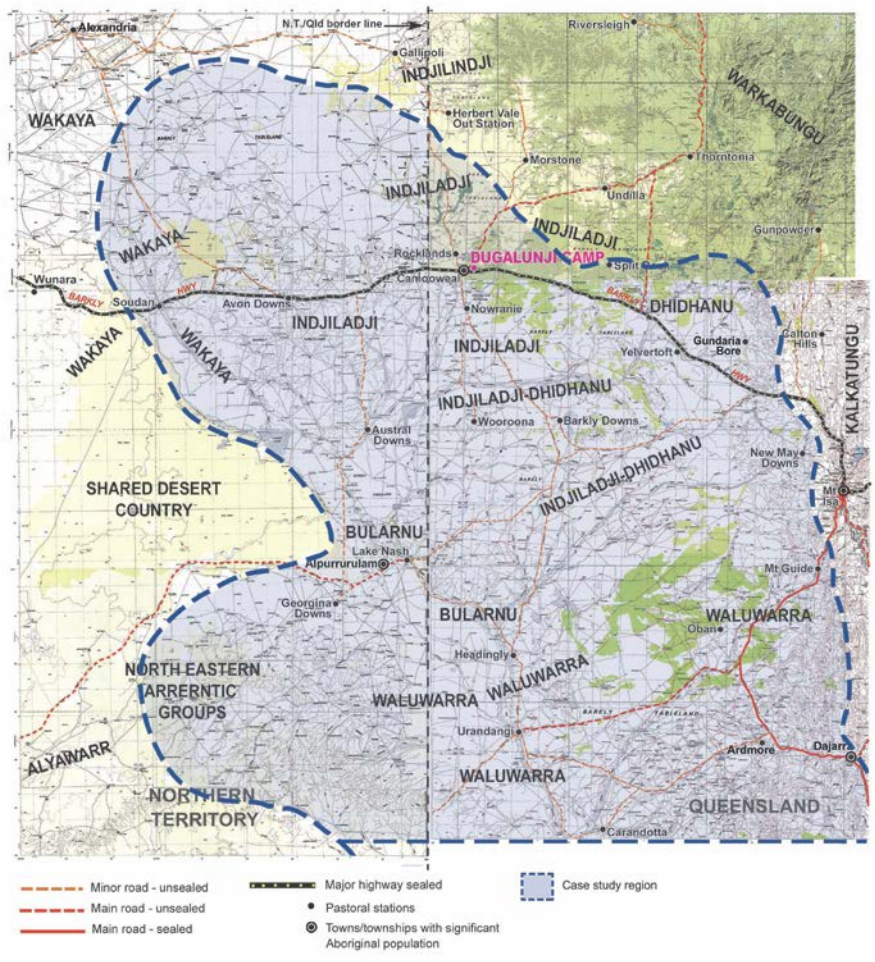

Figure 14: Tribal and Language Group Territories in the Upper Georgina River Basin region during the early contact period. (Source: AERC)

4. ABORIGINAL COMMUNITIES OF THE UGRB

There are five small Aboriginal Communities on the Upper Georgina River Basin namely, Alpurrurulam, Camooweal, Urandanji, Dajarra and Wunara (Figure 10). Their regional service centre is the city of Mount Isa to the east.[2]

4.1 Alpurrurulam

Alpurrurulam community lies near the Georgina River where it loops into the Northern Territory (Northern Territory) at Lake Nash, with a population of 442 people at the 2011 census. The Aboriginal people there (some 417) are bi-lingual, speaking Alyawarr as their first language and also Aboriginal or non-standard English. Their cultural ties focus mainly on the Sandover and Elkedra River communities from where their families migrated in early the 1920s. Alpurrurulam is serviced by the Northern Territory Government and Barkly Shire Council based in Tennant Creek, Northern Territory.

4.2 Camooweal

Camooweal is a small Queensland township close to the Northern Territory/Queensland border which has undergone population decline in recent years with only 187 at 2011 census. The town's Aboriginal population (some 105) has cultural and family connections to Queensland and Northern Territory groups. Camooweal is serviced by the Queensland Government and Mountt Isa Town Council. Four kilometres to the east of town, Myuma P/L operates its training and enterprise facilities at the Dugalunji Camp.

4.2.1 Dugalunji Aboriginal Corporation Camp

The Dugalunji Camp is an Aboriginal owned, controlled and created village, run by Myuma Pty Ltd, which hosts an enterprise staff, training staff and bi-annual intakes of 30 prevocational trainees. It contains a complex of buildings and spaces which include many pre-fabricated, commercial 'dongas' (as they are colloquially called, similar to mobile houses) typical of remote area mining camps, but it also includes a range of customary Aboriginal design principles and architectural elements that contribute along with camp 'setting' rules to a distinct quality of Aboriginal lifestyle. The Aboriginal Manager of the Camp Colin Saltmere conscripts professional design inputs on his own terms which are influenced by customary Aboriginal camping principles as well as pastoral camp experiences. The result has yielded a strong satisfaction by Indigenous workers and residents in the informal architecture of the Dugalunji Camp.

Myuma's Dugalunji Camp is situated on 1.5 hectares in a remote semi-arid setting of red sand, spinifex grass and open eucalypt woodland. In early 2013, the Camp was serviced with town electricity and modern communication technology, and was made up of air-conditioned dining hall, well-equipped kitchen, three office buildings, two

[2] ABS 2011 Census QuickStats (2012) lists the population of the Mt Isa region as 21,237, including 2982 Aboriginal people.

training rooms (including work stations with computers), accommodation for 65 people, semi-enclosed recreational area and workshop, gymnasium, laundries and ablution units, first aid centre, workshops, covered car parks, storage buildings, outdoor barbecue and ground oven facility, artefact keeping place and manufacturing area, fowl house, duck pond, water tanks and vegetable garden.

The leader of the Myuma Group, Colin Saltmere, was the Chairperson of the Mt Isa Gulf Region of the Aboriginal and Torres Strait Islander Commission in the 1990s, gaining experience of bureaucratic transactions and sub-cultures, which was to later prove useful when he advocated on behalf of his clan group and for other Aboriginal people in north Queensland. During the 1990s, he also became active as an initiate within Aboriginal customary Law drawing on the regional support of the wider Georgina River cultural bloc. Colin's leadership attributes had originally come to the fore as a Head Stockman in the mid 1980s, in charge of teams of 10-12 cattle stockmen both non-Aboriginal and Aboriginal of various tribal origins. In dealing with different human resource problems in the Myuma Group during his later life, Colin Saltmere has continued to draw on his learnings as a boss in the Georgina stock camps. The cultural components of the lifeway that manifests in the Dugalunji Camp thus draw on the customary pre-contact Aboriginal law and the pastoral economy.

4.3 Urandangi

Urandangi township, also close to the NT/Qld border in Queensland has a very small Aboriginal population (approx 40), including the Marmanya community a few kilometres to the east. The residents have connections to the local traditional groups in Queensland and the NT.

4.4 Dajarra

Dajarra township lies on the eastern side of the UGR basin approximately 150 kilometres south of Mt Isa. In 2011 the Aboriginal population of the Dajarra Census region was 155 and includes the populations of Dajarra town as well as mining communities and pastoral stations. The Aboriginal residents speak English as their first language and have only some knowledge of their groups' traditional cultural practices and languages. Their families migrated into Dajarra from the 1920s to the 1950s, mainly from the Queensland side of the UGRB. In 1974 the local Aboriginal community formed the Jimberella Housing Cooperative which remains active as the Aboriginal Community Organization which administers local housing. The group and its premises, the Jimberella Hall and offices function as a local community centre and are ideally placed to take an effective role in climate change adaptation strategies. Both Myuma P/L in Camooweal and Jimberella in Dajarra are notable for their established capacity as local Aboriginal-run organizations and consequently are positioned appropriately to deliver services in their regions.

4.5 Wunara

Wunara is a small outstation on the far western edge of the upper Georgina River basin, close to the Barkly Highway, established in the 1990s. It is some 40 kilometres to the west of the Ranken River and sits on Aboriginal freehold land in the Wakaya Desert. Community members draw from the Arruwurra clan of the Wakaya language

group and mostly grew up in Dajarra and Mt Isa. The outstation is occupied intermittently based on employment opportunities in the local phosphate mining and exploration industry.

As a result of this NCCARF Project and the regional ties and proximity of these communities, representatives of these five communities have formed the ‘Georgina River Basin Climate Change Regional Adaptation Group’ in order to coordinate preparedness activities at a regional level, and to act as a communication point with various tiers of government as well as NGOs.

5. UGRB CLIMATE AND NATURAL ENVIRONMENT

The Upper Georgina River Basin (UGRB) lies within north-west Queensland and the central-east of the Northern Territory (Figure 15). The area covers the country between latitudes 19º and 22° S and longitudes 136º and 139° E. There are three dominant bioregions within the study region: the Mount Isa Inlier, the Mitchell Grass Downs, and the Tanami (see map in Figure 15). The soils of the region are mostly lateritic soils of various kinds, grey and brown soils of heavy texture, and Podzolic soils. The soils in the Barkly Tableland plains are 'black-soil' forming the characteristic, mostly treeless, Mitchell grass (*Astrebla* spp.) plains. Large proportions of the soils are stony or highly leached, and are low in phosphates (Christian *et al*., 1954).

The study region includes both arid and semi-arid vegetation and is in the dry monsoon belt. The weather is strongly seasonal with a short wet season and a long dry season (Christian *et al*., 1954). Average annual rainfall varies from 200-400 mm. The annual maximum temperature varies from 36ºC to 39ºC but daily maximum temperatures have reached as high as 50ºC in some parts of the Upper Georgina River Basin. The vegetation in the UGRB is well adapted to these harsh environmental conditions; however, periods of excessively high temperatures adversely affect plants. Under extreme weather conditions, bushfires are a common occurrence (Figure 19). While most of the vegetation recovers due to underground root systems, the intensity and frequency of fires alter the woody-grassland boundary and negatively impact on the obligate seeding species.

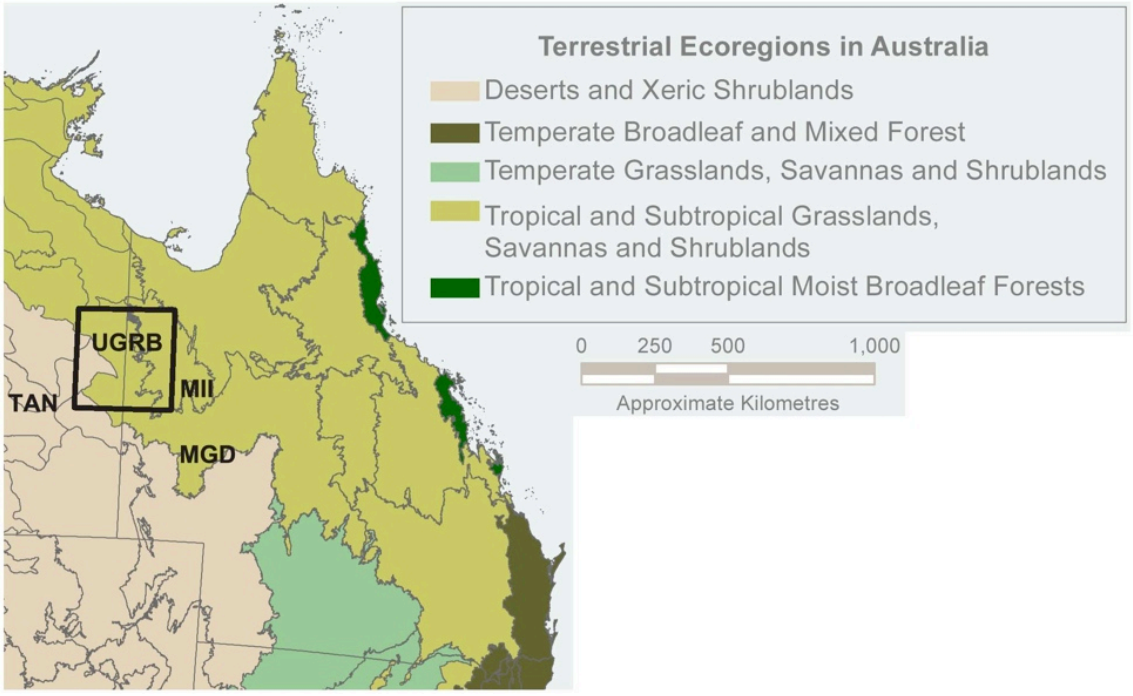

Figure 15: The location of the Upper Georgina River Basin (UGRB) study area in Queensland and Northern Territory, which includes three bioregions: Mount Isa Inlier (MII), Mitchell Grass Downs (MGD), and Tanami (TAN).
(Source: Aust., Dept of SEWPandC (2013)

5.1 Climate of the Upper Georgina Region

The UGRB straddles the border between Queensland and the Northern Territory. The northern fringe of the UGRB is located in the semi-arid tropical region characterised by summer monsoon rainfall and a warm dry winter season. To the south the UGRB becomes more arid as it borders the desert landscape of central Australia with a cool dry winter and hot summer seasons. The climate of the UGRB follows a distinct seasonal pattern, with almost all rainfall falling in the monsoon period of November to April (Figure 16). This is followed by a winter dry season. Total annual rainfall however varies significantly over the UGRB; from 1893 to 2009 the average number of rain days in the north was 41 compared to 22 in the south of the UGRB. Air temperatures show that the number of hot days (≥35˚C) per annum is slightly higher in the northern UGRB at 152 days per year compared to the southern UGRB at 150 days per year. Similarly the number of hot nights (≥20˚C) per annum is 150 in the northern UGRB, compared to 130 in the southern UGRB (Figure 17).

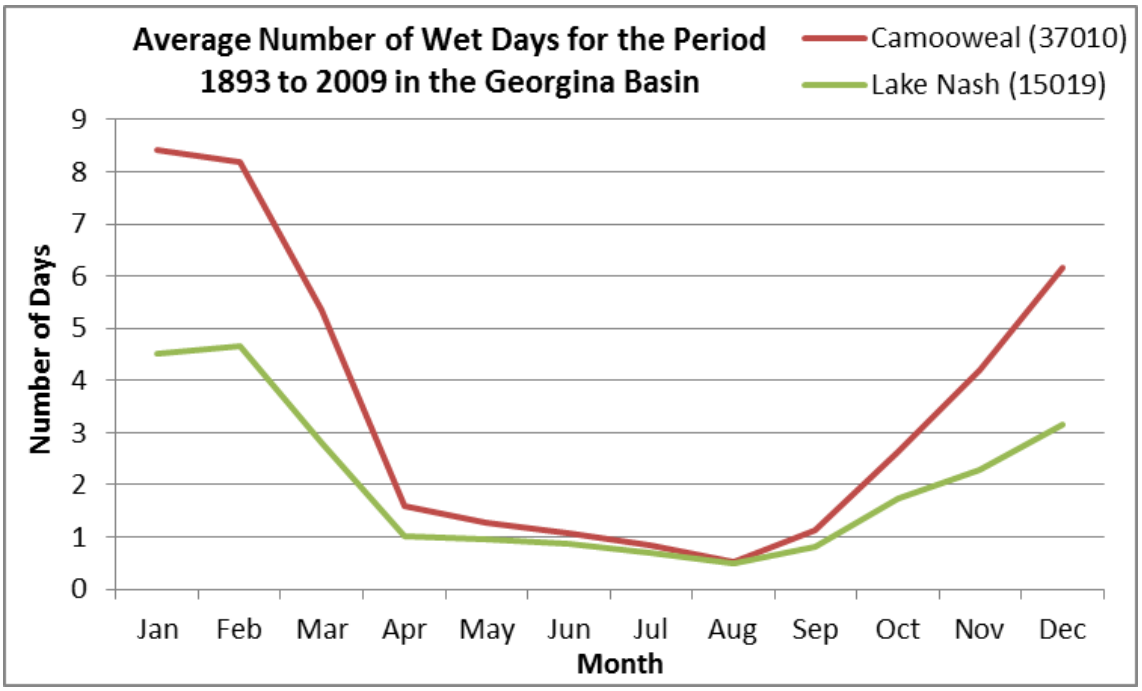

Figure 16: Average number of wet days for the period 1893 to 2009 for Bureau of Meteorology Stations at Camooweal and Lake Nash in the UGRB.
(Source: Data from the Bureau of Meteorology 2013)

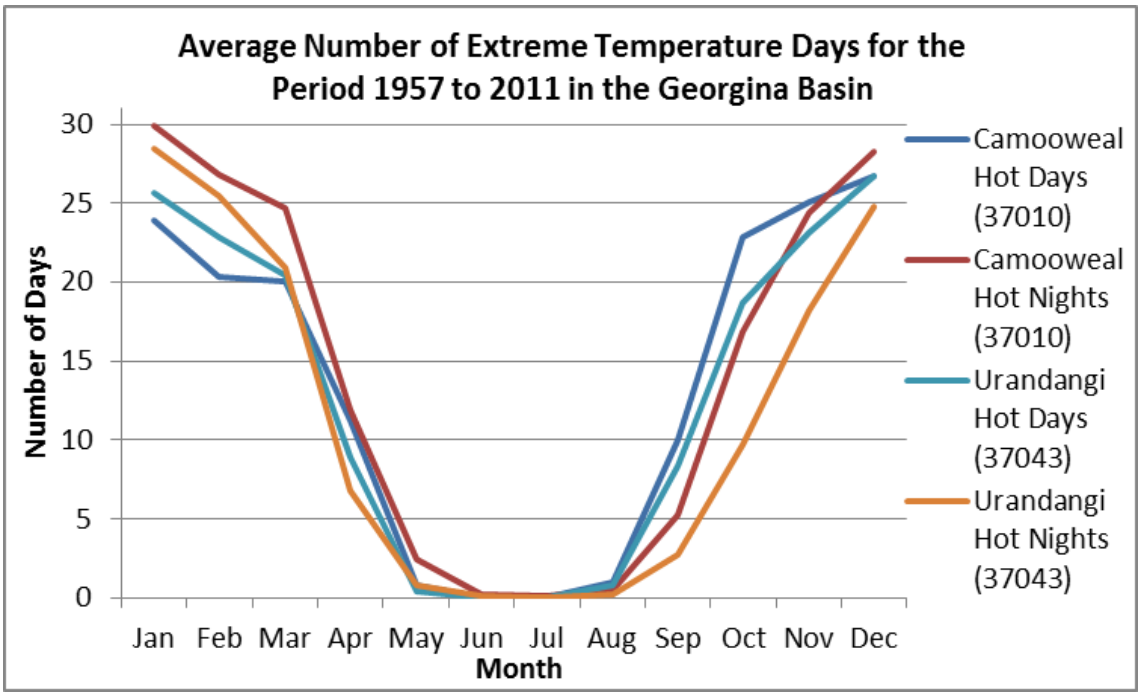

Figure 17: Average number of extreme temperature days for the period 1957 to 2011 for Bureau of Meteorology northern station at Camooweal and southern station at Urandangi in the UGRB.
(Source: Data from the Bureau of Meteorology 2013)

The annual cycle of rainfall and temperature reflect the UGRB's location, where during winter its weather is dominated by the subtropical ridge resulting in settled conditions characterised by clear skies and gentle easterly winds. There are occasional breaks in these conditions, when weather systems from the southern regions of Australia make their way across the interior of the continent and into the UGRB. For example, frontal systems can reach as far north as the UGRB and manifest either as wet convergent systems, or as dry and conducive to dust storm activity with moderate to strong winds. Due to higher aridity dust storms are much more prevalent in the southern section of the UGRB, but it is not uncommon for them to penetrate into the northern UGRB (Figure 18).

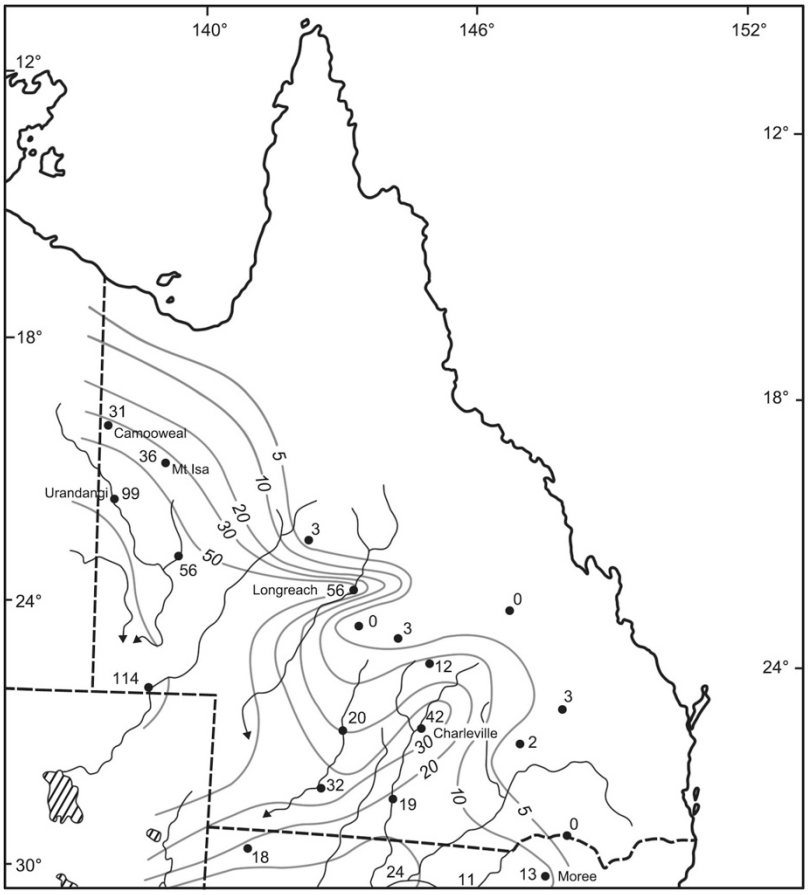

Figure 18: Dust storm totals for the period 1960 to 1984 in North Eastern Australia.
(Adapted from McTanish, GH, Lynch, AW and Burgess, RC 1990, 'Wind Erosion in Eastern Australia', Australian Journal of Soil Research, Vol. 28, pp. 328, Fig 2.)

During spring, air temperatures in the UGRB climb as the sun's zenith angle moves more overhead and the drying landscape of the UGRB ensures that the radiation received is predominantly apportioned as sensible heat flux. This leads to the formation of a springtime heat low over central northern Queensland including the east margins of the UGRB. The heat low is a very important feature that shapes the climate of the area prior to the onset of the summertime monsoon season and may result in thunderstorms and localised heavy rainfall. The lightning from these thunderstorms can be one of many triggers of wild fires, which are common through the late dry season in the UGRB as the temperatures increase and the landscape dries.

As summer approaches the Inter Tropical Convergence Zone (ITCZ) moves south to lie across northern Australia including the UGRB. The ITCZ represents the region of convergence between the south easterly trade winds of the Southern Hemisphere and the north westerly monsoon. The onset of the monsoon typically occurs late in December and is a result of a widespread destabilisation of the atmosphere. Once established, the monsoon will cycle from periods of heavy rain known as monsoon bursts to periods of relative dry monsoon break conditions caused by the 40 to 60 day cycle of the Madden Julian Oscillation (MJO). In the southern part of the UGRB, these periods of break may resemble the dry season with very high temperatures that may

often exceed 40°C. Burst periods of the monsoon may contain individual cells of intense rainfall and include tropical cyclones which after crossing the coastline of northern Australia may travel into the UGRB as cyclonic depressions causing widespread rainfall and associated flooding throughout the UGRB.

Prediction of temperature increases in the 21st century show that for inland Australia, in regions such as the UGRB, there is a likely to be an increase in temperature of between 0.5˚C and 1.5˚C by 2030 and between 1.5˚C and 5.0˚C by 2070 (Suppiah et al. 2007). The variation in these estimates stems from the different global warming scenarios utilised in modelling future global climate. This warming is not uniform throughout the year; there will be greater warming in spring and less warming in winter. These changes will increase the number of hot days and hot nights and reduce the number of cold days and cold nights.

Changes in precipitation do not respond as consistently as temperature due to climate change. There has likely been a small increase in the level of precipitation in the UGRB, but modelling results to date have been unable to separate the attribution between natural and anthropogenic effects. Predictions of global warming scenarios through the 21st century suggest that the UGRB will likely receive more summer rainfall and less winter and spring rainfall. In summer there may be a 0 to 5% increase in rainfall, whereas in winter there may be a decrease of 0 to 20% and during spring a decrease of 0 to 10% by 2030 (Suppiah et al. 2007). Similar patterns exist for projections to 2070, with a rainfall increase of between 0 and 20% in summer, a decrease of between 5 to 30% in winter and a 0 to 20% decrease in spring (Suppiah et al. 2007).

The predicted increase in summer rainfall is likely to be attributable to an increase in the intensity of the Australian monsoon, but modelling to date has not been able to accurately predict the characteristics of the monsoon precipitation. Similarly there is predicted to be an increase in the intensity of tropical cyclones. This is due to the increased water holding capacity of a warmer atmosphere, which can retain more “fuel” within the cyclone. However modelling has not been able to accurately predict the future change in intensity and frequency of tropical cyclones, and thus there is uncertainty in how tropical cyclones will change through the 21st century and their impacts on the UGRB.

The increase in hot days is likely to result in an increase in consecutive hot days, perhaps not unlike those experienced in early 2013. This may not however translate into more droughts. A drought also needs to take into account the physical properties of potential evaporation, which has reduced the confidence in the attribution of anthropogenic influence to increasing drought like conditions. Similarly there is large uncertainty in the predicted changes to dust storm activity. The climatic variables that control dust storm activity are soil moisture, precipitation, wind and surface cover. If monsoon fluctuations become more variable, then it may be possible that dust storm frequency in the UGRB will be more likely. Heavy monsoon summers could result in flooding in the basin, which transports fine grain sediments into the Lake Eyre basin. These fine grains then become available for entrainment in dust storms in the following dry season. For the projections into the 21st century, there is too much uncertainty in

these variables to have any confidence in the future change in dust storm activity through the UGRB.

The incidence of bush fires starting is predominantly related to the condition of the fuel, which is related to the antecedent precipitation. The wild fire season in the UGRB is the later spring months and early summer before the onset of the summer monsoon. With predictions through the 21st century that these periods are likely to have decreased precipitation, it is likely that the fire season will be longer and more intense. Heat related death is relatively uncommon in the northern tropics of Australia, but modelling of the predicted increase in mean air temperature shows that there is likely to be an increase in the number of heat related deaths. Vector borne conditions like malaria and dengue fever are also likely to increase under climate change. The zone of concern for dengue fever would extend further south from the northern Australian coast, and while malaria is not currently a threat to Australia, should there be an introduction of the infection it too would have a similar zone of concern. Due to the aridity of the UGRB, this zone is not likely to extend into the UGRB. However infected individuals from within the zone may migrate south, which would be of concern to the UGRB.

The climate of the UGRB is characterised by a wet summer season followed by a long dry winter. In the north of the UGRB in Camooweal and Mt Isa there are more wet days and rainfall than Urandangi and Dajarra in the south of the UGRB. Temperature extremes are common during the warmer spring, summer and autumn months, with little reprieve from very hot days and very hot nights in December and January. Climate variability is still the dominant driver of inter-annual and inter-decadal fluctuations in the climate of the UGRB. However climate change has increased the average temperatures throughout the 20th century and temperatures are predicted to continue to rise through the 21st century. Current projections show that average temperatures will rise by between 1.5˚C to 5˚C towards the end of the 21st century, with slight variations on a seasonal basis.

There has been a small increase in average annual precipitation levels in the 20th century in the UGRB. However there is uncertainty in the attribution to climate change and that there will continue to be an increase in the 21st Century. However on a seasonal basis the long dry winter is predicted to remain long and become drier in the 21st century, whereas the monsoon summer is likely to become wetter. Particularly in the northern UGRB which is more likely affected by monsoon rains, which may result in more flooding events. The consequence of these rising temperatures and reduced winter time rainfall is that bush fires are more likely in the bush fire season of late spring and early summer. Predictions of the changes to dust storm frequency are less certain as the drivers of dust storms are more complicated, requiring both the right climatic conditions and availability of particulate matter for transport into the dust storm.

5.2 UGRB Biodiversity

Rainfall is the most important factor that influences the vegetation and biodiversity in the UGRB. Other factors are the topography, internal drainage, runoff, permeability of the soil, water holding capacity and wilting point of the soil (Christian *et al*. 1954). For example, the distribution of *Eucalyptus brevifolia* association is widely spread throughout the southern, lower rainfall parts of the region, where it occurs on hills and

slopes but extend across flats which are less drained. In the more northern parts of its distribution, where the rainfall is higher, it is restricted to the steeper, well drained parts of the topography (Christian *et al*. 1954). Among the three bioregions that fall into the UGRB, only the western half of the Mount Isa Inlier (sub-regions: Thorntonia, South-western Plateaus and Floodouts, and adjacent Mount Isa Inlier), the central part of the Mitchell Grass Downs (sub-regions: Barkly Tableland and Georgina Limestone), and the eastern end of Tanami (sub-region: Tanami 3, also known as the Wakaya Desert), are within the study area. Below, we discuss the floral and faunal diversity in each bioregion and future potential threats to biodiversity with anticipated climate changes.

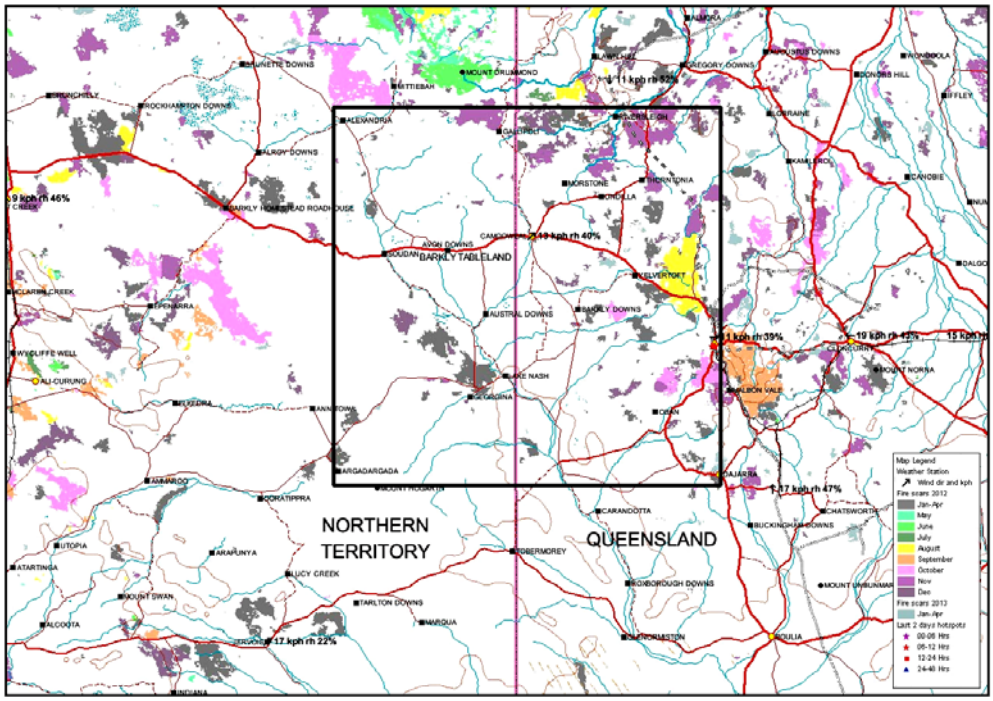

Figure 19: Map of bushfires in the and around Upper Georgina River Basin study area for the period January 2012 to January 2013.
(Source: North Australian Fire Information (2013)

5.3 Flora and Fauna

The plant communities in the Upper Georgina River Basin include treeless grasslands dominated by *Astrebla* spp. (Mitchell grass) on heavy soils, low shrub or sparse tree communities of *Acacia* spp., mallee eucaluptus, *Triodia* spp. (spinifex) in the low rainfall areas, and a range of woodland and open forest communities, mainly dominated by *Eucalyptus* spp. (Christian *et al*., 1954). Forests of *Acacia shirleyi* (lancewood) cover large areas of lateritic country. Plains of Mitchell grasses provide the valuable pastures of the region (Christian *et al*. 1954). Increased fire and heatwaves are the major climate change threats to faunal diversity in the Upper Georgina River Basin due to their causing the reduction of suitable habitats. There are several small vertebrates that are vulnerable to fires and are of conservation significance. If higher temperatures are accompanied by more rainfall, many common species will be affected due to more frequent intense fires burning over large areas.

5.3.1 Mount Isa Inlier

Flora: This bioregion is topographically diverse, but lacks high species diversity. Most of its species are widespread in arid regions of Northern Australia and extend into Western Australia (Low, 2011). The rugged hills and outwashes are primarily associated with Proterozoic rocks, skeletal soils and low open eucalypt woodlands which are dominated by *Eucalyptus leucophloia* (Snappy gum), *E. leucophylla* (Cloncurry box) and *E. pruinosa (Silver-leaved box)*, with a variety of *Triodia* species (*T. pungens*, *T. bitextura*) in the ground layer. There are some large areas of *Acacia cambagei* (Gidgee) and *A. shirleyii* (Lancewood) with low open-woodlands commonly on the valley floors (ANRA). *Acacia cambagei* and *Corymbia* spp. *(*bloodwoods) with *Astrebla* spp. (Mitchell grasses) and *Pennisetum* spp. (buffel grasses) occur on sand and alluvial plains (Christian *et al.* 1954).

The endemic species within the region are the mallee (*Eucalyptus nudicaulis*) and the pea bush (*Cajanus lanuginosus*). The silver-leaved ironbark (*Eucalyptus melanophloia*) is the dominant tree in the region (Low 2011). After fire, the dominant eucalypts regrow as mallees (stunted multi-stemmed trees), and are able to persist under a more arid climate by adopting this form. The eucalypts in the region also shed foliage during drought as a survival strategy. Broad-leaved carbeen (*E. confertiflora*) is completely deciduous during each dry season (Low 2011). Grazing, invasion by exotic weeds, and changed fire regimes are the threats to ecosystems in this bioregion. Ecosystems on plains and flood plains or on sand plains with red earths are under threat. The most common threatened vegetations are the arid eucalyptus low open woodlands with hummock grass and the arid eucalyptus low open woodlands with tussock grass (ANRA). See Appendix 3, Tables 2 and 3 for lists of species that are currently at risk and are vulnerable to future climatic changes, respectively.

Fauna: Mount Isa Inlier has semi-arid avifauna (See Appendix 3, Table 1). Other common fauna species within the bioregion are common rock-rat (*Zyzomys argurus*), euro (*Macropus robustus*) and goannas (*Varanus acanthurus* and *Varanus storri*). In the woodland areas, cockatiel (*Nymphicua hollandicus*) and bearded dragon (*Pogona barbartus*) are common (Morton *et. al.,* 1995). This is the only bioregion with two Grasswrens, the species group with the greatest number of restricted range taxa. The Kalkadoon Grasswren (*Amytornis ballarae*) is endemic, with central Australian affinities, while the Carpentarian Grasswren, whose closest relative is in Arnhem Land, also occurs extensively further west outside the bioregion (ANRA). Other endemic species to the region are a gecko (*Gehyra robusta*) and a skink (*Ctenotus striaticeps*) (Morton *et al*., 1995).

Changes in fire regimes are threats to wildlife in the region. Animals such as woodland birds and mammals, and reptiles and insects that shelter under spinifex (*Triodia* spp.) grasslands are mostly at risk due to increase in fires (Low, 2011). The Carpentarian Grasswren (*Amytornis dorotheae*) is endangered in the Northern Territory due to increase in fires. Most of the remaining populations now occur in Mount Isa Inlier (Low, 2011). Another threat to this species is the increased trampling of its habitat by cattle during extended droughts. The night parrot (*Pezoporus occidentalis*) in the region is endangered. While the exact threats are unknown, it is likely due to large fires (Garnett and Crowley 2000).

The reptiles in the region are less vulnerable than other animal groups, because most species can survive by sheltering in cool burrows and crevices. They can also reduce activity in summer and increase it in spring and autumn. However, spinifex-dwelling species are at risk if a heatwave occurs after a fire due to the removal of the cover they rely on. The spectacled hare-wallaby (*Lagorchestes conspicillatus*), which shelters under spinifex, could also be vulnerable after large fires. The purple-necked rock-wallaby (*Petrogale purpureicollis*) is a common species of special interest because it is endemic to the bioregion. It does best around permanent water but can die out due to loss of access to water during severe droughts (Van Dyck and Strahan 2008). If temperatures rise several degrees, populations could contract back to rugged areas near permanent water, where substantial caves and overhangs afford shelter from extreme heat. Heatwaves may force rock-wallabies and wallaroos (*Macropus robustus*) deeper into caves, potentially disturbing roosting and breeding microbats (Low, 2011). Shift from fine-scale fire mosaic to extensive burn pattern may also affect garnivores (seed-eaters) and other species in rocky hills. The indicator species in the region are Emu, Australian Bustard, Varied Lorikeet, Black-tailed Tree creeper, Purple-crowned Fairy-wren, Jacky Winter hooded Robin (ANRA). Species currently at risk in the region are listed in Appendix 3, Table 4. A detailed list of common avifaunal species in the Mt Isa Inlier Region is provided in Appendix 4.

5.3.2 Mitchell Grass Downs

This bioregion is characterised by undulating downs on shales and limestones with Mitchell grass *(Astrebla* spp*.)* grasslands as the dominant vegetation. The soils are predominantly deep heavy grey and brown cracking clays often with self-mulching and sometimes stony surfaces. The plains are interspersed with drainage lines, supporting open grasslands, herblands or eucalypt woodlands and isolated remnant plateaus supporting a variety of hummock grasslands and shrubland vegetation. Out of the eight sub-regions, two (Barkly Tableland and Georgina Limestone) are within our study area (ANRA).

The Mitchell grass grassland occurs on the deep cracking clays. Grasses dominating in the area are Curly Mitchell (*Astrebla lappacea*) and Barley Mitchell (*Astrebla pectinata)* with other Mitchell grasses and Flinders grasses (*Iseilema* spp.). Scattered shrubs on treeless areas include gundabluei (*Acacia victoriae*), mimosa (*A. farnesiana*)*,* Georgina gidee *(A. georginae*). To the west of the Georgina River, are whitewood (*Atalaya hemiglauca*) and cassias *(Senna* spp.). A large variety of forbs grow on the bare soil between grass tussocks after rain (ANRA).

Coolibah (*Eucalyptus coolabah/microtheca*) in low open woodland over open grassland occurs in patches across the region in association with low-lying plains and periodically flooded drainage lines. Supplejack (*Ventilago viminalis*), whitewood, swamp boxes (*Lophostemon* spp.) and gutta-percha (*Excoecaria parvifolia*) grow in association with the coolibah. Other common grass species include, silky brown top (*Eulalia aurea*) and golden beard grass (*Chrysopogon fallax*) and blue grasses (*Dichanthium* spp.), *Panicum* spp. and *Eriochloa* spp. River red gum (*Eucalyptus camaldulensis*) open woodland can be found instead of coolibah along some watercourses (ANRA). Many of the seasonal shallow lakes or swamps are covered by bluebush (*Chenopodium auricomum*) forming low open shrubland with an understorey of ephemeral grassland,

which grows after rain. The grasses include pepper grass (*Panicum aevinodei*), beetle grass (*Diplachne* spp.) and a range of forbs.

Gidgee (*Acacia cambagei*) is the dominant native tree in this bioregion but some dieback occurs during serious droughts. Woody weeds, prickly acacia (*Acacia nilotica*), mesquite (*Prosopis* species) and parkinsonia (*Parkinsonia aculeata*) are very invasive in the Mitchell Grass Downs (Wilson, 1999). They are more successful than native woody plants at colonising Mitchell grasslands. Weedy buffel grass (*Pennisetum ciliare*) has become invasive on sandy soils in the Mitchell Grass Downs and is slowly spreading onto heavier soils, displacing many other plants. It has survived recent droughts more successfully than native Mitchell grasses (Low, 2011). The widespread aim of fire exclusion would be detrimental to some species such as *Parkinsonia aculeata*, rubber bush (*Calotropis procera*), (*Prosopis* spp.) and noogoora burr (*Xanthium occidentale*) which are generally increasing and are of environmental significance. Prickly acacia (*Acacia nilotica*) is a major environmental and land use problem in the Queensland portion of the bioregion, and has the potential to become a major pest in the Northern Territory portion (Low, 2011). Table 3 describes the species that are currently at risk. The commonly dominant species in this bioregion that have a potential to vulnerability to future climate changes are listed in Table 4.

Intensive cattle grazing occurs in the bioregion due to the high pastoral value of the downs and the expansion of available watering points with bore technology from the 1890s. This widespread grazing is a significant threat to biodiversity. While the perennial Mitchell grass pastures are relatively resilient to grazing pressure, a decline in perennial grass species and an increase in annual herbaceous species are associated with heavy total grazing pressure. Areas such as riparian frontages, alluvial plains and wetlands and waterholes are heavily impacted by grazing pressure and have resulted in extensive areas of bare ground and trampling. Some vegetation clearing has occurred in the bioregion eg. for steam engine bores in the late 19th and early 20th centuries, with the introduction of exotic pasture species (ANRA).

Fauna: Vertebrate species diversity is generally low and there is an absence of most arboreal birds. Several species within the region experience a ‘boom-bust’ population cycle as their population density peaks and declines dramatically in response to rainfall patterns. Species that experience dramatic population fluctuations include the long-haired rat (*Rattus villosissimus*), flock bronzewing (*Phaps histrionica*) and letter-winged kite (*Elanus scriptus*). The cracking clay soils support a very high diversity of large elapid snakes, several endemic reptile species, and very high densities of several grassland birds and small marsupials. Species include the Spencer’s monitor (*Varanus spenceri*), the speckled brown snake (*Psendonaja guttata*), the singing bushlark (*Mirafra javanica*) and the long-tailed planigale (*Planigale ingrami*). The endangered dasyurid mammal, the Julia Creek dunnart (*Smithopsis douglasi*) is largely restricted to this bioregion (ANRA).

The seasonally flooded shallow lakes provide rich habitat for waterfowl and migratory waders. The wet season brings high densities of burrowing frogs, and the formation of swamps, typically surrounded by bluebush. These are nationally and internationally significant for breeding waterbirds including pelicans, ibis, herons, terns and ducks.

The grasslands also form a major summering ground for some migratory birds, such as the little curlew (*Numenius minutus*) and oriental pratincole (*Glareola maldivarum*) (ANRA).

With increasing droughts, species such as black-chinned honeyeater (*Melithreptus gularis*) and broad-headed snake (*Hoplocephalus bitorquatus*) confined to eastern areas within the bioregion are likely to contract further east (Low, 2011). Kangaroo deaths will also increase with increasing droughts. There was a decline in both wallaroos (*Macropus robustus*) and red kangaroos (*Macropus rufus*) during the drought in 2002. Not only kangaroos, birds could also be affected adversely by heatwaves of exceptional intensity. With increasing droughts, ephemeral wetlands will decline in size, frequency of filling and productivity which would be detrimental to breeding ducks, pelicans, ibis, herons, terns and frogs (Low, 2011).

The conservation values include a series of large but mostly impermanent wetlands of national significance, with some meeting the criteria for international significance. These are important for waterbird populations. The region also has five threatened plants and animals, four of which are associated with wetland riparian areas. The bioregion harbours distinctive biota, although there have been possible losses of some species associated with wetlands and tall grasslands, and declines for species, such as the flock bronzewing pigeon (*Phaps histrionica*), which has relatively intolerant to changes caused by pastoralists (Sattler and Creighton, 2002).

There are regional losses of at least three mammal species and substantial decline for the flock bronzewing pigeon in this region. The response of invertebrates, vertebrates and plants to grazing suggests that a suite of species is disadvantaged by grazing and has probably declined substantially. Grazing pressure in the Northern Territory portion of this bioregion is generally less intensive than that in the Queensland portion where paddock sizes are generally smaller. There is a trend for increased pressure on species disadvantaged by grazing, because of increased development in the Northern Territory portion through proliferation of artificial water points (bores with ‘turkey nests’), and more subdivision of paddocks (Sattler and Creighton, 2002). Feral cats occur at high densities, particularly around bores and other water sources. Other exotic animals include: house sparrow, house mouse, red fox, rabbit and are generally more localised or present less serious problems (Sattler and Creighton, 2002). Wild pigs are problematic in riverbeds impacting on aquatic vegetation including water lilies. The indicator species in the region are Emu, Banded Lapwing, Flock Bronzewing, Yellow Chat, Horsefield's Bushlark (ANRA). Species currently at risk in the sub-regions of Barkly Tableland and Georgina Limestone are listed in Table 5. See Appendix 4 for a detail list of common avifauna in the Mitchell Grass Downs region.

5.3.3 Tanami

The Tanami bioregion lies in the western edge of the UGRB study area where it is known as the Wakaya Desert, and comprises mainly red Quaternary sand plains overlying Permian and Proterozoic strata which are exposed in the Wunara locale as hills and ridges. The climate is arid tropical with summer rain (ANRA; Duguid *et al*., 2005). Out of the three sub-regions, only one (Tanami 3) is within our study area. Spinifex (*Triodia* spp.) forms the dominant cover for most of this bioregion. The over-

storey varies according to variations in topography and substrate. In the sand plains, soft spinifex (*Triodia pungens*) or curly spinifex (*T. schinzii*) with a tall-sparse shrubland overstorey of acacias is the predominant plant community. Throughout the region snappy gum (*E. leucophloia)* and scattered shrubs grow with the spinifex on rocky hills. There is a general absence of watercourses in the eastern Wakaya Desert but where small creeks do occur, coolibah (*E. microtheca*), bloodwood (*Corymbia* sp.) and tea tree (*Melaleuca* sp.) prevail.

Desert communities in this bioregion are currently in good condition due to little intensive development. Most of interior of the Wakaya Desert has never been subjected to pastoralism. However, fire regimes have changed substantially over the last century due to less Aboriginal management over large areas, leading to broad-scale detriment in many vegetation communities. This has led to floristic changes and/or demographic changes for some plant species in many communities across much of the bioregion (ANRA). Some weeds are also increasing, with at least localised impacts of buffel grass and woody weed *Parkinsonia*. There are no endemic *Eucalyptus* or *Acacia* species in the sub-region 3 of Tanami (ANRA). See Table 4 for a list of dominant species that are at risk to future climatic changes.

Fauna: This bioregion comprises of large desert communities that are little affected by intensive development and are in good condition. Fauna is typical of the arid zone. Termite mounds are abundant on the clayey soils of the palaeodrainage channels. There has been a substantial rate of regional extinction of small and medium sized mammals including western quoll (*Dasyurus geoffroii*), golden bandicoot (*Isoodon auratus*), brush-tailed bettong (*Bettongia penicillata*) and the central rock rat (*Zyzomys pedunculatus*). There is also ongoing decline of other species including the greater bilby (*Macrotis lagotis*), the common brush-tail possum (*Trichosurus vupecula*) and the black-footed rock-wallaby (*Petrogale lateralis*). The night parrot (*Pezoporus occidentalis*) is likely to be extinct and the princess parrot (*Polytelis alexandrae*) has declined in the region (ANRA). Feral predators (foxes, cats) and other factors have caused the regional extinction of 13 mammal species, and the decline of many other mammals (ANRA). The indicator species are; Emu, Australian Bustard, and Jacky Winter (ANRA). Table 5 summaries the species currently at risk in the Tanami sub-region 3 in the UGRB study area. Appendix 4 provides a detailed list of the common avifaunal species in the Tanami region.

5.4 Land systems in the study area

In describing the environment of the study area, a useful set of units is that of land systems. A land system is "*an area or group of areas throughout which there is a recurring pattern of topography, soil and vegetation*" (Christian *et al*., 1954). There are 18 land systems described for the study area (Table 1), which can be divided geomorphologically onto (a) stable Territory land surfaces, (b) erosional land surfaces, and (c) depositional land surfaces (Appendix 4).

5.4.1 Land use groups

Although the 18 land systems in the study area are well differentiated on the basis of their land characteristics, there are factors common to groups of land systems that

have an overruling influence on land use. Such groups of land systems are called as ‘land use groups’. The 18 land systems can be grouped into 5 land use groups (Table 2). In the study region, apart from phosphate exploration, the dominant land use is beef grazing particularly on the better pasture areas or the Barkly Tableland and the valleys of the Georgina River. (Christian *et al.*, 1954.)

Table 1: The 18 land systems in the study area of Upper Georgina River Basin with their differentiating factors, topography, soil, and vegetation.

Land system	Differentiating Factors	Topography and Soil Types	Vegetation
Argadargada	Low rainfall (10 in. per annum)	Gently undulating, Southern Heavy grey pedocals	*Astrebla pectinata* grasslands and *Acacia georginae-Astrebla pectinata* woodlands
Austral	Higher rainfall (15-20 in. per annum) or poorer drainage	Gently undulating, Heavy Grey pedocals and Heavy brown pedocals	*Astrebla pectinata* grasslands and *Acacia georginae-Astrebla pectinata* woodlands
Barkly	Medium rainfall (10-18 in. per annum)	Gently undulating, Heavy Grey pedocals	*Astrebla pectinata* grasslands
Bundella	Coarse-textured alluvia, partly wind resorted	Undulating, 'Bundella' soils	*Eucalyptus argillacea-E. terminalis* shrub woodland
Camil	Uniform non-lateritic soil cover formed during Tertiary weathering cycle	Gently undulating, Tertiary Non-Lateritic soils	*Triodia pungens* grasslands
Camilrock	Limestone outcrop	Gently undulating, Tertiary Non-lateritic soils	Limestone outcrops, *Triodia pungens* shrub grassland
Georgina	Braided stream channels, flooded for short periods	Gently undulating 'black-soil' cut by braided streamlines; Heavy grey pedocals	*Astrebla pectinata* grasslands
Gosse	Coarse-textured, non-calcareous alluvia, short seasonal flooding	Flats, soils of the 'Desert' distributary complex	*Eucalyptus dichromophloia* woodland, *E. prunisoa* or *E. argillacea-E. terminalis* shrub woodland
Kallala	Fine-textured alluvia	Gently undulating 'black soil' plains; heavy brown pedocals	*Astrebla pectinata* grassland or *Acacia georginae-Astrebla pectinata* woodland
Moonah	Fine-and medium-textured alluvia	Gently undulating, mixed 'black-soil' plains and 'red-soil' rises	*Astrebla pectinata* grassland or *Acacia georginae-Astrebla pectinata* woodland and *Acacia georginae* shrub woodland, respectively
Mt. Isa	Lower rainfall (15-20 in. per annum). Parent material steeply folded sedimentary and igneous soil	Heavy brown pedocals and Georgina Alluvial red-brown earths	*Eucalyptus brevifolia* woodlands
Sylvester	Fine-textured, calcareous alluvia, seasonally flooded for long periods	Undulating to low hilly country, skeletal soils. 'Blue bush swamps', Distributary heavy grey pedocals	*Chenopodium auricomum* shrubland
Thorntonia	Lower rainfall (15-20 in. per annum). Parent material highly calcareous	Rough, rounded hills or stepped slopes, skeletal soils and rock outcrops	*Eucalyptus argillacea-E. terminarlis* shrub woodland or *Terminalia* spp. *–Bauhinia cunninghamii-Cochlospermum* sp. shrub woodland
Tobermorey	Lower rainfall or better drainage	Undulating, Limestone calcareous desert soils	*Acacia georginae-Cassia* spp. or *E. terminalis-Cassia* spp. shrub woodland
Waverley	Parent material granitic	Undulating to low hilly country, skeletal soils	*Eucalyptus brevifolia* woodlands
Wonardo	Higher rainfall or poorer drainage	'Black-soil' plains, Heavy grey pedocals or heavy brown pedocals	*Astrebla pectinata* grasslands
Wonorah	Parent material not highly arenaceous, lower rainfall (<17 in. per annum) Lower rainfall (15-20 in. per annum)	Gently undulating, lateritic red earth	*Eucalyptus brevifolia* woodland or *E.* spp. (low mallees)-*Acacia* spp. shrubland
Yelvertoft	Parent material steeply folded or subhorizontal rocks, small alluvial valleys	Hilly to undulating country, skeletal soils or truncated gravelly Lateritic red earths	*Eucalyptus brevifolia* or *E. dichromopholia* woodland

(Source: Christian et al., 1954.)

Table 2: The land use groups in the UGRB and their constituent land systems.

Land Use Group	Land Systems	1. Current Land Uses
i. Mitchell Grass Country	Barkly, Wonardo, Austral, Georgina, Moonah, Argadargada	Beef cattle raising; some sheep for wool
ii. Bluebush Swamp Country	Sylvester	Beef cattle grazing
iii. Hill Country	Mt. Isa, Thorntonia, Yelvertoft	Mining; beef cattle, and no specific use.
iv. Southern Desert Country	Wonorah, Camil, Camilrock, Bundella, Gosse, Tobermorey, Waverley	

(Source: Christian et al., 1954)

It is important to note that these land use categories were made in the early 1950s on the basis of economic criteria relating to the non-Aboriginal use of the land. Aboriginal land use criteria have not been taken into account, such as the distribution of culturally significant resources and sites. Such criteria are an important focus in this report for the UGRB adaptation strategy and will be discussed in a later section.

5.4.2 BioCondition benchmarks

BioCondition has been developed with a biodiversity perspective, as a vegetation condition assessment tool to provide a measure of how well a terrestrial ecosystem is functioning for the maintenance of biodiversity values. It is a site-based, quantitative and repeatable assessment procedure that provides a numeric score that can be summarised as a condition rating of 1, 2, 3 or 4, or functional through to dysfunctional condition for biodiversity (Queensland Herbarium, 2012). *BioCondition benchmarks* aim to reflect the natural variability in structure and floristic composition under a range of climatic and natural disturbance regimes throughout the geographic extent of a region. Benchmarks are quantitative values derived from reference sites for each condition attribute assessed in BioCondition, and are used as a reference value for comparison purposes. In rangeland ecosystems, seasonal conditions account for wide variation in the values obtained for some attributes assessed in BioCondition. Therefore, in these ecosystems a range is expressed instead of a single benchmark value. When using rangeland regional ecosystem benchmarks to assess condition, the lower value of the benchmark range should be used as the benchmark, or if assessing a site under good seasonal conditions then use of the average value should be used as the benchmark (Queensland Herbarium, 2012). Below, we provide two examples of BioCondition benchmarking from Northwest highland (Mount Isa Inlier) bioregion. These examples show that *Eucalyptus leucophloia* (Snappy gum) has a wider distribution as the dominant and sub-dominant species (Appendix 4) relative to *Acacia aneura* (Mulga, Appendix 4). Benchmarking has occurred on the Queensland side of the UGRB region, no details of such have been found on the N.T. side. One of the recommendations for this study is to review and expand these BioCondition benchmarking sites across the UGRB region and monitor throughout the 21st century.

5.5 Important Wetlands and National Parks

Wetlands are important for maintaining biodiversity. The wetlands in the Mitchell Grass Downs are of value for their uniqueness and rare ecosystems. These wetlands are threatened by grazing, changes in hydrology and invasion by exotic weeds, they are being actively managed to minimise these threats and the condition is improving. In the Tanami bioregion, there are many smaller ephemeral wetlands and watercourses (ANRA-a 2009). The typical wetlands of the bioregion are waterholes in the Georgina River system, Bluebush swamps, grassy swamps, and a number of claypans. The rivers of the Georgina system have large waterholes, some of which are semi-permanent. There are two large Coolabah swamps on the edge of the bioregion at or near the boundary with the spinifex dominated sand plains of the Tanami bioregion. One is presumed to fill from overflow of the Rankin River and the other from the Sandover Floodout. The vast flood-prone flats of the lower Sandover River floodout are included in the Mitchell Grass Downs Bioregion (Duguid, 2005). The only national park in the study region is the Camooweal Caves National Park (ANRA-a 2009).

5.6 Natural Environment Summary

The study region of Upper Georgina River Basin consists of both arid and semi-arid vegetation that support habitats for a diverse array of plant and animal species. The wetlands in the area also support unique habitats for both native wildlife and migrating birds. Changes in fire risks and heat are the most important drivers of ecosystem changes in the region with climate change. If rainfall increases, fire risk will greatly increase from greater fuel abundance and connectivity and higher temperatures. For example, on red earth plains in Mount Isa Inlier, whitewood (*Atalaya hemiglauca*), Cloncurry box (*E. leucophylla*) and silver-leaved box (*E. pruinosa*) replace each other sequentially as dominant species on the south-west to north-east gradient of increasing rainfall. If rainfall declines, the boundaries between the zones of dominance can be expected to shift to the north-east. Apart from temperature and rainfall, rising CO_2 levels provide plants with some compensation for declining water availability under climate change. But some plants will benefit more than others, leading to many shifts in vegetation composition and structure (Low 2011). Below, we list the activities that are important to carry out in conserving biodiversity in the Upper Georgian River Basin:

- Effective fire management by re-establishing the fine-scale mosaic burning.
- Resources and capacity building for Indigenous land owners to be more effective in control of fire, weeds and feral animals.
- Monitoring the change in fire scale, frequency, and intensity using satellite imaging.
- Monitor the distributional and population changes of dominant plant species in the area through the establishment of a set of reference ecosystems (eg. Biocondition benchmark sites) sampled across the overall range of ecosystems in the region.
- Maximise the survival of dominant and widespread native species, such as Mitchell grasses to drought.
- Removal of exotic weeds such as buffel grass from conservation areas that fuel intense fires.
- Control of the invasion of woody weeds such as Prickly acacia.

- Conservation of wetlands (eg. bluebush swamp), waterholes, and sinkholes to preserve the unique biodiversity that are associated with them.

6. PART A – ABORIGINAL RISK PERCEPTIONS AND UNDERSTANDINGS

6.1 Climate Change Risk Perceptions, Understandings, and Responses: Catchment Survey Findings

An important component of the project was to examine regional risk perceptions, understandings, and responses to the phenomenon and threat of climate change in the study region. A related objective was to compare and contrast, where possible and useful, the perceptions, understandings and responses of these Upper Georgina River Basin communities with survey findings from two successive national surveys undertaken by a Griffith research team in 2010 (n=3096) and 2011 (n=4347) (Reser, Bradley, Glendon, Ellul and Callaghan, 2012a,b). This required the design of a substantially modified and abbreviated survey instrument and interview protocol which took into account the often very different context, backgrounds, and lifestyles of individuals living in these communities, while also acknowledging the multicultural, including indigenous and majority culture, identities and realities of these communities (e.g., Arnett, 2002; Hong et al., 2007).

There has been a strong international research investment with first nation peoples addressing risk perceptions, understandings, individual and societal responses, and unfolding physical environmental and psychosocial impacts of climate change over the past decade (e.g., Baer 2008; Casimir, 2008; Crate and Nuttall 2009; Ford et al 2010; King, Skipper and Tawhai 2008; Leduc 2010; Leiserowitz and Craciun 2006), with such research on Australian Indigenous perceptions now well underway in many regions of Australia (e.g., Bardsley and Wiseman 2012; Green 2009; Green, Jackson, Morrison 2009; Greene, Niall and Morrison, 2012; Langton et al 2012; McIntyre-Tamwoy, Fuary, and Buhrich 2013; Petheram et al. 2010; Sherrat, Griffith and Robbin 2005). Logical and strategic research questions in the present research included possible regional and cultural differences in risk perceptions, experiences, understandings, concerns, psychological and behavioural adaptation responses, and psychosocial impacts.

Through this systematic approach to understanding Aboriginal risk perceptions and understandings of climate change, this research project makes a significant contribution to the priority research topics outlined in the NARP (Langton *et al*. 2012). For example, this analysis of Aboriginal perceptions of climate change offers unique insights into the ways that such perceptions shape, and are shaped by, the unique Aboriginal people-environment relations of the UGRB. This is an important contribution to understanding how the people of the UGRB map their own risk landscapes, how they understand the vulnerability and resilience of their communities, and how strategies may emerge from an engagement with contextually specific understandings of threats and risks associated with climate change (NARP Priority Research Topics 1, 2, 4, 5, 6). Indeed, our research findings indicate 'epistemic gaps' between globally and nationally oriented climate science research and the perceptions and experiences of Aboriginal people in the UGRB, which are in some way grounded in Aboriginal knowledge of the regional environment and local cultural practices. Thus, engaging directly with the perceptions of Aboriginal people will enable a closing of these

'epistemic' gaps and the development of contextually relevant and culturally grounded adaptation strategies.

6.1.1 Survey Sampling and Procedure

The survey sample included 72 respondents. Previous long-term engagement with Aboriginal people in the study region by members of the UQ research team allowed for an efficient link-up with prospective survey respondents. All communities were advised that the surveys would be taking place, and that they were part of the larger research exercise as set out on the information page in the first workshop. UQ researchers contacted the Jimberalla Housing Coop at Dajarra, the NT Barkly Shire Office at Alpurrurulam, the Dugalandji Camp at Camooweal, and also various Aboriginal community members were contacted in Mt Isa, Urandangi and Wunara. The project was also fully explained at the workshops and through participant information flyers given to each respondent.

After the initial formal consultation between the UQ team and relevant Aboriginal organizations in the study communities, the team relied heavily on Keith Marshall, the local Aboriginal team member. Keith travelled with the other two project researchers when required, liaising with individuals and generally facilitating genuine researcher and respondent communication. Sampling for the survey-based interviews was based on Keith Marshall's social connections in all locations. As Keith is himself Aboriginal his presence ensured that if and when any cross-cultural communication problems arose, he was able to assist if this seemed necessary. In this context, and across virtually all Aboriginal communities in Australia respondents are bicultural Australian Aboriginals, however cross-cultural communication issues can still exist and pose problems in an interview situation such as that undertaken in a region such as the Georgina catchment. The survey sampling conformed to established best practice in such indigenous community circumstances in Australia, favouring individuals seen as having reasonable knowledge, status, and willingness to be involved in such an interview. Also, in Alpurrurulam, Daphne Nash interviewed people from families she knew previously. The survey interviews took place across three time periods during 2012: 16/5/2012 – 22/5/2102 in Dajarra, Urandangi, Alpurrurulam (Lake Nash) and Camooweal (JD and DN); 1/8/2102 – 3/8/2102 in Mt Isa (DN); and 17/92012-18/9/2102 in Camooweal (JD).

Two members of the research team with disciplinary expertise in anthropology and architecture, and extensive cross-cultural fieldwork experience, conducted the interviews and themselves completed the survey protocol for respondents, in part to standardize the procedure. It could be argued (as one reviewer of this document did) that the instrument is not perhaps the most appropriate way of surveying a diverse range of people with at least some people with Aboriginal language/s as their first language. However, a judgment call was made in the field with respect to having the hard copy survey completed by the researcher, given the language/communication issues for some respondents, the presence of an interpreter/facilitator in many circumstances, taking into account the ease of the respondent, and to standardise the procedure. This is often standard practice for face-to-face interviews, and happens automatically in the case of telephone surveys. The survey instrument in this case becomes the semi-structured interview protocol. It must also be remembered that an

important objective of this component of the research was to compare and contrast Aboriginal survey responses from this area with national survey findings; hence a reasonable approximation of the procedure used in the national survey was required. It is also the case that such semi-structured survey interviews are a very standard procedure used across Australia in indigenous communities, are prerequisite when needing sensitive quantitative measures of change over time for psychological parameters, and such surveys and rating scales have been used very effectively in remote communities as well as country town and urban situations for at least the past four decades.

The 72 individuals who completed the survey included 41 male respondents and 31 female respondents. Three of these (2 male and 1 female) were non-Aboriginal people who had long-term experience of living close to the land; their responses have been included in the analysed data. Respondents were aged from 17 to 81, with a mean age of 52. The sampling procedure, reflecting knowledge and status as well as availability, clearly influenced the age range, with 11 individuals being 70 or older, and 45% of respondents being 50 or older. Only nine respondents were under the age of 30. Hence the age profile of this sample is very different from the age profile of the indigenous population of remote northern Australian communities generally, which is much younger than the Australian national demographic profile. Sixteen respondents indicated that they were employed, six indicated they were not employed, and employment data was not provided or recorded for 18 respondents. Twenty-four respondents reported completing schooling at various stages between grades one through six; 14 respondents completed their schooling across grades seven and eight; and 26 respondents reported completing one or more years of high school. The number of individuals who were asked but declined to participate in the survey was minimal as most participants were approached by a member of their community with whom they knew and trusted. The $30 cash payment for interview was also a significant incentive.

The survey findings reported, and any comparisons made, require a number of important caveats. Obviously the Upper Georgina River Basin region and such geographic and cultural contexts in general are very different from the typical contexts, residential circumstances, backgrounds, and lifestyles of most of the above-mentioned national survey respondents, who were all members of a survey provider ‘panel’, and who complete such surveys, on-line, three or four times a year (e.g., Reser et al. 2012a; Yaeger et al. 2011). As well it is probable that the survey format and language issues would have provided more of a challenge for some indigenous respondents to the survey than was the case for the national survey respondents. The survey protocol employed was also different from the national survey instrument in being far briefer and in the use of less formal wording in some instances, though an attempt was made to keep the nature, wording, and sequencing of survey items as close to that of the national survey as was practicable and possible given the context in which the survey was administered. There was no apparent evidence of particular response biases in the face-to-face administration of the survey, either with respect to extreme ratings or acquiescent response styles (e.g., Berry et al. 2011; Davis, Resnicow and Couper 2011), and the respondent sample was very heterogenous with respect to bicultural backgrounds and life experience as indigenous Australians. Finally, the procedure

followed, with the interviewer effectively completing the survey instrument for the respondent, meant that this was a further and important difference in the administration of the survey, along with the face-to-face situation, as contrasted with the on-line nature of the national surveys. Notwithstanding these differences, comparisons are arguably reasonable and defensible, and indeed the many striking similarities found suggest that overall comparisons with national survey results are reasonably robust and meaningful.

Appendix 1 provides all survey/interview items and proportional frequency data for all quantitative response data collected. Appendix 2 provides all responses given for each open-ended survey question, with more extended responses abbreviated for qualitative response items. The section which follows reports and discusses both the quantitative and qualitative findings from our survey instrument.

6.2 Survey Findings

The 'climate and weather' component of the survey/interview commenced at survey item #12 (see Appendix 3), with respondents asked to describe the "the weather and climate patterns in this area over the past year." When then asked *"Have you seen changes to these weather patterns over the past ten years or so as compared to earlier years?"* (#13), 42%[3] of respondents agreed that they had seen changes, 7% replied no, and 51% of interviewed individuals provided no clear response to this question. Hence 29 out of 40, or 73% of individuals who answered this question reported seeing or experiencing noteworthy changes. A view expressed by several individuals in the Georgina community during the research was that 'climate change' was basically a somewhat silly whitefella story. Yet, as with the national survey findings, while 6 to 7% of the population might be considered genuine skeptics with respect to the reality of climate change, these views did not dissuade most respondents from accepting that climate change was happening, and a matter of appreciable concern. Over the period of the research it also became clear that at least several of those individuals expressing the 'just gammin' view were actually quite accepting of the fact that climate change was taking place.

Item #14 asked: *"How has it changed?"* The types of changes mentioned included general seasonal pattern changes, variability and unpredictability (8 responses, 15%); temperature changes, typically hotter (26 responses, 48%); rain patterns, amounts, and type of rain changes (10 responses, 19%); more dust storms (3 responses, 6%); general affirmations of change (4 responses, 7%); and some statements of no real change (3 responses, 6%). Table 1, Appendix 1 provides a full listing of responses to this initial question concerning climate change.

Item #15 asked for extent of agreement with a series of five statements regarding unusual weather events, and changes in weather patterns (see Appendix 2). There was strong agreement that: there are more unusual weather events these days (76%);

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[3] All percentage figures are based on the number of respondents out of 72 survey participants who completed extent of agreement or other rating scales. Because many items have high missing data counts, percentage figures are often very conservative.

that many people are saying that the weather is changing around the world (81%), and that respondents had experienced changing weather patterns over their lifetime (82%). There was also fairly strong *disagreement* with the statement that there are things people can do to fix changing weather patterns (54%).

Similarly, item #16 asked for extent of agreement with eight statements relating to weather and climate perceptions, and the judged likelihood and effectiveness of government, scientist, and community responses. Very substantial majorities of respondents either 'strongly agreed' or 'agreed' that *"Climate change is happening"* (75%) and that "The weather is getting harder to predict these days" (75%). Only 19% of respondents either 'strongly agreed' or 'agreed' that "The idea of climate change is gammin [false/pretend] and talked up too much," and 47% of respondents either 'strongly disagreed' or 'disagreed' with this statement. Clearly the occasionally heard observation that Aboriginal people in regions like this are dismissive of climate change is not true for this region. Responses to the statement that "Things like the moon landing might well be causing these weather changes", a statement that 33% of respondents either 'disagreed' or 'strongly disagreed' with, suggest rather mixed views with respect to causes of climate change, with this supported by the 31% of respondents who chose 'No idea/Don't know". Extent of agreement/disagreement with statements respecting likely government, scientist, and community responses to climate change are interesting, with over twice as many respondents disagreeing rather than agreeing with statements that the government or scientists would "take action" or "fix the problem before it becomes too bad". Yet respondent confidence that people in the community would help each other out in an emergency weather situation was very high, at 85%.

Item #17 was a qualitative item which explored respondents' explanations and accounts of why changes in weather patterns and extreme events were happening. A listing of individual explanations and accounts is provided in Table 2, Appendix 3. Content analysis and coding of these responses indicates that the most frequent explanation related to population growth, associated greenhouse gases, and pollution (11 such responses, 20%). The next most frequent explanation related to natural cycles and variability, and 'mother nature' (5 such responses, 9%). A number of types of accounts competed for the next most frequent explanations offered. These were: human and scientific interference, with several references to satellites (3 such responses); the absence of traditional Aboriginal rainmakers who controlled and managed the weather (3); an anthropomorphised and negative macrosystem feedback in the face of human actions and culpability (4); and global warming (3). These responses overall suggest that there exist some very different and distinctive causal accounts for perceived changing weather patterns in the Georgina River catchment region, and little real consensus, at least as reflected by these provided explanations. Responses also suggest that the topic of climate change is salient, and a matter of public concern, interest, and discussion.

It is interesting that five respondents specifically mentioned 'mother nature', 'mother earth', and 'nature', and several of these individuals and other respondents intimated at a Gaia-type feedback or punishment (e.g., Lovelock 2006) for damaging or interfering with natural systems. This could be seen as reflecting both indigenous and majority

culture notions of an anthropomorphized and conscious earth system retributive feedback (e.g., Rose, 1996; Tamisari, 1998; Veland et al. 2013). The repeated reference to 'pollution' was also of note in that this also suggests both a hybrid risk domain with respect to causes involving both human technology and natural system factors (e.g., Baum, Fleming, and Davidson 1983; Edelstein, 2002; Haque and Etkin 2007), and culpable human agency and irresponsibility. Finally three respondents specifically mentioned 'global warming' in response to this question, though no one mentioned 'climate change'; and repeated oblique reference to carbon emissions and 'pollution' suggested a clear and underlying greenhouse gas emission narrative for many in the context of this particular question.

Survey items #18 and #19 frame the explanation and causal attribution question somewhat differently, in an attempt to capture the likely narrative nature of circulating explanations and accounts with respect to perceived weather and climate changes. *"Are there stories going round about what might be causing these weather and season changes?" "What are these stories?"* These questions were not directly answered or addressed by most respondents, but of the 24 individuals who provide a response to item #18, 10 said there were such stories, and 14 respondents indicated that they had not heard of these. Similarly, only 18 respondents provided an answer to the question at #19, *"What are these stories?"* and of these, eight responses simply stated in various ways that there either were not such stories, or that the respondent was unaware of them. The 10 provided 'stories' are interesting and diverse, again implicating the absence of the 'human' and traditional climate management provided by traditional Aboriginal rainmakers (4 such accounts), reference to the simple reality that things were changing, further reference to the hole in the ozone layer mentioned in responses to #17 (an erroneous notion) and suspicions with respect to science and satellites, and a government cover-up. Responses are found in Appendix 2.

> *People have to look after the country. Can't expect government to fix. I blame the rockets and all these things, satellites, circling the air. Gotta do something to the weather.*

An important aspect of public risk perceptions and understandings relating to environmental events and changes are causal attributions and explanatory accounts of why the threat exists or the change is happening (e.g., Hilton 2007; Morris, Nisbett and Peng 1995). Such causal accounts also reflect aspects of natural versus human agency, accountability, the possibility of human corrective mitigation, etc. (e.g., Miller 1984; Reser et al, 2012a). Item #17 asked respondents *"Why do you think these changes in weather patterns and extreme weather events are happening?"* Appendix 1 presents these 56 responses, which included 78% of respondents, suggesting that this was a salient question, but not easy to answer. Indeed a number of responses did not really constitute explanations or accounts.

It is important to stress that it is not just that these local understandings and causal explanations of 'climate change' are different from more general popular culture or popular climate change science understandings and causal explanations, but that the meaning and compass of the term 'climate change' itself as a phenomenon and threat is different. Hence it is not surprising that in this regional and cultural context of the

Upper Georgina Basin, public understandings (i.e., collective individual understandings) of climate change' might be rather different from public understandings elsewhere in Australia, both in indigenous communities and in mainstream, but invariably culturally mixed, communities. Hence a survey or interview question relating to climate change can elicit a response with respect to local meanings, with a local explanation or account provided. What is too often overlooked is that popular culture understandings and explanations of climate change are not simply flawed or limited understandings and accounts. They often constitute and reflect *very different* but quite genuine understandings of what is being asked about. While the present research and that of others have gone to some length to word questions in alternative ways to convey a focus on unusual environmental changes or events which *might* be deemed as instances or manifestations of climate change (e.g., Petheram et al. 2010; Reser et al., 2012a,b), there are inevitably communication challenges relating to the language that is used to talk about a designated phenomenon such as 'climate change'. In the Upper Georgina Basin region and in other cross-cultural research contexts in Australia it was nonetheless clear that the questions were about often strange or noteworthy events or changes related to the weather, climate, and seasons, and plant and animal species, with the meaning and referent for 'climate change' being an implicit and parallel question and matter of investigation.

Item #20 again consisted of five statements with which respondents indicated their extent of agreement or disagreement. Together these items constitute a measure or scale of *self-efficacy* in the context of climate change. An important construct and research variable in much social science research addressing public perceptions and responses to climate change has been the issue of human agency with respect to the perceived causes of climate change, i.e., 'anthropogenic forcing', and felt efficacy and perceived control with respect to what can be done (e.g., Bandura, 1997, 2006; Heine, 2007; Reser et al., 2012a,c). Across these five items one finds moderate levels of perceived self-efficacy and control (Appendix 1). Responses to the initial three items, which relate more directly to human control and influence over climate change itself, suggest that most respondents do not feel that there is very much that they can do, although there are strong differences of view. While 26% of respondents, for example, either 'strongly agreed' or 'agreed' that they could personally help to reduce climate change by changing their behaviour, twice that many respondents, 53%, either 'disagreed' or 'strongly disagreed'. Similarly only 17% of respondents disagreed with the statement, *"It is hard to take action against climate change even if I wanted to"*, while 65% of respondents 'strongly agreed' or 'agreed'. A third statement which could be seen to include reference to one's own carbon footprint, *"I believe my actions have an influence on climate change",* received levels of agreement and disagreement more evenly divided, though more individuals disagreed than agreed. When the items were more focused on what individuals could do to manage their own feelings and influence others, the pattern was quite different. Respondents provided very high self-efficacy responses to emotional self-regulation through their actions, and were evenly split among themselves as regards their felt ability to influence the behaviour of others through their own actions.

Item #21 consisted of four statements with which respondents could indicate their extent of agreement or disagreement, all of which related to possible *psychological* adaptation and adjustment to climate change. This construct and set of intra-individual psychological adaptation processes refers to the extent to which individuals are changing how they are thinking and feeling about climate change, and to their more general psychological adjustments *to* and possible psychological impacts *of* the threat of climate change. It is a shortened version of a new Psychological Adaptation to Climate Change scale used in previously mentioned national surveys (Reser et al. 2012a,b).

Perhaps the most sensitive of these item statements was the initial statement, *"Because of climate change, I have changed the way I think about the seriousness of environmental problems."* It is noteworthy that 57% of respondents either 'strongly agreed' or 'agreed' with this statement, while only 15% disagreed. It is interesting, though perhaps not surprising, that in response to the statement, *"Because of the increasingly evident impacts of climate change, I have seriously thought about alternative places to live",* 65% of respondents disagreed. The connection to own country and community is very powerful in Aboriginal contexts throughout Australia, and leaving is not a climate change adaptation strategy that most individuals would consider. But it is particularly noteworthy and arguably less expected that the corresponding disagreement figure for national, non-indigenous, survey respondents was 79%. It is interesting that 43% of UGRB respondents agreed with the statement *"I have often discussed my thoughts and feelings about climate change with others over the past several years."* Quite apart from the suggestive evidence that appreciable psychological adaptation and adjustment is taking place in Aboriginal community contexts, this finding does suggest that climate change is a not an uncommon topic of conversation in this region, and a probable source of some concern.

It is noteworthy that the terminology used by respondents in interviews was predominantly that of 'global warming' which suggests that many have been monitoring what the international media and particularly North American news is saying about climate changes, as global warming is the preferred phrase in North America. Finally it is interesting that the last statement in this section, *"When considering the challenges of climate change it is important to look for things that I can address and change in my everyday life,"* elicited substantial agreement, 45%, whereas disagreement was very modest, at 15%. Again, overall, and as was the case in related national survey findings, there would appear to be substantial and genuine psychological engagement with, and on-going adaptation to, the threat and environmental changes and impacts of climate change in these communities.

Item #22 constitutes a conventional self-report question relating to how much respondents feel they actually know about climate change. See Appendix 2. Only 8% of respondents indicated that they felt they knew 'a lot' about climate change, and over two thirds of respondents felt they knew 'very little'. An important caveat, however, is that such self-reported or subjective knowledge tends to have only a very modest relationship with actual, objective knowledge (e.g., Reser et al. 2012a,b; Roser-Renouf and Nisbet 2008), and many respondents are no doubt more objectively knowledgeable about local region, climate and weather, and perceived changes and

impacts, than these survey responses might suggest. However, taking other survey responses into account, it does seem to be clear that climate change is a subject and phenomenon about which Aboriginal respondents in this region are fairly uncertain about with respect to its *nature* and *causes*, though there appears to be less uncertainty about its *reality* and unfolding *impacts*.

The initial two survey statements at item 23 addressed the question of whether the phenomenon of psychological distancing or farsightedness in the context of the threat of climate change was evident in the communities being surveyed (Spence, Poortinga and Pidgeon 2012; Uzzell 2000; Weber 2006). Essentially this selective perceptual bias respecting local/global phenomena relates to whether the threat and problem of climate change is more accurately accepted and acknowledged as a distant and global phenomenon, but not seen as a salient local threat or issue (e.g., Uzzell 2000, 2004). The results suggest that respondents, on the whole, did see climate change as more of an issue for other more distant regions and countries than it was for their own local region. Nonetheless just over 25% of respondents clearly disagreed that this was the case. There are a number of plausible explanations for this general finding, with a cogent possibility relating to dramatic international coverage of how climate change has been impacting other countries and, in particular, indigenous groups in northern polar regions and elsewhere in the world.

The third and fourth statements at item #23 related to the *personal importance* of climate change as an issue and concern, and whether or not climate change was seen as conferring some potential advantages to Aboriginal communities such as those in the region of research focus. The finding that 68% of respondents agreed that *"Climate change and its effects are important to me,"* again suggests that this is an important issue and concern worth monitoring and of substantial adaptation and psychological impact significance. Such perceived and personal issue importance is considered to be one of the strongest and most reliable predictors of many other psychological responses, including concern, distress, and behavioural engagement (e.g., Krosnick, Holbrook and Viser, 2000; Reser et al. 2012a,b). The matter of whether climate change might bring with it some economic advantage and prosperity for communities such as those being investigated is arguably salient here, and perhaps reflects recent discussions in Aboriginal communities about what they might stand to achieve by way of some financial gains with respect to carbon capture and storage credits. In any case the fact that 38% of respondents agreed with the statement that *"Climate change will create new jobs for people in the region"* as compared with 18% who disagreed suggests that the implications of climate change, as understood, by survey respondents, were not all bleak.

Item #24 addressed the cumulative experience of survey respondents with natural disaster events. As an important research focus in the national surveys undertaken prior to this current research concerned perceived interrelationships between natural disasters and climate change, as risk domains and environmental threats and impacts (e.g., Reser et al. 2012a,b), it was judged important to examine Aboriginal perceptions of extreme weather events, given that extreme weather events and natural disaster implications are common topics of conversation and consideration in mainstream Australia media coverage and scientific reporting about climate change. Our survey

findings and field work suggest that a substantial proportion of catchment area residents do in fact follow media reports and discussions concerning climate change so these information channels are important, though less so in those communities where many households may not have working television sets and radios. There is ample and very strong evidence that 'first hand' conversations and community discussions in these communities are nonetheless very important to individual and collective sense making with respect to a phenomenon like climate change. However, it is clear that most respondents do not feel that they actually know very much about climate change, and some kind of community forum through a local radio station or community centre or school projects might promote interest in and self confidence about one's own understanding and knowledge about climate change.

In response to the question *"Have you ever experienced a natural disaster warning or natural disaster impact situation?"* (# 24), 54% of respondents indicated that they had personally experienced such an event or events. Item #25 asked respondents to indicate the types of natural disaster events they had direct experience of, and the number of times they had experienced each type of event (See Appendix 1). Clearly natural disaster events are a familiar part of many individuals' lives in this interior region, with an average of 38% of respondents having experienced one or more of each of the provided events at least five times or more. While there is a question of what constitutes a 'natural disaster' in some more traditionally oriented Australian Indigenous communities (e.g., Reser 2011), in this Upper Georgina River Basin region it would appear that 'natural disaster' was understood in a reasonably conventional way, in the context of the survey situation and the questions asked. With respect to the broader range of extreme weather events which respondents reported as being more or less common, at item #26, it is clear that severe rainstorms, cyclones, and water scarcity were appreciably lower in incidence in the research area than dust storms, floods, drought, heat waves, and bushfires.

Many of the open-ended responses to interview questions #s 17, 19, 23, 27 (see Appendix 2) were very thoughtful and informed regarding environmental conditions elsewhere in Australia and the world generally. This was particularly the case in responses to the statements in item 23, for example, regarding views on weather changes. This suggests that that there has been considerable discussion of possibly changing climate regimes and their implications, though it would seem that the Georgina Basin region was being viewed as reasonably different and distinct.

The open-ended question 30, *"If things have changed, what do you think caused it to happen?"* immediately follows specific provided response questions about changing weather events and extreme weather event experience. In this second substantive question about possible causes for changing weather patterns, it was again clear that most respondents could not offer very clear or coherent answers, with most responses being simply a statement of 'not knowing' or a statement that these weather changes were having particular consequences. Actual causal statements and attributions were rather different from each other, with no categories of causes attracting more than one or two entries. For example, two individuals simply stated that the changing and now more erratic and extreme nature of weather patterns were causing the changing weather being experienced. Several individuals stated that the increased and now

extensive grass growth was reducing the frequency of dust storms. Several other individuals mentioned that the fuel provided by the abundance of grass was leading to more frequent and serious bushfires. One individual mentioned 'global warming' and one mentioned 'climate change'. A third individual provided a local way of framing the carbon emission explanation: "Electricity, gas, fuel. Mining putting chemicals into the atmosphere". So, while it would appear that there is a clear community recognition and general consensus that weather patterns are changing, it would be fair to say that the majority of respondents were not able to provide clear or coherent reasons why this might be happening. However many were able to offer quite logical and insightful reasons for why particular changes and events were interrelated, e.g., "late storms, so late bushfires". As well, some explanations were simply not correct with respect to climate change science accounts, e.g., "ozone layer being polluted".

Item #31 addressed perceived causes, worries and concerns about changing weather patterns and their implications for this region. Respondents were asked to indicate the extent of their agreement with the first three statements (See Appendix 1). The first two of these related to possible cultural explanations and filters when considering climate change, and hence relate to above matters of causal explanation and accounts. *"Weather changes are caused by Dreamings going the wrong way, because people are not following the Law." "Weather changes are caused by Aboriginal people not looking after country properly."* Extent of agreement and disagreement with the initial statement was mixed, with 29% of respondents indicating 'strong agreement' or 'agreement', whereas 33% of respondents 'disagreed' or 'strongly disagreed'. Agreement was much stronger in the case of the second statement, 40% agreement versus 17% disagreement, with this causal account being a common narrative line and moral theme. The third statement might best be regarded as a statement of exposure and vulnerability with respect to the Upper Georgina River Basin, *"My country will be affected by weather changes."* It is noteworthy that 68% of respondents either 'strongly agreed' or 'agreed' with this statement, while 20% 'disagreed' or 'strongly disagreed', again suggesting both strong majority acceptance and concern.

6.3 Direct Comparisons with Australian National Survey Findings for 2010 and 2011

As the final form and content of the survey instrument emerged in the initial stages of the research, based in part on preliminary field work, a number of more directly comparable survey items were deleted, reflecting the stronger ecological, natural resource management focus of the research, and more general weather, climate and landscape change considerations. However, a number of directly comparable items were retained, as an important research objective was to ascertain whether and how the risk perceptions, understandings, and responses to climate change of Indigenous Australians in a region such as the Georgina Basin might differ from mainstream Australia. As well, on-going research across the world with indigenous communities would suggest that some of the most important parameters relating to climate change adaptation have to do with changes and impacts taking place in the human landscape, i.e., changing psychological, social, and cultural adjustments to not only the manifestations and threat of climate change per se, but to multiple other, and often chronic, environmental stressors, including the nature, magnitude, and pace of regional

and global change itself (e.g., Evans and Stecker 2004; Furberg, Evengard and Nilsson 2011; McDowell and Hess, 2012; Reser and Swim, 2011). Hence the research and survey attempted to address the changing nature of risk perceptions, understandings and responses to climate change and other, often associated, environmental, climate, and extreme weather event changes in this inland region of Australia.

The initial and most directly comparable item was #16A, seeking extent of agreement with the statement that "Climate change is happening". Seventy-five percent of respondents 'agreed' with this statement, with 28% 'strongly agreeing'. National survey findings for 2011 (n= 4347, Reser et al., 2012b) found that 74% of respondents agreed that climate change was happening, with 69% either strongly agreeing or tending to agree with the statement, "I am certain that climate change is really happening." Hence these respective findings for belief in or acceptance of climate change are virtually identical, though certainty is clearly less in the Georgina region, based on responses to other questions. Nonetheless, when presented with the statement "The idea of climate change is gammin and talked up too much", #16D, 19% of respondents agreed with this statement, though no respondents 'strongly' agreed, 14% neither agreed or disagreed, 47% disagreed and 13 chose 'No idea/Don't know'. Given that a few local spokespersons at times suggested that climate change was a dubious 'whitefella' story, these are, again, strong findings of general acceptance of climate change. This surface scepticism but deeper uncertainty and concern appears to be reasonably widespread in Aboriginal communities (e.g., Veland et al. 2013).

The second most directly comparable finding relates to the perceived causal relationship between climate change and local weather and climate changes. Respondents were asked to indicate their extent of agreement with the statement "Climate change is partly causing these changes in weather patterns and uncertainty and making it harder to predict the weather" (#16C). Sixty percent of respondents either 'strongly agreed' or 'agreed' with this statement. National survey findings for 2011, in response to the question, "Overall, how much do you think that climate change is influencing the frequency and intensity of weather events like storms and droughts?" found that 68% of respondents answered 'a good deal' or 'substantially'. Again, these Georgina Basin and national responses are arguably quite similar, making allowances for the different item framings and response formats. It is clear from our findings that general understandings of 'climate change' were somewhat different in this regional and Aboriginal cultural context; however a number of respondents were actually quite knowledgeable about popular science explanations and current media and documentary coverage of climate change.

A directly comparable set of interview items related to self-efficacy in the context of climate change, #20A-E. These items comprise a scale which has been used internationally in climate change survey research (e.g., Kellstedt et al., 2008). See Appendix 1. The proportions of Georgina Basin respondents agreeing with items such as "I can personally help to reduce climate change by changing my behaviour" (#20A), were 26% (A), 29% (C), 43% (D), and 33% (E), suggesting moderate self efficacy. In response to the negatively framed item in this series, "It is hard to take action against climate change even if I wanted to" (B), 65% of respondents agreed. It must be noted that with respect to these items, fairly high percentages of respondents either chose

'No idea/Don't know' or did not provide a response: A, 15%, B, 11%, C, 21%, D, 38%, E, 29%, reflecting both difficulties with the structured format of the questions and response options, and the possible difficulty of the particular items. The direct comparisons across these items for Georgina Basin residents and the 2010 national sample were: 26% versus 65% (A), 65% versus 36% (B), 29% versus 36% (C), 43% versus 43% (D), and 33% versus 27% (E). Clearly self efficacy in the face of climate change appeared to be lower for respondents in this region, particularly considering comparative agreements with statements A and B. In addition to the lower overall response rate for these items, it must be noted that there are substantial differences across domains of perceived control, locus of control, and self-efficacy across cultures (e.g., Choi, Nisbett and Norenzayan, 1999; Rothbaum, Weisz and Snyder, 1982; Weisz, Rothbaum and Blackburn, 1984), and it has been generally argued that Australian Indigenous culture is characterised by lower individual perceived control but arguably high collective and ritual locus of control and efficacy (e.g., Reser, 1979, 1991).

Given the bicultural character of contemporary indigenous communities in regions such as the study area, such generalities with respect to factors underlying felt self-efficacy, particularly in the face of climate change, must be treated with caution. Nonetheless a substantive finding, supported by qualitative interview comments, and with practical and strategic implications regarding adaptation to climate change, is that Georgina Basin respondents do appear to be experiencing less efficacy with respect to being able to effectively address the threat and environmental changes associated with climate change. It is noteworthy than a number of survey participants made independent reference to the absence of traditional 'rainmakers', who were seen as having considerable knowledge and power to effectively control and modulate climate and weather events, suggesting a different cultural take on efficacy and perceived control, but now lost traditional environmental/ecological knowledge, in the context of climate change and extreme weather events (e.g. Atran and Medin, 2008; Berkes, 2008; Ellen, Parkes and Bicker, 2000; Smith and Sharp, 2012). It is interesting that in many still tradition-strong indigenous communities, such as the Inuit and Maori, the problem is not that traditional knowledge is lost, but that it is no longer useful or reliable, as the rate of environmental change is so great (e.g., King et al., 2008; Krupnik and Jolly, 2002; Leduc, 2010).

An arguably central construct and set of items allowing for direct comparison is that of *psychological* adaptation to climate change, #21A-D. These items were selected from a newly developed psychological adaptation scale employed in the Griffith national surveys (e.g. Reser et al. 2012a,b), and particularly focuses on self-reported changes in how individuals think and feel about the phenomenon and risk domain of climate change. (See Appendix 1). The proportions of Georgina Basin respondents agreeing with items such as "Because of climate change, I have changed the way I think about the seriousness of environmental problems" (#21A), were 57% (A), 14% (B), 43 % (C), and 45% (D). These responses would suggest moderate levels of psychological adaptation to climate change, again noting that the framing of the survey items and response options may have led to underreporting. On average, just over 20% of respondents either indicated 'No idea/Don't know' or did not provide a response. Corresponding figures across the three virtually identical items from the 2010 national

survey were 31% versus 57% (A), 33% versus 43% (C), and 49% versus 45% (D). These results would clearly suggest that the Georgina Basin community is changing their thinking, emotional responses, and general views, risk perceptions, and understandings to climate change, though perhaps somewhat less so, currently, than the larger Australian community

With respect to knowledge of climate change, the Georgina survey included a measure of self-reported knowledge, i.e., subjective knowledge as distinct from objectively assessed knowledge, #22. International survey findings, along with Griffith survey findings (Roser-Renouf and Nisbet, 2008; Reser et al., 2012a), indicate very low correlations between subjective knowledge and actual objective knowledge about more popularised climate changes science. In the case of Australian findings this was r =+.12 (Reser et al, 2012b). Nonetheless this measure of self-reported knowledge says something about community member confidence in their knowledge and understanding of climate change and its implications. When asked: "How much do you feel you know about climate change?" responses were telling. See Table 3 below. While 37% of the national sample indicated that they knew 'a lot', or a reasonable amount, about climate change, only 8% of Georgina Basin residents were prepared to claim this degree of knowledge. And whereas only 9% of the national sample selected the last two categories, 47% of the Georgina region sample selected these latter response options, indicating very little or no knowledge about climate change. Qualitative responses by Georgina residents would indicate that objective knowledge might well be higher than these self-report figures indicate. Paradoxically national survey respondents clearly tended to overestimate their actual objective knowledge, especially men, whereas a different situation may have obtained for the Georgina sample, perhaps buttressed by the fact that 'climate change' appeared to be a construct and domain with less clear meaning and boundaries than for non-indigenous respondents.

Table 3: Comparison of self-reported knowledge levels about climate change between Upper Georgina River Basin and National respondents. (Source: AERC)

Q22. How much do you feel you know about climate change?

			Georgia Basin Respondents (N=69	National Survey Respondents (n=4347)
6	100%	A lot	4.2%	11.1%
5	80%		4.2%	25.5%
4	60%		20.8%	35.8%
3	40%		18.1%	18.3%
2	20%		30.6%	7.4%
1	0%	Nothing	16.7%	1.9%

These findings would appear to underscore a very substantial difference between these Georgina Basin community respondents and the Australian public in general. Namely, two- thirds of Georgina Basin respondents felt they knew '*very little'* about climate change, whereas almost three quarters (72%) of national survey respondents felt that they knew '*a substantial amount*' about climate change. It would be interesting

to know how Georgina catchment individuals might have scored on the objective knowledge quiz utilised in the national survey research, however the nature and content of the quiz might well have missed the very real objective knowledge that individuals in this region have of the local changes associated with climate change. But widespread acceptance of climate change, and genuine concern about it, exist with a very strong sense on the part of residents that they actually know very little about this new phenomenon and threat and what it might actually mean. This situation finds supporting evidence in the kinds of responses that participants gave with respect to perceived causes of climate change, and a more general sense of powerlessness with respect to taking adaptive action to address climate change. Clearly this is not an ideal situation, but one which identifies clear courses of action with respect to the need for strategic public engagement in this region, both to reduce this epistemic and sense-making uncertainty, and to provide culturally and locally coherent, respectful, and meaningful information about western science understandings with respect to climate change.

In considering responses to survey item #23, it was clear that the majority of Georgina Basin respondents did see the threat of climate change to be considerably worse for more distant regions and peoples than themselves, evidencing a degree of farsightedness or psychological distancing. But this was very different from national survey findings. Item #23A was identical to that completed by national survey respondents in 2010 and 2011. Respondents were asked to agree or disagree with the statement, “Changes in weather will mostly affect places that are far away from here.” While 44% of Georgina Basin respondents agreed with this statement, only 8% of national survey respondents in 2011 agreed with this statement. This is a dramatic difference, reflected in this and other items. For example 51% of Georgina catchment respondents agreed with the statement that “Changes in weather will affect other parts of Australia more than where I live.” While this latter statement is not directly comparable to national survey items, it is very clear that the Australian public as a whole appears to be much less susceptible to this protective distancing of the threat phenomenon, than is the case for respondents to the present survey. This is a concern.

Item #24 asked respondents whether they had ever experienced a natural disaster warning or impact situation. 54% of respondents answered ‘yes’. An identical survey question was used in the 2010 national survey, with 37% of respondents indicating that they had had such a personal experience. When asked, in each of these respective surveys, how often it was that respondents had experienced each of specified natural disaster events (e.g., cyclone, bushfire, drought, flood – and dust storms and heatwaves in the Georgina Basin survey), it became clear that Indigenous residents in the present survey reported far greater experience of all natural disaster events, with the exception of cyclones, with close to 40% of Georgina Basin respondents having experienced each of these extreme weather events other than cyclones. Hence natural disasters and extreme weather events are a familiar part of many respondents’ experience, and more so than for the Australian populace as a whole. A somewhat unresolved question is whether this exposure and experience has influenced risk perceptions and responses to the threat of climate change.

One of the most important indicators with respect to environmental risk perceptions and responses to environmental threat is that of *environmental concern(s),* both for oneself and others, and for the natural environment (e.g., Reser and Bentrupperbäumer, 2005, 2008; Schultz, 2001). The construct of concern can be distinguished from risk perception, as concern, notionally and conceptually, relates more to one's *psychological response* to a *personal appraisal* of the nature and magnitude of, and personal exposure to, a risk or threat. Environmental concern is also an often-used proxy measure for environmental values. While multiple concern items were employed in the 2010 and 2011 national surveys, none of these identical items were used in the present survey. Nonetheless a number of items both directly and indirectly examined level of concern, though framed in terms of 'worry', a more meaningful local term and synonym for concern, for example, items #31-34, 36, and 48. In 2011, just under two-thirds (64%) of national survey respondents reported being 'very' or 'fairly' concerned about climate change, 76% of respondents judged that "if nothing was done to reduce climate change" it would be a 'very serious' or 'somewhat serious' problem for the world, and two-thirds of respondents thought that climate change was a serious problem 'right now' (Reser et. al. 2012b). It is interesting that across the ten areas of worry relating to climate change in item #36 of the Georgina Basin survey, including concerns for people as well as for the natural environment, 60% of respondents, on average, indicated that they were worried. This is very close to the national survey results for climate change concern in 2010 and 2011.

One of the most dramatic findings in the Griffith national surveys was that 45% of respondents in both 2010 and 2011 reported having direct personal experience of environmental changes or events which they deemed likely due to climate change. In the current Georgina Basin survey, #54A constituted a very similar item. Respondents were asked to indicate their extent of agreement with the statement, "I have had direct experience with climate change." Forty-two percent of respondents agreed with this statement. This is very close to the national survey finding. It is again important to note that for 14% of respondents, the response selected was either No idea/Don't know' or no response was given. These responses are important as they make a strong albeit indirect statement about acceptance and belief, and they are important as such perceived direct experience was powerfully and positively associated with all core psychological measures in the Griffith research. This again is a salient example of where the findings for the Georgina Basin sample are in fact very similar to national findings overall.[4]

6.4 Summary: Risk Perceptions, Understandings, and Responses

While the past decade has seen an increasing focus on the use of national surveys to examine changing public perceptions, understandings and responses to global climate change (e.g., Brechin, 2010; Brechin and Bhandari, 2011; Nisbet and Myers, 2007), rarely do such surveys include indigenous groups (e.g., Leiserowitz and Cranciun, 2006), for many understandable reasons. The nature of surveys, their associated

[4] In the preceding coverage of comparative findings, 2011 Griffith findings were used whenever comparable items were available. When this was not the case, 2010 national survey findings were used.

administration, the limited sensitivity of conventional survey question framings and response formats, can all pose substantial impediments to credible and useful cross-cultural research, even with very bicultural communities. Yet, in many developed countries where national climate change surveys are being undertaken, the views of first nation respondents are of particular value, not only because of their often extensive knowledge and familiarity with very climate change exposed and changing natural environments, but because there exists a strong consensual view that many indigenous populations, communities, and residential regions are particularly vulnerable to the impacts of climate change, including, for example, Alaska and northern Canada, far northern European countries and regions, and Australia (e.g., Crate and Nuttal, 2009: Green and Raygorodetsky, 2010; Ford and Furgal, 2009). Hence it would make good sense to include indigenous respondents in such national surveys, to assess similarities and differences in not only risk perceptions, and understandings, but with respect to psychological, social, and behavioural adaptation responses and impacts.

While there now exist many studies examining the circumstances, and adaptive capacities and strategies, of indigenous groups in the context of climate change, the more qualitative and ethnographic strategies used do not typically produce the kind of data and findings which can be directly compared with national survey data, or indeed other research studies. Notwithstanding the clear limitations of survey approaches in addressing the complexity of considerations such as public risk perceptions and understandings, and psychological adaptations and impacts, the strategic inclusion of standardised and sensitive item framings, response formats, and psychometric measures can complement and validate more qualitative and archival data collections. The current research has taken these survey data collection and comparison challenges on board, in the context of a much broader national study of adaptation to climate change as compared with the Upper Georgina River Basin region, and strove to incorporate a survey component and protocol using a number of very similar and in some cases identical survey questions and response formats to those used in recent national surveys in Australia to make genuine comparisons possible. The resulting findings are very informative, and underscore the importance of including standardised and sensitive quantitative measures as well as corresponding qualitative alternatives when addressing climate change perceptions, adaptation responses, psychological and social impacts, and respective changes over time, in indigenous community contexts.

Current comparison survey findings indicate the following:

- the proportion of respondents who accept the reality of climate change is essentially identical with national survey findings, at 75%;
- causal explanations for why climate change is taking are quite varied, but often reflected greater uncertainty and poorer understanding of climate change science accounts than was the case for national survey respondents;
- self-reported knowledge differences between Georgina Basin community respondents and national survey respondents are quite marked, with just under two-thirds (65%) of community respondents reporting that they knew very little about climate change, whereas almost three-quarter (72%) of national survey respondents felt that they knew a substantial amount about climate change;

- the extent of temporal and geographic psychological distancing or 'far-sightedness' with respect to the magnitude, immediacy, and vulnerability to the threat of climate change was greater for Georgina Basin respondents, with climate change more accepted and acknowledged as a distant and global phenomenon, than as an immediately salient local threat and issue, compared with national survey respondents, though 25% of Georgina respondents clearly disagreed that this was the case, with climate change being viewed a much more immediate and personally important issue;
- 68% of Georgina community respondents nonetheless agreed that climate change was a personally important matter and issue to them as compared with an identical 68% of national survey respondents in 2011;
- UGRB community responses evidence considerably less self-efficacy or collective efficacy than national survey respondents with respect to being able to address the threat and implications of climate change, but comparable and high self efficacy responses with respect to emotional self-regulation through their actions, and moderate felt ability to influence the behaviour of others in the context of climate change related responses;
- 54% of community respondents reported personal experience with natural disaster warning or impact circumstances, as compared with 37% of national survey respondents in 2010, and, on average, 38% of Georgina Basin respondents with such disaster experience reported having experienced one or more of each provided disaster category at least five times or more;
- 42% of UGRB respondents reported having had direct personal experience with an environmental change or event deemed to be associated with climate change, as compared with 45% of national survey respondents in 2010 and 2011;
- 60% of community respondents indicated that they were 'worried' about climate change across 10 areas of specific concerns, as compare with 64% of national survey respondents in 2011 who reported being 'very' or 'fairly' concerned about climate change.
- the UGRB community appears to be changing their risk perceptions, thinking, emotional responses, and understandings of climate change, though seemingly less so, currently, than the larger Australian community.

Clearly the current survey data is much richer than these more quantitative data comparisons can communicate or suggest, including as it does the detail and responses to open-ended survey items administered in the context of a face-to-face interview between researcher and respondent, as well as more general participant observations, and close experience with these communities and region over an extended period of time by University of Queensland researchers, and the outcomes of two community workshops, including group discussions relating to climate change and adaptation options following the surveys.

These comparison findings should not be viewed as reflecting 'cultural' differences in any simplistic way. Clearly the Georgina survey respondents constituted a rather distinct sample by virtue of age, experience, education, residential circumstances and other circumstances in which many bicultural Aboriginal people live in remote regions such as the Upper Georgina Basin and regional centres. As well, Aboriginal residents in the communities and region sampled are quite heterogeneous with respect to their

'indigenous culture' backgrounds. In brief the sampling of indigenous Australian residents in this region cannot be understood as an operationalization of culture as a variable, a common fallacy in risk and culture research (e.g., Johnson, 1991; Kitayama and Cohen, 2007), however indigenous culture assumptions, meaning systems, and world views clearly appear to be informing and influencing a good number of the explanations and understandings of environmental changes and 'climate change' elicited – and appreciable concern. Having said this, it is equally clear that these survey findings are evidencing many very similar views, understandings, uncertainties, and concerns to those of the larger Australian community.

What do these survey findings appear to be saying? First, perhaps, that the region and respondents exist within and are attempting to come to terms with historical and contemporary cross-currents of social, economic, and environmental changes which are experienced, thought about, and commented on from quite diverse perspectives, reflecting the cultural and life history heterogeneity of such indigenous and non-indigenous communities (e.g., Arnett 2002; Nguyen and Benet-Mertinez 2013). The spectre and 'story' of climate change is clearly a salient theme and narrative element within the broader context of global media coverage and exposure, and social and environmental changes which are making generational divides true cultural divides (e.g., Sampson 1988, 1989; Smith, Bond and Kagitcibasi 2006). Nonetheless the phenomenon, risk domain, and perceived manifestations of climate change appear to be very salient but background to more general and immediate weather and climate preoccupations and musings, landscape changes reflecting other clear and familiar forces and causes, and other more tangible and immediate life and livelihood concerns, in such a way that specific concerns and/or distress about climate change do not seem to be as salient, specific, and articulated as they are in Australian popular culture and public life generally.

It must be kept in mind that the very nature of global climate change is that it is an on-going, background environmental stressor, punctuated by extreme weather events, but characterised by less marked, but cumulative seasonal, landscape, and ecosystem changes (e.g., Aldwin and Stokols, 1988; Evans and Stecker 2004; Reser and Swim 2011). The salience and stress of such environmental changes for traditionally-oriented subsistence communities around the world is nonetheless palpable, unsettling, and outside of collective cultural and community experience. A number of the more traditional, older, individuals interviewed, currently reside in the larger regional centre of Mt Isa, at some remove from the more remote communities with which they still strongly identify, and arguably have lived a life encompassing dramatic cultural, social, and environmental changes. It is interesting that in climate change surveys around the world, older respondents are accepting of climate change, but somewhat less concerned, have much greater life experience with adapting to change, and typically have more limited discretionary options or control with respect to lifestyle decisions or adaptation changes. While the survey findings are clearly evidencing important areas of similarity across these Indigenous communities, it is likely that available and visible similarities tend to mask important but less obvious differences, with these relating to cultural assumptions, values, and worldviews, profound ties to country, felt responsibilities for looking after country, and culturally informed causal understandings far different from those in more conventional households and communities.

It is important to keep in mind that the region in focus, while extensive in area, is but one of many very disparate regions of Australia with strong Indigenous representation. Important cultural and historical differences are compounded by important regional culture differences (e.g., Cohen, 2009), and differing contemporary socioeconomic and regional development circumstances. With respect to environmental knowledge, many authors have stressed that traditional ecological knowledge is based on regional or localized level of knowledge and can really only be viewed and applied on these levels (e.g., Smith and Sharp, 2012). While the area researched is in some ways 'typical' of many more marginal rangeland regions of northern Australia, the extent to which more traditionally-oriented environmental values, beliefs, cultural meaning systems, and assumptive world views currently influence individual and community risk perceptions, understandings, and adaptation responses to climate change can be profoundly different (e.g., Petheram et al. 2010; Reser 2011; Veland et al. 2013). What is clearly needed is the establishment of regional baseline data with respect to the diverse human landscape that characterizes regions like the Upper Georgina Basin, and the undertaking of a longitudinal research investment which can more closely examine not only changes in regional and cultural risk perceptions, understandings and responses to the dynamic risk domain of climate change, across communities and age cohorts, but adaptation directions, strategies, and strengths, as well as psychological and social impacts and costs (e.g., Reser et al. 2012a,b).

7. PART B – UGRB ABORIGINAL ADAPTATION PLAN

7.1 Introduction to Part B

This second part of the NCCARF report on the Upper Georgina River Basin (UGRB) contains a preliminary Plan for Aboriginal Adaptation Response to Climate Change. It builds upon a set of observations of climate and environment recorded from Aboriginal people in the region, as well as past experiences of disaster responses. It then outlines strategies and barriers to adaptation respectively. The material is organised into four thematic domains:

- Anticipatory adaptation for changes in the mean climate and related weather extremes
- Land and riverine management responses
- Housing and settlement infrastructure adaptation, and
- Enterprise initiative and capacity arising from and contributing to adaptation

8. ANTICIPATORY ADAPTATION FOR CLIMATE CHANGE

In the context of this report, the term 'anticipatory adaptation' or 'preparedness', herein used interchangeably, is defined as a set of physical, psychological and social precautionary measures taken to prepare communities of the Upper Georgina River Basin for the occurrence of climate change and related extreme weather events.[5] In evaluating anticipatory adaptation, there are two broad categories of climate change that we need to consider: incremental changes and extreme event changes. Incremental changes (also known as 'chronic') are those that will vary gradually over one's lifetime, such as increasing mean temperatures and evaporation rates, whilst changes in extremes (known as 'acute') include changes in the frequency and intensity of cyclones, floods, heat waves and droughts, and indirect extremes, such as bushfires.

By using an extreme weather event to highlight some of the salient issues of climate change preparedness response, we are able to draw upon the practical realities of a recent weather event as experienced by Aboriginal people in the UGRB. We follow this with a range of observations and recommendations arising from empirical analysis, in order to identify response strategies for the effects of both incremental and acute climate change.

8.1 The Impact of an Extreme Event, Cyclone Yasi (February 2011)

In recent history, one event that triggered widespread concern and stress amongst Aboriginal people in the study region was that of Cyclone Yasi in early February 2011. One of the largest Australian cyclones on record, Yasi came from Fiji, crossed the Queensland coast around midnight on 2 February 2011, destroyed Mission Beach and Tully, then tracked westwards causing widespread damage and flooding as a rain depression (Figure 20). The cyclone's momentum was so strong it was expected to cause damage to Mount Isa, then cross the Northern Territory border and possibly impact on Alpurrurulam. What followed was a difficult period for the Aboriginal people of Alpurrurulam; the sequences of events are set out in Figure 21 below and were as follows. Local government staff began evacuating, which panicked the Aboriginal residents and local Council employees (i.e. the Night Patrollers). Due to the isolated nature of Alpurrurulam, a decision was made by the Barkly Shire Council to evacuate residents. People then travelled in a convey of cars south-west down the Sandover Highway to the small remote community of Ampilatwija. Here there was said to occur a gross overload of the infrastructure (septics failing) so the bulk of the convoy travelled on to Alice Springs where they were accommodated in the Showgrounds. According to previous research, many of the Alpurrurulam people felt socially isolated in Alice Springs and moved of their own accord north to Tennant Creek and then east to Mount Isa in Queensland where they knew they could stay with close relatives until the roads dried out (Memmott 2012).

[5] As previously discussed, the Intergovernmental Panel on Climate Change (IPCC) has defined climate change to be "any change in climate over time, whether due to natural variability or as a result of human activity" (IPCC, 2007 pp. 2).

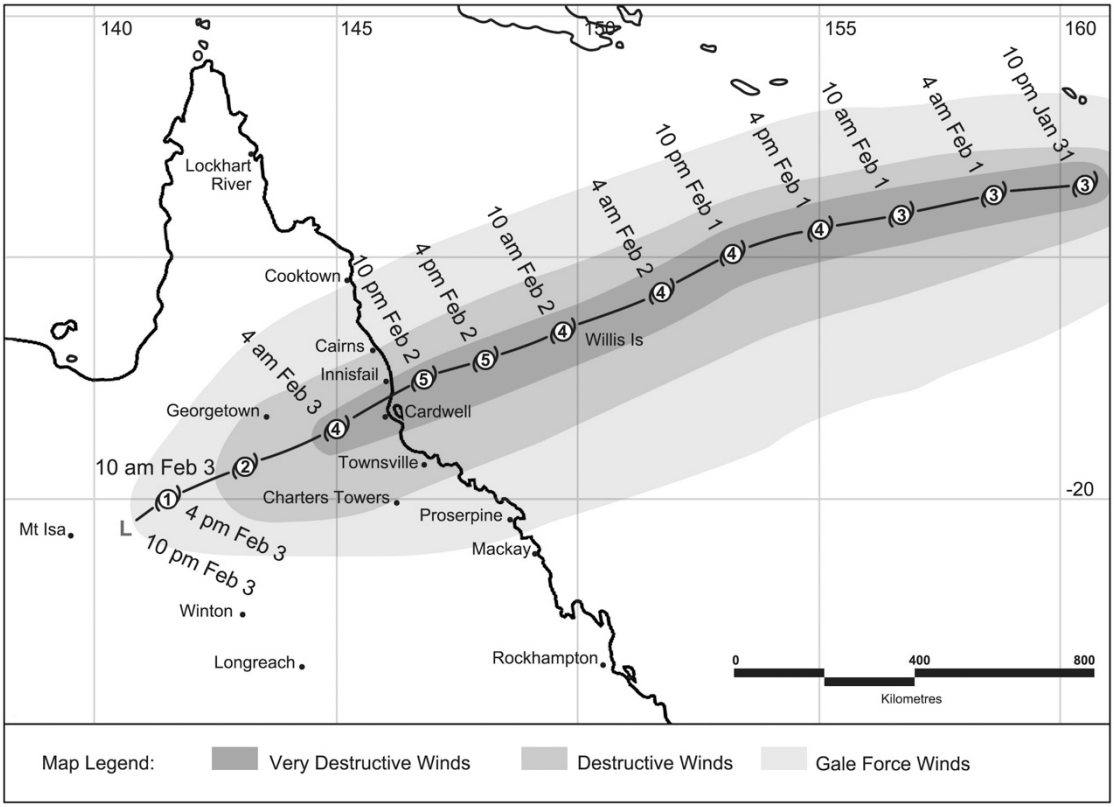

Figure 20: Track and intensity of Tropical Cyclone Yasi, 2011 (Source: Aust, B.O.M. 2011)

According to our interview and workshop findings, a lack of appropriate shelter in Alice Springs created stress on existing infrastructure and services, which resulted in food and bedding shortages that eventually led to the onward displacement of approximately 150 Alpurrurulam people to Tennant Creek. Anecdotally, it was reported that at the time, there was very little cross-community decision-making in terms of the most appropriate evacuation process or plan. Additionally, reports suggest there was also a lack of communication between Government jurisdictions (Figure 22) and agencies which exacerbated the ad-hoc nature of the disaster management process.

The case study shows that the impacts of spontaneous decision-making resulted in widespread population displacement, disorganised mobility patterns and household crowding pressures in a number of host communities. Additionally, and in terms of post-disaster coordination and communication effectiveness, it was reported that a lack of cross-jurisdictional collaboration between authorities in the Northern Territory and their counterparts in Queensland further exacerbated the Alpurrurulam resettlement process. Over the course of a week or so, the 150 displaced Alpurrurulam residents encountered representatives firstly from the Barkly Shire Council, then Alice Springs Town Council, then the Barkly Shire again in Tennant Creek and finally many settled in the Mount Isa City Council region.

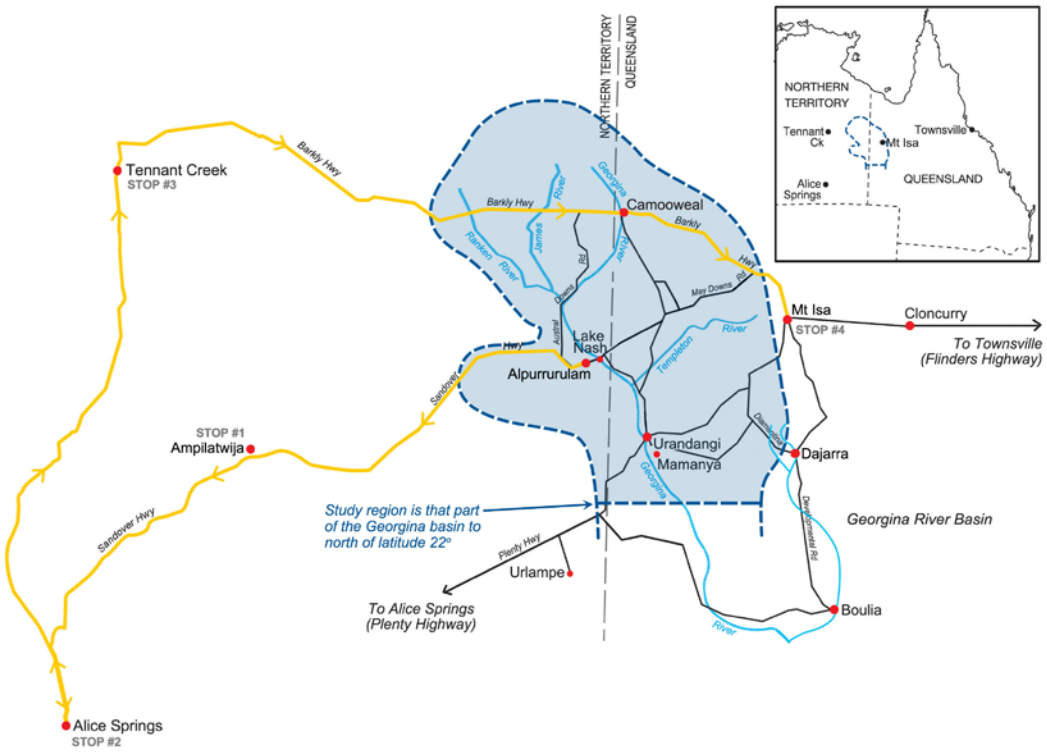

Figure 21: Map showing the journey taken by Alpurrurulam people in the aftermath of Tropical Cyclone Yasi. (Source: AERC)

One key factor which was overlooked in the response by agencies was the strong needs of the evacuees to be able to co-reside with close kin, which ultimately drove their circular mobility. Furthermore, it was reported that during this post-disaster period, a lack of disaster preparedness by those jurisdictions in question, meant that a number of other issues arose. For example, road closures and subsequent re-openings became a major issue with the police service being responsible for closing roads prior to and during an event, while the re-opening process relied on civil engineers to inspect and certify that the road/bridge structures were sound before re-opening. In a region that encompasses approximately 247,000km^2, 6 major roads and more than 30 river crossings it took months before roads and bridges were officially re-opened. It should be noted that the above has been compiled from a number of anecdotal reports collected from public servants and one MP. No official analysis of the response has been made available publicly. Critical questions remain, such as why did people head south-west? Could they not have headed to Camooweal and sheltered at the Dugalunji Camp, then travelled on to Mount Isa in the beginning? Was it jurisdictional confusion rather than the ability to support that caused this to occur?

Given that Cyclone Yasi was so recent in the experiences of Aboriginal people in the Upper Georgina River Basin, it was not surprising that this particular 'big weather' event was raised on many occasions during field interviews and workshops. Thus, our team felt it was appropriate to begin the preparedness section with a description of the events of Cyclone Yasi in order to introduce and frame our general research results

below. We have attempted to retain the Aboriginal voice as much as possible in this description and have structured the following discussion accordingly.

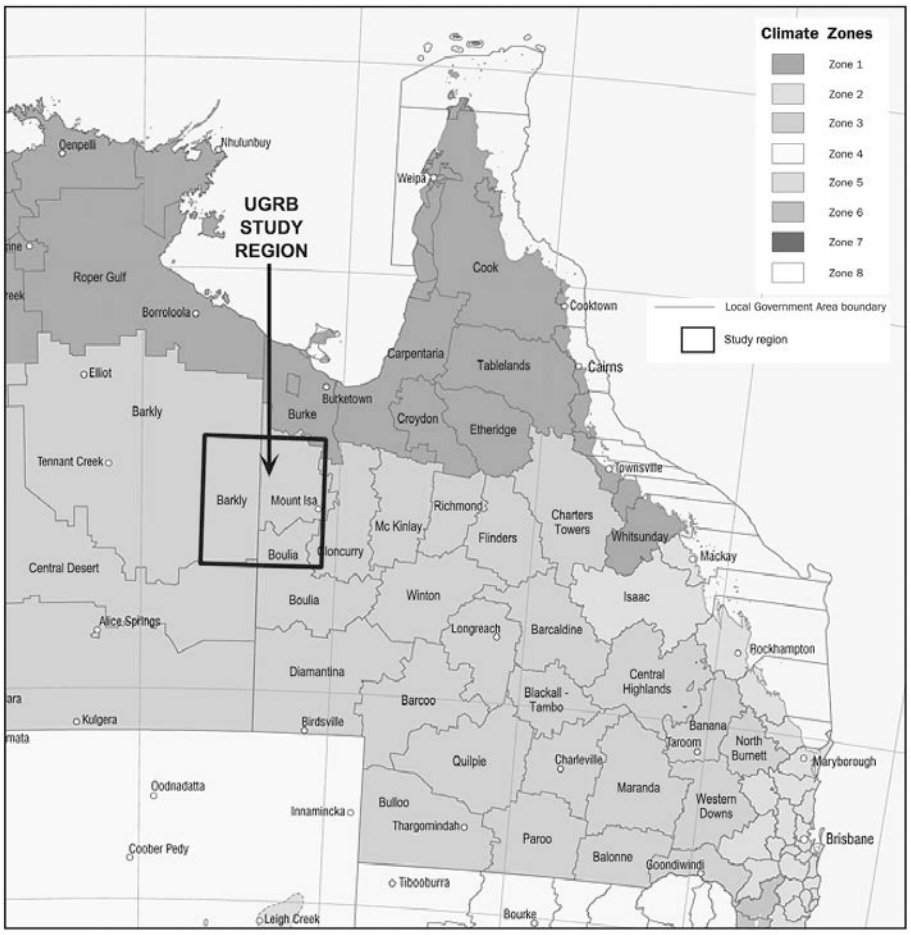

Figure 22: Local Government Areas (LGAs) and climate zones, with the Upper Georgina River Basin study region highlighted and containing parts of Barkly, Mt Isa, Boulia and Cloncurry LPAS.
(Source: adapted from Australian Building Codes Board (ABCB) 2012 "Climate Zone Maps" http://www.abcb.gov.au/en/major-initiatives/energy-efficiency/climate-zone-maps)

This case study on the effects of Cyclone Yasi has demonstrated issues of vulnerability, mobility, adaptive strategy, and capacity to respond amongst those from the UGRB directly affected by the event, and is also suggestive of the resource constraints felt by communities elsewhere who are involved in aiding and accommodating those displaced. Extended kin networks can provide people with options when displaced, but the generally poor income, health, and domestic infrastructure status of many regional and remote communities affects their ability to respond to relatives in need. The case of Cyclone Yasi appears to have significantly influenced motivation levels regarding participation in the NCCARF research, reflecting the fact that once basic recovery from the event has occurred, consideration of how to respond next time is both appropriate and important. The impact of Cyclone Yasi was less a physical/climatic experience than the result of lack of disaster management competency.

8.2 Research Results – Survey Data and Comparative Analysis

With a view to preparedness for climate extremes, it is important to supplement the discussion above with findings from field interviews and workshops conducted during the course of this research program. Our team was interested in what experiences of climate change/variability Aboriginal people had encountered in the study region during their lifetime. Of particular interest were what perceptions people held, what responses to climate change did they recommend, and were the differences related to gender, age and location? The following description interweaves these variables into a discussion of perceived climate change, weather predictability, and personal experiences of natural disasters, as well as an individual's most common 'big weather' experiences over the course of their lifetime; and whether or not they perceive there to be more or less of these weather events occurring now, when compared to past experiences.

The general overview presented in Part A, showed there to be widespread consistency amongst interview respondents in terms of personal perceptions of climate change and variability, however, the actual experiences of big weather events varied according to location, age and gender. The following discussion is divided into locations, the benefit of which relates to being able to comparatively analyse the differences and similarities between communities. Moreover, from a preparedness point of view, given that each community has a slightly different micro-climate and relationship to the Georgina River, it is important that each is treated as a separate entity when it comes to planning for future adaptation processes. It is envisaged that the discussion below will provide the initial foundation for a much larger scoping study framed around community preparedness throughout the region. The reader is encouraged to refer to Figure 27 during the course of this discussion.

8.2.1 Camooweal Respondents

Of the 22 respondents interviewed in Camooweal, 15 were male, aged between 18 and 81 years; and 7 were female aged between 31 and 66 years. In terms of employment, the males identified as being either machine operators or stockmen while the women identified as either stockwomen or 'nannies' (child carers) on pastoral stations. In terms of the occurrence of climate change, the overwhelming majority of all respondents either agreed or strongly agreed that climate change was happening. Interestingly, one of the male respondents (Pic Willetts) stated that he didn't know if climate change was occurring and was also the only one of 22 respondents interviewed who strongly disagreed with the statement "the weather is getting harder to predict." His response was "nature goes through cycles every hundred years or so where everything's up and down" and that "if you listened to television" it was definitely happening.

Of further interest to the current study, Pic was one of two Anglo-Australian respondents amongst the Camooweal interviewees. His background and experience in the region is interesting and may shed light on his views regarding climate change and weather pattern predictability. At the time of being interviewed Pic was 81 years of

age. For 66 years he has maintained a drover's lifestyle, travelling from NW Queensland to the Kimberleys in WA and the western reaches of NSW. Camooweal in NW QLD had been his base since moving there with his family in 1946. In terms of the current research, Pic's knowledge and observations of weather patterns during that time have special significance given that he has spent the majority of his 81 years living off the land and travelling outdoors, often on horseback according to seasonal variances. He has also spent a lot of time working and living with Aboriginal people and has a number of Aboriginal children. As his view was more long term than many of the other respondents in this study, Pic was not worried by what he referred to as 'perceived' changes in the weather. He stated:

> *Winter has come earlier this year. A lot drier this year than last. Years ago we'd get the big winter rains but not now. Waterholes down the Georgina have been full from winter rains (1960s). I don't think it's got any colder or hotter. Cold was killing the birds (1960s) and the cattle wouldn't work. You gotta be out there to know what's going on. Daylight's the coldest. [On the land] you hear about unusual weather events but you don't notice it much. If you listen to TV you hear a lot about climate change, but I don't know. I also don't think the weather's getting harder to predict. Nature goes through cycles every hundred years or so. Everything's up and down. Might get two hot days then one cold day. Oil is creating the problem. I've never experienced a natural disaster but have been through many bushfires, droughts and floods. When you live on the land you don't notice things as much, it's a difference of opinion. [He means people are accustomed to dealing with things]. Droughts are probably the major events I've lived through, there have been less of them recently. I don't know why things have changed. In the 1960s and early 70s there were a lot of droughts. Around that time we had 12 years of drought. Storms would stop at Split Rock [in the east of UGRB region].*
>
> *[In terms of how the country has changed in my lifetime] every 7-10 years the acacia scrub dries out and dies. A cycle of 10-15 years the coolibah trees were kept down by the goats now there is lots. The country is looking as good as I've ever seen it. Biggest body of grass I've seen. Not looking after country will cause huge bushfires. It all depends on how much rain you get and also when you get it. The trees will come back. Country here is different. Black soil country up this way. Down south it's sand country so there's more erosion. I don't worry too much about these things. If climate change is happening it'll right itself in a couple of hundred years – there are too many people on the Earth. What can anyone really do about climate?*

In coming back to the survey results, it is interesting to note that only six of the fifteen male and three of the seven female respondents from Camooweal stated that they had experienced a natural disaster situation or warning in their lifetime, with all noting that Cyclone Yasi had been a recent critical situation which they had lived through and the first of its kind in their lifetime. In terms of 'big weather' events, results show that bushfires were consistently the most common event experienced by people in the Camooweal region. Heatwaves were the next most common with drought and flood occurring more frequently than dust storms. It was reported that severe rainstorms and

cyclones were very infrequent. There was general consensus on this between males and females in terms of the most common events, however, females reported much less experience with big weather events than the males. Furthermore, one of the major differences between genders related to whether or not there were more, less or the same number of these events in recent times with the women stating that such 'big weather' events were increasing in number while the men seemed to think that there were the same number of events in recent years when compared to earlier years.

Peter Parlow is a senior Aboriginal (Waynagardena) Stockman from Camooweal, currently working at Connell's Lagoon in the Northern Territory. He stated:

> *We've had some real funny weather in recent years. Even in summer you get cool change. Now you just can't tell. Like last year it was warm all the way through round about September. We normally get storms in late October going into November. But last year we had dry storms in September. Early. You could see dry storms starting bushfires up. Last year we had frosts on the grass in April which we don't normally get. No frost here. But now there is. Even the wind was changing. Normally its south-easterly but last year it was from west, north, everywhere. This affected fire as it couldn't burn properly, the wind kept changing. You used to know the weather but now you can't tell. When I was a boy it was hotter in summer and in winter it was really cold. But these days it can be hot and cold. Growing up with my people they were the weather people.*[6] *They could change the weather. I've seen it myself. You may not believe me but they've all gone and they didn't pass it on to us. They had songs for cyclone, wind, you could ask them for help. Good for hunting. The old people could control the seasons.*

Peter's mention of traditional rain-makers ties back into the earlier discussion in Section 3.1. Peter continued the discussion on extreme weather events:

> *Working in the NT, I've experienced cyclones and also an earthquake once. There was an earthquake around Alice Springs, we felt it in Brunette Downs. [Peter listed the most common events he'd seen as dust storms, drought, bushfires and cyclones]. The rain season normally starts in October and goes through to April. Now you'd be lucky to tell. If you don't have a good wet you don't have bush tucker. When it's green the kangaroos have worms. Dry grass means less worms so they have more fat and they're better to eat. They have more hard toilet. The turkeys the same.*
>
> *I think there have been the same number of these events recently as in the past, however, the problem is the predictability. Also, if you got no grass to protect the land, the dust storms blow all the soil away. Rain helps to regenerate the land. In my lifetime the country hasn't changed; the only change has been more mining. The Country is suffering a bit. A lot of pastoral activity has caused change. Can't say better or worse. Cattle carry seed and regenerate but they also*

[6] Section 3.1 of this report presents a discussion on the Rain-makers of the region.

damage country. In Camooweal, the week after a big flood the ground is back completely dry. The caves were filled and then about 30 minutes later the water was gone. A few weeks later they couldn't get any water as it has passed into the artesian basin underground.

Hazel Windsor is a senior Injalandji woman from Camooweal. Her father was a famous Head Stockman on Barkly stations. As a child she was raised on Lake Nash and Morestone Stations and at the age of nine began droving cattle with her family from the Northern Territory to Dajarra. Hazel stated:

[The weather these days has been] queer, some days cool weather and then a hot day; more hot than cool. Summer – much hotter; winter – colder mornings than it used to be. [The] early 1990s there were frosts in winter – wearing a coat for weeks and weeks. [But] no coat over the last six years. Weather is going queer. We never had this sort of weather years ago. [Most common] are droughts and bushfires; usually Sept/Oct. Last year bushfires – had to evacuate Myuma camp last year in December – beginning of storms. Don't know, storms I suppose. Grass is dry, the lightning comes especially chain lightning. Bad things – bushfires kill bush tucker trees. Rain good for trees and all that. [The Country has changed in my lifetime.] More trees and more rain, even at the river here – not like years ago. Years to come it'll be a big scrub. Things are looking good at the moment. Overstocking on the [Town] Common. Cattle trampling the young trees and we're trying to keep it to a limit. Owner [lessee] of the Common on both sides of the Georgina River has a limit to number of cattle. Wild orchids in bloom out on 'the run'; see them down the Gregory Rd; flowering and fruiting after rain. Not too many goannas in hot time. Haven't really taken any notice but I think there's more birds all the time now. Black swans have not been in the Georgina River this year for the first time. Saw a jabiru on his own at the lake – seen them before (4 or 5) but they're rare. Red claw yabbies for the first time in Georgina – must've come up with the floods.

8.2.2 Dajarra Respondents

Of the 20 respondents interviewed in Dajarra, eight were males aged between 53 and 78 years; while nine were female aged between 17 and 79 years. The majority of men had diverse work histories from administration officers in the local Council, field technicians for mining companies, fencers, drovers and stockmen. Women reported their work histories to entail administration officers, health workers, shop assistants, teachers, cleaners and stockwomen. In terms of our research questions, 80% of people (16 of 20 respondents) stated they agreed climate change was occurring however this response level dropped to 60% (12 of 20) when agreeing that the weather was getting harder to predict. From a gender perspective, 7 out of 12 of women and 5 out of 8 men thought the weather was getting harder to predict. Survey results show that 50% of people had experienced a natural disaster in their lifetime. This result was greater than Camooweal relative to the overall proportion of respondents interviewed. Results also diverged between these two communities with respect to the most common 'big weather' events experienced during one's lifetime, with dust storms and droughts being reported as the most common events in Dajarra, with floods and heatwaves coming in a close second. This was significantly different to Camooweal

where bushfires were the most common while heatwaves, drought and floods were the next most common, with dust storms being the least frequent event (Figure 24).

One might conjecture that this can be explained by the fact that Dajarra is one of the southern-most communities in the Upper Georgina River Basin and that its proximity to the dry lands of Central Australia would result in it being more susceptible to dust storms arriving from the south towards Boulia. Camooweal on the other hand is the northern-most community and borders the savannah of the southern Gulf of Carpentaria and the central desert region, thus, being prone to the dry storms known for igniting bushfires. In terms of whether or not these events were still occurring at the same rate, there was a marked difference between men and women. The majority of men stated that there were less of these events in current times compared to earlier years while the majority of women stated that the occurrence of these events have remained the same.

Dellroy Dempsey is a senior Pitta Pitta and Waluwarra woman living in Dajarra. She is a qualified teacher and works at the local primary school. Dellroy stated:

> *The last year has been colder while summer was hot. The winter at the moment is colder while the summers have been getting hotter. Around Easter there's more rain these days. Everyone goes to the Georgina for Easter. The grass is higher and more now than before. Carbon dioxide caused by burning fuel is damaging the ozone layer and creating problems for weather.*

Dellroy reported that she believed climate change was happening and that the weather was getting harder to predict. She said she has never experienced a disaster event, but has experienced many bushfires, droughts, floods, dust storms and heat waves. This implies she saw these things as normal events, which did not constitute disasters, supporting Pic's earlier assertion regarding a lack of perceived vulnerability coupled with a high perceived adaptive capacity throughout the UGRB region. Dellroy continued:

> *Flooding has been more frequent. Dust storms have been less. More severe and frequent droughts. We've lived with water scarcity all our lives so it's not really an issue. We do worry about it. The creeks and the billabongs have been filled from the floods. Silting up the creeks. A lot of trees now whereas there weren't in the past. A lot more fruit trees. The country is doing pretty good. [At this time of year we would normally collect conkerberry, bloodwood nuts, wild bananas, kangaroo, gidgee gum, but things have changed. Normally the fruit trees have flowers on them around Christmas time. Now they're flowering in May. More birds now. More fish now. In the past the black bream were 100mile away. Now catching them in the creek. Witchetty grubs are found in the bloodwood gum trees in July (cooler). More galahs and parrots. Kangaroos are scarce. Budgies are also scarce. Quarrions [cockatoo-parrots] are also scarce.*

Timothy Dempsey is a senior Pitta Pitta and Waluwarra man from Dajarra. He worked as a stockman his entire life and grew up living in the West End area of Dajarra with his parents before moving into Dajarra town itself. Timothy stated:

Winter cool and summer warm. Less dust storms these days. Weather seems to be changing a lot. Less predictable now. No idea what's going on with the weather. I watch the news and don't have enough knowledge. I don't understand too much about climate change. I just go with what the weather throws our way. There hasn't been trouble in this area for quite a few years. I've been through heat waves, sometimes it could get a bit warm, and floods, monsoonal rains would come every year. Floods would be the worst one. Been no rain here for years. Not really drought. More dust storm before from cattle. No such thing as droving cattle anymore now; have roads and trucks so that's reduced it. Used to have railway line for cattle. Country's looking good and healthy at the moment.

Ronald Condren is a senior Kalkadoon man from Mt Isa way. He has lived in Dajarra for many years and described his work history as 'a bit of everything', but mainly a stockman; having lived in Dajarra for a number of years at the time of interview. Ronnie stated:

Last five years have been so hot. Been changes. Seems to be hotter and also colder in winter. Never used to be changeable like this. The change is too quick. Only Bedourie dust storms. Too late to fix the weather now. Start from scratch. The moon does seem to be shifting each year to the south. I think the scientists are causing it. Send all the satellites up in the atmosphere. We used to get winter rain in the 1950s and 1960s when we were half way down the droving track. June July every year was the same. In winter it's cold and when the wind comes it gets colder. Water scarcity is big problem these days; got to wait for a good storm for the creeks to run. January we had rains, June we had rains, September it burned, October/November few whirly winds then December it rained again. Same intensity just before the rains; we would burn the country to take advantage of the new shoots after the rains. The problem now is predicting the weather. Back in the good old days there was better grass except where the sheep were. Ardmore Station sheep destroyed the grasses and caused dust storms. Country starting to come good. Looking good. Sheep caused many problems, ruining the land. Stockwork has changed. Now 2-3 months mustering whereas we worked 12 months a year. A lot of the springs around Dajarra have dried up. Less flowering. Wild oranges have dropped right off. Even wild bananas thinning out a bit. Don't see many budgies, quarrions [cockatoo-parrots], willy wagtails anymore.

Sally Maher is a senior Waluwarra and Wangkayujuru woman who has lived in Mount Isa for the past 40 years. Originally from Dajarra, Sally's traditional country is the land on which Carandotta Station is now located some 220 kilometres to the southwest of Mount Isa. Sally stated:

In the last year, we've had good rain but pelted down. In old days good steady rain. Not pelting down like now. Christmas time two years ago I had to wear a coat to go Christmas shopping – that's not normal for around here. There have been many changes. Even our sun and moon – they're coming up in the wrong place for me. The days of the moon landing – wind like a dust storm. Our old people said they shouldn't have done that. Pollution has a lot to do with it.

Community doesn't get together – not even neighbours. Just close family. Don't talk about the weather anymore. I travelled everywhere in a buggy as a kid. By night in summer, by day in winter – different era for me. Today, people just use air conditioned cars and can go anytime. Water in Georgina River has dropped right down. Plants that were there when I was a kid aren't around now, such as pennyroyal and a 'cane' that floats on water. All happened because small gullies have turned into creeks – very rough around the Georgina now. Grasses used for dilly bag and fish traps – grow way off the river bank.

Sally reminisced about the early and mid decades of the 20th Century, mentioning the Rainmaking ceremonies on the Georgina. One of her tribal grandfathers, King Belia was a Rainmaker.

My father (born 1896) talked about 30 years drought – old stockyards covered by sand (Kidman's time in the 1930s). Might lose jobs – mines can't operate in drought. If a long drought comes to Mt Isa I don't think anyone will be here. I've seen many heatwaves and dust storms. Years ago used to be good rains – 'grass rain'. Now it just pours and ruins the ground. In old days they could make rains with the corroborees. Aboriginal people don't follow the law now. In the old days Aboriginal people just moved around the country, slept on river in the dry, moved up to high ground during wet. They looked after country. Lived in mia mias or gunyahs. Now graders everywhere, not an improvement, they're wrecking the place. Erosion … roads out over hills by graders – they don't give two hoots – ripping up ground, making tracks and loosening the soil. Depends what you want and where you go. Don't eat emu anymore because not enough people to eat it. Lots of people don't eat bush food anymore. Years ago – millions of cockatiels [quarrion] and budgerigars. My old granny would throw a stick into the flock to catch them. Nobody would eat them anymore. Before you could see them nesting in hollow trees but now, not so many of those trees for them.

Figure 23: 1974 floods, Alexandria. (Photo by Ron Spedding.)
(Source: Kowald and Johnstone 1992:165)

8.2.3 Alpurrurulam Respondents

Of the 22 people interviewed in Alpurrurulam, 11 were male aged between 32 and 72 and 11 were female aged between 18 and 70. The men identified their work histories as stockmen, wardsmen, drovers, station hands and machine operators, while the women worked as teacher's aides, storepersons, housing officers, health workers and domestic assistants.

With regard to the research questions, the majority of people (16 of 22 respondents) stated they agreed climate change was occurring and that the weather was getting harder to predict. Survey results show that 15 of 20 people had experienced a natural disaster event in their lifetime. This result was greater than both Dajarra and Camooweal in terms of the overall proportion of respondents interviewed. Results further diverged with respect to the most common 'big weather' events experienced during one's lifetime, with Alpurrurulam respondents reporting dust storms, heat waves, bushfires and floods as the most common events with equal intensity. This was significantly different to Camooweal where bushfires were the most common event, and in Dajarra where dust storms were reported as being the most frequent event experienced. It appears from the survey findings that Alpurrurulam experiences a greater range of events more frequently than the other three communities in the Upper Georgina River Basin. Of further interest is the divide between genders in responding to a question about whether there had been more or less of these events in recent times. The majority of males stated that there had been more of such events, however the survey shows that women saw it differently with a majority stating that in terms of numbers, such events were much the same as years past.

David Riley is a senior Bularnu man from Alpurrurulam who was born and raised at Split Rock Station near Camooweal. David reported that his father was from Pine Creek and his mother from Headingly Station. His skin is Pitjara on his father's side and Kemarre on his mother's side. David has worked as a drover and stockman for the majority of his working life. He stated:

> *Weather's been changing a lot. From hot to cold to rain. Goes hot then cold. It's been really hot. Bush tucker comes on when rains come. So if rains come at different times then fruits change. Hot times all seeds drop down; the rains come and they grow. Georgina is getting narrower and it used to be deeper. The floods are filling it up with silt. It seems like temperature is the same but rains are more now. Desert here so it's not. Camooweal is black soil. Our people could tell by looking at the stars and things and predict the weather. Now they watch TV weather to know. [At the moment] the country is greener. Fish is good: Yellowbelly Dreaming, Big Snake Dreaming. Camooweal used to be green back then. Out here was really dry and dusty. Bedourie dust would come from the south. The bloodwood tree has flowers on it now but it shouldn't be flowering until December. We gotta go further now to find animals to hunt. Kangaroos follow the rain; turkeys too. Plain goannas all come back now. Depending on feed they keep moving. They follow the green young shoots. Changing patterns have made it harder [to hunt successfully].*

Robert King is a senior Waanyi-Alyawarr man from Alpurrurulam. He was born and raised on Lake Nash Station and continues to work there as a stockman, ringer and station hand. One of Robert's main roles is checking the station water bores which he said gives him a good understanding of weather patterns throughout the year as the water level in the bore gives an indication of rainfall patterns in a particular season. Robert stated:

> *We had good rain a year ago. Not too good this year, not much rain. 2007 good. 2008 drought. 2009 good. 2010 drought. 2011 good. 2012 dry. Rain would stay for months before; now it's only weeks. Rain would come at end of year. In the 50s, 60s and 70s we knew when the rainy season was coming. We didn't need to rely on weather forecast on TV. More consistent before. The big wet was normal back in 60s and 70s. The Georgina was really high. It used to be up at the station. [Climate is changing because there's] more people in this world than before. It all goes into the air and changes the pattern. More cars. Companies have to make things cheaper so that people can afford to make change.*

Robert also stated that he's experienced many bushfires, floods, droughts, dust storms and heat waves in his time, adding:

> *Rains normally come during December, January and February with bushfires from dry storms just before rains in November. In 1974 I was working at Barkly Station and it was a very big wet. Army had to drop feed to us. More electrical storms these days. Really bad lightning and thunder these days. More floods back in the 60s and 70s. More trees have come up near waterways mostly bad trees. More plains. Less trees in others. [At the moment], it's [the country] not too bad. In some places the country is suffering. Different areas. Putting more bores*

or dams in has helped as there's more water around. People mainly talk about the wet. Not as much wild food lately. Not so much with fish but animals yes. Animals and plants yes – wild fruits are becoming harder to find now. Some small kangaroos (kangaroo rats) you don't see any more. We had lots of fruit bats and rabbits but not anymore. Emus and kangaroos seem to be moving elsewhere. Since I was a boy there have been big changes.

Irene Toby is a senior Aboriginal woman from Alpurrurulam whose traditional country includes Irrmana (mother's side) and Bonya (mother's mother, Eastern Arrernte). Irene has worked as a teacher's aide at the local primary school for many years. She stated:

[The weather this year has been] different; cold night, warmer day. Not sure why, flood like last year didn't happen before. In May I thought it's winter just like every other year but it's warmer. Easter 2008 it was cold early. Flood last year in hot time – kids swimming in this street water up to my knees; happening more – might be changing. Some fellas filled holes in roads after floods. Rain, dust storms, floods, drought, heat waves, bushfires all happening; hot time.

Irene also referred to the traditional Aboriginal Rain-makers:

When I was a little girl they used to have rain-making dances here at Lake Nash. Those old fellas passed away. These days they don't have them here. Some old fellas know them laws but they didn't pass that on to young fellas from here. Some fathers take the young fellas back other side – to No5 bore (near Harts Range) or to Ampilatwatja [for initiation ceremony]. This side the old ladies never passed on to us young ones. I used to watch; sometimes they paint me up but I never learnt – they passed away too quick.

Irene went on to discuss changes to gathering plant foods and hunting small animals, which are staples for many people at Alpurrurulam:

Might be worse than last time. We might not be getting bush tucker! After rain bush tucker will come out all right. More young trees; some old trees died, fell down. Bush potato, goanna, kangaroo, turkey, emu; bush tomatoes, bush orange, bush passion-fruit – If there's no rain you don't get these foods. On the river there used to be lots of pretty flowers after floods, rains – yellow and blue ones. I don't see them now. We used to have cubby houses – make mud-cakes and put pretty flowers on like birthday cake. Same at Utopia. Changing climate maybe. Yesterday we went hunting for goanna and couldn't find any. Place where you always see them – flat country. Other mob went further, Georgina River side and got some.

Jennifer Mahoney is a senior Arrernte woman from Alpurrurulam where she has lived since 1991 and recently became a Barkly Shire Councillor. She has also lived in Boulia, Dajarra and Mt Isa and reported that prior to living in Alpurrurulam, she lived in a traditional iron humpy in the old station camp at Lake Nash Station. She is currently employed as an assistant teacher at the Alpurrurulam Primary School. Despite her bush upbringing, she immediately referred to global examples of climate change, and stated:

When we look at the news and we see islands disappearing because the ice is melting…and the north pole, all that ice melting; trees being cut down over there in Brazil, smoke from all those chimneys overseas coal stations, cars with their carbon… People have more health problems that they didn't have before. We just deal with it [climate change] when it happens. We think that it was your time – for the old people. This is our time – we do things differently and you look at the kids nowadays and they do things a lot different from how we used to do it. Today, same thing – different way. And we got to get the grandchildren to listen to what is the right way. The right way is our traditional ways. Young ones want hip hop instead of corroboree – they want to do it that way. My grand-daughter was at a making-men [male initiation] ceremony at No.5 [bore] and she says: We going to disco tonight? She didn't know. When people burn grass today they don't think about, don't know which way it's going [to burn]. Don't know what the old people used to do.

Jennifer's statement above again refers to ways in which traditional customary behaviours and life-ways assisted Aboriginal people in the past to adapt to changing environmental and social conditions. The question is, with the rate and extent of social and cultural changes having occurred in remote Aboriginal communities, what social structures exist to assist Aboriginal people in adapting to future environmental changes when required? Jennifer continued to discuss climate variability:

Goanna hibernating now but they don't know what time winter is. We're here in our short sleeves and it's cold in Alice [Springs]. At some time last year the weather messed up the time we'd go for bush tucker. Normally when rain came in December and January, we then get February, March and April to go hunt goanna, bush tucker, but this year we got one lot of rain, brought all that bush tucker up and then next rain washed them off. We only had first lot. But our old people say that the first lot are for the birds and animals and the second lot are for us. But there was nothing for us because the second lot of rain came [and ruined them]. All [bush tucker] getting scarce: goanna, kangaroo, emu, turkey, echidna, pelican. Bush potato – OK on the Sandover, bush tomato – grown but gone dry, gidgee gum – not this year. Rabbits and [native] rats have disappeared – must be some other animal eat them out – feral cats!

Jack Mahoney is a senior Eastern Arrernte man from Alpurrurulam. Jack was raised on Lake Nash Station and continues to work there as a stockman and station hand. He stated:

The weather's gone mad [this year]. Rain, hot, hail, cold. We had floods. In years gone by we used to know the seasons. These days I don't know how to predict. Scientists created the problem. I watch the weather channel on TV and they keep talking about the ozone layer. In the past black fellas could fix it; now they can't. They're all gone. If I look at the country now and think about it when I was a boy, we have many more trees now. When I was a boy there were less. Cattle spread the trees; that's why there's more. The country is looking good. Everyone has been talking about the rain. All the grass bring plenty of goanna; where now the yabbies are even bigger.

8.2.4 Urandangi Respondents

Of the six people interviewed in Urandangi, four were male aged between 41 and 71 and two were female aged between 32 and 60. The men identified their work histories as stockmen and ringers while the women worked as a teacher's aide and health worker. Due to the small number of interview respondents from this community, it is difficult to make generalisations regarding overall community perceptions, however, in terms of our research questionnaire there was very little differentiation between genders. All respondents stated that they believed climate change was occurring and that the weather was getting increasingly harder to predict. Only 50% of respondents said they had experienced a natural disaster situation; this ratio matched those interviewed in Camooweal and Dajarra with only Alpurrurulam having a higher ratio. Drought was the most commonly reported 'big weather' event, with bushfires, dust storms and heat waves the next most common.

Marlene Speechley is an older Waluwarra woman living in Mount Isa. Marlene was born in Urandangi, grew up on Headingly Station, lived in Boulia for many years, and has spent the last 38 years coordinating the Nawamba House Women's Shelter in Mount Isa. She stated:

> *This year's been just like any other. The seasons are changing, especially in summer, it's hotter. [Aboriginal people] only talk about it [climate change] after rainy season. Can't get kangaroos but can get tortoise and turkey. We talk to kids, e.g. if it's green time turkey, goanna. Raining fish… haven't seen that since I was a kid. Once in Boulia it was raining crabs. Urandangi – once was shown us where water-filled cavity in a drought Uncle's Dreaming site's 'Marmanya' tree full of yellowbelly [fish]. I would like to live on the blocks at Urandangi [where the group has native title] but problem about access to health services [because it's so remote]. I've been through cyclones on the Queensland coast, and many droughts, floods and dust storms. As a child in Boulia we had dust storms daily for 15 years at 3pm on Maryvale station. Still eat wild cabbage. It's also "turkey food"; not much bush tucker now compared to Carandotta where you used to get bush passionfruit. A lot of bush tucker is not in abundance like it used to be. The country is not as good as when we were growing up. Used to go bush, looking at sites and there are bushes growing that didn't grow there before. Maybe its from mining companies aerial reseeding: 'Soap Bush' (acacia). [At the moment] the kangaroos are fat, yellow bellies biting. We might live in the city but traditional country still has to sustain us.*

Billy Tommy is a senior East Arrernte man born in Urandangi and raised at Lake Nash (near Alpurrurulam). He lived in Urlampe for almost 20 years and worked as a stockman and ringer during the course of his life. Billy stated:

> *[The last year's] been dry and hot. Lot of bushfires. It's hotter now and colder before. Lot more grass around today. In times past the old people would burn it but not now. Years ago it was green all the time. Much less rain now. Got to look at TV now for the weather. We used to have Rain-makers in the old days. No more rain makers. They used to make rain every year (in the 1960s). Each Christmas the manager would give people a killer [a cow for meat] and tell 'em to*

make rain, so they [The station] would have grass after Christmas. Less floods and more bushfires now. Thunderstorms start the fires everywhere which makes it hard to manage. Less droughts now. More grass and more trees now. Bigger storms creating this. Looking good now. Less kangaroos these days. Before they were everywhere.

At the time of interview, Wayne Age was a young Aboriginal man born and raised in Urandangi. His traditional tribal affiliation is Waluwarra from Urandangi. Wayne's work history was mainly as a ringer on the local pastoral properties. He stated:

[The weather recently] has been pretty good. We had bushfires in December [2011] and then good rains at the same time. So everything came good. I've seen a lot of change since the 1970s. It's been hotter and also colder. Have seen too many dust storms these days. In the 80s we had big dust storms. 1982 terrible dust storms. In the 1980s we lived down around the creek behind the pub. We moved up here to Marmanya cause it was higher ground away from floods. Cyclones (big rains) bring more water. We have had much drought recently. We do talk a bit about climate change. Been drier up here. If they have cyclones and storms around the Gulf area we get the floods coming through here. There're more grass and trees these days than before. More bushfires from people burning in the past. Things are looking really good at the moment. A few people are saying that the weather is changing.

Ken Isaacson is a senior Aboriginal man who grew up in Mount Isa and spent 68 years in the UGRB region. He currently lives in Charters Towers where he has spent the last 4 years. His tribal affiliation is Waanyi from the Gregory River to the north-east of the Upper Georgina River Basin. Ken currently works as a cultural heritage monitor throughout the Georgina River basin and is included in the Urandangi survey results due to his knowledge and work history in this part of the region. Ken stated:

Actually in the last year they're [weather patterns] nearly back to normal, [compared to] how we used to get them. Post office in Tambo – 1958 June/July frost was fierce, now no frost. I was a weather reader in Tambo and used to record evaporation, rainfall, air temp, ground temp, wind direction and cloud cover. We could nearly predict last three years. We predict by watching birds, crocs (laying early), ants flying. You can feel the rain coming in your skin. October to December was the stormy season. We used to get winter rains as well. January to February the monsoon comes in from the Gulf. I'm not a scientist so don't know why climate change is happening but I do believe it's happening. Maybe the human emissions are to do with it. The old days when we were kids there were Rain-makers who used to know all about the weather. They could predict droughts and rains by watching the animals and birds etc. As a bushman I reckon I know a lot about the weather and climate [in this region]. Maybe because I'm a bushman and love the country. I think about my kids and grandkids and what future they'll have. 57 years ago was the biggest dust storm I've been in. In 1945 at Bedourie, Boulia, Birdsville, massive dust storms. The storm season in October to May. That much fuel around. Bushfires – there's been a lot of burn off material so more bushfires these days. Dust storms, not

sure why, wind change perhaps. A lot of the winds have changed I reckon. Droughts are disastrous, our bush food and medicine would be devastated. Drought causes financial problems, a lot of conflict with it, affecting families. The last ten years we've had plenty of rains and grass and trees. [Country] is looking good and healthy. All dams are full.

Ken referred to the impact of mines in the Mt Isa uplands:

Mining companies have caused significant damage. Fumes and poisonous gases landing on country. Water and mines are a big part of our life these days. Emu, wild bananas, wild oranges, the fruit and bush medicines wait on the rainfall – the early storm. Sometimes we get early rains and plants flower early. Birds will nest early. Everything's in a pattern you see. We used to see the conkleberry but now you don't see them at all. Climate change has caused this. Looking for bush tucker I've changed my hunting patterns due to changing climate.

8.2.5 Discussion on Survey Results

In analysing the information collected during fieldwork, the survey data shows that the majority of residents in each community believe climate change to be occurring and that predictability of weather patterns has become a major issue; given that it negatively effects customary economic patterns of behaviour, such as hunting and gathering food and other resources. From a preparedness perspective, it is evident that subtle differences between each community exist. For example, Alpurrurulam had the highest number of reported 'big weather' events, being bushfires, droughts, floods, dust storms and heatwaves, whereas Camooweal residents reported experiencing only floods, droughts and bushfires. Dajarra residents reported dust storms and drought as the 'big weather' events typical to that community. In contemplating on disaster management preparedness, the anecdotal evidence from fieldwork suggests that while exposure to the effects of climate change was high, the perceived vulnerability to these effects on an individual basis was relatively low. Some respondents even referred to these events as normal experience perceiving extreme weather events as something else. Also, evidence suggests that a given community's capacity to respond to 'big weather' events related to whether or not they had experienced such events in the past and had an appropriate level of preparedness built into community governance procedures in readiness for when such an event occurred; for example, the issues surrounding Cyclone Yasi.

In relation to a given community's adaptive capacity and preparedness for climate extremes, the anecdotal evidence from fieldwork supports the climate change scenarios expected for the Upper Georgina River basin as presented in Section 5.1, and include:

- Incremental climate changes, creating higher average temperatures and higher evaporation rates;
- Possible increases in cyclonic depressions penetrating inland with accompanying flooding events resulting in possible settlement evacuations;
- Increasing frequency of heatwaves and bushfire events;

- More droughts (with dust storms) and bigger wet seasons (possible increased summer storm and lightning events);
- Reduction in perennial waterholes, shifts in ecosystem balances, reduction or loss of certain fauna/flora species and increase of others;
- Impacts on animal habitats and migration patterns; and
- Increased difficulty of regional infrastructure maintenance during and after disaster events.

In cross-referencing these scenarios to both the survey data and anecdotal evidence from fieldwork, an increase in extreme weather events would require better emergency management procedures and protocols. Our research recommendations are that disaster management protocols throughout the region need to reflect the subtle differences between each locale. For example, a simple reading of the survey data would show that residents in each community have experienced the gamut of 'big weather' events common to the region as a whole, however, subtle locality differences illustrate that certain events have reportedly occurred with greater frequency in particular communities suggesting the need for community-appropriate management and governance protocols.

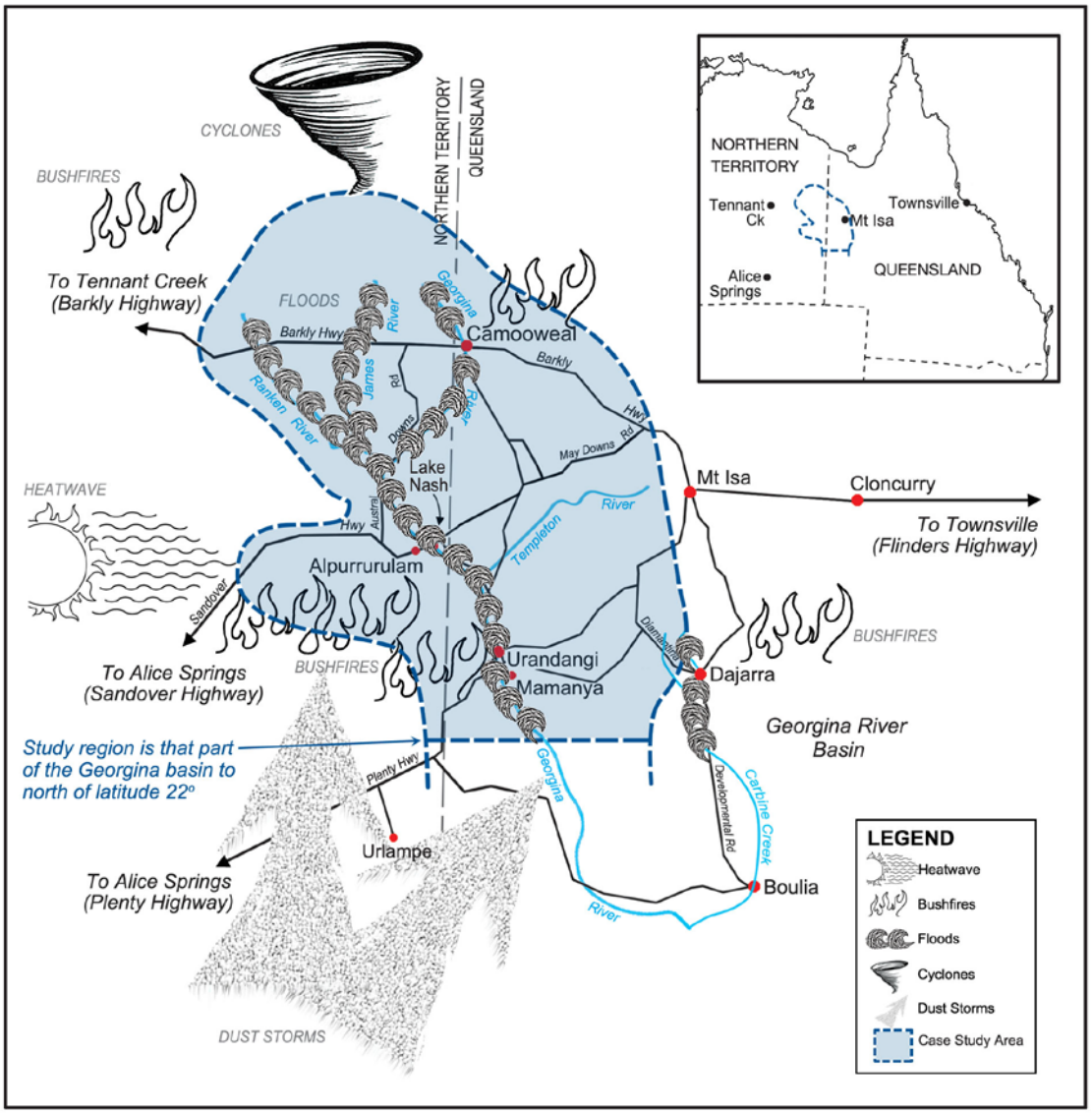

Figure 24: Regional map showing the micro-climate variability affecting Upper Georgina River communities. (Source: AERC)

8.3 Strategies for Adaptation – Workshop Results

As discussed in the methodology section previously, in order to appropriately present an Indigenous voice throughout this research, our research framework was structured to firstly interview residents from the four main communities of the UGRB as to their perceptions and understandings of climate change and extreme weather; and secondly, to present the findings from these interviews back to representatives from each community via two major workshops, held in Camooweal. The intention was to draw out those grass-roots ideas from Aboriginal people themselves as to the most useful and appropriate local adaptation processes required for each community in the region. In addition, our research team invited representatives from both Government and non-Government agencies to participate, particularly in the second workshop. The reason being that workshop participation could then be shaped according to the four research streams, with authorities from the region being given the opportunity to hear

and speak directly with Aboriginal people residing in the communities concerned. The discussion below presents the strategies for adaptation in relation to climate change preparedness and disaster management which arose during workshop considerations at the time.

In focussing on preparedness, the November 2012 workshop was attended by residents from the four UGRB communities along with representatives from the Australian Red Cross (ARC), Emergency Management Queensland (EMQ), Xstrata, Desert Channels and Southern Gulf Channels.[7] The workshop outcomes below are divided into three main areas, being emergency management and response, disaster management and response, and the establishment of a regional climate adaptation group with representatives from each of the four main communities.

In terms of climate adaptation, those people present at the workshop advised they were interested in establishing a 'Georgina River Basin Climate Change Regional Adaptation Group' whose role it would be to coordinate preparedness activities at a regional level. It was discussed that this specific group would also be the conduit between local communities and State, Federal and non-Government agencies when it came to disaster management and coordination. Workshop attendees discussed the viability of such a group and thought that its long-term survival would be a mixture between self-sufficient funding regimes and local, state and Federal partnership funding arrangements. Discussion also focussed on linking with the Australian Red Cross so as to assist with response and recovery processes throughout the region during and after an extreme event. Workshop attendees also proposed the use of social media for disaster response and climate change preparedness. The ARC State Manager stated that they would be open for collaboration with Aboriginal community groups and would need to pursue funding and explore other case studies of Indigenous disaster management. Given that the Mount Isa City Council (MICC) has its own local disaster management plan (2011) and Local Disaster Management Group (LDMG), the ARC has not been invited by the Mount Isa City Council to manage evacuation centres in the region at this point.

Typically, Local Disaster Management Groups (LDMGs) comprised of local and state government agencies (SES, EMQ and others) and manage disaster mitigation, preparedness, prevention and response and administer recovery plans for Queensland communities in the event of a disaster. However, according to the EMQ representative at the November workshop, LDMGs are not as well organised in smaller, remote areas such as the UGRB. It was reported that EMQ have only two staff in Mt Isa to cover the whole region, underscoring the need for communities to be well-prepared for such events themselves given that in a disaster, as a rule of thumb 3% of people account for 90% of service resources. In the event that more than 3% of people are affected in a given disaster, resources begin to run out (E.D. pers. comm. 2012). Aboriginal people

[7] Many of our stakeholders were unavailable for these key workshops due to having had their Departments either dismantled or subsumed into other agencies in the recent Queensland Government fiscal management process.

are under-represented in this 3% further underscoring the importance of self-sufficiency in the adaptation process.

Workshop attendees proposed that the Regional Adaptation Group could be the vehicle that oversees Aboriginal-focussed LDMGs throughout the study region. In conjunction with the LDMGs, it was also proposed that the Dugalunji Aboriginal Corporation's (Myuma Pty Ltd) headquarters at Camooweal and the Jimberella Cooperative headquarters in Dajarra are good locations for Evacuation Centres in the region. Discussion also canvassed that Myuma could provide coordination services for Aboriginal responses to disasters for the northern basin communities of Lake Nash and Camooweal, while Jimberella could play a similar role for the southern basin communities of Dajarra and Urandangi. The development of a Regional Disaster Management Plan and a specific DMP for each community were important considerations and recommendations arising from the workshop discussion. When viewed in conjunction with the results of the field survey presented previously, the varying climatic subtleties in each community justify the preparation of a number of slightly different disaster management plans. Accordingly, the ARC's 'Emergency REDiplan' emergency kit and the *Keeping Our Mob Safe* (2007) report were good background documentation that would be useful in establishing such plans. In furthering this discussion, it was proposed that a link with Emergency Management Queensland for bushfire and emergency response training in each of the communities be established; beginning with Camooweal, and linking EMQ/SES into existing TAFE accredited training courses at Myuma which could focus on climate change preparedness and adaption. The development of the EMQ/TAFE training at Myuma is also way of empowering local Aboriginal people through their being solutions to problems rather than simply being seen as vulnerable and needing assistance. In summary, the diagram below indicates the governance flow suggested by workshop attendees.

Community REDiplan

↓

Community Development

Community Leadership across NT/QLD (via Myuma)

↓

Focal point for training

e.g. Myuma or Jimberella

In terms of appropriate communication strategies, workshop participants proposed that the regional adaptation group could also enter into an agreement and arrangement with primary and secondary schools in each community in order to firstly educate children as to DM protocols relevant to their district and region, and secondly, disseminate the planning principles arising from their local community's disaster management plan. In terms of an adaptation framework, a number of questions remain:

- Who should develop the community wide education process?
- How should Aboriginal knowledge be used?
- Or a process for including it in best practice preparedness be developed?

If in the future this study moves beyond the scoping stage, a model for this approach could be the series of sea country plans developed by Indigenous communities seeking

partnerships and action from Governments and others in the sustainable management of their marine estates (see http://www.environment.gov.au/indigenous/seacountry/). The utilisation of local Aboriginal knowledge of the country should be synthesised with the latest best practice preparedness and emergency management strategies available at the Government (LDMGs) and non-Government agencies.

8.4 Barriers to Adaptation – Workshop Recommendations

When contemplating on adaptation strategies arising from the regional workshops, it is important to also address barriers to those strategies being recommended for implementation. An analysis of workshop discussions illustrates that such barriers can be divided into three main areas, with these being: cross-jurisdictional issues, appropriate resourcing, and the regulatory environment influencing the implementation of such strategies.

8.4.1 Cross-jurisdictional Issues

In terms of cross-jurisdictional issues, the fact that the UGRB sits across the Queensland/Northern Territory border is a significant barrier to the overall implementation of adaptation strategies in the region. From a preparedness perspective, workshop discussions elicited a lack of coordination between the respective State and Territory Governments (QLD and NT) in firstly preparing and then responding to emergency and disaster situations when affecting the cross-border region. Given that the Northern Territory Police Force currently coordinates the Northern Territory Emergency Services, whereas Queensland has a separated Department of Emergency Services, one of the major issues related to the different regulatory environments between the States. It was reported that at the present moment, Queensland and the Northern Territory have an agreement (MOU) for the deployment of search and rescue units (SES) in the border region, which mostly entails rescuing stranded motorists between Urandangi and Alpurrurulam. Because the administration processes between the State and Territory Governments are so different, it was felt that an alternative method of regional governance was needed to mitigate the dysfunctional situation that currently exists. In delving into this further, workshop attendees felt that the proposed regional coordinating organisation partially or fully funded by the Federal Government could play such a role throughout the UGRB. Given that during an emergency, disaster management coordination could be required of Police (QLD and NT), LGA, DDMG, EMQ, SES, Ambulance (QLD and NT), ARC, LDMG, Rural Fire Services, and involve a range of different needs including but not limited to food, manpower, vehicle usage, aircraft, earthmoving equipment, apparatus, it appears that a regional organisation drawing on Indigenous knowledge of country and the social capitals available in such remote locations would be a welcome addition to the preparedness landscape.

Furthermore, given their local knowledge and longevity in the region, this same Aboriginal-run (Government or non-Government funded) organisation could assist Government and non-Government organisations in a post-emergency / post-disaster context. For example, there was a lot of discussion at the workshop regarding contingency planning for transport and mobility corridors throughout the region with discussion focussing on the opening and closing of roads in a post-flood situation. In

Queensland for instance, roads are a local Council responsibility however the problem occurs in a disaster context when roads/bridges are closed by local Police and the authorisation to reopen them is coordinated by the local Council civil engineer. Given such large distances and the diverse geography of a region like the UGRB, it can take months for affected areas to firstly be inspected and then repaired before re-opening can occur. In addition, such ongoing closures can further disrupt essential services to outlying communities. Consequently, a regional organisation such as the one proposed here could take advantage of the high mobility rates of Aboriginal people in the region to firstly identify, through photographic surveys uploaded via social media sites, those major points in the transport infrastructure needing attention and secondly coordinating with the local authorities to repair the affected areas (e.g. by the Myuma P/L road construction team). This would lead to valuable employment opportunities in a region where the population has already stated they will remain on country even in the light of climate and associated environmental changes.

8.4.2 Resourcing

Moreover, in establishing an organisation that represents the various Aboriginal communities of the UGRB, greater resourcing would need to be committed to the region. Given the highly mobile and relatively small population in the area, it is understandable that Governments shy away from funding essential services. However, if there was an organisation that could draw from the social capitals available in each community, the level of funding needed could be efficiently allocated. Furthermore, in referring back to Section 8.2.5, the subtle climatic differences between communities influencing disaster management and preparedness justifies a slightly different local governance response. For instance, funding for emergency plans, kits, infrastructure and essential services for those communities can be appropriately tailored to the actual need in that community with monies being spent wisely and not wasted on non-essential services and infrastructure as has occurred in the past.

8.4.3 The Regulatory Environment

When discussing the regulatory environment that currently influences preparedness in the UGRB, our workshop attendees indicated that at present, and given the cross-jurisdictional issues described previously, there is potential miscommunication and even confusion between regulatory authorities when it comes to disaster management and associated responses. Consequently, attendees felt that such problems only served to negatively affect a local community's preparedness for climate change and the inevitable weather pattern extremes that are predicted to arise. In contemplating on this, attendees also felt that a statutory organisation supported at a Federal level could assist with removing the regulatory barriers that exist at the moment. It is envisaged that a stable Aboriginal-run regional organisation supported through Federal funding could have memorandums of understanding (MOUs) with all relevant local authorities and both Government and non-Government agencies working in the region and thereby take on a critical coordination role.

Turning to relevant statutory references, the Queensland S*ustainable Planning Act 2009* places responsibility on local governments for mitigating the adverse impacts of flood, bushfire and landslide (SPP State planning policy 1/03 : 6.15) which states:

Wherever practicable, community infrastructure should be capable of performing its role in maintaining the health, safety, and well being of the community in the event of a natural disaster. However, locating and designing community infrastructure to withstand natural hazard events, no matter how severe, would be unrealistic. Accordingly the SPP guidelines sets out appropriate levels of risk for differing types of community infrastructure and provides advice on assessing community infrastructure proposals against outcomes. Locating and designing community infrastructure to withstand these specified levels of risk also needs to be weighed against the need for that infrastructure to serve the community effectively in normal circumstances when there is no natural hazard event.

However, there is clearly a need for the local response group to call for support from the state level at time: "Due to the geographical isolation of the district, and the logistical considerations of providing support for local groups, the District Group must be cognitive [sic] of its limitations(s) and request assistance from the SDMG early" (Mt Isa LDMG). In this situation, an Aboriginal group could also be called upon to play a major role.

8.5 Key Recommendations: Preparedness

A number of overarching recommendations can be drawn out of both the field interview responses and workshop discussions when contemplating on preparedness in climate change adaptation and weather extremes.

One of the major messages arising was that given existing socio-economic disadvantage in the region, Aboriginal people are typically the most vulnerable to the effects of climate change, however, the most likely to stay on traditional country as the climate does change; further underscoring the importance of appropriate planning and preparedness at the local community level in building adaptive capacity in remote arid-zone townships. This was offset by a resilience grounded in traditional values and customary behaviours however as times change, many people were worried that community resilience to these events would be seriously diminished. Self-sufficiency and partnering were seen as key aims to managing the adaptation process, thus the development of the UGRB group.

Appropriate communication pathways between community members on the ground and the relevant jurisdictional authorities need to be devised when extreme weather events do occur. In terms of a preparedness framework, a community-wide education process should be in place prior to such events occurring in order that residents are aware of what protocols to follow when needed.

There are also a number of important contributions to the NARP Indigenous research priorities. By thematically exploring preparedness/anticipatory adaptation, we were able to shed light on some of the structural vulnerabilities that result from the absence of Aboriginal perspectives in formal policy spaces and the lack of understanding of the specific needs of remote desert communities. The example of incoherent and *ad hoc* flight responses to Cyclone Yasi by the people of Alpurrurulam highlighted the vulnerabilities that are associated with overdependence upon scarce and frail communication, transport and emergency infrastructure systems. This chapter also

illustrated a number of the procedural and regulatory constraints upon disaster management, emergency services, localized training, the availability of qualified emergency workers in the UGRB region, and the ability to utilize local social and cultural capital to facilitate successful adaptation. Our approach has engaged with the political, social, cultural, economic and ecological factors that play a part in shaping the preparedness and adaptive capacity of communities in the UGRB.

9. LAND AND RIVERINE MANAGEMENT

The early contact history of Aboriginal groups in the study region including northern Alyawarr, Wakaya, Indjalandji-Dhidhanu and Waluwarra/Georgina People suggests the close and detailed knowledge of land and water resources which enabled people to survive traditionally in the harsh arid environment. Across the different landforms and vegetation types in the Upper Georgina River Basin (UGRB), Aboriginal people used a range of plant and animal resources with year-round or seasonal availability which influenced their movements. The lack of surface water in the Wakaya Desert restricted the distribution of animals such as kangaroo and emu, however birds and fish were prevalent around the waterholes, particularly on the Georgina River to the east but also on the Ranken and James Rivers. Despite the highly variable and seasonal nature of water in the Georgina, it supported a range of resources at all times. For example, "[f]reshwater mussels were a winter staple, their shells reported in abundance at the major waterholes and lagoons by the first European explorers" (Memmott 2008: 11). In general people moved along the river corridors accessing animal resources (including fish). They used the hill country for land resources such as echidna, wallaby and emu, and travelled into the grasslands for seed staples, bush potatoes and grubs. Availability of ground water was critical. The distribution and amount of rainfall influenced their seasonal movements including the timing of cultural group gatherings for social and ceremonial practices, some of which were specifically targeted towards rainmaking. The use of fire was also crucial as a resource management strategy, where carefully timed burning events optimised resource production in the landscape following culturally sanctioned rules.

Today, Aboriginal people's knowledge of the region is still alive although much has been lost or fragmented and continues to be threatened. Aboriginal Knowledge (AK) has also adapted and transformed based on life histories of the people who hold it, and in some cases such as the cattle industry, the people's life histories have involved extended periods of time on the land. Most significantly for today, access is constrained by rights to land. While the people are restricted in their access to traditional lands and the practice of that knowledge, their capacity to manage against potential climate risks is compromised. The relationship of knowledge to land tenure and control of land management is a crucial one. Various kinds of rights exist in the form of legal title and more than one kind of title can exist on a piece of land at any time. Large tracts of land, indeed almost all of the land, is owned by the Crown and leased for cattle production to non-Indigenous enterprises as pastoral stations such as Headingly Station (Figure 30) and to the mining company, Xstrata. There is no Aboriginal owned land on the Queensland side of the border in the study region although most of the area is either covered by Native Title determination (Indjalandji-Dhidhanu) or under Native Title claim (Waluwarra/Georgina People) (see Figure 25). On the NT side of the UGRB region there is a small area of Aboriginal Land under *Land Rights (NT) Act* 1976 excised from Lake Nash Station where the community of Alpurrurulam has been established.

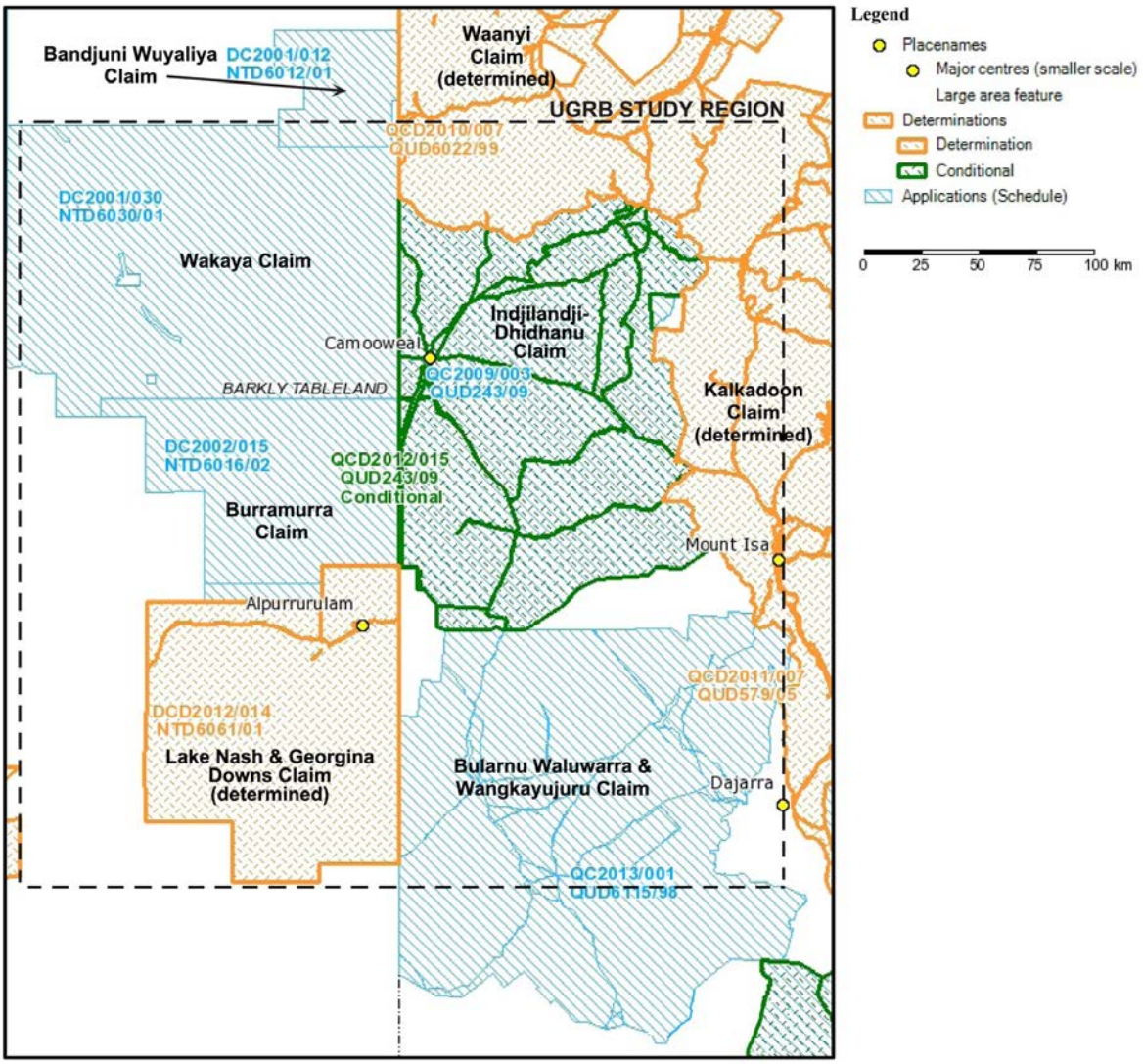

Figure 25: Map of Native Title Claims in UGRB study region. (Source: National Native Title Tribunal, 28/02/13.)

Responsibilities for land and river management in the Upper Georgina River Basin are mostly not in Aboriginal hands but are controlled by various bodies at all levels of government (federal, state, and local) with advice from regional natural resource management organisations such as Southern Gulf Catchment Management Authority, Desert Channels and Territory Natural Resource Management as well as non-government organisations such as Land Care. Although these groups are not all active across the study region, the potential risks to the environment from the impacts of climate change in North West Queensland which apply to the whole study region are relatively well understood and can be summarised as follows:

- Changes to native ecosystems in the long-term could lead to the loss of populations and perhaps more vulnerable species.
- The potential changes to water flow regimes has implications for ecosystems that are dependent on flows and flooding, with fauna dependent on water holes for maintenance of populations being threatened if inflow events become less frequent.

Though the natural ecosystems of this region are generally well adapted to climate variability, there is almost no capacity to artificially modify flow regimes to reduce any adverse impacts of climate change.

- Increased drought may result in changes in vegetation composition in grassland, savannah and wetland ecosystems, with more adapted species including weeds) displacing less adapted species" (Queensland Government 2009).

These potential impacts have specific implications for Aboriginal people and their role in environmental management strategies. This section of our report identifies the relevant themes that Indigenous people of the Upper Georgina River Basin communicated through the interviews and workshops about the threats from climate change and also potential adaptation strategies. In this context, adaptation and resilience strategies have been put forward together with potential barriers to action in relation to land and river management. Finally recommendations have been made which intend to capitalise on the cultural knowledge and commitment of the local Aboriginal community in collaboration with regional stakeholders in natural resource management.

9.1 Research Results – Survey Data and Workshops

Aboriginal people in the various survey locations have had different life experiences which are relevant to their understanding of environmental change. While many people recognised changes to their land and river system, others did not see any changes in the natural environment. Those people who are resident mainly in the remote communities of Alpurrurulam and Urandangi generally live more closely with the land and so have greater knowledge of changes relating to plant and animal species than people who reside mainly in Dajarra and Mt Isa. Furthermore middle-aged and older people have had more experience with traditional resource management strategies than younger people who may rarely go hunting and gathering on the land (whichever place they currently reside). Although the responses to Questions 41, 43, 45[8] could indicate that fewer people observed changes than those who did, the qualitative responses of most knowledgeable and generally older people suggested that observable environmental changes are occurring. For these reasons we have focussed in this section on the qualitative responses as they revealed the depth of local knowledge that some people hold.

As the survey results showed some people also had an understanding of climate change and its potential impacts. These perceptions add further dimensions to the adaptation strategies in that people may become increasingly overwhelmed by the scale and urgency of potential impacts of climate change for their land and river system. Adaptive strategies have taken into account these needs. Participants at the workshops were mostly middle-aged men and women who had spent significant parts

[8] Q41. Have you noticed any changes in fish, birds, animals, plants? Y 47.2%, N 37.5%, Don't know 1.4%. Q43. Have you noticed that some animals are having their young earlier or later in the season? Y 13.9%, N 56.9%, Don't know 1.4%.

Q45. Are there some plants, animals or birds that you don't see so much anymore, or have completely gone? Y 31.9%, N 41.7%, Don't know 1.4%.

of their lives in close contact with the land; they were invariably interested and knowledgeable about their country and ready to engage with the issues of environmental management and change despite their incipient knowledge of climate change. Through the interviews and workshop discussions, people identified the following areas of concern:

9.1.1 Changes to the Georgina River

In the first workshop and also in interviews, people commented on how sections of the river are becoming increasingly silted-up, brackish, altered by cattle use and other introduced plant and aquatic species. Open cut mining was also viewed negatively in terms of river management.

> *Water in the Georgina River has dropped right down. Plants that were there when I was a kid aren't around now, e.g. pennyroyal and a 'cane' [Swamp grass] that floats on water. All happened because small gullies have turned into creeks - very rough around the Georgina now. (Sally Maher)*
>
> *Fish die sometimes. Silted up – the river is so shallow. No floods so it has become brackish. (Henry Dempsey)*
>
> *Red-claw [crayfish, yabbies] on Georgina are a problem ... there's thousands of them. The water at Lake Nash is very muddy due to yabbies. (Ronell Frazer)*
>
> *Acid dams at Phosphate Hill caused pollution. Gypsum stacks are polluting Burke River [tributary of the Georgina River]. (Keith Marshall)*

9.1.2 Protection of culturally significant places

During the workshops and interviews many participants indicated the importance of looking after their country. The people quoted below are representative of the sample group interviewed, including men and women from Alpurrurulam, Camooweal, Dajarra and Mt Isa who ranged in age from late 20s to late 60s. Just as the entire sample showed a range of views about whether people are looking after land with culturally significant sites, the opinions in these quotes vary but divided along the following lines, namely:

- Concern about lack of care and knowledge shown by Aboriginal people

> *Bushfires burning [emu] nesting grounds making it harder to reproduce. (Dwayne Rankin)*
>
> *No one pays him (pointing to JM) he's a TO and is always trying to look after his country … we know the sites. (Colin Saltmere)*
>
> *Near Urandangi once I was shown a water-filled cavity in a drought (uncle's dreaming site). It was full of yellow belly. (Marlene Speechley)*
>
> *I will not kill turkey, goanna or porcupine because they're rare now. (Alec Marshall)*

When people burn grass today they don't think about, don't know which way it's going. They don't know what the old people used to do. (Jennifer Mahoney)

Before old people would stay with their law and culture – everything all right. Now mob go drinking in town – they're too busy in town not looking after sacred sites. (John Wickham)

Burnt out – not my 'secret side' – everything still there. [He's been burning and looking after sacred sites that he is responsible for.] Old people know, got to look after them. Lose old people and you never get any knowledge. (Willie Bookie)

Older people want the younger people to know how to look after country. Bushfires might burn sacred sites and damage our country. (Pam Corbett)

- Concern for destructive actions of outsiders, such as mining companies

  Mother earth is rejecting us. Too many mines, too many people. (Joel Saltmere)

- People aren't looking after the earth.

  My family really know because they will go hunting. They respect the country; they respect the dreamings. If others go into our country they respect and look after it. Here [Mt Isa region] the mine owns it, not the black people. (Trisha Frank)

9.1.3 Negative impacts from tourists on water ways

Large numbers of tourists visit the area particularly in the cooler months of the year for over night camping, such as on the lakes near Camooweal, and to fish in more remote river locations. There are many culturally important water places in the UGRB and currently there are no restrictions on tourists or other non-Aboriginal visitors except for some signage or fencing in a few places. Apart from concern about outsiders taking desirable resources such as fish and crayfish, Aboriginal people believe that most visitors are unaware of Aboriginal interests in the area.

I'm worried that too many tourists are impacting on the Georgina River. (Ronell Frazer)

Grey nomads are compressing the roots of the trees along the riverbank near Camooweal. (Shirley Macnamara)

Two sacred trees were graded out ... at Urandangi. A monument is to be erected. Waluwarra [people] had 394 special sites recorded. The Marmanya tree [sacred site] needs to be fenced off, but a fence might wash away, so I go with educational signage. (Marlene Speechley)

9.1.4 Changing seasons, unpredictable weather and impacts on land and water resources

People were aware of some seasonal variation between years and how some events occur a little later or earlier. Increasingly people are noticing that the variations are

becoming the norm and already they are adapting in some ways with this new knowledge, such as exploring different places for hunting. Also people commented on the degradation of hunting and gathering areas with favoured resources being adversely affected.

We don't know what's going on! (May Campbell)

Mainly we are noticing vegetation, bush tucker – goannas – plains and desert goannas hibernate in different seasons. Some coming out a bit too late. In Tennant Creek and Elliott they're still out now. In goanna season nothing was fat…. Bush tucker from trees is not coming in right seasons; not many bush bananas – not coming at the time we need them, after the wet. Wet was late bush tucker missed time to come out. Bush potato comes in winter-time. Last year we couldn't see the cracks. …Weather is changing, winter is shorter… One month ago went over 100kms to get kangaroo – nothing; and no goannas. No bush tucker – bush orange, bush banana. Reasons might be the mines or too many people – the 'roo shooters frighten them. (Trisha Frank)

Medicine, 'ilpengke' [possibly A. tenuissima] is better, stronger now with flower coming on. Put leaves in boiling water on fire … to wash that little boy (grandson). It's flowering early this year because of rains – also other seed plants; birds are nesting earlier, budgie, white cockatoo, galah - see them in holes in dead trees… (Eva Bookie)

At some time last year the weather messed up the time we'd go for bush tucker. Normally when rain came in Dec./Jan we get Feb, Mar and April to go hunt goanna, bush tucker, but this year we got one lot of rain, brought all that bush tucker up and then next rain washed them off. We only had first lot. But our old people say that the first lot are for the birds and animals and the second lot are for us. But there was nothing for us because the second lot of rain came [and ruined them]. (Jennifer Mahoney)

Had a hailstorm last year at Alpurrurulam. First time last year we've ever seen hail at Alpurrurulam (Jack Mahoney)

Weather pattern now: always cold/hot/cold/hot 'snaps', changing all the time. Not predictable. (Lennie Corbett, George Anderson, Jack Mahoney, Kerry Campbell, Nelson Casson)

Dead fishes at Alpurrurulam – early this year. Both sides of bank, Yellow belly, bream. Too frightened to eat them. Blamed on pelicans by some – but Jacky doesn't agree. At Lajamanu – same happened. (Lennie Corbett, George Anderson, Jack Mahoney, Kerry Campbell, Nelson Casson)

There used to be a flat plain – made for hunting and located around the road driving up to Camooweal on the Barkly – Alpurrurulam Road. Now the plain has dropped down. Slumped down. Sand has covered up land at Alekerenge. Used to be plain with salt tree. Spinifex all wiped out. Come from north. Drifted into

Community. Kids get sore eye, sick now. (Lennie Corbett, George Anderson, Jack Mahoney, Kerry Campbell, Nelson Casson)

Alpurrurulam hunters must go half way to Isa to get kangaroo. Ampilatwatje hunters come to Alpurrurulam for kangaroo. Bush turkey and kangaroo all come this way (i.e. to north). (Lennie Corbett, George Anderson, Jack Mahoney, Kerry Campbell, Nelson Casson)

9.1.5 Lack of consultation with regional stakeholders about resource management

People talked of the need for better consultation with Traditional Owners by regional stakeholders with cattle station and mining interests, e.g. on some stations the number of kangaroos has greatly decreased over the past few years, possibly because the station people shoot kangaroos too often and drive them further away (see also Figures 26 to 31 for the impact of cattle). Participants also argued that a return to traditional burning regimes would restore important resources, including kangaroo and reduce the threat to sacred sites. Other concerns were expressed as follows:

Roads over hills (made by graders) – they don't give two hoots – ripping up ground, making tracks and loosening the soil… Big rains come, causes erosion. (Sally Maher)

We used to go bush looking at sites and there are bushes growing that didn't grow there before. Maybe from mining companies aerial reseeding: 'Soap Bush' [Acacia holosericea]. (Marlene Speechley)Stations won't let Aboriginal people burn country. But they burn country, burn sacred sites! (Alpurrurulam men)

After mining they revegetate – wrong balance of species – upsets pattern. One species overtakes. There's no consultation with Traditional Owners. (Shirley Macnamara)

Overstocking on the Common. Cattle trampling the young trees and we're trying to keep it to a limit. Owner of the common on both sides of the GR has a limit to number of cattle… (Hazel Windsor)

Overgrazing town common in Camooweal – too much cattle in one paddock. Damage country. Erosion wipes out hunting grounds. (Alpurrurulam men)

Wild fire can kill cattle. They smell it and run. (Shirley Macnamara)

Figure 26: Rain erosion north of Dajarra (Photo by Daphne Nash)

Figure 27: Cattle tracks on the Georgina River near Urandangi (Photo by Daphne Nash)

Figure 28: Headingly Station (Photo by Daphne Nash)

Figure 29: Brolgas on the Georgina River (Photo by Daphne Nash)

Figure 30: Grazed grasslands on road through Barkly Downs between Alpurrurulam and Camooweal (Photo by Daphne Nash)

Figure 31: Barkly Downs Station trucking yards on the road between Alpurrurulam and Camooweal (Photo by Daphne Nash)

9.2 Results: Aboriginal Knowledge

The responses that Aboriginal people gave in the interviews and workshops, some of which have been documented above, suggest the nature and extent of land and river resource knowledge in the study region. As for other Aboriginal groups in Australia and for Indigenous peoples elsewhere in the world, traditional environmental management was based on detailed cultural knowledge, now known as Traditional Ecological Knowledge (TEK). In this report we prefer the term Aboriginal Knowledge (AK) to include both TEK and the historical knowledge acquired by Aboriginal groups in the UGRB region since the beginning of the contact period.[9] Through life and work on the cattle stations and more recently in mining and other activities, people have acquired new knowledge of environmental management.

In the debates on climate change including potential impacts on Indigenous people around the world (including Australia), much literature has focussed on their reduced capacity to combat change for various social, economic and historical reasons (e.g. Leary et al 2009). This lack of capability can be traced at least in part to their lack of relevant knowledge in a rapidly changing natural environment. In the right circumstances however Indigenous Knowledge can build and maintain both social and environmental resilience. Under changing environmental conditions, Indigenous people can be socially empowered by the relevance of their place-based knowledge and heritage and in conjunction with science can build and maintain the resilience of the natural environment, including biodiversity (Bohensky and Maru 2011; Dube 2009). Similarly our research suggests that Aboriginal Knowledge together with science can be a key component for adaptive responses to changes in the natural environment and to impacts of climate change for people in the UGRB.

9.2.1 Seasonal knowledge

Land and river management and resource use rely on knowledge of seasonal changes and the natural species' responses to those changes. The perceived signs of seasonal changes or related events involving plant or animal species or natural phenomena, such as winds and rain are called 'indicators'. Changes in the behaviour of such 'indicator species' (Lantz and Turner 2003) can help monitor the extent of seasonal variation over years. Local knowledge of this kind has been studied for many Indigenous peoples and is significant for studying the impact of global warming particularly because of the time depth of their knowledge (Berkes 2012). Australian research on Aboriginal understandings of indicator species is relatively new and unexplored although in some areas of northern Australia, such as the Torres Strait Islands research is well underway (see Green, Jack and Tapim 2010).

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[9] Aboriginal Knowledge (AK): A wide range of terms is used in the literature but the most commonly used and accepted term is Indigenous Knowledge (IK) or Traditional Ecological Knowledge (TEK). Increasingly Australian researchers are rejecting the use of 'Indigenous' and preferring 'Aboriginal', e.g. DKCRC (n.d.). Our report follows this trend and the recent style advice from the National Congress of Australia's First Peoples to the University of Queensland and uses the term 'Aboriginal', except when referring to the work of others who use other terms. In the study region, Aboriginal people referred to their knowledge in a variety of ways including culture, cultural knowledge, Aboriginal knowledge, old people's knowledge and also Traditional Ecological Knowledge.

In the UGRB region, people have observed the seasonal changes and associate them with a range of other phenomena. During our research, as people commented on seasonal events it became clear that their knowledge was extensive and local being based on many years of experience. For example, according to Molly Ah-One of Camooweal:

> *If you see plagues of grasshoppers then budgies, it's going to rain. When it's going to rain you get all different sorts of birds. When the rains are coming the kangaroos all move south. The cattle move towards it.*

Keith Marshall, a Waluwarra man from Dajarra (and also a member of our research team) provided the following indicator events for the study region (Table 4 below):

Table 4: Indicator Species and Events as told by Keith Marshall (Source: AERC)

Indicator species	Signs/Indicator event
Kangaroos	Look for tracks, fresh droppings; go to where they might camp near a waterhole, usually under gidgee trees
Frogs	You'll hear the frogs – they come out when a bit of rain starts to run down the gutters at Dajarra
Storm-bird	A big brown bird [possibly Channel-billed Cuckoo (*Scythrops novaehollandiae*)] makes a lot of noise and lets you know when the rain is coming in the wet season. Also when you see a bunch of galahs flying around, going stupid in the sky – going this way and that – you can bet it'll rain in a couple of days time.
Ants	Old people always used to say that when the ants are climbing up on everything in the house then it is going to rain.
Soap bush	You know when they've got seeds on them because all the galahs are hanging around eating the seeds. People don't use it now except to show kids how people used to get soap using the seed-pods.
Sugar leaves [lerp]	On gum trees usually after rain; you might see 50 or 60 corellas on a tree – they break off the leaves, eat the young leaves with the sweet stuff and drop all the rest; the leaves and bits are broken off and drop to the ground – make big heap to rake up in the yard.
Emu (stars in the Milky Way)	You know that dark hole in the Milky Way that looks like an emu … around July when it looks like the emu is sitting down, that's when it is nesting. When it starts to sit up when it's getting hotter towards summer time, wait until a couple of months after that while they're getting fatter (after they've been sitting on the eggs) and you can hunt them. Or maybe there's a single male walking around with them who is fat, because he hasn't been sitting on the nest.
Emu (feathers)	When you look at the feathers on the emu, if they're light coloured then people will say, "He's bone-y one" – but when they're dark, that's when the emu is fat."

9.2.2 Seasonal calendars

The seasonal calendars represented below are a preliminary attempt to document Aboriginal Knowledge for the Upper Georgina region. Two members of the research team, Keith Marshall, a Warluwarra man from the UGRB collaborated with a non-

Indigenous researcher on the team to document some aspects of Keith's knowledge. Several drafts of the calendars were discussed and amended accordingly. The calendars presented here do not purport to be a complete record of local Aboriginal Knowledge, instead, even in this elementary stage, the calendars are indicative of the nature and extent of previously undocumented understandings. We acknowledge that further work is required not only to elaborate these findings but more importantly to validate these or alternative representations of Aboriginal knowledge more broadly in the local Indigenous community, as others have discussed, e.g. Woodward et al (2012).

The UGRB seasonal knowledge is presented in two draft forms: a circular calendar (see Figure 32) and a calendar table (see Table10) containing further details and quotations. Seasonal knowledge includes understanding of cycles longer than one year but partly due to its bounded format, the circular calendar is only able to show a generalised annual cycle. In order to capture the well-known 'boom and bust' cycle of rainfall in the region (Robin et al 2011: 126-131), a circular calendar needs to be used together with linear calendars to give a more accurate depiction of changes over several years. Incorporating a wide range of data, seasonal calendars provide a 'highly detailed frame of reference' for the study of species and change (Veland et al 2013: 322). Although the UGRB calendars are in early stages of investigation, already they offer potential as tools:

- For the transmission of culturally significant environmental knowledge within the Aboriginal community and also through formal and informal education to the wider community;
- For capturing the cultural connections within knowledge, e.g. caring for certain species and the knowledge about them may be the responsibility of a particular group and others may not have this knowledge.
- To highlight knowledge about environmental management that may be complementary to science (adapted from Prober, O'Connor and Walsh 2011).

If developed further the calendars presented here could have a significant role in the adaptation strategies for the UGRB region (see Section 9.4).

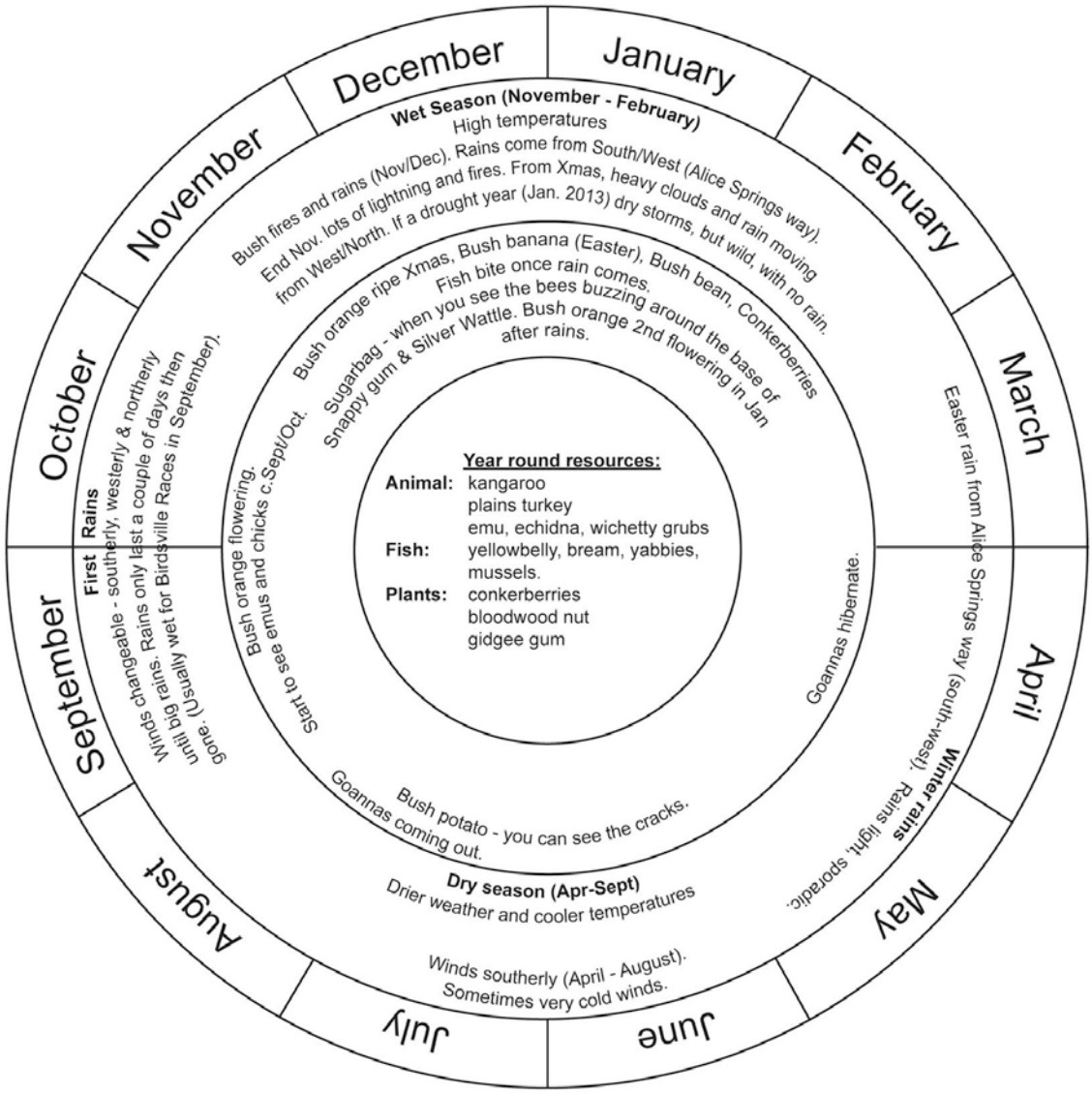

Figure 32: Upper Georgina River Seasonal Calendar A (Source: AERC)

Table 5: Upper Georgina River Seasonal Calendar B[10] (Source: AERC)

Calendar month (approx.)	Season (local)	Weather	Wind/rain/ Clouds	Animal/plant indicators	Activity - Resource related
November	Wet time	Hot; Bush fires and rains; lightning (from end Nov.)	End Nov. big rains begin	"Fish bite when rains come"; mussels, big ones around the Georgina River KM; "kangaroos move south" from Camooweal MA[11]; "see plagues of grasshoppers and budgies before rains" MA	"Queensland side stations burn spinifex"
December - January	Wet time	Hot Bush fires and rains	"From xmas time heavy clouds are moving from west to north"; "Jan. 2013 wild storms but no rain at Dajarra"	After rain, bush oranges ripe; also snotty gobbles (mistletoe fruit); bush cabbage grows along the creek after rain[12]; bush cucumber[13]	
February	Wet time or The wet	Hot Bush fires and rains		Feb – Apr. goannas fat; Bush tucker ripe e.g. bush banana	"NT side burn Jan. to 1st or 2nd week in April."[14] Good hunting for emu, turkey[15]
March	Green time	Cooling down	"Easter rains come from Alice Springs way"		
April		Cooler	Southerly winds	Kangaroos fat[16]; yellow belly; Goannas go underground	
May			Southerly winds	Bush medicine (*ilpengke*[17]) "stronger when bush flowering" Eva Bookie	
June	Dry time/ The Dry	Cool/cold; little/no rain	Southerly winds	Cracks in ground, new bush potato;	Dig for bush potatoes
July	Dry	Cool/cold; little/no rain	Southerly winds; 'cobwebs' blow in with winds from the north[18]		
August	Dry	Cool/cold; little/no rain	End southerly winds	Wild plum ripe	
September		"Rains only last for a couple of days"; warming up	Northerly winds begin	"Emu and chicks start to walk around"; bush orange flowering	
October		Hot weather starts			

[10] The information in the circular calendar, the table and text below is compiled by Daphne Nash based on interviews with Keith Marshall and additional information from other Aboriginal participants in the project, as acknowledged.

[11] MA: Molly Ah-One

[12] "In the stock camp at Ardmore Station they used to cook it up [bush cabbage]. Aboriginal and white people used to get a big bag full and take it to the cook. Next day he'd put it in the water with the corn beef and cook it up together." KM

[13] "When I was going to school in Dajarra, there was a vine growing wild at the school near the single-men's quarters. We used to pick them and try not to get caught! One old white lady used to get bush cucumbers and put them in a bottle with vinegar and have them like a gherkin with meat and bread." KM

[14] "You'll get fined after that!" KM

[15] "Wait for the kangaroos to get fat." KM

[16] "By end of April kangaroos are getting fat when the green grass dies off a bit; before that they're pretty poor just after rain while they're feeding on the green pick. They reckon that's when the kangaroos can have worms." KM

[17] Ilpengke (Gidgee fuchsia bush *Eremophila dalyana*) A powerful medicinal shrub from Alyawarre country, Ilpengke leaves are used in rubbing medicines to treat flues and chest ailments. A decoction of the leaves is also used to treat scabies and other skin complaints.' (Olive Pink Botanic Garden 2012). The specimen being processed however was not a species of *Eremophila* but possibly *Acacia tenuissima* (see Figure 34). More information needed. Gidgee Gum also used for medicinal purposes (see Figure 33).

[18] People talk of long white lengths of fibre 'cobwebs' that blow in with northerly winds – can be several metres long. Some say it is from a large harmless spider's web. KM

Figure 33: Gidgee Gum used for food and medicine (Photo by Keith Marshall)

Figure 34: Bush medicine tree (Photo by Keith Marshall)

9.3 Adaptation Strategies

Key features of Aboriginal people's perceptions of their capacity to adapt to climate change in the UGRB include their desire to stay in the region (i.e. place-attachment) coupled with their traditional cultural responsibilities linked to their particular kin relationships to land and people. These values, ideas and motivations can be converted to adaptive advantage through a suite of appropriate management strategies. Attachment to place may be viewed as a barrier to adaptation when changing climatic conditions demand permanent relocation, as in the case where rising sea-level floods coastal communities or indeed where change is so great that continued occupation is not viable. As Memmott et al (2006) have demonstrated,

however, Aboriginal people in the study region are highly mobile throughout the region and neighbouring regions in the NT and Queensland for social and cultural reasons, often residing in different places for extended periods with their kin. In this way, Aboriginal people strengthen their resilience and ability to cope with change through family networks. The following adaptive strategies address the need for building and maintaining both social and environmental resilience (Bardsley and Wiseman 2012; Muir, Rose and Sullivan 2010) through greater knowledge of, access to, and control of land and river resources:

9.3.1 Documentation, mapping and protection of culturally and historically significant places, including culturally significant plant and animal resources.

Indigenous people's knowledge is relevant for answering questions about climate change and biodiversity particularly in relation to 'key stressors such as fire, invasive species, salinity, disease, changes to water availability, grazing and clearing' and about 'the integrated implications for ecosystem structure and functioning' (Hughes et al. 2010: 5). Mapping can be a useful tool to provide baselines for understanding biodiversity and changes to species.

Georgina River people's comments about environmental changes point to the need for further research to map the distribution and abundance of valued land and water resources as well as commenting on their current state, e.g. threats from feral species and disappearing waterholes. As others have emphasised, Aboriginal peoples' effective participation in resource management is dependent on their knowledge being recognised as complementary to scientific knowledge and valuable (Altman 2012). At the time of writing the Indjalandji-Dhidanu group produced an account of their Traditional Ecological Knowledge (Graham and Sheldon 2012), which sets out their current concerns about natural resource management, and the areas in which they are already active and the partnerships which facilitate their work. The group is developing an archive of Aboriginal Knowledge to inform their work and so far is focussed on local plant uses. Some aspects of this work have been produced as a series of plant information sheets documenting Aboriginal knowledge of plants in the Barkly region (Dugalunji Aboriginal Corporation 2012). Together these projects demonstrate the wealth of Aboriginal knowledge and people's desire to communicate it to others but also the previous lack of previously recorded knowledge.

Aboriginal people also understand the need to get baseline scientific data so that they can be more informed about the changes they have seen and about future changes. It is not possible to accurately plan for the future without information that comes from fine-grained research or close and continual contact with the land. Using that information, there is potential for collaboration with other groups who have conducted recent surveys in the region such as Northern Territory and Queensland Governments and the mining company Xstrata. People expressed concern over the possible contamination to ground water from mining activities in the region.

At back of Mt Isa mine, everything is dead, even spinifex.... (Alec Marshall)

Cooperation and information sharing with mining companies could be beneficial for planning around such contingencies.

In the August 2012 workshop participants were shown how other groups in northern Australia including the Ngan'gi of Daly River, NT and the Bunaba from Fitzroy Valley of the Kimberley region in Western Australia have used well-documented environmental resource knowledge to maintain and transmit cultural knowledge (Jackson et al. 2012). The project included cultural mapping where use of important places is noted and tracked over time. A similar kind of project could be effectively undertaken with knowledgeable people in the study region, especially where they live on the traditional lands near Alpurrurulam, Urandangi, Camooweal and Dajarra.

> *We know a lot of fishing holes along the Georgina like that … and places we go for kangaroo. We've been going to the same places (Keith Marshall)*

The idea of a representative UGRB group put forward at the first Camooweal workshop was based on a vision of greater local Aboriginal participation in land and river management, such as burning. Participants considered the potential benefits of collaboration between communities in the region but also saw the value of individual people's knowledge of particular species in particular places. Aboriginal people in the UGRB are well placed to indicate which species require assistance and where there is need for more information on life cycles. For example,

> *We need to study yabby demography. (Marlene Speechley)*

As so many people are observing their decline in the usual fishing spots but also the over-abundance of some species in particular places, workshop participants suggested that further documentation and dissemination of local Aboriginal people's knowledge and understanding of the environment could have a positive influence on the actions of outsiders when they visited the region.

> *Local tourist guide of Camooweal – no reference to Aboriginal people. (Shirley Macnamara)*

Scientific studies have documented aspects of the biodiversity in the Georgina River. In particular, the river system has significant value as it hosts some unusual species, e.g. the large dark blue-grey shelled mussels appear to be restricted to the Georgina River system in the arid NT and some species of fish such as the Golden Goby whose population in the Georgina River is possibly genetically unique (Duguid et al 2005: 190, 151). Just as the full extent of scientific knowledge of plants and animals in the region has not been explored, Aboriginal knowledge for the region is under-explored in the literature. Our preliminary investigations to compile a seasonal calendar relied primarily on information provided from this project. The recent works from the Dugalunji Aboriginal Corporation mentioned above can be drawn on for further work on seasonal calendars and other aspects of Aboriginal Knowledge.

It is important to acknowledge the complementarity of Aboriginal and scientific knowledge systems for prioritising, planning and managing resources in a sustainable way. Precedents now exist particularly in northern Australia for their complementary

use in natural resource management, e.g. on the Daly River, NT (Woodward et al 2012). Documentation of Aboriginal Knowledge can have other social and cultural applications, e.g. for capacity building through education and training at all levels and for reinforcing regional, group and individual identity.

9.3.2 Negotiation over land and water use with regional stakeholders including pastoralists and all levels of government by the newly proposed UGRB group

May Campbell's statement in her interview captures a point of view held by several Aboriginal participants:

> *Mother nature is opening people's eyes but the government closes its ears.*

During the first Camooweal workshop, participants spent considerable time discussing current land tenure in the UGRB region and ways to ensure that Aboriginal voices are heard. They identified the need to negotiate with regional stakeholders, such as station owners/managers, mining companies and local councils. During discussions one group put forward the idea of a local group to coordinate and oversee such negotiations, calling for better recognition of Traditional Owners, their knowledge and traditional management. Aboriginal workshop participants identified issues for negotiation including:

- Consultation between Aboriginal people, pastoralists, mining and other companies about re-vegetation (need to make planting species compatible with bush tucker) and control of feral species (opportunity to collaborate with land care specialists in other areas to develop skills in this are).
- Working with stations to put up signs for tourists, e.g. No hunting, fishing, camping signs in places of special significance for local people
- Use of fire. Although some knowledge of traditional practices exists, Aboriginal people in Queensland especially have not been able to burn on station land. Conflicts of interest exist with pastoralists who have concerns for their cattle and stock feed, so burn in ways to suit grazing regimes. On the other hand some evidence from the region provided at the Workshop from a mining company biological survey suggests that inappropriate fire management is a threat to ecosystems, e.g. gidgee and other key species.

Some participants have had experience in negotiation and litigation for Native Title which came into being under the *Commonwealth Native Title Act* 1993. The Warluwarra/Georgina People have a Memorandum of Understanding (MOU) with the pastoral leases and the Indjalandji-Dhidanu are proposing an Indigenous Land Use Agreements (ILUA) which allow traditional owners in Queensland to apply for a range of rights relating to the management of land and water administered under the *Native Title (Queensland) Act* 1993. In the NT, a separate body is responsible. The proposed Georgina River Group could engage with this process in a cultural advisory role for claims that apply to both states.

9.3.3 Education about Aboriginal land and river management (history and culture) in the region

Educational issues relating to land and river management in the UGRB centre on the kind of knowledge (Aboriginal and scientific knowledge) and access to it, including the transmission of Aboriginal people's knowledge and also access to and support for relevant formal education on scientific aspects of climate change in the school and TAFE systems. As discussed earlier in this section, Aboriginal people expressed concern in interviews and workshops about the erosion of environmental knowledge as older people pass away.

> *Lose old people and you never get any knowledge. (Willie Bookie)*

Due to on-going cultural and social change, the opportunities for intergenerational transmission of knowledge have greatly reduced, including loss of Aboriginal languages in the region. Nevertheless, some older Aboriginal people in the study region have significant cultural knowledge about the local environment and 'would like to teach the young ones'.

> *People still worship culture way. People can still sing and dance for the rain – they can dance and cool the place down. (Pam Corbett)*

Passing on this kind of knowledge and related values can strengthen people's ability to cope with change as they reinforce belief in the survival of their culture.

During both Camooweal workshops, Aboriginal participants called for a range of educational initiatives across institutions, including local schools (primary, secondary and post-school), the wider community (tourists in particular) and also within the local Aboriginal community to fill the knowledge gap about climate change. Participation by local knowledgeable people in the collection, documentation and dissemination of the information would be an important part of the process to build adaptive capacity.

Apart from Aboriginal knowledge there is currently a lack of detailed scientific understanding in the Aboriginal community in the study region about how the UGRB is responding to climate change. A complementary approach to land and river management based on Aboriginal Knowledge and scientific knowledge would require careful planning and would involve significant research and collaboration to develop local educational resources. This kind of approach to acquiring knowledge for managing the environment followed elsewhere in Australia (see Horstman and Wightman (2001)) could arguably increase local Indigenous capacity for managing the impacts of climate change.

On the other hand, lack of education limits adaptive capacity and educational resource development cannot be effective without better access and support for Aboriginal students in the region. For various social and economic reasons, many young people are not participating in education sufficiently to achieve success (Biddle 2010). Lack of education has effects on their lives after school. In 2006, Aboriginal and Torres Strait Islander Queenslanders aged 18-24 were less likely to be fully engaged in the economy than non-Indigenous young people and this increased with remoteness. With

21% of Queensland's Aboriginal and Torres Strait Islander people living in remote and very remote areas of the state (Queensland *Closing the Gap* 2010) that includes the study area, these young people are a significant population. Educational and training facilities including Myuma at Camooweal are very aware of these current issues as they continue to engage young Aboriginal people in a range of pre-vocational courses.

9.3.4 Training and employment of local Aboriginal rangers

Ranger training was appealing to the Georgina River group because of their many concerns about protection of significant sites, about the practical problems of degraded or inaccessible waterholes and the issue of traditional burning regimes. Although they have knowledge of country, without the appropriate skills, transport and equipment, it is not possible to carry out the management work required especially over such vast areas of land. Over the last 10 years, many Aboriginal communities in northern Australia and elsewhere have established ranger-training programs which have had significant achievements for environmental management (Kerins 2012).

Ranger training covers a broad range of transferable skills, such as machine operation and maintenance, fencing, tree planting and bore maintenance, providing opportunity for other employment. In remote communities such as Alpurrurulam job and training opportunities are very limited and non-Indigenous outsiders hold most of the few skilled jobs in education, health, administration and other services. Having local and experienced Aboriginal work force makes a long-term program of sustainable management practices more feasible.

Ranger work is especially suitable for Aboriginal people who are local and already living on the land. For the Georgina River people, most residents have lived in the area all of their lives and are connected through kinship relationships to areas of land and to particular places – they have responsibilities to their kin and to the land. With appropriate support, the local Myuma group (Memmott 2012) is in the process of expanding their training operations to include ranger training. With the advantage of being an established and successful training institution located on country, Myuma has begun to offer local young people both cultural and environmental knowledge and skills at their Dugalunji camp.

Following the collaborative model between Indigenous owners living on the land and others who can assist (Altman 2012), there may be opportunities for local people with ranger training or similar skills to collaborate with land-owners in the region such as pastoralist, mining companies or local government to conduct management activities. Recently in the NT the Barkly Land Care group provided training in weed eradication and control to Aboriginal people from Corella Creek on Brunette Downs station. This group now carries out this kind of work for the station and also travels to other stations (N. Wilson 2012, pers. comm., 29 November).

9.4 Barriers to Adaptation

There are many barriers operating against the potential strategies for Aboriginal people in the Upper Georgina River region. These barriers are discussed in terms of:

- Resourcing, and
- Cross-jurisdictional issues and the regulatory environment.

9.4.1 Resourcing

Problems in resourcing affect all of the four stated adaptation strategies in significant ways. Each adaptation strategy has been addressed and the relevant barriers listed below.

Resourcing barriers to the documentation, mapping and protection of culturally and historically significant places relate to both human and financial resourcing and include the lack of:

- Availability of qualified and skilled people to record knowledge;
- Access to knowledgeable people in the Aboriginal community. As knowledge holders pass on the traditional knowledge for particular areas of land is eroded.
- Funding to support a recording program which could include multiple field trips, Indigenous and non-Indigenous payments
- Funding to establish and maintain an archive for knowledge storage and retrieval
- On-going funding to protect sites, e.g. to conserve culturally and environmentally important natural areas.

Resourcing barriers to negotiation over land and water use with regional stakeholders include lack of:

- Availability of knowledgeable Aboriginal people (often elderly people)
- Appropriate representation from all stakeholders
- Funding for training in cross-cultural communication and awareness
- Funding for meetings between stakeholders
- Funding and resources for lobbying local authorities and governments.

Resourcing barriers to education in schools and in the wider community about Aboriginal land and river management include lack of:

- Appropriate teacher training and professional development relating to IK
- Teacher-ready resources to apply in the classroom
- Availability and training for Aboriginal community mentors and teachers
- Commitment and leadership from the relevant education authorities
- Local government resources to build relationships with local Aboriginal community
- Funding for development of interpretative material, in collaboration with local Aboriginal community, such as a Georgina River booklet for tourists to inform about Aboriginal history in the region.

Resourcing barriers to training and employment of local Aboriginal rangers include lack of:

- Funding for ranger training programs, especially within the Barkly and Georgina River regions, e.g. Queensland Indigenous Land and Sea Ranger Program
- Funding for salaries and equipment including vehicles for rangers in the field
- Availability of suitable trainers and mentors.

9.4.2 Cross-jurisdictional issues and the regulatory environment

The Upper Georgina River Basin region straddles the Northern Territory/Queensland border which has impacted on the ways in which the land and river have been managed. Each state has its own government with a range of departments responsible for land and water related issues. Regulations that support the various government policies are different for the two states. The Australian Government also has responsibilities for aspects of land and water management and its policies apply to both States. For example, Natural Resource Management (NRM) bodies have support and advisory roles in the study region: Southern Gulf Catchment Authority overlaps very slightly with our study region in the north and east, the vast Desert Channels NRM region stretches from Camooweal to the border areas of south-west Queensland, and Territory NRM covers the whole of the NT. There is very little engagement between these groups although each advises on planning for parts of the UGRB region.

A cross-jurisdictional issue currently exists in relation to the *Wild Rivers Act 2005* which covers the parts of the Georgina River within Queensland. The central aim of the legislation is to manage and protect the natural values of the Georgina and Diamantina Basins (Queensland Government 2011). Activities along the entire river impact on its overall condition, especially when it flows. Yet outside Queensland, the Act cannot be enforced. Currently the Queensland Government is reviewing the Act and UGRB people are concerned about the future protection and development of the Georgina River, one of the 'Wild Rivers'.

The following cross-jurisdictional issues and barriers formed by the regulatory environment can impact on land and river management in the UGRB region.

Barriers to the documentation, mapping and protection of culturally and historically significant places include:

- State boundaries that operate for environmental and heritage protection
- Fragmentation of relevant environmental information along state jurisdictions e.g. scientific studies from environmental and land management experts.

Cross-jurisdictional barriers to negotiation over land and water use with stakeholders include:

- Title to land based on commonwealth and state legislation
- Structure of current land management divided on state basis, e.g. Land Care
- No provision for Indigenous land management in the study region
- Native Title process including the negotiation of ILUA, is cumbersome, slow and difficult.

Cross-jurisdictional barriers to education on climate change in schools and in the wider community about Aboriginal land and river management include lack of:

- Shared curriculum for schools including programs on ecology, Aboriginal Knowledge and climate change in the UGRB region
- Indigenous cultural resources on climate change adaptation at the regional level incorporating Queensland and the NT.

Cross-jurisdictional barriers to training and employment of local Aboriginal rangers include:

- State-organised ranger training which makes it difficult for the UGRB region to have a coordinated program with participants in two states
- Lack of access to highly resourced NT training opportunities for Queensland based group.

9.5 Key Recommendations: Land and Riverine Management

As a result of our study we recommend that the following actions be taken to further develop the adaptive capacity of Aboriginal people in the Upper Georgina River Basin region in order to reduce the impacts of climate change on their land and river system:

- Document traditional land use and knowledge of significant environmental resources in collaboration with local Aboriginal people
- Build the capacity of Aboriginal representatives in the practices of negotiation over environmental protection strategies and access to funding
- Encourage government to support greater involvement of Aboriginal native title holders and applicants on their lands
- Support the development of locally focused curriculum materials on Aboriginal environmental knowledge for all levels of education
- Develop a range of educational resources on land and river management and climate change in the UGRB, for use in local and regional schools and the wider community
- Collaborate with the local Aboriginal community to develop information resources for their use on the local impact of climate change as it effects land and rivers in the UGRB region
- Build relationships between the Aboriginal community and local government and community groups in the study region so that the wider community becomes more aware of Aboriginal history and culture
- Support local Aboriginal groups to gain access to ranger training programs in the Georgina River region

In the literature review of this report, we highlighted the marginalization of Aboriginal knowledge in relation to scholarly research on climate change adaptation. We also noted the salience and importance of Aboriginal knowledge about the changing environment. By foregrounding the role of Aboriginal knowledge in land and riverine management in the Upper Georgina River Basin, this report makes important contributions the research priorities set out in the NARP. The use of Aboriginal knowledge of the environment – and environmental change – serves as important baseline data for observing and adapting to future change. Moreover, Aboriginal knowledge systems have proved to be a useful resource for broadening our understanding of the bio-physical and socio-cultural constraints upon the Aboriginal people of the UGRB to adapt successfully to climate change, given that much of their activity in the 'hybrid economy' (Altman 2012) relies upon economic and cultural resources that have heretofore been abundant. Conversely, utilizing Aboriginal knowledge of the natural environment will likely provide important opportunities for

successful climate change adaptation. This may be achieved by developing a culturally embedded approach to land and resource management, which in turn, may also help Aboriginal people of the UGRB to overturn the socio-ecological and economic vulnerabilities they currently face.

10. HOUSING AND SETTLEMENTS

This section of the report provides an outline of adaptive responses to the potential effects of climate change on Aboriginal housing and settlements, and their associated infrastructure. The four case study settlements are Camooweal, Dajarra, and Urandangi in Queensland, and Alpurrurulam in the Northern Territory. These small remote settlements typically have a high percentage of Aboriginal and Torres Strait Islander residents (ABS 2011). Beer *et al*. (2012) identify this type of inland community as the most susceptible to risk from climate change, which poses a range of chronic and acute threats to the Aboriginal inhabitants of settlements in the upper Georgina River Basin.

Climate change models for the upper Georgina River Basin increase particular risks for Aboriginal people that are either directly or indirectly related to their built environment. These risks include:

- Increasing temperatures and heat waves can result in thermal stress, affecting the health of housing residents (AMA 2013; Pricewaterhouse Coopers 2012);
- Increasing temperatures will affect the performance of building fabric and building services;
- Increased evaporation and variable rainfall has implications for drinking water supply;
- Wind gusts from extreme weather events threaten existing building structures;
- Dust storms can affect human health, infrastructure and building fabric;
- Flooding events affect transport and communication infrastructure;
- Flooding events damage housing and displace people;
- Bushfires threaten infrastructure, buildings and livelihoods;
- Weather-damaged infrastructure compromises the safety and sustainability of settlements in remote regions;
- Ecological change vary risks of vector-borne disease, which has implications for housing construction and maintenance;
- Increased risks from food and water-borne disease that that relate to food storage and preparation; and,
- Heat, evaporation and less predicable rainfall may affect the conditions for domestic production of fresh food.

The focus in this section is on planning for the long-term effects of climate change. Section 8 preparedness and emergency section also outlines the effects of extreme weather events on the built environment.

10.1 Aboriginal Settlement Profiles of the Region

This section presents a profile of the four Aboriginal settlements of the region that are the principal focus of the housing and infrastructure section.

10.1.1 Alpurrurulam

Alpurrurulam is a discrete Aboriginal settlement located in the Northern Territory, about 120 km south of Camooweal (192 km by road), and roughly 80 km from Urandangi.

Frequently called Lake Nash, Alpurrurulam is within the Barkly Shire, but located 640 km to the east of the Shire's administrative centre Tennant Creek. The settlement is at the eastern end of the Sandover Highway, an unsealed track that is invariably cut during the wet season, which meets the Stuart Highway north of Alice Springs. Several unsealed roads north of Lake Nash join the Barkly Highway, providing alternative routes to the regional service centres of Camooweal, Mt Isa and Tennant Creek. Each of the roads from Alpurrurulam is impassable after relatively small amounts of rain, and thunderstorms can cut access to the settlement for short periods when the Georgina's tributaries quickly rise over causeways. The Lake Nash Station airstrip serves Alpurrurulam but is unsealed.

The settlement was formed in c1989 when roughly 4 km^2 was excised from Lake Nash Lease, with which many Aboriginal people in Alpurrurulam have historical, socio-cultural and economic association. The settlement formation was catalysed by the King Ranch Pastoral Company trying to close down the Aboriginal pastoral camp in the 1980s when it no longer had use for Aboriginal labour, which had been its mainstay since the 1870s. Despite their lack of facilities in makeshift humpies, the community refused to leave due to their attachment to the area. Alyawarr people make up the majority of the community, and have strong traditional connections to country to the west on the Sandover and Elkedra and Frew Rivers in the Northern Territory. However due to their ceremonial and custodial succession to the Lake Nash region they recently mounted a successful Native Title claim to the Pastoral Lease. According to the 2011 census: 'In Alpurrurulam 10.2% of people spoke English at home. The only other responses for language spoken at home were Alyawarr 86.5%, Warlpiri 0.7% and Arrernte 0.7%' (ABS 2013).

In 2011 in Alpurrurulam, 417 Aboriginal people made up 87% of the total population of 442 (ABS 2013). This compares with a population of 322 Aboriginal people in the 2006 census and 346 in the 2001. Since 2006, the Aboriginal population increased by almost 30%. While the median age in 2011 was 21 years, significant intra-regional mobility complicates the interpretation of demographic change over time. All housing in Alpurrurulam is public rental housing with no home ownership. Aboriginal residents occupied 80 of the 100 houses counted in the 2011 census, with an average of 5.2 people per dwelling. With regard to mainstream infrastructure services, Indigenous Essential Services, a not-for-profit subsidiary of the Power and Water Corporation, are responsible for the water and electricity supply to Alpurrurulam. In 2012 Indigenous Essential Services installed a photovoltaic solar power station to be integrated with the existing diesel power station and commissioned in 2013 (Power Water 2012). Town water is supplied from bores, with groundwater limited and of marginal quality. The per capita water consumption is typically high at 677 L/person/day (Power Water 2012: 9).

10.1.2 Camooweal

The town of Camooweal was established on the Georgina River in 1884 with customs, stock and cross-border transport functions. The Barkly Highway passes through the town linking Townsville and Mt Isa to Tennant Creek being the only east-west bitumen road across the continent in Northern Australia. Camooweal is 13 km east of the Northern Territory border, 188 km west of Mt Isa and 484 km east of Tennant Creek. Although it is the major vehicular route from northern Queensland to the Northern

Territory, in the wet season, river flooding can still cut the Barkly Highway. Camooweal can be isolated for short periods, but this is less frequent since the highway was upgraded in the early 2000s.

The township of Camooweal is in the Mount Isa City Council local government area, and municipal services (water, sewerage, waste and public space) are administered and supplied from Mt Isa: for example, domestic rubbish bins are emptied by a truck, which travels the 188 km trip, from, and returns to Mt Isa. The Camooweal Aerodrome is owned and maintained by the Mt Isa City Council and used regularly by the Royal Flying Doctor aircraft.

In the 2011 population census, Camooweal had a population of 187 in the 2011 census, with 105 (56%) Indigenous people. The median age of the Indigenous population was 20. During much of the twentieth century Camooweal was a much larger town when cattle stock was moved across the continent by drovers, but since the advent of beef trains and mechanical mustering its role as a pastoral centre fell away. Its main economic mainstay is now passing winter tourist traffic and the services provided to the Dugalunji Camp.

This population decline is reflected in the recent census housing profile: out of a total of 73 dwellings, 17 (32%) were unoccupied in 2011. Indigenous housing is managed and supplied by the Department of Housing and Public Works while electricity is supplied to the town by an Ergon Energy power station run on automotive diesel, which is delivered by road transport. The sub-artesian bore water supply has a high lime content, which affects the distribution system of potable water throughout the community.

10.1.3 Dajarra

Dajarra is a small, remote town located 150 kilometres south of Mt Isa. Situated toward the eastern edge of the Georgina drainage basin, Dajarra was established on Carbine Creek in 1917 as a railhead to the Great Western Railway. Aboriginal people from the region began to migrate to Dajarra in the 1930s. In the 1960s and early 1970s, the State ‘resettled’ Aboriginal people from the Georgina River to Dajarra. The closure of the police station at Urandangi, and mandatory schooling for children, were reasons given for the forced movement of Aboriginal people to Dajarra. Roughly equidistant between Boulia and Mt Isa, Dajarra has developed into an important social and service town for Aboriginal people from the greater local area. (Long 2005, 2007.)

In the 2006 census, Aboriginal people made up about 85% (151) of the population of the 178 residents of Dajarra. In contrast to many of the discrete Aboriginal communities of the Gulf and Cape York Peninsula, the population of Dajarra has declined slightly over the last decade (see Tables 6 and 7). Health services, secondary school education and employment, as well as socio-cultural factors, draw Dajarra people to Mt Isa (Memmott *et al.* 2006).

Table 6: Population change in Dajarra, 1981 to 2006.

	1981	1986	1991	1996	2001	2006
Aboriginal population	250	146	154	171	163	151
Total population	300	180	190	204	190	178
Aboriginal proportion	83.4%	81.1%	81.5%	84.2%	85.8%	84.4%

(Source: Memmott et al. (2006) and ABS (2009)

Table 7: Populations of settlements in north-western Queensland and east Northern Territory, 2006.

Place	Indigenous Population	Total Population	Proportion Indigenous	Settlement Type
Dajarra	151	178	84.4%	Town
Boulia	75	205	36.6%	Town
Urandangi, Marmanya	20	25	80%	Town/ outstation
Mount Isa	3,089	18,857	16.4%	Regional city
Camooweal	131	312	42.0%	Town
Alpurrurulam	322	343	93.9%	Discrete settlement
Cloncurry	1,149	2,384	%	Town
Burketown	53	173	30.6%	Town
Doomadgee (locality)	979	1,052	93.1%	Discrete settlement

(Source: Table by Long (2005:69) and figures based on ABS (2009) except Urandangi from Long (2005)

The Aboriginal housing stock of the community is managed and delivered by two separate entities; the State Government, through the Department of Housing and Public Works, and the Commonwealth funded Aboriginal housing organization, Jimberella Housing Co-operative. The State managed the tenancy of 18 houses in Dajarra, while in 2012, Jimberella managed 26 houses, including one dwelling in Mt Isa that was rented to the general public through a real estate agent. The Jimberella Housing Co-operative was established in 1974, initially to provide affordable housing for Aboriginal people in Dajarra. The Co-operative owns the Jimberella Hall and the attached offices with the Jimberella Hall and office complex serving as a central location for service providers and consultants visiting Dajarra and as a venue for formal and informal meetings. As well as its social function, the hall is used to accommodate groups of visitors to Dajarra, and has been used for temporary accommodation for

locals when flood-prone houses are inundated during the wet season. This occurred in January 2009, when 300 to 400mm of floodwater passed through seven State houses, prone to flooding when Carbine Creek rises.

The township of Dajarra lies within the boundaries of the Cloncurry Shire, which is administered by the Cloncurry Shire Council. The main sealed road from Cloncurry to Dajarra is via Mount Isa, which, since the 1960s, has become the major service centre in the Northwest region, and head quarters of the Mt Isa City Council. The Boulia Shire, located to the south of Dajarra and is responsible for maintenance and upgrades to the Diamantina Developmental Road, which passes through Dajarra to Mt Isa. Thus, for a road trip to their Shire offices, Dajarra residents travel on a road maintained by a second local authority, passing through a regional centre under the control of a third local authority. The Mica Creek Power Station in Mt Isa, supplies electricity to Dajarra and most of the northwest region, through the Ergon Energy-owned distribution network. In 2012, the Queensland Government-owned, gas-fired power station at Mica Creek was not connected to the national grid. The domestic use of electricity in Dajarra was relatively high, related to the use of air conditioners, hot water systems and refrigeration.

10.1.4 Urandangi

Urandangi is located on one of the perennial Georgina River waterholes, close to the Northern Territory border. Like Camooweal, it was also established in the 1880s as a border customs and cattle processing centre to accommodate the numerous droving plants moving between the Queensland railheads and the Northern Territory and Kimberley cattle stations. Its function in this capacity ceased in the 1950s when a number of services were shut down by the government (police, school, stock inspections) and the Aboriginal population was moved to Dajarra. The town now consists of the Urandangi Hotel, and a small number of private houses and Aboriginal households living in self-constructed camps. The small Aboriginal community of Marmanya is only a few kilometres east of Urandangi. Established in 1984, Marmanya consists of six houses and a community hall. The settlement was located on a ridge to avoid seasonal flooding. The re-established Urandangi State School is located next to the community. The community name ‘Marmanya’ derives from the name of a sacred Caterpillar site in the Georgina River a small distance to the immediate west of the town.

At Urandangi one Aboriginal family occupied a timber building that was once the police station, one man owned a block of land with a shed as a house and has running water and sewage connected, and another family occupies a caravan on a serviced block. In the late 2000s there were around six camps comprised of caravans and self-built shelters. Some of these were on blocks owned by Aboriginal people. The Boulia Shire Council is the local government service provider for Urandangi however the council administration is located approximately 300 km away in Boulia. The nearest towns are Dajarra (160 km south-east), Mt Isa (173 km north-east) and Camooweal (160 km north). However all of the connecting roads are likely to be cut in wet weather, isolating the townspeople. Privately-operated generators and solar arrays are the source of electricity in Urandangi, which is not connected to the Ergon grid. In 2007, Marmanya had been without an electrical supply for five years until residents entered into a

Shared Responsibility Agreement (SRA) with the Indigenous Co-ordinating Council (ICC) under which each dwelling was provided with a generator, with householders responsible for their own fuel. The water supply to Urandangi comes from sub-artesian bores.

10.2 Research Results – Survey Data and Workshops

The sources of data on Aboriginal housing and settlement infrastructure were firstly surveys and interviews, and secondly the two workshops. The workshops – particularly the first – elicited anecdotal responses to presentations as well as directed group discussions. Observations in the field and literature on the region contribute to the description and analysis of the built environment and its relationship to Aboriginal communities in the study region. The surveys were used to ask 32 questions about the informant's experience and use of the built environment and utilities. This included housing, domiciliary behaviour, water supply and electricity, with some questions related to weather. Three of the questions required qualitative responses. In regard to housing, 72% of the respondents (N=68) agreed that their house was too hot in summer and similar numbers agreed that their houses were too cold in winter. Over 70% used air-conditioning to 'get through summer', although the preference to live in an air-conditioned house was less than 50%.

The responses demonstrated that preferences for outdoor living were still prevalent in the settlements, and external areas were used to adapt to summer temperatures. Just over half of the respondents agreed that they camped most of their time outside in summer, and 73% expressed a preference for outdoor shaded areas over house interiors. In the survey, just under half of the respondents preferred to sleep outside in summer. These sorts of domiciliary behaviours – external orientation, and camping in yards and on verandahs – are common to traditionally orientated communities (Memmott 2003). Well-designed housing and yards can support and encourage these types of behaviour, which are sustainable responses to the arid and semi-arid climates.

Although two thirds of the participants agreed that they could afford their current electricity bills, three out of four respondents were expecting charges to increase. Interestingly, 55% worried a lot about paying bills and the same number of respondents had changed the way they used household appliances in an attempt to moderate electricity usage. A smaller but still significant number (37%) had changed the way they lived in their house and yard due to extreme weather events.

The participants were also asked a qualitative question on their dwellings that elicited information about suggested approaches to adapting housing for hotter weather: If it gets hotter in summer how would you change your house to make it more comfortable in summer? The significance of this data is limited without providing more detail on the respondents' housing conditions at the time, but it is revealing nonetheless.

The most frequent answer to house adaptation involved landscaping or the use of trees in the respondent's garden. Of these responses, most were about planting trees. To mitigate the hotter weather, Jack Mahoney's proposal to change his house in Alpurrurulam was to 'grow more trees around it and put more lawn around it.' In Dajarra, Maisie Bismark (aged in her 70s) 'would like to grow trees' but was not sure

that know ‘if housing mob is going to do it’ – Maisie Bismark lived in a State government house with no trees or shrubs in the garden. Pam Corbett from Alpurrurulam suggested improving her house by ‘grow[ing] creeper for verandah shade.’ As these types of responses recognize, both trees and vine-covered walls are an effective method of improving the microclimate around housing in semi-arid and arid regions.

Continuing the external focus, three respondents indicated that they would build bough sheds (related to traditional Aboriginal shade structures) in their gardens. Trevina Rogers from Dajarra suggested planning for summer heat extremes with a ‘[p]lan to [build] bough shades before summer.’ Joe Patrick from Alpurruluram would ‘build a bough shed or go sit under a tree. Wouldn’t change house, have winter side and summer side for house.’ Patrick reconfirms Long’s (2005) observations of Dajarra houses; longer-term Aboriginal residents adapt and use their government-provided houses in response to the seasonal conditions. A general preference for externally orientated living combined with this apparent interest in improving the domestic yards offers a potentially effective and relatively inexpensive technique for building structural and behavioural adaptation to climate change. Nine out of 72 respondents answered that they would use domestic air-conditioning to cope with increased summer temperatures. In contrast, more respondents talked about structural alterations or additions to their house to improve comfort in summer. Six of the respondents would add verandahs to their houses to improve their performance and/or increase their living options in hot weather:

‘Open windows. Big verandahs all around.’ (Irene Bula, Mt Isa)

‘Better with verandahs.’ (Ronald Condren, Dajarra)

‘More fans, bigger verandah right round.’(Henry Dempsey, Dajarra)

‘Open it up and put verandahs on it.’ (Mark Webb, Urandangi)

Another six respondents suggested increased ventilation of their houses in summer. In Dajarra, Mick Marshall suggested his house would be improved with ‘more ventilation to get the breeze blow through’. Similar responses were recorded in Camooweal; ‘more windows for breeze’ (Molly Ah-One), at Urandangi, ‘Make sure it’s more open so breezes come through’ (Wayne Age), and Alpurrurulam; ‘Let more air through it’ (Robert King). Five respondents stated a preference for masonry houses, based on their experience of living in both lightweight and masonry houses in summer. Keith Marshall from Dajarra commented that the ‘older 60s house in Dajarra are better than the new ones because they’re made of block and brick’. Similarly Clifford Morton from Alpurrurulam ‘like[d] brick house more better. Had one [and it was] cooler.’ The brief responses to this question about adapting housing to deal with summer heat extremes indicate that Aboriginal people in the region considered a combination of structural adjustments and/or behavioural strategies to mitigate the summer heat.

The third question requiring a qualitative response asked; what will you do when power bills go up? Two of the respondents from Urandangi were unable to answer this

question because their dwellings were not connected to an electrical power supply. Of those who responded, 14 people stated that they would reduce their use of electricity.

> *'Try and cut down on power usage. Especially hot water usage.' (Mick Marshall)*
>
> *'Cut back (can't get good money from the government).' (James Anderson)*
>
> *'Use less power and turn all power points off.' (Patricia Frank)*
>
> *'Try and reduce electricity.' (Krystal King Mt Isa)*
>
> *'Look at ways I can reduce the bills. Change my usage.' (Cora Lynch Cloncurry)*

Faced with increased electricity bills, 16 of the respondents would opt to cook outside on wood fires, with half of those choosing to also camp outside of the house. Electrical cookers were unlikely to be the primary source of electrical consumption, compared to hot water and refrigeration, but the frequency of this response was significant and worthy of further research.

> *'Use a kerosene lamp and get some wood for fire.' (David Riley, Alpurrurulam)*
>
> *'Cook outside, stove most expensive.' (Marlene Nancy Ah-One, Dajarra)*
>
> *'Camp outside. Use a fire.' (George Anderson, Camooweal)*
>
> *'Camp out a lot more. Old place we had no power. Today got to go get wood for cooking kangaroo tail.' (Julie Sandover, Alpurrurulam)*

In the Georgina River Region, these responses demonstrated that adaptive strategies used to cope with such changing domestic conditions were influenced by Aboriginal domiciliary traditions. In the two workshops participants expressed a strong desire for information about climate change. In Aboriginal participants in the workshop identified the following factors regarding their housing and towns:

- Housing is uncomfortable in both hot and cold weather;
- The cost of electricity bills associated with air-conditioning, refrigeration and heating is a major concern and a cause of financial stress that can contribute to eviction from housing;
- Aboriginal people recognize the need for houses that are better designed for the climate;
- Yards are used extensively and could benefit from shade structures and plants suitable for hotter and dryer conditions;
- Secure supplies of potable drinking water are a concern in the smaller settlements;
- Cyclone-proof emergency accommodation is required in each settlement and, mostly, upgraded community buildings could serve that purpose; and,
- Localised repairs and maintenance services are required for community housing.

Figure 35: The rainwater collection systems built by a tenant at his Dajarra house provided the main supply of drinking water in 2008. The town bore water was used liberally to maintain a lawn, which reduced dust around the house. (Photo by Tim O'Rourke)

Figure 36: Managed by the Queensland Government, this house in Dajarra was vacant in June 2008. It had been inundated by creek flooding the previous year, with the tenants moving to the Jimberella Hall. (Photo by Tim O'Rourke)

10.3 Housing and Settlement Strategies for Climate Change Adaptation

In this section, the adaptive responses and strategies are considered in three parts:

- Improving settlement planning and adapting infrastructure;
- Adaptation of public housing and yards;
- Building capacity of Aboriginal people to adapt their built environments and domiciliary behaviour to climate change.

10.3.1 Settlement Planning and Infrastructure

The remote settlements in the study region, and semi-arid zone generally, have a history of sub-standard service delivery compared to urban areas (Long 2007; Stafford Smith et al. 2009). In general terms, the four Aboriginal communities under investigation can be categorized as settlements most vulnerable to the effects of climate change (Beer et al. 2012). This vulnerability is related to both structural or systemic factors that are a consequence of geography and settlement location. Additionally, and interrelated with geography, the demographics of the four settlements, and particularly socio-economic status of the residents, variously affect the capacities to respond and adapt to climate change. Despite the considerable disadvantage across numerous indicators, cultural knowledge, social networks and place attachment can perhaps increase the capacity of Aboriginal people in the Georgina River to adapt to the effects of climate change on their settlements.

Both the *National Indigenous Infrastructure Guide* (FaHCSIA 2011) and the *National Indigenous Housing Guide* (FACSIA 2007) emphasize the centrality of meaningful community consultation in construction projects that affect Aboriginal settlements. Prior to the implementation of adaptive strategies to ameliorate the effects of climate change, culturally astute consultation and education programs need to be implemented and evaluated. Consultation and participation of communities need to continue through the duration of adaptation programmes, both in the development and implementation phases.

10.3.2 Transport

The four communities differ in the quality of their settlement infrastructure and access to services and technology, but each relies heavily on the regional centre Mt Isa for numerous essential government and commercial services. Road networks are essential to the safety and viability of settlements, which become structurally more vulnerable with greater remoteness from Mt Isa. Camooweal benefits from its location the Barkly Highway, which ensures road transport to Mt Isa is relatively rarely interrupted by seasonal flooding. Although flooding can cause major damage to the Barkly Highway, its national importance ensures that repairs and upgrades of the infrastructure are prioritised. Dajarra also benefits from its location on the sealed Diamantina Development Road, with road transport, seasonal tourism and mineral exploration raising the political and economic profile of the town in the transport network. In contrast, Urandangi has tenuous unsealed road connections to Mt Isa, with the small community reliant on the Urandangi Hotel for fuel (for generators) and basic

supplies including food staples. Similarly at Alpurrurulam, the community is vulnerable to isolation when rain or flooding cuts the unsealed roads to the Barkly Highway.

Without new economic incentives such as mining, the transport infrastructure to settlements such as Urandangi and Alpurrurulam will remain marginal, particularly when construction services are derived from regional centres. But these roads will remain an essential part of a national transport network, serving pastoralists, tourists and future industries, as well as communities. Adaptive strategies for roads need to build on the existing capacity of the Aboriginal people and organisatons in the region. At Camooweal, Myuma Corporation has developed considerable plant and human resources in civil construction and is well placed to take a leadership role in improving the road network to meet the challenges of climate change, as well as continuing its vocational training programmes in this industry. Members of the Aboriginal community in Dajarra have a history of employment in road construction and maintenance in the region. Dajarra's capacity to increase services to Urandangi and maintain its road infrastructure should be explored. With the existing training capacity of Myuma Corporation, and its strong cultural relationships, Aboriginal people in the Georgina Region can participate more directly in the provisions of transport infrastructure. The benefits are potentially twofold: more resilient regional infrastructure and greater economic participation of the remote settlements.

10.3.3 Communications and Information Technology

Despite widespread economic disadvantage, mobile phone networks and social media create communication networks that are potentially highly useful in disseminating knowledge and increasing Aboriginal peoples' capacity to respond to climate change threats, both in emergency situations and in long-term adaptability. Digital media and the existing social networks will form and integral part of the overall adaptation strategy for Aboriginal people in the region. Training, particularly for older generations, would improve the capability to use communications and information technology. Improving socio-economic status will also improve the capacity to buy the services and hardware.

10.3.4 Water Supply

Australian and State legislation provides a legislative framework to manage the Georgina River Basin as a catchment. The management plans focus on surface water, with limited data on groundwater in the region. Municipal water supply and drinking water quality is the responsibility of the local government in the Dajarra (Cloncurry Shire), Urandangi (Boulia Shire) and Camooweal (Mt Isa). The government-owned Power and Water Corporation is responsible for the water supply in Alpurrurulam. Settlement water supply varies in quantity and quality varies across the region. Each of the four settlements has different, but enduring problems with drinking water (Long 2007; O'Rourke 2011). In periods of uninterrupted supply, high per capita consumption of town water (unmetered) is typical of the region and, in general, arid and semi-arid zone communities in Australia (Power Water Corporation 2012). Predicted increases in evaporation, coupled with the likelihood of increased in variability in rainfall, have consequences for potable water supplies and the sustainability of landscapes in settlements such as Dajarra, Alpurrurulam and Urandangi. Adaptive strategies for the water supply include:

- Introduction of appropriate technology and water efficiency hardware suited to the highly mineralized bore water
- Demand management programmes directed toward Aboriginal engagement
- Assess the benefits and risks associated with domestic and communal rainwater tank (not currently permitted in Camooweal because of the risk of Mt Isa pollution)
- Adequate drinking water testing regimes aligned with changing health risks
- Precautionary use of groundwater until better understanding of the sustainability of aquifers can be assessed.

10.3.5 Flood Planning

All four settlements have a history of flooding. Flooding events isolate the communities, and damage infrastructure and housing. Repeated flooding of a low-lying area of Dajarra suggests the relocation of houses from this area. Flooding in the aftermath of Cyclone Yasi led to inundation of a housing in Alpurrurulam—the town plan shows and expansion of housing adjacent to the flooded area. Adaptive strategies include:

- Revised flood plans that reference climate change models
- Relocation of vulnerable buildings and housing with a history of repeated flooding
- Ensure community buildings/evacuation centres are flood-proof
- Relocate waste treatment plants and settlement refuse dumps that are susceptible to flooding

10.3.6 Bioclimatic and Cross-cultural Planning

Town planning and subdivision of land needs to encourage the optimum orientation of housing and community buildings for each particular place. This is a basic and often ignored principle of good practice in planning that has significant potential to improve thermal comfort in the built environment and reduce energy consumption in arid regions (Duel et al. 2006). Culturally appropriate planning principles, which still have strong currency in these communities, need to be accommodated in planning schemes—poor planning of facilities can exacerbate social problems (Memmott 2003). Adaptive strategies for bioclimatic planning include:

- Settlement planning and subdivision of land for community expansion (or relocation) prioritises bioclimatic principles related to site conditions and climate
- Planning supports Aboriginal socio-spatial patterns and preferences

10.3.7 Bushfires

Cycles of drought and ‘big’ wet seasons create bush fire risks in the region. Climate change may exacerbate this risk to communities and the built environment. Adaptive strategies for bush management include:

- Minimize and manage bushfire threats through local community involvement in fire regimes that reduce risk to the settlement and infrastructure.
- Model risk and revise classification of settlements and buildings in relation to bushfire risk
- During refurbishments, vulnerable buildings should be altered to meet National Construction Code (NCC) bushfire codes

- Community evacuation buildings should adhere to or exceed NCC code requirements.

10.3.8 Energy

Only one of the four settlements, Dajarra, is connected to the Mica Creek power station. Without significant improvement to building design and more efficient building services, climate change will increase the overall demand for energy. Although supply costs are substantially subsidized in remote settlements (particularly off-grid supply), low-income Aboriginal households already suffer from economic stress associated with power bills, as clearly indicated in the survey and workshop. Data from the survey question on increasing energy costs revealed that few of the respondents had the financial reserves to cope with rising prices. Increased demand resulting from climate change and projected higher costs for electricity will exacerbate this form of stress. Adaptive strategies for energy usage include:

- Research options for off-grid energy supplies to reduce reliance on diesel-fuelled generators
- Install renewable energy plants that can be maintained by local Aboriginal people
- Multi-faceted programmes that aim to reduce energy demand in housing and community buildings.

10.3.9 Community Buildings and Evacuation Centres

In each settlement, community buildings are important as evacuation centres that can be a refuge in extreme weather events and climate-driven disasters. In Dajarra, the Jimberella Hall has been used as accommodation for relatively long periods by community members affected by flooding of state government houses. As an important part of a settlement's adaptation plan, these buildings need to provide at least the following features:

- Structural design to resist cyclonic winds, with category revision of the location (currently non-cyclonic in the region)
- The building scaled to accommodate the community
- Ensure flood planning is taken into account with the location and access to the building
- Planning needs to support socio-spatial behaviours and preferences or the environment may contribute to stress
- Rooms within the building need to offer relief from heat waves
- Regularly maintained generators and a secure, treatable water supply attached to the building.

10.4 Housing and Yards

The primary function of housing is to provide adequate levels of thermal comfort and shelter from radiation, wind and rain. The majority of Aboriginal housing in the study region is public ownership, managed mostly by the State or Territory governments, although Indigenous Housing Organisations (established by the Australian Government) were still active in Dajarra and Urandangi. In 2013, the majority of the public housing stock in the study area was poorly designed for the hot-arid climate

(Long 2007; O'Rourke 2011). This results in poor levels of thermal comfort for the residents in both winter and summer (Roaf *et al*. 2009: 32). Extreme heat events affect morbidity and mortality of the more vulnerable population, including the very young, elderly and those with chronic illnesses (AMA 2013; Pricewaterhouse Coopers 2011). In these events, mortality is also linked to housing that is either poorly designed or constructed for such conditions (Salagnac 2007). A high incidence of chronic disease in older Aboriginal populations would tend to increase their vulnerability to extremes.

There is a strong correlation between the quality of the built environment and Aboriginal health in remote regions of Australia (Bailey et al. 2004). National guidelines identify approaches to Aboriginal housing design and maintenance that lower the risk of poor environmental health outcomes for residents, particularly in remote and semi-arid regions typical of the study area (FACSIA 2007, 2010). The guidelines, supported by research, recognize the significance of culturally appropriate design and community consultation (Memmott 2003).

10.4.1 Housing Design and Construction

Indigenous housing in the study area requires new approaches to architectural design that respond to the semi-arid climate and reduce energy consumption related to cooling and heating buildings. A broad approach is to adapt and test architectural precedents and building technologies that function effectively in arid-zone climates. Design standards and codes for new buildings and existing housing stock need to factor in climate-induced-change risks at local scales. Currently, building standards and regulations influence structural design, water efficient design, fire-resistant envelope in bushfire-prone settlements, and design to reduce energy consumption. Architectural and construction strategies for new and existing housing should include:

- Design, construct and evaluate bioclimatic Aboriginal housing for semi-arid climates, with emphasis on consultative and culturally appropriate design (Memmott 2003).
- Revise the building code classification of regions and localities for wind loading
- Revise and localise climate zoning and the requirements for energy efficient design
- Thermal stress safe-room: provide an insulated air-conditioned internal room to accommodate vulnerable householders during extended heat waves
- Employ shading structures and elements to reduce solar heat gain though: e.g. parasol roofs, eaves, awnings, screens and trellises calculated to shade walls and windows between particular dates
- Orientate and design screened verandah rooms, breezeways and shade structures for sleeping in summer
- Integrate passive (or low energy) cooling technologies, which require, judicious place-specific application; for example, thermal mass (Meir and Roaf 2002)
- Employ and test building technologies appropriate to remote settlements: solar air-conditioning, geo-thermal etc.
- House refurbishments should meet revised codes for insulation, screening, and efficiency measures
- Optimize rainwater collection systems and capacities, which attempt to manage rainfall variability

10.4.2 Landscape Design

Landscape design of both settlements and yards can affect microclimates, which can improve thermal comfort and reduce heating loads. Without careful planning, vegetation can increase risks to buildings from bushfires and wind. There is also need to balance maintenance of landscaping with the sustainability of water supplies. In arid and semi-arid regions, dirt and dust are implicated in a range of environmental health problems that affect Aboriginal communities (FACSIA 2007). Landscape adaptive strategies include:

- Aim to use landscape design for vegetation cooling to reduce heat load on housing, community buildings and provide discrete areas of outdoor thermal comfort.
- Trail methods to reduce dust without heavily irrigated lawns
- Select plants (xerophytic species) suitable for arid and semi-arid zones and that are responsive to predictive climate models
- Provide adequate resources and community training in landscape maintenance
- Encourage local production of food in yards and community gardens.

10.4.3 Education and Capacity Building

Generic and mainstream adaptation programmes and advice may not be culturally appropriate or sufficiently tailored to culturally diverse households and climatically and geographically specific settlements. Community adaptation plans also need to be aware of stereotyping the capacity and resilience Aboriginal communities. Skills and levels of education vary in the communities. Aboriginal people in the study area—and across the arid regions of the continent – have a long history of adapting their built environments to the climatic extremes in region (Long 2005). The relative simplicity but effectiveness of traditional architecture – spinifex grass claddings – and the self-constructed additions to public housing demonstrate effective adaptation to relatively extreme conditions.

A desire for information on climate change and its consequences, as well as adaptive strategies, was clearly expressed by Aboriginal participants in this study's workshops. Adaptive strategies to educate and build the capacity of communities and individuals include:

- Aboriginal participation in the choice, commissioning and maintenance of community infrastructure and technology
- Tailoring generic adaptive strategies to suit Aboriginal communities and resources
- Communication through existing Indigenous social networks and media
- Establish or reinforce communication networks that relay climatic data and weather forecasts
- Refine and improve local capacity to maintain and adapt dwellings and household utilities
- Involvement of local Aboriginal people in the alteration, refurbishment, and maintenance of dwellings.
- Emphasize and increase existing skills and local and customary knowledge related to the built environment and self-constructed dwellings

- Education on the optimum use of housing in changing climates; for example, night cooling of thermal mass purging

10.5 Barriers to Adaptation

The following barriers to climate change adaptation in land and riverine management are detailed below.

10.5.1 Resourcing: Settlements

Over the past decade researchers and government ministers have questioned the viability of small remote Aboriginal communities (Stafford Smith et al. 2008). Remoteness, climatic variability, sparse populations, cultural difference and limited and unpredictable economic opportunities, are factors that contribute to disadvantage in settlements in semi-arid and arid regions of Australia (Stafford Smith 2008). Service delivery, and the construction and maintenance of both buildings and infrastructure in these remote locations are expensive generally (Szava et al. 2007).

Urandangi presents perhaps the most extreme case of economic and social disadvantage in the study area, with Aboriginal people residing in informal settlements or sub-standard housing, with intermittent household power supplies. For the few households that had generators, Long (2007) recorded weekly costs between $50 and $200 for fuel. In 2008, the Queensland Premier acknowledged the problems and inadequacies of the power supply in Urandangi but added: "Many people choose to live in these very remote places because of other lifestyle reasons, and understand, I think, that not every service is going to be available to them" (ABC 2008).

In remote communities dependent on poor quality groundwater, the infrastructure required to produce potable water is currently expensive in capital and operational costs: for example, using a reverse osmosis plant to provide drinking water for Dajarra (O'Rourke 2011). In the case of Dajarra, it is highly unlikely that the town water supply will equate to standards expected in urban areas, because of the geographic and demographic context and expense of current technologies. Poor quality water affects the potential efficiency of household energy consumption, limiting the range of appropriate technologies such as solar hot water systems. Such chronic problems that threaten the viability of settlements are rarely afforded the resources and expertise required to analyse the problem and recommend viable, place-specific solutions that are informed by and involve local communities. This is largely a problem of resourcing, but also one of procedure.

Each of these settlements requires an integrated planning approach to infrastructure and the built environment that correlates community needs – based on social, cultural and economic profiles – with climate, place and technologies.

10.5.2 Resourcing: Housing

A number of factors contribute to sub-standard housing in the remote settlements: architectural design, construction quality, material selection and availability, occupant numbers, and maintenance regimes. The chronic problem of adequate funding for Indigenous housing in remote settlements affects both the quantity and quality of

dwellings. Levels of funding are reflected in the existing public housing stock in the study area, which is aging and generally of low-quality construction (Long 2007; O'Rourke 2011). High householder numbers affect the longevity of building fabric and building services, while census data and research confirms the shortfalls in quantity of dwellings (ABS 2013; Memmott et al. 2012). In most communities, demographic patterns will continue to exacerbate the mismatch between current levels of funding and the required numbers of new and refurbished housing; see, for example, population increase in Alpurrurulam.

In the upper Georgina Region the built environment is neither effective nor efficient for existing climatic conditions. It will require considerable funding to refurbish buildings to a standard that can provide safe and comfortable living environments able to respond to climate change. For new dwellings, low-energy housing that incorporates appropriate passive design principles, good quality construction, and energy-efficient technologies has a high capital cost that is increased by remoteness. In the short term, the participation of local Aboriginal people in the design process, construction and then training in the optimum use of the house and its maintenance adds to the cost of housing delivery. Participation, more effective design and higher quality construction yield social and economic benefits in the long term. Varied approaches to the housing delivery process need to be evaluated against social, environmental and economic criteria over lifecycles that account for climate change. Without significant changes to the built environment, increasing quantities of increasingly expensive energy will be required to support healthy lifestyles in the region.

Training in building construction has a mixed history in remote Aboriginal communities because programmes are often project-based or insufficiently long-term and limited to discrete settlements. An approach to training that offers regional employment may help maintain the diversity and consistency of practice required to develop and maintain the skills and knowledge necessary for a competent tradesperson. A well-trained local tradesperson, with varied work experience, is better placed to provide local solutions to the problems that climate change will affect in these remote settlements.

10.5.3 Cross-jurisdictional Issues

In the Georgina River Region, socio-cultural patterns of high intra-regional mobility ensure regular movement of Aboriginal people across the Queensland-Northern Territory border (Long and Memmott 2007). Influenced by a number of factors, the movement between settlements affects housing and settlement infrastructure. Differences between jurisdictions also affect adaptation strategies and climate change planning. Some of these barriers include:

- Housing standards and regulations vary between jurisdictions
- Many of Alpurrurulam's service and infrastructure needs would be better supplied by Mt Isa/Camooweal.

10.5.4 The Regulatory Environment

Shire councils are responsible for the provision and oversight of much of the infrastructure and services to the four settlements in the study region. Reliant on state/territory and Australian Government funding, municipal councils provide and

maintain roads, town water supply, sewage and waste removal, and construct and maintain public space. Alpurrurulam, Urandangi and Dajarra are disadvantaged by distance from their respective municipal administrative centres. In the latter two settlements, shire boundaries create geographic anomalies between service and administrative centres. Planning for settlements and infrastructure at the shire level is hampered by the administrative and technical capacity of the smaller councils, where retaining local expertise and corporate knowledge is also a problem (O'Rourke 2007).

The Building Code of Australia (BCA) sets out requirements and references standards for the design and construction of buildings in Australia. In 2003, the BCA included minimum energy efficiency standards to improve the environmental performance of residential building. Energy efficiency compliance with the BCA can be achieved though either Deemed-to-Satisfy provisions or software tools (House Energy Rating Software) that comply with the Nationwide Housing Energy Rating Scheme (NatHERS). In 2010, the COAG-sanctioned National Strategy on Energy Efficiency (NSEE) increased the stringency of residential energy efficiency from the minimum five to a to a six star rating in the BCA, but the minimum rating measure varies between jurisdictions. State and territory governments have discretion over the implementation of the rating measures and as of 2013, the Queensland Government maintained a minimum five star rating.

Although the broader aims of the energy efficiency measures for housing are sound in theory, and the software tools useful, the practical application of such measures does not necessarily encourage the innovation required to adapt housing to climate change in the region. Models used in the House Energy Rating Software tools are limited and rely on assumptions that can vary considerably from the fabric of the constructed house. There are a number of reasons why these regulations can be problematic in remote Aboriginal communities:

- Achieving compliance does not necessarily result in best-practice low energy buildings suited to the location
- Increased cost of compliance may result in a reduction of design features related to significant socio-cultural and location-based parameters.
- Self-certification of the construction is open to abuse and perhaps more so in remote areas: for example, the installation and rating of insulation is invariably difficult to check after constructions
- In remote areas, the consistency of supervision of sub-contractors by builders is not always practicable
- Remoteness can reduce the inspections of buildings under construction by certifiers.
- BCA energy efficiency measures do not affect existing housing stock and, in Queensland, and alterations trigger retrofitting at the discretion of the certifier: "How the discretion is exercised will depend on the nature and size of the work, and each case must be assessed on its merits" (QDC 2009)
- In an analysis of arid-region housing in the Northern Territory, Duel et al. (2006:2) found that BCA energy efficiency measures were not clearly beneficial over a ten-year cycle, the lifespan used to retrofit the houses under study.

Water efficiency measures in the BCA and the Queensland Development Code (QDC) affect new housing and are suited to urban areas with good quality water.

10.5.5 Tenancies and Home Ownership

A combination of tenancy regulations, low incomes and variable skills related to construction capability (Seeman et al. 2008) combine to limit capacity of many Aboriginal people to adapt houses and yards. In the region however, housing precedents demonstrate significant adaptation of outdoor spaces with the self-constructed alterations that support externally orientated living (Long 2005). In Dajarra for example, adaptation of houses is dependent on the age and experience of the tenants, the stability of the tenancy and, importantly, the housing authority. These types of activities—as well as the development and maintenance of construction skills—require support from housing agencies.

In general, public housing tenants have less control over their domestic living environments than home owners and invest less in their homes due to the risks of leasing arrangements—eviction due to rental default is a cause of household mobility. Despite a range of impediments, increased home ownership in the remote settlements needs to be explored as a key component of strategies to adapt existing public houses.

10.6 Key Recommendations: Housing and Settlements

As a result of our study we recommend that the following actions be taken to further develop the adaptive capacity of Aboriginal people in the UGRB to climate change through the modification of their settlements and housing.

- Increase Aboriginal participation in decision-making and employment in the supply side of infrastructure.
- Increased local employment in the delivery of infrastructure, services and housing construction will lift standards of living, which will improve adaptation capacity of individuals and families.
- Introduce and fund integrated approaches to planning of settlements and the design of houses that consider the socio-cultural, historical, geographic and economic factors.
- Incorporate participatory planning of settlements to utilise local knowledge and engage the Aboriginal participants in long-term administration and volunteer activities in communities.
- New low energy housing precedents need to be built and evaluated using processes that combine Aboriginal participation in design, planning and construction, with teams of qualified building consultants, experienced in cross-cultural design.
- Landscaping of yards and public space can be used to moderate microclimates around buildings, to improve thermal comfort and reduce energy consumption.
- Cultural preferences for externally orientated living can be effectively supported with architectural and landscape interventions that improve thermal comfort in extreme temperature events.
- Each settlement requires a publically accessible community building that can serve as a safe evacuation centre during and after extreme weather events.

The research findings on housing settlements and infrastructure indicate a mismatch between centralized planning regulations and the climatic and cultural requirements that Aboriginal people in remote arid zone areas have of their built environments. Insights gleaned from these findings help to augment this report's contribution to the NARP research priorities. It was found that a lack of appropriate investment in built environments (such as housing) and infrastructure (such as roads) may in fact inhibit the adaptive cultural resources that Aboriginal people can draw upon. Such resources include the use of traditional materials (that are often cheap and in abundance), shelter design that is suited to the climatic conditions of the UGRB, and the use of traditional land management technologies to mitigate catastrophic threats, such as those posed by bushfires. Moreover, an investigation of the material aspects of socio-economic disadvantage (such as high proportions of income spent of fuel and power, substandard housing, residing in informal settlements) reveals a gap between policy/political frameworks and the needs, cultural resources and responses of Aboriginal communities – another important barrier to successful climate change for Aboriginal people in the region. Understanding and addressing some of the failings of housing and settlement planning is itself a core step in developing climate change adaptation strategies to allow people of the UGRB to create healthy built environments, while remaining on country.

11. ENTERPRISE POSSIBILITIES

In aiming to develop climate change adaptation strategies which hold relevance for future generations of Aboriginal people in the Upper Georgina River Basin (UGRB), the report authors felt it was necessary to propose ways in which those strategies could be implemented in an on-going meaningful way throughout the region as time passed. This section of the report describes ideas arising out of the focus group workshops regarding enterprise possibilities related to climate change preparedness, land and riverine management, as well as housing design and infrastructure planning in the UGRB.

11.1 Research Results – Survey Data and Workshops

As recorded in both focus group workshops, the majority of workshop attendees believed that enterprise development was one of the most significant elements in establishing a long-term adaptation plan and strategy for the UGRB region. Discussion focussed on the importance of developing methods by which Aboriginal people in the region could synthesise traditional knowledge systems with contemporary business frameworks to achieve long-lasting economic development, and thereby transforming local communities to an adapted future where their tenure on country is better guaranteed. This is further underscored by the results from both the survey instrument and workshops which illustrated that the overwhelming majority of Aboriginal people in the UGRB intend on remaining on Country in the face of climate change and greater variability in weather pattern extremes.

Furthermore, workshop participants thought it valuable that future enterprise developments build on local systems and enterprises that currently exist in the region rather than reinventing the wheel so to speak. It was pointed out to the research group that many good governance examples exist in the region which could be utilised to support the development of new enterprises arising out of the need for climate change adaptation. The following discussion, divided into research streams, presents a series of enterprise possibilities posited by Aboriginal people at our August and November 2012 research workshops. Discussion begins with enterprise opportunities arising from preparedness.

11.2 Preparedness for Climate Extremes

Discussion during the Camooweal workshops brought forward ideas for enterprise opportunities which involved preparedness for climate change and related extreme weather conditions. A key strategic principle was arising from these discussions was: to utilise the existing social capitals in the region. It was proposed to establish a local disaster management group (LDMG) in each community and to support these groups through appropriate training and employment methods. One key enterprise is the development of an emergency road repair service after extreme weather events including for both public and private roads susceptible to erosion. Such a service would include the supply of road gravel, compacting and road-drain installation. A set of secure storm-proof community buildings is also desirable in each of the settlements which could be rolled into the proposed repairs and maintenance enterprises

discussion previously. There is also a need to produce and maintain a register of community buildings which can serve as safe locations during extreme weather events.

Furthermore, another possible enterprise is the flood-proofing (again through a locally-supported construction process) of river crossings throughout the UGRB region; this could also be tailored into a program for the identification and monitoring of crossings needing for flood-proofing, a task within the current EMQ regional agenda (refer Elliot Dunn discussion). Such assessment needs to cover all crossings on roads from Dajarra, Urandangi, Lake Nash, Camooweal and Wunara into Mt Isa.

A further enterprise would be an emergency response service to mining pollution disasters, including environmental clean-up, restoration and post disaster monitoring. In terms of carrying out these ideas, our research team suggests that some of the above enterprises could be written into FaHCSIA's DEP/welfare money/employment management contracts as well as the Federal Government's National Disaster Relief and Recovery Arrangements (NDRRA) related to the tendering of public works and road infrastructure. Furthermore, workshop participants proposed that training specific to climate change adaptation strategies presented above be undertaken throughout the region and could potentially utilise the existing business and cultural heritage structures of the Myuma organisation in Camooweal.

11.3 Land and Riverine Management

Discussion during the Camooweal workshops brought forward ideas for enterprise opportunities which involved land and river management. A key strategic principle was: to transfer existing knowledge of environmental resource management in the local Aboriginal community to the development of business and social enterprise programs through a partnership approach.

11.3.1 Knowledge Production

Educational courses in environmental management and resource use could be developed to include the study of Aboriginal Knowledge drawing on local Aboriginal people's understandings about people–environment relationships. Once documented and adapted for curricula in appropriate post-school education, relevant aspects of this body of knowledge could then be deployed for enterprise purposes. The courses could have relevance to other groups and so be adapted effectively for training within current programs. At Myuma in Camooweal, training programs already include some local, culturally specific content which could be expanded to include more Aboriginal environmental knowledge. As well as enhancing the reach and relevance of current courses, such locally based courses could target and support specific education-based enterprise opportunities in the region.

A set of program modules developed in collaboration with the local Aboriginal community could appeal to regional TAFEs and other Aboriginal groups who are involved in ranger training. Ranger work requires a composite knowledge and skill set and in the UGR could relate effectively to:

- Fire management including fine-scale mosaic burning and evaluation

- Management of weeds (e.g. buffel grass, prickly acacia) and feral animals (e.g. pigs)
- Monitoring of the distributional and population changes of dominant plant and animal species
- Conservation of important wetlands and waterholes.

11.3.2 Working with the Environment

Although relatively untested to date, a range of land and water based enterprises could be researched and developed for the UGR as documented for other regional Aboriginal groups (see Alexandra and Stanley 2007). These could include enterprises such as horticulture (including nurseries to supply private company's bush regeneration, orchards, market gardens), aquaculture on the UGR and lakes, land care activities including control of feral plants and animals, and cattle or other livestock production. The Australian Government program Working on Country (http://www.environment.gov.au/indigenous/workingoncountry/index.html) could provide initial support for these kinds of enterprises as it does for other Aboriginal groups in northern Queensland, the NT and elsewhere. Projects could follow the North Australian Indigenous Land and Sea Management Alliance (NAILSMA) model where planning and involvement are community-based and target both social and economic enterprise (http://www.nailsma.org.au/). Some programs may need continuing support while others may be sustainable outside this system.

The UGR group were interested in a collaborative approach to working with mining companies to carry out ecological restoration. Once skilled in propagation techniques, the group could establish a bush nursery and seed harvesting service for these operations. Other collaboration on Country could involve agreements (ILUA) with pastoral properties for the harvesting and bailing of grass for sale as stock feed and also weed eradication and feral animal control. The most pressing collaborative arrangements on Country could involve fire. The UGRB people are aware of the benefits of systematic patchwork burning particularly to reduce bushfire intensity and to maintain ecosystem diversity.

11.3.3 Carbon Farming

Currently Indigenous carbon farming has been promoted where Aboriginal people have land rights or hold a lease on Crown land. To date there is no precedent for such initiatives where Aboriginal people hold the land under Native Title only. Nevertheless, it is possible for the UGR groups who have Native Title over their traditional lands to negotiate some kind of agreement that could include a carbon farming initiative. In the first instance the parties would need to negotiate a 'burning ILUA' over a portion of land. Rights to the carbon credits would also be an area for negotiation and requires consideration of the relevant laws as they are evolving. Certainly the UGR group demonstrated keen interest in such enterprise and put forward the idea of a Georgina River Peoples Carbon Farming Initiative at the first Camooweal workshop. Also the workshop included discussion on the possible integration of such a plan with the University of Queensland in terms of its carbon off-set plan. It may be possible for the UGR group to partner with the University or some other body to apply for funding which would be required to pursue a carbon credits proposal.

11.3.4 Cultural Heritage Tourism

As part of building up a local Indigenous-run consortium, local Aboriginal people could train in environmental management strategies to complement their own local knowledge. This training would facilitate employment by local organisations (government, tourism authorities) and potentially partnerships with local and regional tourism operators, particularly in the grey nomad sector, back-packers and eco tourists. The Georgina River Group may choose to engage cultural heritage planners and local Aboriginal people could work as consultants. Particular sites such as the Camooweal Caves could be targeted for tourism and local Aboriginal people could expect jobs to perform many related roles.

Under the Native Title legislation the traditional owners and managers of the land could negotiate co-management agreements through Indigenous Land Use Agreements (ILUA). While their main area of interest would be the protection of culturally significant sites and the sustainable use of the land, the UGR people are motivated to allow overnight camping in areas such as Mary Lake, if the visitor impacts can be controlled and managed. A partnership with the local shire council might allow a business enterprise to develop for the benefit of all stakeholders in a tourism context.

11.4 Construction Enterprises in the UGRB

Discussion during the Camooweal workshops brought forward ideas for enterprise opportunities involving housing and infrastructure at the local level. The main strategies for climate change adaptation included education campaigns on housing sustainability—including the use of housing—improving (and, in some cases, establishing) local construction and repairs and maintenance capacity within the communities in the region.

11.4.1 Housing Repairs and Maintenance

There is an existing need for locally based contractors with building repair and maintenance skills. An intra-regional organisation would accumulate expertise across the housing maintenance and repair problems that are common to settlements in the region. Small settlements are unlikely to sustain a localized organisation, but a company focused on the Upper Georgina Region, with a stock of about 200 houses would be more financially viable. In adapting to climate change, the contractors would be well placed to renovate housing to improve their sustainability and thermal comfort. The Myuma Group is already building this capacity through pre-vocational training programme for local young people.

In calling for greater opportunities to be given to Aboriginal organisations in the region, there is also an inherent vulnerability in relying on government funding (or any single source of funding). The Myuma Group has clearly managed to survive for an extended period, but one consequence of increasing climate impacts will be increasing pressure on the funds to help alleviate them. Section 11.5 below presents an Aboriginal perspective on this issue.

11.4.2 Domestic Water Supply Contractors

Given the effects of climate change on evaporation and rainfall variability, the use of rainwater tanks for potable water and bores for town water supply will require on-going improvement, maintenance and testing to meet Australian Drinking Water Guidelines. At present, Municipal councils maintain the town supplies but rainwater tank installation and maintenance practices are at best haphazard, and current water testing is limited by remoteness. Additionally, problems with bores can result in interrupted supplies of town water due to the distance of settlement from the municipal service centres. A technician certified in water supply technologies could provide an already much-needed service that will become more essential to the on-going viability of settlements in the Georgina Region, which faces uncertainties and risks due to climate change.

11.4.3 Building Construction

The use of local or regionally based Aboriginal construction companies has potential economic and social benefits to the region. Low-energy housing suitable to the changing climates in the region requires new approaches to design, construction and then evaluation of the buildings. The continued use of external consultants and contractors is expensive and can result in inconsistent standards as well as a fragmented knowledge base. Construction training of Aboriginal people also develops the skills and adaptive capabilities of individuals who tend to remain in the region. For Aboriginal contractors, kinship networks and social relationships can make intraregional travel, accommodation and work in communities less of burden compared to outside contacting staff. Appropriate levels of training and qualifications can be difficult to establish and maintain in remote regions but a regional rather than localized focus may be beneficial to both participants and the communities.

11.4.4 Landscaping Supplies and Contracting

Landscaping services are required by existing communities and should form part of the climate change adaptation planning for settlements. The types of landscaping include seed collection and propagation, plant nurseries, landscape construction and maintenance of public housing and public space. Adaptation to climate change requires increased experimentation and evaluation of landscape designs, different xerophyte species, and maintenance regimes. Although households should be encouraged to maintain their own yards and gardens, tenanted buildings require long-term maintenance regimes to establish mature gardens. A landscaping enterprise requires training in horticulture, landscape construction and design, as well as adequate resourcing and contracting opportunities throughout the region. The skills and resources required by this type of enterprise are similar to those required for broader scale landscape restoration work.

11.4.5 UGRB Building Supplies

A company specializing in local materials and the manufacture of building components could contribute to reduce construction costs, reductions in embodied energy of buildings and products suited to architecture of semi-arid climates. This could include adobe or rammed earth construction. Limestone is quarried and crushed by the Myuma Group which has potential for gabion construction or for stone masonry. Another

example is the manufacture and installation of thermal insulation using post-consumer waste (cellulose insulation).

11.5 Enterprise Development: An Aboriginal Perspective

In his role as the Managing Director of Myuma Pty Ltd, Colin Saltmere has several roles in the public sphere of the UGRB region. Not only is he a business manager/owner, education provider, academic, but also an Indjalandji-Dhidhanu Elder and Traditional Owner. In these roles he (and any others who may want to follow his business model locally) are critical of some aspects of adaptation strategies which are outlined in this report, e.g. to pursue government funding for employment and training/research. These opinions are worthy of further discussion here. Colin commented critically and reflectively on these possibilities:

> *But, it's all government hand-out money. We need to be more independent of government. Need to be involved in actual mining not just in rehab of mining sites, right from the start to the end, including the rehab of the mine landscapes. The coalition is going to chuck the carbon tax out [if it wins government]. Can't wait that long [till after coalition's term changes again]; too uncertain.*
>
> *Road repairs can be a good income. But if a drought, no emergency road repairs – it's a very weather dependent economy. It's good when weather extreme events happen like cyclones – plenty of road repair work around.*
>
> *Introduced weeds and feral animals, need to get government funding for that. No-one is paying on properties for burning. Pastoralists will tend to do this themselves. Grass baling could be good, but need to break into grass baling. If a property has a contractor they prefer, and often they do, it may not be possible to get into this business quickly.*
>
> *One way to go is to first incorporate contracts into the FaHCSIA employment programs… but no real income in this other than welfare. Need to build beyond that.*
>
> *A key problem is the uncertainty of government. Don't know how long they're going to be in for. And these days Government is run by the media and the mining companies. Not a democratic process anymore. Gotta get away from government funding. It's too inconsistent.*
>
> *Must be mining. Mining's the only thing; the only economy that is available to break into [in this region], independent of government. Other enterprises need to add on or fit around this.*

As Director of Myuma Pty Ltd, Colin's comments highlight the problems associated with enterprise development in the region and the particular issues that relate to an Aboriginal company. He identifies road repairs as the main area in which the company has achieved business growth and where it continues to be successful. Other potential business opportunities require third party, especially government funding – a path he is not content to follow. He understands that work on the control of introduced weeds and

feral animals relies on government funding. Pastoralists in other regions however have contracted Aboriginal groups to do this kind of work (for example, Brunette Downs employ local Aboriginal businesses groups for this purpose). Perhaps there are untapped opportunities for similar programs in the UGRB region? As Colin also points out, the regional adaptation group proposed as part of this study, may encounter problems in relation to grass-bailing, where pastoralists continue to favour current contractors making it difficult for a newly trained Aboriginal organisations to break into the same sphere. Although potentially slow, progress in this avenue may be possible.

The overall theme of Colin's message above is that both government and business opportunities for Myuma are in a state of constant flux in ways that make any engagement with them highly uncertain and therefore untenable in the future. By contrast, the mining industry is an attractive option. While such opinion may seem overstated at first, it clearly points to the main barriers for achieving success in the region.

On a personal level, Colin has adult children but also a very young son and so his concern for the future has a very close and personal focus. While his comments about uncertainty in the future outwardly relate to short-lived governments, their policies, the media and the breakdown of the democratic process, it is his perceptions of uncertainty as well as feeling a lack of control over the forces that can determine the future of his business security which should be acknowledged here. While it is instructive to consider the points of difference that mining-related enterprise has in its favour from the perspective of a regional Aboriginal business, it is well known that agreements between mining companies and Aboriginal people in Australia have a varied and checkered history. Of note, how can involvement in the mining industry, known to produce significant amounts of carbon dioxide, be a viable climate adaptation strategy for Aboriginal people in the UQRB region? Also like Aboriginal people in other regions, the negotiation process involved in entering into agreements with mining companies requires compromise that may result in destruction and/or change to traditional lands – a process that can cause considerable social and emotional conflict.

Nevertheless, Colin's statement above is a reminder of the practical implications necessary for climate change adaptation in the UGRB region, and suggests that enterprise development in the region is grounded in a complex and multifaceted set of issues. It is our recommendation that these issues become the foundation for future trans-disciplinary and cross-cultural research and analysis.

11.6 Key Recommendations: Enterprise Opportunities

From the findings presented above, Aboriginal people in the UGRB have been involved in considering several proposals for innovative economic enterprise to make their communities more productive and self-reliant in the face of climate change adaptation. These enterprise ideas include, but are not limited to, the following:

- Carbon farming via Government funding e.g. the Indigenous Carbon Farming Fund.
- Mining land rehabilitation that involves ecosystem restoration using benchmark ecosystem sites, researched propagation techniques, bush nursery and seed harvesting service.

- Emergency response to mining pollution disasters – environmental clean-up and restoration.
- Ranger training program including fire burn training.
- Emergency road repair after extreme weather events including public and private roads with erosion; supply of road gravel, compacting, road drains.
- Weed eradication programs (seek government funding).
- Feral animal hunting (seek government funding).
- Systematic patchwork burning for landowners to prevent wildfires, maintain ecosystem diversity, gain carbon credits.
- Negotiate a role in University of Queensland Carbon Plan.
- Harvesting and bailing grass enterprise.
- Incorporate some of above enterprises into FaHCSIA's/DEP welfare and employment management contracts.
- Partnering with local, State and Federal Government departments and agencies on critically important projects in order to build Aboriginal adaptation capacity.

It is noteworthy that the great majority of such economic development options involve partnerships or other forms of support from external organisations, such as science research and development bodies and government agencies. These forms of collaboration require local leadership as well as inclusive community processes to build trust and expand the skills base of the population. In addition, it is also important to consider the following enterprise recommendations as adaptation strategies in the communities in question.

- Aboriginal people participating in community planning for climate change adaptation.
- Aboriginal people involved in the design of houses that suit local climate and available resources etc.
- Aboriginal people involved in the repairs and maintenance of local housing etc.
- Much greater input by Aboriginal people into the design, construction and evaluation of bioclimatic Aboriginal housing for semi-arid climates, with emphasis on consultative and culturally appropriate design.
- Employ Aboriginal people to firstly develop and then test building technologies appropriate to remote settlements: solar air-conditioning, passive cooling walls etc.
- Educate people in the region as to statutory building codes and amendments which have influence long-term design for insulation, screening, and efficiency measures.
- Educate Aboriginal people as to optimal rainwater collection systems and capacities, which attempt to manage rainfall variability.
- Refine and improve local capacity to maintain adapt dwellings and household utilities, this can be achieved through appropriate repairs and maintenance strategies whereby Aboriginal people are employed to undertake the work.
- Involvement of local Aboriginal people in the alteration, refurbishment, and maintenance of dwellings.
- Emphasise and increase existing skills and local and customary knowledge.
- Education on the optimum use of housing in changing climates: night cooling of thermal mass purging.

- Aboriginal participation in the choice, commissioning and maintenance of community infrastructure and technology.

Aboriginal participants of the workshops also endorsed a proposal for the establishment of the UGRB regional Climate Change Adaptation Group as being important for on-going adaptation and knowledge dissemination. This group would continue to develop an overarching Adaptation Plan for the entire region which builds on this scoping study. One of its functions would be to tailor generic adaptive strategies to suit local Aboriginal communities which take into consideration available resources. In the process of establishing a Georgina River Basin Climate Change Regional Adaptation Group with representatives from each of the four communities, some practical suggestions emerged, including:

- Use the Myuma Camp as an Emergency Evacuation Centre for the region;
- Link with Emergency Management Queensland for bushfire and emergency response training in each of the five communities, beginning with Camooweal, and link this to existing TAFE accredited training courses at Myuma. (Climate Change preparedness);
- Link with the Red Cross to assist with disaster preparedness, planning, response and recovery throughout the region during and after an extreme event.
- Revise the secondary school curriculum throughout the region to disseminate the planning principles arising from this study.

A secondary motivation for bringing people together from the five communities was to promote the benefits of organising a regional collective action whereby members of these communities collaboratively establish an Upper Georgina River Basin (UGRB) climate adaptation group which aims to mutually support each community in adapting to future climate change in the region. It is envisaged that the communities will find strength in collective action rather than attempting to address climate change adaptation on their own.

The present research makes substantive contributions to the NARP research priorities by illuminating some of the economic barriers to climate change adaptation for Aboriginal people in the UGRB. It also exposes some important risks and vulnerabilities that have been produced or compounded by persistent socio-economic marginalization. However, its most important contributions to the NARP research priorities come by way of identifying concrete and realizable enterprise possibilities. These include emergent economic practices that harness the unique insights offered by Aboriginal knowledge, and include culturally embedded land and riverine management practices (including knowledge production and environmental stewardship), carbon farming by utilizing early-season burning practices, and cultural heritage tourism. Further enterprise opportunities include integrating training and service delivery, to provide employment opportunities and reduce the vulnerabilities created by a lack of investment and human resourcing to deal with housing maintenance, water supply, building construction and climate-appropriate landscaping. Such enterprise strategies will greatly minimize the structural vulnerabilities that Aboriginal people in the URGB face, as well as providing important financial resources to assist with climate change adaptation in the region.

12. POLICY IMPLICATIONS FOR UGRB CLIMATE CHANGE

This chapter will focus on identified needs for better governance processes. By 'governance' we refer to the arrangements for decision-making, planning, consultation and accountability together with necessary supporting processes, such as on-going community participation, and information systems to monitor change and to report on progress in meeting goals (Lockwood et al, 2010; Head 2011). The discussion will focus primarily on the demonstrated need to enhance the economic and physical resources of the local community, to clarify the roles and responsibilities of governmental and community bodies, and to initiate inclusive planning processes directed at tackling the challenges presented by climate change, socio-economic resilience, and capacity to cope with extreme events.

12.1 Background

The Upper Georgina River Basin is on the far western border of the Mount Isa local government area (LGA), but also includes parts of the Burke Shire to the north, and the Barkly Shire in the Northern Territory to the west (see Figure 37). The Indigenous population of the River Basin thus live mainly in one LGA area but also in two adjacent LGAs, and to some extent move between them on a seasonal basis. The small Queensland town of Camooweal, close to the Northern Territory border, is 188 kilometres from the city of Mt Isa and suffers greatly from its remoteness from this large services centre; its small population can access only low standards of support services in their locality, and have to travel long distances for many goods and services. The Mt Isa local government authority, dominated in terms of population and political resources by the City of Mt Isa, is responsible for around 40,000 square kilometres, which is nearly twice the area of the Southeast Queensland region. The Georgina River flows south into the Diamantina and into Lake Eyre. The Lake Eyre Basin (LEB) region is a vast area which includes the Upper Georgina study region. The LEB has a Ministerial Forum (Commonwealth, Queensland, Northern Territory and South Australian representatives) and community consultative forums. The Ministerial group considers broad issues concerning the sustainability of the river system, and encourages discussion of common themes and issues, but has no deliberative powers. It also sponsors a biennial Indigenous Forum which considers a range of issues including cultural and biodiversity documentation, threats to the natural and cultural resources of the LEB, and the need for more science concerning extractive industries such as coal-seam gas: see http://www.lebmf.gov.au/conference/index.html#aboriginal

In rural North West Queensland during times of natural disaster, the communications and emergency response services are stretched by competing claims across a wide area and are therefore experienced as being highly unreliable for the local population of the Upper Georgina. Over many years the local population have learned to be self-sufficient in seeking to avoid the worst impacts of natural disasters (e.g. floods, bushfires, droughts), but they have low resources for rebuilding damaged infrastructure and dwellings. Given the factors associated with remoteness, the most practical strategies for maintaining and improving liveability for the local communities, and for protecting the natural and cultural environment, would require initiatives to build more robust decentralised communities which could be relatively self-managing in a

changing world. Recent work on community resilience, especially in the face of natural disasters and climate change (Brown and Westaway 2011; Berkes and Ross 2013), demonstrates that scientific knowledge and improved physical planning need to be complemented by building community strengths and resilience through “agency and self-organization, with attention to people-place connections, values and beliefs, knowledge and learning, social networks, collaborative governance, economic diversification [etc.]” (Berkes and Ross 2013: 5). Thus, the analysis in this chapter will demonstrate that better governance arrangements, including empowerment of local groups and indigenous corporations in the Upper Georgina, can make a large difference, not only for the resilience and quality-of-life available for the local population, but also for taking care of the natural environment in future periods of climate change and variability.

Sustainable development and socio-economic resilience are widely supported objectives in the planning systems of all contemporary Australian communities, and many indicators for measuring these phenomena have been developed in the literature. Much less clear are the most appropriate mechanisms for delivering desired outcomes in remote locations, and for scoping the organisational and other resources needed to underpin such improvement strategies for particular localities. This is the challenge for developing appropriate governance arrangements to address sustainability in the Upper Georgina study area and in other remote localities.

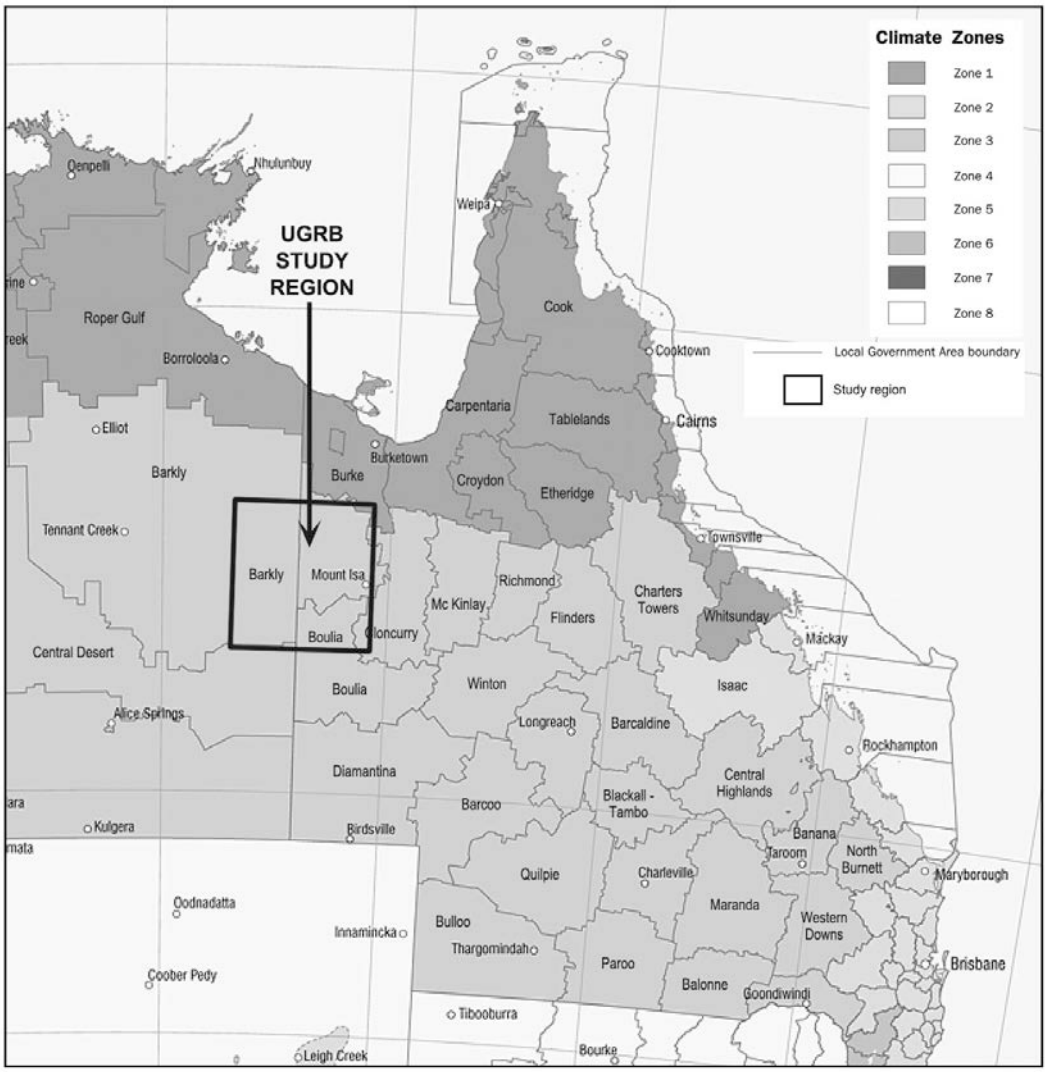

Figure 37: Local Government Areas (LGAs) and climate zone, with the Upper Georgina Basin study region highlighted and containing parts of Barkly, Mount Isa, Boulia and Cloncurry LGAs.

(Source: adapted from Australian Building Codes Board (ABCB) 2012 "Climate Zone Maps" http://www.abcb.gob.au/en/major-initiatives/energy-efficiency/climate-zone-maps)

This chapter focuses on four sets of substantive issues related to climate change, as discussed in earlier chapters of this report, where it is claimed that better governance can help achieve much better outcomes for remote communities:

- Responding to direct effects of climate change such as rising temperatures, extreme events and disaster management;
- Meeting the pressing needs of land and riverine management;
- Improved design and urban planning for coping with the long-term effects of climate change; and
- Innovative options for self-reliant local economic development, including carbon credits.

The enhanced governance responses that respond to these substantive climate change challenges can be grouped around three key dimensions that are vital for improved outcomes. The first dimension is to identify and enhance the amount and nature of the resources available for local communities to manage their individual, group and collective purposes. These resources include the level of skills that are available locally plus those readily accessible from neighbours and partners; the financial resources available for maintaining human and physical capital and for investment in new enterprises; the availability of accurate and sufficient information on key issues; and the participation and influence of local people in planning and decision-making processes that affect their future.

The second dimension is the benefits which flow from clarification of key roles and responsibilities between the local, regional and higher levels of government, along with better coordination between these levels of public authority within the state of Queensland and across jurisdictional boundaries. In parallel with improving the responsibilities and capacities of existing public sector agencies, reconsideration of the potential role of local community organisations is warranted. Indigenous organisations could not only provide a focal point for coordination with the three levels of government, but could also be empowered to take a more active role in a wide range of issues – social, economic, ecological, physical infrastructure, communications, and so on. The lack of investment funds, and the fragmented nature of funding sources, suggests there could be advantages in exploring some options for pooled funding processes to accelerate innovative solutions.

The third dimension of governance reform is to reconsider the regulatory environment which shapes, constrains and facilitates economic and social behaviour. Questions arise concerning the suitability of regulatory systems and service systems which allow or even encourage inefficient or ineffective forms of energy use, building design, local enterprise on collective tenures, and so on. Clearly there is a need for further collective and collaborative work to guide the redesign of how these planning and services regimes operate in relation to business enterprises and human settlements in remote areas.

12.2 Problems requiring increased monitoring and policy response

The following discussion outlines four substantive problem areas related to climate change that require enhanced governance responses, including better information, better resourcing, clarification of roles, more inclusive planning processes, and more appropriate regulatory regimes as a basis for effective policy responses to climate change.

12.2.1 Increased intensity and variability of climate and natural disasters

The climate trend analysis was outlined in chapter 5. The predicted increases in summer rainfall, river flooding, the intensity of tropical cyclones, and the number of very hot days will all require careful risk assessment and suitable responses. The future prevalence of droughts, dust storms and bushfires is less clear but these are already substantial features of the regional climate. Modelling predicts an increase in the number of heat related deaths. Vector borne conditions like malaria and dengue fever

are likely to increase under climate change, and the zone of concern would extend further south from the northern Australian coast. The community survey outlined in chapter 6 demonstrated a substantial awareness of climatic variability and tangible environmental changes during the lifetime of the respondents. Many reported multiple experiences of dust storms, floods, drought, heat waves and bushfires, and somewhat less in relation to severe rainstorms, cyclones, and water scarcity. There was a strong perception that external authorities and experts were unlikely to be active in assisting the Upper Georgina communities to cope with the consequences. Yet there was extremely high respondent confidence that people in the community would help each other out in an emergency weather situation. Because of the strong attachment to locality and country in this Aboriginal community, very few would consider moving to another region as a future option if conditions worsened. Major natural disasters have been highly disruptive from time to time. The need for self-reliance has been demonstrated on many occasions, and this reinforces the need for strong local organisations. The Mt Isa City Council has developed a relationship with a large NGO (Centacare), which provides assistance in situations requiring emergency response, however the far northwest with its dispersed population is inevitably low on the list of priorities and the communication lines are stretched.

In the process of establishing a Georgina River Basin Climate Change Regional Adaptation Group with representatives from each of the five communities, some practical suggestions emerged, including:

- Use the Myuma Camp as an Emergency Evacuation Centre for the region;
- Link with Emergency Management Queensland for bushfire and emergency response training in each of the five communities, beginning with Camooweal, and link this to existing TAFE accredited training courses at Myuma. (Climate Change preparedness);
- Link with the Red Cross to assist with disaster response and recovery throughout the region during and after an extreme event; and
- Revise the secondary school curriculum throughout the region to disseminate the planning principles arising from this study.

12.2.2 Role of Indigenous knowledge in land and riverine management

The local Aboriginal people have demonstrated considerable knowledge and understanding of the land, water and biodiversity natural resources of this region. Their perceptions of changes in ecological and climatic conditions over time have been outlined in previous chapters. In addition to weather-related trends, the people reported changes to the Georgina River, which is increasingly silted-up, brackish, subject to cattle use and the introduction of foreign species. They were also concerned about the impacts of unregulated tourism on waterways and surrounding areas near Camooweal, and that culturally significant places are not being looked after, e.g. sacred sites on stations. Moreover, some areas used for hunting and food gathering are becoming degraded, and favoured food resources are disappearing or changing their habitats.

These are complex and changing problems that require persistence over time, with attention to the need for good processes, coordination and sufficient resources. Options for identifying solutions would benefit from greater consultation with traditional

owners, e.g. reduced numbers of kangaroos on stations could be managed differently, irrespective of climate change; and a return to traditional burning regimes could restore important resources. In many cases, solutions will also require careful negotiation over land and water use with other stakeholders including pastoralists and with all levels of government.

Some of the necessary pathways will involve a concerted effort concerning better information and better education and training. There are important benefits from enhanced documentation, mapping and protection of culturally and historically significant places – keystones of cultural significance – together with the recording and compilation of local Indigenous knowledge of plant and animal resources. This documentation can then be linked into educational initiatives, e.g. the schooling curriculum, and visitor centres; and also linked into training and skilling initiatives, e.g. training and employment of local Aboriginal rangers in land and river management, e.g. to protect sites; clear and maintain waterholes; and carry out traditional burning regimes.

12.2.3 Improved housing and settlement planning for climate change

The quality and appropriateness of housing and the built environment in this region are unsuited to the current climate and will be increasingly vulnerable under future patterns of climate change. Long-term changes in planning objectives and local participation in co-designing future options will be necessary. Local communities will need to be involved in educative and consultative processes concerning alternative options for housing and settlement planning. It is clear from the evidence that local populations perceive the current stock of housing is uncomfortable in both hot and cold weather. The insulation quality of the housing is poor, and air-conditioning is necessary in hot weather. However, the very high cost of electricity for the necessities of air-conditioning, refrigeration and lighting is a major concern and a cause of financial stress that can contribute to eviction. Houses could be much better designed for the climate, and the yard areas could benefit from shade structures and plants suitable for hotter and drier conditions. Maintenance and refurbishment services for community housing need greater investment and prioritisation. Building codes and design standards need to provide guidance for domestic dwellings and public buildings that are highly resistant to extreme weather events. Public buildings or community centres need to be designed as suitable for secure accommodation in emergency situations. More generally, the urban planning functions need to be more inclusive and take account of disaster management issues, including prolonged periods affected by flooding, cyclones, bushfires and so on. The adequacy of basic services, and their capacity to withstand extreme events, should be central to planning for transport infrastructure, water supplies, waste management, and communications.

Overall, Aboriginal settlement in the UGRB is characterised by a scattering of small communities which predated, but have now come to depend on, the much larger regional centre, Mt Isa. One pertinent policy debate in this context is the argument to centralise these small communities into the regional centre to achieve economies of service delivery and promote employment opportunities. However our previous research in the region indicates this would not be viable due to strong spiritual and affective place attachments, evidenced by previous attempts and actions to move

people, migratory patterns and circular mobility (Long 2005, Long and Memmott 2007). The impressive rise of Myuma Pty Ltd at Camooweal in a seemingly non-viable economic environment is further evidence of hidden capacity to invoke 'desert knowledge' (more specifically in this case, riverine knowledge) to generate independent communities. The counter argument is that as chronic climate change worsens with rising temperatures, small place-attached Aboriginal communities may become more vital in decentralized service delivery such as road and infrastructure maintenance, tourism support, disaster response and national security in semi-arid and arid regions.

12.2.4 Innovative options for self-reliant local economic development

The local Indigenous population have been involved in considering several proposals for innovative economic enterprise to make their communities more productive and self-reliant. As discussed in Section 11, these project ideas include the following:

- Seek Government funding via the Indigenous Carbon Farming Fund (Spinifex project);
- Mining land rehabilitation that involves ecosystem restoration using benchmark ecosystem sites, researched propagation techniques, bush nursery and seed harvesting service;
- Emergency response to mining pollution disasters – environmental clean-up and restoration;
- Ranger training program including fire burn training;
- Emergency road repair after extreme weather events including public and private roads with erosion; supply of road gravel, compacting, road drains;
- Weed eradication programs (seek government funding);
- Feral animal hunting (seek government funding);
- Systematic patchwork burning for landowners to prevent wildfires, maintain ecosystem diversity, gain carbon credits;
- Negotiate a role in University of Queensland Carbon Plan;
- Harvesting and bailing grass enterprise; and
- Incorporate some of above enterprises into FaHCSIA/DEP welfare and employment management contracts.

It is noteworthy that the great majority of such economic development options involve partnerships or other forms of support from external organisations, such as science bodies and government agencies. These forms of collaboration require local leadership as well as inclusive community processes to build trust and expand the skills base of the population.

13. REPORT SUMMARY AND DISCUSSION

13.1 Returning to the Research Aims

This study had two principal aims: the first was to take an interior arid-zone region, the Upper Georgina River Basin located in far northwest Queensland, as a scoping study in which to investigate and document Aboriginal perceptions and understandings of climate change. The second aim was to study the capacity of remote Aboriginal communities to respond and adapt to the effects of climate change on a number of levels, specifically preparedness for weather extremes, land and riverine management, housing and infrastructure adaptation and enterprise development responses. These aims are integrated into the findings of the report, through the following summary and discussion. In addition a draft Adaptation Plan for the UGRB is set out below. The discussion will also focus on the ways in which our findings address contribute to the six Priority Research Topics (nos. 1, 4, 5, 8, 9 and 11) outlined in the National Climate Change Adaptation Plan for Indigenous Communities (NARP) (Section 13.3.1 to 13.3.6).

13.2 Responding to the NCCARF NARP Research Priorities

The following discussion relates our key research findings to the NARP research priorities established by NCCARF.

13.2.1 Risk sensitivity reduction (NARP Research Topic 1)

A core contribution of this report is that it draws ecological assessments and Indigenous knowledge(s) and practices into the same analytical frame in order to develop adaptive strategies that may lead not only to the survival of remote Aboriginal communities of the Upper Georgina River Basin, but also assist these communities to improve the well-being and prosperity of Aboriginal people in the region. Central to the development of this Plan has been a focus on Aboriginal perceptions and understandings of climate change, as well as attendant risks, costs and benefits. This has enabled the researchers involved to develop a highly contextualized and place-specific set of findings. These findings provide a geographically specific and place-based analysis of the perceived and objective risks and vulnerabilities faced in the UGRB, as well as a concrete strategy to help the people of the region minimize ecological, economic and cultural risk. Such strategies will enable communities in the UGRB to build resilience and improve their adaptive capacity, and overcome some of the physical, geographic and socio-economic barriers to successful climate change adaptation.

Understanding the risk factors relating to built environments is a significant component of the research findings, and represents an important contribution to this Research Topic. Built environments – including housing and settlement infrastructure – are a crucial aspect of climate change adaptation. Understanding the physical, material and design aspects of built environments, and the ways built environments interact with changing natural environments, is a pressing task in the face of climate change in remote communities. A lack of attention to housing, for instance, may be a principal determinant of unsuccessful adaptation – or maladaptation – for Aboriginal individuals,

households and communities. Moreover, by not adapting housing and settlement infrastructure to future climatic needs, Aboriginal businesses and institutions may suffer as remote settlements become unviable, as people migrate under duress away from country and community. It is likely that climate change models for the Upper Georgina River Basin region (see Section 5) will amplify the risks and vulnerabilities imposed by inadequate or inappropriate housing design and insufficient housing stocks upon Aboriginal people.

Another significant component of the research findings is the multi-dimensional and complex nature of the social, political, economic and historical determinants of climate change risk and vulnerability. The research findings highlight the enduring legacy of historical determinants of vulnerability of remote Aboriginal communities in the region, such as hegemony engendered through the violent frontier history of the colonial period, the political exclusion and socio-economic disadvantage of Aboriginal people in the region, brought about largely by the lack of enjoyment of land rights and marginal employment opportunities, as well as uneven and inconsistent policy (from all levels of government) pertaining to housing, health, education, planning and investment. Adding to these challenges are the physical and geographical risks and vulnerabilities posed by remoteness, and demographic mobility patterns. Moreover, an absence of cohesive cross-jurisdictional arrangements and Aboriginal governance institutions has also been highlighted in the research findings as a significant barrier to successful climate change adaption in the UGRB.

One strategy to overcome this complex nexus of historical, social, material and environmental risk factors, and the vulnerabilities associated with them, is the establishment of a UGRB regional body, that will play a concrete role in the planning and roll-out of a range of adaptive strategies, such as emergency management, employment and training, housing and infrastructure planning, land and riverine management and the creation of new economic opportunities that arise from climate change adaptation and mitigation, such as residential adaption and carbon abatement through fire management.

Thus, from the research findings we have developed an account of sensitivity to climate change risks that is embedded in Aboriginal communities' and peoples' experiences and perceptions of changing climatic and meteorological conditions in the region. This goes some way to developing a contextualized and place-based mapping of "risk landscapes of Indigenous communities" (Langton *et al*. 2012: 27) in the Upper Georgina River Basin region. In doing so, the research design and subsequent analyses have also allowed us to make a significant contribution by developing a more accurate and in-depth picture of Aboriginal people's perceptions, understandings, and responses to climate change using social psychological and anthropological methods.

13.2.2 Vulnerability reduction (NARP Research Topic 4)

This project developed a socio-ecological vulnerability assessment that drew together extant research, anthropological, psychological, political, scientific and Aboriginal perspectives on the complex regional vulnerabilities of the Upper Georgina River Basin. It also considered the multi-dimensional and multi-level nature of vulnerability in a highly contextualized manner, taking account of the linkages between seemingly

disparate issues and policy areas. Using these assessments, and the insights of respondents in the area, the project developed a regional adaptation strategy, which focuses upon four primary streams, namely anticipatory adaptation (or preparedness), land and riverine management, settlements and infrastructure, and enterprise possibilities.

Examples of elements in the strategy are as follows: utilizing local knowledge of country to both monitor and evaluate impacts of a changing climate on the environment; utilizing customary land care practices, and mobilizing the resources available to Native Title holders in order to develop economic opportunities in the region, thereby augmenting adaptive capacity; identifying weaknesses in current built environments in the region, and considering housing, infrastructural and environmental design that suits the local climate, that is subject to change, reduces exposure to fuel stress, avoids heavy maintenance costs, and reduces the health risks of climate change on Aboriginal households and communities, many of whose residents already suffer from a range of chronic illnesses.

13.2.3 Adaptation capacity (NARP Research Topic 5)

The project has involved the development of a region-specific adaptation study for the Upper Georgina River Basin, as per the NARP (Langton *et al*. 2012: 19), based on an analysis of regional Indigenous capacity in partnership with other agencies. The project has also increased understanding of the adaptive capacity of Aboriginal communities in the UGRB region by consulting and collaborating with community stakeholders to design and conduct the research. This has manifested in several ways, such as recruiting Aboriginal research partners in the region (Colin Saltmere and Keith Marshall), and utilizing Aboriginal knowledge and local expertise to develop novel forms of data, such as photographic records and seasonal calendars. Importantly, the project has drawn primarily upon insights offered by Aboriginal people in the region, placing data collected in surveys, interviews and workshops at the centre of the research project, with resulting conclusions and recommendations developed from 'the bottom up'.

Moreover, the Upper Georgina River Basin Adaptation Plan aims to increase resilience in the face of both acute climate change effects (e.g. increasing local disaster management capacity to respond to extreme weather events) and chronic climate change effects (e.g. adapting housing and settlement infrastructure to cope with increased heat, flooding and dust storms). A multi-scalar and multi-sectorial understanding of the governance of remote Aboriginal communities has been used as a backdrop for developing a comprehensive and concrete Adaptation Plan. Regulatory and cross-jurisdictional barriers and associated strategies to overcome these were advanced across all four research streams.

The creation of an Upper Georgina River Basin regional consultative and regulatory body is the centrepiece of these strategies. This body is considered to be an important institutional mechanism to encourage dialogue between Aboriginal and non-Aboriginal stakeholders, government and regulatory agencies, pastoralists, mining companies and non-governmental organisations. This body may play a role in coordinating disaster management (including training and recruitment) in collaboration with existing

agencies; coordinating post-disaster recovery efforts; housing construction and maintenance; and identifying issues that may adversely impact local resilience.

13.2.4 Preparatory, response and recovery capacity (NARP Research Topic 8)

Through the survey and workshop phases of the research, we have identified significant barriers to adaptation to *the threat* of climate change and (currently and prospectively) to broader climatic, landscape and ecosystem changes and impacts. These include a low disaster management agency presence in the UGRB region, geographical remoteness, *ad hoc* cross-border mobility, a lack of emergency coordination in remote areas, a lack of material resources available to communities and government agencies to deal with the consequences of extreme weather events (such as road closures, thermal insulation and cooling of houses), and the absence of reliable communication channels. Utilising a combination of climate science, biophysical data, meteorological predictions, and observations by Aboriginal people in the region, the project has identified several core context-appropriate strategies for disaster management, relief and recovery.

We have identified the role of social networks as a critical mode of community resilience. In the wake of Cyclone Yasi, we have seen that intra-regional mobility and tapping into kinship networks has been a crucial strategy for people in the region to respond to impending natural disasters. However, we have also seen that these mobility patterns are not sufficiently understood from a disaster management perspective, and this has resulted in a sub-optimal outcome for those displaced from a perceived cyclone threat. With a road network that is subject to extensive flooding and prolonged closure, we have identified the need to assist communities in the region to develop mobility plans with contingencies and redundancies built in. We have also been alerted to the need to give more attention to intraregional mobility in post-disaster recovery planning and coordination; since once departed from the region, it can be a lengthy period of time before people are able to return home. We have drawn upon the historical experiences of Alpurrurulam evacuees to highlight some of the challenges faced by remote communities when intra-regional mobility and the lack of disaster management and post-disaster recovery collide.

By developing collaborative networks between communities, local, state and federal governments, regulatory bodies, commercial entities (including mining companies) and non-governmental organisations, there lies the potential to devise ways to extend the reach of existing emergency disaster management arrangements to remote areas. In this regard, the Plan has proposed the creation of a Regional Disaster Management Group for the Upper Georgina River Basin region, that would be charged with coordinating across Local Government Areas and State and Territory jurisdictions, thereby reducing some of the regulatory barrier to effective disaster management and relief and recovery efforts in remote Aboriginal communities.

The need to embed international best-practice disaster management and emergency shelter principles in the UGRB was also identified in the research findings. To this end, the Adaptation Plan includes a discussion of the establishment of dedicated, high-capacity emergency shelters in Aboriginal settlements in the region. These shelters

should be sited at both the Dugalunji camp in Camooweal and the Jimbarella Hall in Dajarra and ideally also at Alpurrurulum (new facility). The idea here would be to utilize community ownership over these sites and facilities to encourage a grassroots engagement with emergency shelter principles, such as those utilized by government agencies and non-governmental organisations (see Queensland Government 2010; Australian Red Cross 2012a, 2012b). In addition to strengthening emergency shelter capacity, the Plan also advances a consultative approach to developing community contingency plans, as well as developing local disaster-management skills training regimes with the assistance of Emergency Management Queensland and the Australian Red Cross.

The need to account for intra-regional differences in assessing the risks posed by extreme weather events has also been highlighted. For instance, the northern parts of the region are more prone to rain and wind, whilst the south is more prone to flooding and dust storms). Such intra-regional differences mean that the disaster management requirements of each community in the region will be slightly different, and these differences are acknowledged and accounted for in the development of this aspect of the Adaptation Plan.

13.2.5 The population movement factor (NARP Research Topic 9)

Intra-regional mobility is a standard Aboriginal customary behaviour in the UGRB region (Memmott, Long and Thomson 2006). It has been shown in this study, that not surprisingly, mobility is used as an adaptive mechanism when affected by extreme weather events. Such mobility patterns will likely have an increasing effect upon housing and emergency shelter capacity in evacuees' destinations, in the context of extreme weather events associated with severe climate variation. Such pressures highlight the need to integrate an understanding of intra-regional mobility pattern into the Adaptation Plan. The study has certainly found that mobility patterns do not feature in existing disaster management plans, and to this end we have proposed that equipping designated emergency shelters to deal with demand from the region will have a positive impact upon regional resilience and remove a degree of uncertainty for those forced to move, temporarily or permanently.

13.2.6 Biodiversity usage impacts (NARP Research Topic 11)

The scholarly literature suggests that climate change will adversely affect biodiversity, and thus the use of biodiversity resources by Indigenous peoples and groups. By linking the biophysical, cultural and social aspects of climate change in the region, we have also suggested that indigenous knowledge and understandings, and traditional ecological knowledge, are also central to mitigating biodiversity loss, as well as creating new employment and enterprise opportunities in the region, thereby strengthening community resilience. The Adaptation Plan thus integrates future planning of land and riverine management as a central component of the regional adaptation strategy. Strategies to reduce socio-ecological vulnerabilities and create new employment opportunities include:

- Documenting traditional land use and knowledge of significant environmental resources in collaboration with Aboriginal people;

- Building the capacity of Aboriginal representatives in the practices of negotiation over environmental protection strategies and access to funding;
- Supporting the development of locally-focused school curriculum materials on Aboriginal environmental knowledge for all levels of education;
- Building relationships between Aboriginal and non-Aboriginal stakeholders to ensure that Aboriginal history, culture and knowledge of the environment is mainstreamed into all aspects of policy and planning; and
- Encouraging governments to support greater involvement by Native Title holders and applicants on their lands, and supporting Aboriginal groups to gain access to ranger training programs in the UGRB.

13.3 Key Findings: Aboriginal Risk Perceptions in the UGRB

While the past decade has seen an increasing focus on the use of national surveys to examine changing public perceptions, understandings and responses to global climate change, rarely have such surveys included Australian Aboriginal respondents and communities. Yet, in many other developed countries where national climate change surveys are being undertaken, the views of first nation respondents are seen as of particular value, not only because of their often extensive knowledge and familiarity with changing climate and environment, but because many indigenous communities are particularly vulnerable to the impacts of climate change. We thus chose to focus on Indigenous respondents in a regional survey, which also allowed us to assess similarities and differences with and between the UGRB sample and a national database reflecting national survey findings from 2010 and 2011. There were some common findings on a number of dimensions between similar proportions of UGRB and national respondents:

- The proportion of respondents who accept the reality of climate change is essentially identical with national survey findings, at 75%;
- 68% of Georgina community respondents nonetheless agreed that climate change was a personally important matter and issue to them as compared with an identical 68% of national survey respondents in 2011;
- 42% of UGRB respondents reported having had direct personal experience with an environmental change or event deemed to be associated with climate change, as compared with 45% of national survey respondents in 2010 and 2011; and
- 60% of community respondents indicated that they were ‘worried’ about climate change across 10 areas of specific concerns, as compare with 64% of national survey respondents in 2011 who reported being ‘very’ or ‘fairly’ concerned about climate change.

On the other hand, there were contrasting findings between how the UGRB and the national survey interviews responded with respect to the following:

- Causal explanations for why climate change is happening are quite varied on the UGRB, but often reflected greater uncertainty and poorer understanding of climate change science accounts than was the case for national survey respondents;
- Self-reported knowledge differences between Georgina Basin community respondents and national survey respondents are quite marked, with just under two-thirds (65%) of community respondents reporting that they knew very little

about climate change, whereas almost three-quarter (72%) of national survey respondents felt that they knew a substantial amount about climate change;

- The extent of temporal and geographic psychological distancing or 'far-sightedness' with respect to the magnitude, immediacy, and vulnerability to the threat of climate change was greater for Georgina Basin respondents, with climate change more accepted and acknowledged as a distant and global phenomenon, than as an immediately salient local threat and issue, compared with national survey respondents, though 25% of Georgina respondents clearly disagreed that this was the case, with climate change being viewed a much more immediate and personally important issue;
- UGRB community responses evidence demonstrated considerably less self-efficacy or collective efficacy than national survey respondents with respect to being able to address the threat and implications of climate change, but comparable and high self-efficacy responses with respect to emotional self-regulation through their actions, and moderate felt ability to influence the behaviour of others in the context of climate change related responses; and
- 54% of community respondents reported personal experience with natural disaster warning or impact circumstances, as compared with 37% of national survey respondents in 2010; and, on average, 38% of Georgina Basin respondents with such disaster experience reported having experienced one or more of each provided disaster category at least five times or more.

In general, it was found that the UGRB Aboriginal community was in a process of changing their thinking, emotional responses, and general views, risk perceptions, and understandings of climate change, though seemingly less so, currently, than the larger Australian community. The survey findings suggest that the region and survey respondents exist within and are attempting to come to terms with historical and contemporary cross-currents of social, economic, and environmental changes which are experienced, thought about, and commented on from quite diverse perspectives, reflecting the cultural and life history heterogeneity of such indigenous and non-indigenous communities. The spectre and 'story' of climate change is clearly a salient theme and narrative element within the broader context of global media coverage and exposure, and social and environmental changes which are making generational divides true cultural divides. Nonetheless the phenomenon, risk domain, and perceived manifestations of climate change appear to be very salient, but background to more general and immediate weather and climate preoccupations and musings, with landscape changes reflecting other clear and familiar forces and causes, and other more tangible and immediate life and livelihood concerns, in such a way that specific concerns and/or distress about climate change do not seem to be as salient, specific, and articulated as they are in Australian popular culture and public life generally at present.

The survey findings relating to climate change risk perceptions and understandings tell us a number of important things about climate change adaptation, from more psychological and social science perspectives, in the Upper Georgina Basin region. The survey results suggest that respondents in this region generally accept the reality of 'global climate change', and that clear and obvious climatic and other environmental changes have been occurring in their region over their lifetimes and more recently.

The strength and spread of this acceptance and these risk perceptions are very similar to Australian national survey findings (e.g. Reser et al., 2012a,b). General understandings of the phenomenon and implications of contemporary global climate change, and climate change science accounts of climate change, nonetheless appear to be somewhat distinct from national findings, clearly influenced for many by differing cultural assumptions and worldviews, and multiple and salient historical land management, pastoral, mining, and tenure issues, and local sense making, and considerable uncertainty about the specific nature and local and global implications of the threat of climate change. Again, respondents also reported feeling much less knowledgeable about climate change than national samples, though their responses nonetheless reflected considerable regional environmental and ecological knowledge.

Importantly, survey responses reflected reasonable concern about climate change, moderate perceived exposure to the physical environmental impacts of climate change, and relatively low self-efficacy with respect to being able to do very much about climate change, when compared with national survey findings, with all of these factors very likely influenced by considerable uncertainty and very mixed and confusing explanatory narratives about the nature and causes of climate change. As well, understandings of climate change as an on-going and background environmental stressor, punctuated by increasingly extreme and erratic weather events, suggest that any comprehensive and strategic risk perception and adaptation response regional picture must factor in this psychological and social reality; and that the presence and environmental stress of climate change is but one of multiple and on-going environmental stressors with which individuals living in these communities must contend.

It should be emphasised that these survey findings with respect to climate change differ from objective or formal regional *risk assessments* or audits; however they say much about current individual and community acceptance, understandings and felt knowledge levels, *perceived and subjective* exposure and vulnerability, and current climate change adaptation dynamics, motivations, and impacts. There is little question but that local climatic and environmental changes, extreme weather events, and 'the threat and phenomenon of 'climate change' are salient and often discussed issues, and thoughts and feelings and sense making with respect to climate change are changing as communities like the Georgina region come to terms with the nature, meaning(s), and implications of climate change. Such changing risk perceptions, understandings, and responses to climate change are integral to the emergence and development of climate change adaptation In the Upper Georgina River Basin. Yet individual and community behavioural engagement and adaptation to climate change was understandably, at the time of the research very limited by multiple and convergent life circumstance and structural constraints, as evidenced throughout the report.

Self-evident implications of these current survey findings are that clarification of the nature and local implications of formal science accounts of climate change would be very useful in reducing uncertainties and confusions, but that any such initiative would need to acknowledge and address current and diverse community and culture informed *understandings* of 'climate change', and other immediately pervasive or pressing socioeconomic and regional development determinants of environmental changes and conditions. Equally it seems critical that these current but changing individual and

community level climate change risk perceptions and understandings, and psychological and social responses and impacts, continue to be measured and monitored as climate change adaptation and mitigation initiatives are adopted and implemented in the region, and benchmarked against on-going national survey data addressing climate change adaptation processes and outcomes. The current research provides a regional database, prototype research platform, and spectrum of climate change adaptation indicators and measures.

In completing the survey analysis, we have a regional database with which to examine similarities and differences with respect to perceptions, understandings, and responses to climate change, with all of these informing and having implications for more psychological and behavioural engagement adaptation responses. The specific findings regarding similarities and differences are interesting and groundbreaking in that no other research programs to our knowledge have produced such climate change focused survey findings for Aboriginal communities. In this sense, they are 'key findings'.

A clear recommendation here is to initiate a community education and discussion program which could assist interested individuals and the community as a whole better understand the nature of the projected climate change impacts for the region, as well as the nature of what can really be done, both in addressing the additional environmental stressor of the ongoing threat, as well as the actual physical environmental changes and weather and seasonal changes taking place. Clearly perceived understandings and knowledge levels could be greatly improved, with flow-on consequences in terms of both individual and collective efficacy, and clearer pathways forward in terms of adaptation and mitigation. The provision, in the community discussion meetings of how their own survey data corresponds to that of mainstream Australia, and other indigenous communities elsewhere in the world would also be very informative and in many validating and reassuring.

Other immediate recommendations that suggest themselves are the importance and value of refining the survey protocol and procedure on the basis of our findings, and endeavouring to establish a biannual monitoring program for this catchment region, and possibly several other catchment regions, to document and further examine the kinds of adaptation changes and impacts that are currently taking place, and to utilise this research platform and survey protocol to also monitor and evaluate the effectiveness of particular climate change adaptation initiatives which are under way or in the planning stage. Recommendations such as these are about actual adaptation and change, but less directly relate to the processes of adapting.

One further key finding is that the research and workshops have no doubt been very reactive in a positive way in that the communities involved have been engaged in a protracted consideration of climate change, its causes and implications, what their own collective views are, how these seem to compare with mainstream Australia, etc. Therefore, this has been a very educational engagement with the issue, and people's thoughts and feelings about climate change are undoubtedly changing, resulting in psychological and social adaptation.

13.4 Key Findings: Climate Change Adaptation in the UGRB

The discussion below focuses on the key outcomes and findings from the survey and workshop process as related to the four major research streams.

13.4.1 Anticipatory Adaptation for Climate Change and Extreme Weather

A number of overarching recommendations can be drawn out of both the field interview responses and workshop discussions when contemplating preparedness in the context of climate change adaptation. One significant message was that given existing socio-economic disadvantage in the region, Aboriginal people are typically the most vulnerable to the effects of climate change, however, the most likely to stay on traditional country as the climate does change; further underscoring the importance of appropriate planning and preparedness at the local community level in building adaptive capacity in remote arid-zone townships. Appropriate communication pathways between community members on the ground and the relevant jurisdictional authorities need to be devised for when extreme weather events do occur. In terms of a preparedness (or anticipatory) framework, a community-wide education process should be in place prior to such events occurring in order that residents are aware of the protocols to follow when needed. The utilisation of local Aboriginal knowledge of the country of the region should be synthesised with the latest best practice preparedness and emergency management strategies available within the Government (LDMGs) and non-Government agencies. The report authors also see this stream as having the most potential for addressing psychological, social, cultural, and community responses and adaptations to climate change.

13.4.2 Land and Riverine Management

Aboriginal groups have lived in the study region for thousands of years and developed highly effective land and river management strategies. During that time they experienced climatic fluctuations of varying length and intensity but they were consistently able to adapt and survive. Their resilience or ability to cope (Reser and Swim 2011) was based on the integration of their traditional belief systems and a hunting and gathering culture which incorporated seasonal movement, land ownership, burning of country, trade as well as other cultural practices. Most importantly people today have inherited kinship relationships based on land which gives them rights and obligations for care and maintenance of all aspects of the natural environment. This knowledge can be revitalised to help people adapt to and cope with the threats of climate change.

Throughout the period of colonisation and since that time, social changes brought significant impacts to local land and river management characterised by the introduction of pastoralism and the removal of people from their land. Consequently, Aboriginal people could not apply their traditional beliefs and practices in the old ways. Their self-sufficiency was threatened and eventually negated. Moreover, they have observed how the management practices of the settlers have increasingly degraded the natural environment in ways that may be irreversible, e.g. altered habitats which threaten the survival of native plant and animal species.

As the workshops and survey results indicate, the risk perceptions of Aboriginal people in the UGRB region about climate change appear to be strongly influenced by their frustrations over the loss of land and their reduced capacity to manage their traditional country. As outlined above (see Section 6), misunderstandings of the threats of climate change and environmental impacts can affect people's ability to cope psychologically and their capacity to act. This suite of considerations is compounded for the study group by the reality that Aboriginal people in these communities have relatively low socio-economic status as well as very limited capacity for moving out of this category.

It follows then that adaptive strategies (for coping with climate change) for Aboriginal people in this region need to involve rights, access and opportunities for future land-based living. Typical pathways to resilience include economic development and increase in social capital (Norris et al 2010). For the UGRB these pathways could focus on greater awareness, knowledge and application of Indigenous environmental knowledge in natural resource management strategies. As discussed above (see Section 9. 4) potential adaptive strategies for reducing the impact of climate change in land and river management include a collaborative research process to document Aboriginal knowledge, negotiation of environmental management roles especially for long-term implementation, education about local Aboriginal culture and ranger training for Aboriginal people. All of these are predicated on using Aboriginal people's knowledge in ways which can bring about sustainable land and water use. With increased roles in land and river management, Aboriginal people can experience greater self-efficacy and be less exposed to potential impacts of climate change.

The barriers (as discussed in Section 9. 5) which work against adaptive capacity in the region could be partly dismantled by drawing significantly on the social processes and social networks of Aboriginal people in the study region. We identified the kin relationships between people across all the communities in the UGRB as a primary source for social and economic enterprise building. By supporting these established links between people in ways they have indicated in the workshops, people can follow a holistic approach to land and river management in the UGRB region and collaborate on goals, role and responsibilities. Partnerships with local Aboriginal organisations, government and non-government service providers will also be critical to an adaptation plan which deals with such a vast arid area of remote land with a relatively low population and subject to a 'boom and bust' climate pattern. In the UGRB region, Aboriginal people want to remain on their land in order to undertake sustainable land and river management. Working towards more effective partnerships can better facilitate these goals.

13.4.3 Housing and Settlement Infrastructure

In January 2013, Urandangi Aerodrome recorded the second highest mean daily maximum temperature in the state of 43.1 °C: first place went to Birdsville Airport at 43.3 °C, with Boulia Airport third, with a recording 42.5 °C (BOM 2013). Climate change modelling indicates significant additional risks to the people in the Upper Georgina River Basin reliant on housing and infrastructure, which should support viable, healthy lifestyles. The survey and workshop data reinforce concerns about the quality of the built environment, the supply and increasing cost of utilities and the robustness (and

sustainability) of infrastructure. Despite these concerns, individuals and Aboriginal communities continue to live in the region with strong attachments to place, to their traditional country and to family. Over three quarters of the survey participants declared that they would not move from their settlements in the event of increasing extreme temperatures.

Aboriginal people in the UGRB have negligible control or representation in either the administration or provision of infrastructure, with the exception of Myuma. Greater participation in decision-making and employment in the supply of infrastructure has potential to improve the sustainability of services, reduce labour costs and raise living standards. Demand for utilities and services can be influenced by the increased awareness that arises from participation and comprehensive community consultation—the Camooweal workshops clearly demonstrated the responsiveness to shared knowledge on climate change.

The quality of the infrastructure in the region varies according to the location of the settlement. And poor quality drinking water and electrical supply are persistent problems in the more remote settlements. Government provided Aboriginal housing is of marginal quality. Dwellings are poorly designed and constructed for semi-arid climate and require inefficient amounts of electricity—predominantly generated from diesel fuel (in 2012) —to maintain thermal comfort. The installation of a solar power station in Alpurrurulam, funded by the Australian and Northern Territory Governments (although not operable at time of writing), is a step toward improving the sustainability of that community. Across all of the settlements in the region, managing the demand for electricity though improvements to the efficiency of the built environment and education of the consumers are additional strategic approaches to the much-needed technological solutions. These approaches require direct participation of Aboriginal people.

One purpose of this scoping study is to identify existing capabilities and adaptive techniques that are evident in the built environment and allow Aboriginal people to remain without complaint in such a harsh climate. The survey data, supported by the research literature on Aboriginal housing, reiterates preferences for externally orientated living. Houses and yards adapted to support these behaviours demonstrate both the knowledge and adaptive capabilities related to place and climate. The resources required to assist Aboriginal people exert greater control over their external living environments—including landscape strategies—are both affordable and achievable in the short term. In addition to resources, expertise, innovation and evaluation are still required if landscapes and yards are to be successful components in adaptive plans for remote settlements.

Housing itself is a more complicated problem. Multiple factors need to be considered in the supply of housing to remote Aboriginal communities. The barriers of cost and expertise alone begin to explain why there are so few housing precedents that are exemplars of climate-responsive design, which also support Aboriginal lifestyles. New housing precedents need to be built and evaluated using processes that combine Aboriginal participation in the design, planning and construction, with teams of qualified building consultants including members experienced in cross-cultural design. In

response to the persistent ‘Aboriginal housing problem’, remote settlements across Australia are home to numerous well-meaning technical solutions that demonstrate little understanding of the householders, the place or the climate.

13.4.4 Enterprise Development

Through this project, Aboriginal people in the UGRB have been involved in considering several proposals for innovative economic enterprise to make their communities more productive and self-reliant in the face of climate change adaptation. Recommendations arising from both the interview process and focus-group workshops generated a number of enterprise ideas covering topics such as carbon farming, land rehabilitation, emergency response, ranger training programs, in addition to housing and infrastructure construction programs. It is noteworthy that the great majority of such economic development options involve partnerships or other forms of support from external organisations, such as science research and development bodies and government agencies. These forms of collaboration require local leadership as well as inclusive community processes to build trust and expand the skills base of the population. In addition, the focus-group workshops recommended that Aboriginal people were important participants in planning for climate change adaptation through processes that suit the local climate and available resources with emphasis on consultative and culturally appropriate design. The role and importance of education programs was discussed in order to refine and improve local capacities and decrease vulnerabilities; emphasis was also shown to respecting the existing skill base in a given community as well as local and customary knowledge.

In order for this to work, Aboriginal participants of the workshops also endorsed a proposal for the establishment of the UGRB regional Climate Change Adaptation Group as being important for on-going adaptation and knowledge dissemination. The purpose of this group is to continue to build on the findings from this report in developing an overarching Adaptation Plan for the entire region in supporting the four communities of Urandangi, Camooweal, Alpurrurulam, Dajarra and Wunara to adapt to a changing future. An emphasis was also given to the role of partnering and linking with Government authorities and other agencies. Furthermore, in addition to the workshop findings, a word of warning was sounded by one of the main report contributors who stated that as both government and business opportunities in remote regions are typically in a state of flux, any engagement with them is highly uncertain and therefore prone to risk for the Aboriginal communities and people involved. He saw mining as the main consistent income earner for remote Aboriginal communities and saw climate change adaptation as playing a part of the mining industry’s social and environmental responsibility. Our research team’s reading of the region’s complex and multifaceted set of issues suggests that the UGRB can benefit further from trans-disciplinary and cross-cultural analysis in order to achieve a balanced enterprise outcome built from the social and natural capitals of the remote communities of the region.

13.4.5 Establishing the UGRB Regional Climate Change Adaptation Group

As mentioned previously, the Aboriginal participants in the workshops endorsed a proposal for the establishment of the UGRB regional Climate Change Adaptation

Group (CCAG) as being important for on-going adaptation and knowledge dissemination. This group would continue to develop an overarching Adaptation Plan for the entire region, which builds on this scoping study. One of its functions would be to tailor generic adaptive strategies to suit local Aboriginal communities, which take into consideration available resources.

13.5 Key Findings influencing the UGRB Adaptation Plan

Notwithstanding the findings listed in the previous pages, the following major points are relevant to the establishment of an overarching and long-term Adaptation Plan for the UGRB region, and the fostering of enhanced and sustained individual and community adaptation responses. Some of these points are identifiable as barriers to effective adaptation, whilst others are strengths for adaptation.

- *Climate is Changing.* Most respondents are experiencing hotter weather but also changeable weather, however, some respondents mentioned that the climate seems cooler in winter; these are not necessarily contradictory responses. Anecdotally, and from the literature, the conditions in the 1960s, for example, were much drier and dustier with less vegetation. Also people are spending less time out in the elements. In the UGRB, Aboriginal people spend more time indoors, living in houses, looking after children, in employment, such as office work compared to the 1960s when people had very basic housing and were commonly living outdoors in hunting, gathering, stock work and droving lifestyles.
- *Predictability of the weather is a real problem.* Aboriginal people are increasingly uncertain about the weather and have responded by changing the way they act on country. For example, some people are hunting when the conditions are likely to be most productive rather than following the previous practice of seasonally based activities.
- *People are unclear and uncertain about climate change.* People admitted uncertainty and also a lack of knowledge about reasons for the changing weather together with certain feelings of powerlessness and vulnerability against natural forces. Big weather events in other parts of the world (as well as in Australia and the region) are now seen as the typical scenario by some. Most people demonstrated belief in normal cycles. For example, bush tucker will come after rain.
- *Country has changed over the decades and culturally important places and significant species are changing.* Both Aboriginal and non-Aboriginal respondents have experienced big weather events and have observed changes. For example, the 1940s and 1960s are identified with the big dust storms. There is some recognition that climate change has influenced the changes, for example, damage from frequent bushfires and the effects of changing climate on hibernation patterns of animals such as goannas and also growth of favoured plant resources.
- *There was limited general or more formal knowledge of the contemporary phenomenon of global climate change, its causes and projected and unfolding global and local consequences.* Knowledge of climate change was clearly related to the age, gender, experience, work, education and other life history considerations. For example, middle-aged stockmen were able to share experiences of noteworthy human-induced landscape and ecosystem changes, whereas few other people acknowledged human causes for climate change.

- *People are dealing with change in many aspects of life.* Questions about climate change provoked responses about the social and cultural changes that they are currently experiencing. Climate is only one factor that affects how Aboriginal people live especially in remote arid regions and they are worried about how they will live in the future. Aboriginal people have many day to day concerns about costs of living, such as for food, power and fuel, as well as enduring problems associated with health and stress on families from the breakdown of traditional family relationships, particularly in relation to childcare, and the loss of traditional knowledge as old people pass.
- *Living on Country is paramount.* People's knowledge of their country is linked to their cultural obligations, which make it imperative for them to live on their land. As the 'old people' pass on, Aboriginal people are concerned about the transmission of appropriate knowledge to the younger generations. Being on Country is integral to knowledge transmission, cultural maintenance and well-being. There is a strong history in this region of bushfire and rain dreaming with reports of significant people being able to sing the weather; a generation ago, there were significant rainmakers present in the Georgina River basin.
- *Resilience is grounded in cultural values, beliefs and practices.* People expressed commitment to 'traditional ways' and also to continue living in their communities. With the exception of interviewees from Camooweal, people believe that they would have community support in an environmental crisis. There are socio-economic barriers for Aboriginal people as they adapt to the impacts of climate change; however, they are most likely to stay on their country as the climate does change.
- *Felt responsibility for looking after country and addressing identified risks is a real strength in the UGRB, but a lack of land tenure and land management authority is a real barrier to climate change adaptation*. There was an appreciable concern about climate change as an adverse psychosocial impact, however in comparison to the national survey findings climate change concern and even distress were also found to be powerful motivators with respect to psychological adaptation and behavioural engagement. With respect to the current survey findings, any such adaptation plan should take into account the reasonably strong findings relating to particular similarities and differences when compared to the national findings. The finding relating to respondents' felt lack of knowledge about climate change is a good example. This presents a real opportunity as well as an identified need, which could be well met by a tailored community education program, informed by and sensitive to the regional and cultural contexts of the Upper Georgina Basin.

13.6 Key Strategies of the UGRB Adaptation Plan

The key strategies, actions and outcomes necessary for the successful implementation of the UGRB Adaptation Plan are outlined in the table below.

Table 8: Key Climate Adaptation Strategies, Strategic Actions and Outcomes (Source: AERC)

Adaptation Strategies	Strategic Actions	Key Outcomes	Barriers
1. Anticipatory Adaptation / Preparedness for Climate Change			
1.1 UGRB Aboriginal communities to work together in building climate change adaptation (CCA) strategies.	Establish a UGRB Climate Change Adaptation Group .	Coordinate preparedness and anticipatory adaptation activities at a regional level.	Potential issues regarding who funds the formation of this group.
1.2 Appropriate regional climate change planning processes required.	Consult with Aboriginal community members and Government/NGO agencies .	Develop further the Regional Climate Change Management Plan Develop a Disaster Management Plan for each community	Lack of funding and cross-jurisdictional issues.
1.3 Better regional climate change preparedness communication processes needed.	Establish a regional CCA social media program.	Coordinate local communities and State, Federal and non-Government agencies re. practical climate change adaptation ideas, both for chronic change and acute weather response.	Lack of funding and cross-jurisdictional issues disrupting good communication outcomes.
1.4 Management of response and recovery processes during and after an extreme weather event.	Link with the Australian Red Cross (ARC).	Become the conduit between local communities and State, Federal and non-Government agencies re. disaster management coordination.	Potential issue with communication protocols, roles and responsibilities during such events.
1.5 On-going climate change adaptation research in the UGRB region required.	Continue communicating with Aboriginal climate change protagonists in the UGRB region.	Seek further funding to continue current research.	Lack of funding options prevents this from occurring.
1.6 Appropriate regional and local CCA education programs need to be implemented.	Consult with Aboriginal community members and Government/NGO agencies .	Develop a primary and secondary schools education program.	Lack of funding.
1.7 Appropriate regional and local CCA training programs need to be implemented.	Consult with Aboriginal community members and Government/NGO agencies.	Develop a regional EMQ/TAFE training program.	Lack of funding.
2. Land and Riverine Management			
2.1 Managing culturally and environmentally significant places.	Documentation and mapping of culturally and environmentally significant places. Protection of culturally significant places and plant and animal habitats. Negotiation over land and river use with regional stakeholders including pastoralists and mining companies.	Establish a set of cultural places and plant and animal habitats for monitoring and protection; and implementation of program. Build the capacity of Aboriginal representatives and their involvement in environmental management.	Access to knowledgeable Aboriginal people and availability of suitably skilled people to record knowledge as well as funding for Aboriginal Knowledge recording, archiving and retrieval. Accessing funding. Availability, willingness of knowledgeable Aboriginal people and regional stakeholders to meet, discuss and lobby effectively.
2.2 Education about Aboriginal land and river management and climate change in the region.	Lobby local government for visitor interpretation and history of Aboriginal land management.	Develop a range of educational resources in collaboration with the Aboriginal community on land and river management, Aboriginal Knowledge and climate change in the UGRB, for use in local and regional schools and in the wider community.	Availability and application of appropriate teacher training and educational resources for schools as well as for the wider community.

2.3 Training and employment of local Aboriginal rangers.	Create further opportunities and programs for Aboriginal ranger training in the UGRB region.	Support local Aboriginal groups to gain access to ranger training programs in the UGRB region.	Funding for all aspects of locally based ranger training programs and availability of suitable trainers and mentors.
3. Housing and Settlement Planning			
3.1 Improve adaptive capacity of individuals.	Increase employment in local service delivery.	Aboriginal provision of infrastructure, services & housing construction.	Aboriginal participation and initial cost.
3.2 Integrated settlement design.	Aboriginal participatory planning.	Utilize local knowledge in settlements planning.	Upfront cost.
3.3 Bioclimatic housing.	Low-energy housing case study housing.	Aboriginal participation in design, planning and construction, with teams of qualified building consultants, experienced in cross-cultural design.	Cost and complexity.
4. Enterprise Development Opportunities			
4.1 Ecosystem restoration works in relation to carbon farming initiatives relevant to the region.	Investigate Aboriginal environmental management processes.	Develop a regional carbon farming enterprise and mining land rehabilitation enterprise.	Complex land use agreement process between local pastoralists and UGRB Aboriginal communities. Lack of will by mining companies to support such an activity.
4.2 Environmental disaster management and clean up.	Investigate environmental disaster management processes.	Develop an environmental land rehabilitation enterprise.	Lack of will by mining companies to support such an activity.
4.3 Emergency road repair.	Investigate infrastructure and disaster management processes.	Develop an infrastructure and disaster response enterprise.	Lack of funding opportunities to support such an activity..
4.4 Weed eradication programs.	Investigate Aboriginal environmental management processes .	Develop an environmental land rehabilitation enterprise.	Complex land use agreement process between local pastoralists and UGRB Aboriginal communities .
4.5 Feral animal hunting.	Investigate Aboriginal environmental management processes.	Develop an environmental land rehabilitation enterprise.	Complex land use agreement process between local pastoralists and UGRB Aboriginal communities.
4.5 Patchwork burning programs.	Investigate Aboriginal environmental management processes .	Develop an environmental land rehabilitation enterprise.	Complex land use agreement process between local pastoralists and UGRB Aboriginal communities.

The key roles and responsibilities of local, regional and state authorities and organisations required to implement the Adaptation Plan above are outlined as follows:

Organisations	Roles and Responsibilities
UGRB Aboriginal Communities	Participation in all activities
UGRB Climate Change Adaptation Group	Decision-making, Representation and Mentoring
Myuma Pty Ltd and Jimberella Co-op	Aboriginal Coordination Agency; Enterprise Development Mentoring
Local Councils (Mt Isa, Cloncurry, Boulia, Barkly)	Individual Stream Functions e.g. disaster response, land and riverine management, housing and infrastructure
Government Agencies (e.g. TAFE, Housing, ICC, EMQ)	Individual Stream Functions e.g. disaster response, land and riverine management, housing and infrastructure
NGOs (e.g. Australian Red Cross)	Individual Stream Functions e.g. disaster response
AERC, UQ Researchers	On-going and Longitudinal Research
Regional Pastoral Companies	Joint Land and Riverine Management, e.g. burning, carbon farming
Regional Mining Companies	Joint Land and Riverine Management, e.g. rehabilitation, pollution control

13.6.1 The Adaptation Process

From the above findings, as well as further consultation with Aboriginal people in the study region, a climate change adaptation plan could follow the process set out below. Each phase would include a number of steps involving communication, negotiation and action at appropriate levels both within the Aboriginal community and with other bodies. The timeline is not prescriptive and focuses on the short-term goals but we acknowledge that an adaptation plan could readily become a longitudinal project. The beginnings of an adaptation process are outlined below.

Phase 1 – Information Gathering and Analysis. *Timeline: Completed*

- Complete NCCARF report on UGRB people's risk perceptions, anticipatory adaptation and strategies for coping with potential threats of climate change;
- Conduct on-going information gathering and analysis of relevant scientific data for future publication.

Phase 2 – Identifying key people/roles *Timeline: Year 1+*

- Establish Georgina adaptation group e.g. UGRBAG or GRPCFI;
- Build/maintain links with other stakeholders (identify, approach and brief);
- Circulate report findings to the regional adaptation group and other stakeholders including local councils, and natural resource management bodies/organisations;
- Develop social media communication plan and strategies;
- Monitor and review at each phase.

Phase 3 – Workshop/s *Timeline: Year 1+*

- Engage Aboriginal community throughout the region in climate change discourse;
- Meet with stakeholders, such as local Aboriginal organisations and local services and administration bodies – EMQ, Dugalunji Aboriginal Corporation, Barkly Shire;
- Scope social media outputs for local Aboriginal community;

- Prioritise strategies –e.g. aspects of housing, disaster management, land management;
- Develop action plan/s – allocate tasks, goals, timelines;
- Investigate relevant funding grants;
- Explore partnering for training, employment, funding through streams identified in this report:
    - Disaster preparedness and response with ARC
    - Land and River management adaptation with DEHP (formerly DERM)
    - Housing adaptation with DOH
    - Enterprise development with Xstrata and other mining companies

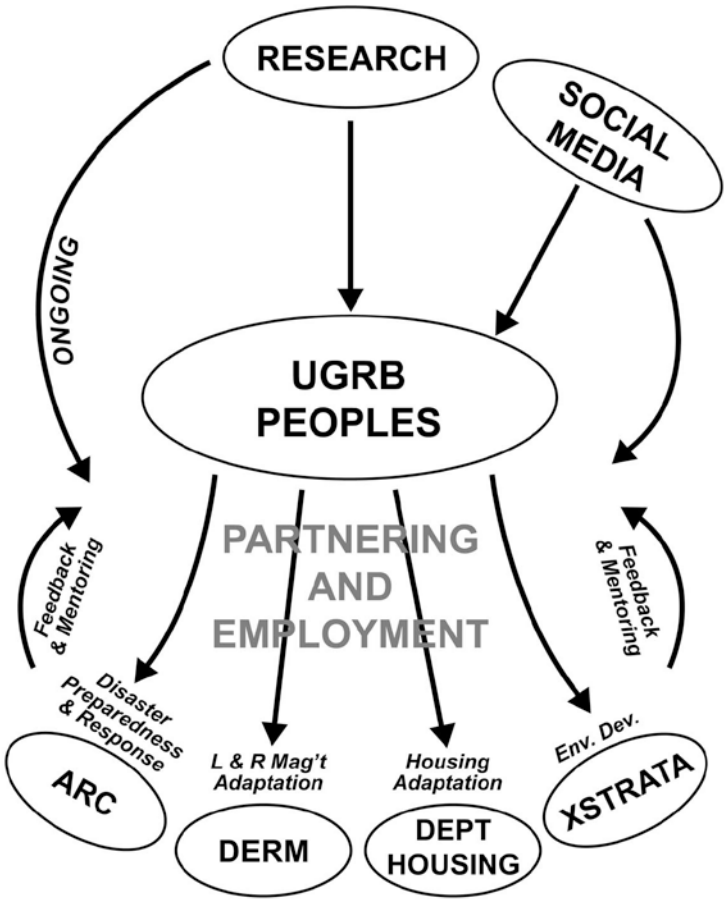

Figure 38: Proposed UGRB Adaptation Plan Process (Source: AERC)

13.6.2 On-going Longitudinal Study as Part of the Plan

There is a need for some region-specific research programs, which would have as a high priority the systematic longitudinal monitoring of important changes and impacts taking place in both the natural and the human environment in the context of unfolding climate change. We see changes in public perceptions, understanding and responses to climate change as of particular importance to climate change adaptation and individual and community well being.

How exposed and vulnerable to climate change and extreme weather events is our research area? Are indigenous communities in locations such as the Upper Georgina

Basin as exposed and vulnerable as the broader characterisation of indigenous communities in the face of climate change would suggest? If this is only partly true, how, and in what ways? Should we and could we address the difference between objective exposure and vulnerability assessments and subjective exposure and vulnerability appraisals? Important similarities and differences need to be identified and taken into account in adaptation planning, and risk communication and management initiatives and programs. Research findings would suggest that, across some survey items, community views of their own exposure and vulnerability to climate change are at clear odds with objective assessments of regional exposure and vulnerability. How should such findings be considered and addressed?

In light of the above, it is recommended to undertake a longitudinal research study (starting with ten years, but ultimately up to 100 years) to closely examine not only changes in regional and cultural risk perceptions, understandings and responses to the dynamic risk domain of climate change, across the communities and age cohorts of the UGRB region, but adaptation directions, strategies, and strengths, as well as psychological and social impacts and costs. This needs to be combined with a parallel longitudinal study of the climate and environment, utilizing a set of reference ecosystems (Biocondition benchmark sites) sampled across the overall range of ecosystems in the region, as discussed in an earlier section.

13.7 Final Word and Reflections

This study has generated information that is vital for building a national model of Arid Zone response and adaptation to climate change, notwithstanding the heterogeneity in understandings and response capacities in different regions and communities. It is recognised that other important research projects have also been addressing the climate change challenge for Indigenous communities in Australia and internationally (e.g. Green et al 2010). Capacity to extrapolate findings partly rests on the observation that since the advent of independent Aboriginal corporations in the early 1970s, a number of good-practice corporations have demonstrated proven capacity to survive and adapt to shifting government policy in multiple jurisdictions and associated economies, sustained in part by intermittent project funding. It is argued that such stable and resilient corporations have on-going viability to take a major role in climate change management in rural and remote Australia. This will have significance in protecting Australia's future. Maintaining an interconnected decentralized settlement system in the arid interior of Australia will become increasingly difficult with climate change threats, but such a settlement and communications infrastructure is believed necessary not only for land and riverine management but also for national security given that global warming may greatly increase the illicit arrival of 'climate refugees' from overseas (refugees fleeing from ecological catastrophes in their home countries).

Aboriginal people, as regional environmental managers will have an increasingly important role to play in maintaining their land and country as well as their communities. It will be important to link these roles to the responsibilities of the three levels of government for various aspects of service planning, infrastructure provision and emergency management. The study has also identified relevant issues of cross-jurisdictional response to climate change impacts and the inherent difficulties of coordinated responses to climate events and natural disasters which cross governance

boundaries. The unique evidence available from this project can make important contributions to evidence-informed policy and planning.

In response to the original research questions, the authors have provided a better knowledge of Aboriginal perceptions and understandings of climate change from within the interior of Australia, most notably the UGRB study region. While it needs further work and much greater financial input and commitment from Government, NGOs and the private sector to become a reality, a skeletal framework for a climate change adaptation strategy for remote arid-zone communities has been developed. In addition, a research program was designed and implemented that addressed the key issues of an adaptation plan and showed that such a plan requires the critical and crucial input of Aboriginal people if such communities are to successfully adapt to the increasing effects of climate change. The next step is to begin implementing the findings from this report. Only time will tell if there is enough political will to support the project's Aboriginal collaborators who are themselves the change agents needed to fulfil the broader aims of this study.

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APPENDIX 1 – SURVEY ITEMS AND DESCRIPTIVE STATISTICS

Q1. Interviewer name

Q2. Age

N	Minimum	Maximum	*M*	*SD*
72	17	81	52.10	16.19

Q3. Where do you live now? Open-ended response

Q4. Where did you grow up? Open-ended response

Q5. Where's your country? (Where you are a traditional owner?) Qualitative response

Q6. Gender

	Frequency	%
Male	41	56.9
Female	31	43.1
Total	72	100

Q7. What grade at school did you go to? Open-ended response

Q8. Do you have a job?

	% (N=40)
Yes	40.3
No	15.3
Missing data	44.4

Q9. What are some other jobs you have had? Open-ended response

Q10. Do you pay the household bills?

	% (N=68)
Yes	69.4
No	25.0
Missing data	5.6

Q11. Have you lived in the same house for a long time? Open-ended response

Climate and Weather

We're going to talk about weather patterns and climate affecting country over the last few decades.

Q12. How would you describe the weather and climate patterns in this area over the past year? Qualitative response.

Q13. Have you seen changes to these weather patterns over the past ten years or so compared to earlier years?

	% (N=35)
Yes	41.7
No	6.9
Missing data	51.4

Q14. How has it changed? Open-ended response.

Q15. How much do you agree with the following statements regarding unusual weather/climate changes?

		Valid *N*	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing data	*M*	*SD*
A	There are more unusual weather events these days compared to earlier years	66	26.4	50.0	2.8	6.9	5.6	5.6	2.8	3.92	1.09
B	Lots of people (scientists) are saying the weather is changing all around the world	62	12.5	68.1	4.2	0	1.4	12.5	1.4	4.05	0.59
C	I have experienced changing weather patterns in my lifetime.	69	19.4	62.5	2.8	6.9	4.2	2.8	1.4	3.90	0.96
D	I have experienced a big weather event (natural disaster) in my lifetime.	71	9.7	45.8	0	30.6	12.5	0	1.4	3.10	1.30
E	There are things people can do to fix the changing weather patterns.	59	5.6	12.5	9.7	36.1	18.1	18.1	0	2.41	1.91

N.B. The 'Valid *N*' is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Q 16. How much do you agree or disagree with the following statements regarding unusual weather/clime changes?

		Valid N	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing data	*M*	*SD*
A	Climate change is happening.	63	27.8	47.2	6.9	0	5.6	6.9	5.6	4.05	0.99
B	The weather is getting harder to predict these days.	70	27.8	47.2	11.1	5.6	5.6	1.4	1.4	3.89	1.07
C	Climate change is partly causing these changes in weather patterns and uncertainty and making it harder to predict the weather.	61	15.3	44.4	12.5	6.9	5.6	12.5	2.8	3.67	1.08
D	The idea of climate change is gammin and talked up too much.	58	0	19.4	13.9	25.0	22.2	19.4	0	2.38	1.14
E	Things like the moon landing might well be causing these weather changes.	46	2.8	18.1	9.7	18.1	15.3	30.6	5.6	2.61	1.26
F	The Government will take action against these weather changes before they get too bad.	56	1.4	19.4	12.5	25.0	19.4	19.4	2.8	2.46	1.18
G	Scientists will fix the problem before it becomes too bad.	52	0	13.9	15.3	27.8	15.3	26.4	1.4	2.38	1.03
H	People in the community will help each other in an emergency weather situation.	71	56.9	27.8	1.4	12.7	0	0	1.4	4.31	1.01

N.B. The 'Valid *N*' is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Q17. Why do you think these changes in weather patterns and extreme weather events are happening? Qualitative response.

Q18. Are there stories going round about what might be causing these weather and season changes?

	% (N=24)
Yes	13.9
No	19.4
Missing data	66.7

Q19. What are these stories? Qualitative response.

Q20. To what extent to do you agree or disagree with each of the following statements regarding climate change?

		Valid N	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing data	*M*	*SD*
A	I can personally help to reduce climate change by changing my behaviour.	61	5.6	20.8	5.6	33.3	19.4	11.1	4.2	2.52	1.27
B	It is hard to take action against climate change even if I wanted to.	64	13.9	51.4	6.9	15.3	1.4	5.6	5.6	3.69	0.99
C	I believe my actions have an influence on climate change.	57	2.8	26.4	12.5	23.6	13.9	9.7	11.1	2.75	1.21
D	I believe my actions have a positive influence on how I am feeling and thinking about climate change and environmental problems generally.	45	8.3	34.7	9.7	5.6	4.2	18.1	19.4	3.6	1.05
E	My actions to reduce the effects of climate change in my community will encourage others to reduce the effects of global warming through their actions.	51	5.6	27.8	6.9	23.6	6.9	12.5	16.7	3.02	1.21

N.B. The 'Valid *N'* is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Q21. Please indicate the extent to which each of the following statements best describes your won response to the threat of climate change.

		Valid N	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing Data %	*M*	*SD*
A	Because of climate change, I have changed the way I think about the seriousness of environmental problems.	56	15.3	41.7	5.6	12.5	2.8	9.7	12.5	3.7	1.08
B	Because of the increasingly evident impacts of climate change, I have seriously thought about alternative places to live.	61	4.2	9.7	5.6	30.6	34.7	2.8	12.5	2.03	1.18
C	I have often discussed my thoughts and feelings about climate change with others over the past several years.	61	6.9	36.1	4.2	19.4	18.1	5.6	9.7	2.93	1.37
D	When considering the challenges of climate change it is important to look for things that I can address and change in my everyday life.	50	4.2	40.3	9.7	9.7	5.6	16.7	13.9	3.4	1.07

N.B. The 'Valid *N'* is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Q22. How much do you feel you know about climate change?

			% (N=69)	*M*
6	100%	A lot	4.2	2.72
5	80%		4.2	
4	60%		20.8	
3	40%		18.1	
2	20%		30.6	

1	0%	Nothing	16.7

Q23. How much do you agree or disagree with the following statements regarding weather changes? And why? (Qualitative response.)

		Valid N	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing data %	*M*	*SD*
A	Changes in weather will mostly affect places that are far away from here.	61	6.9	37.5	13.9	18.1	8.3	6.9	8.3	3.2	1.17
B	Changes in weather will affect other parts of Australia more than where I live.	61	6.9	44.4	6.9	18.1	8.3	6.9	8.3	3.28	1.19
C	Climate change and its effects are important to me.	63	8.3	59.7	6.9	8.3	4.2	4.2	8.3	3.68	0.95
D	Climate change will create new jobs for people in this region.	48	5.6	31.9	11.1	11.1	6.9	19.4	13.9	3.27	1.16

N.B. The 'Valid *N*' is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Q24. Have you ever experienced a natural disaster warning or natural disaster impact situation?

	% (N=67)
Yes	54.2
No	38.9
No answer	6.9

Q25. If yes, please indicate the type of event(s) and the approximate number of times you may have experienced such an event?

		Cyclone (N=33) %	Bushfire (N=38) %	Drought (N=44) %	Flood (N=49) %	Dust Storms (N=48) %	Heatwave (N=43) %
A	Experienced the event on one occasion.	36.1	4.2	8.3	4.2	8.3	1.4
B	Experienced the event twice	5.6	2.8	13.9	11.1	6.9	6.9
C	Experienced the event three times	1.4	4.2	1.4	8.3	4.2	5.6
D	Experienced the event four times	1.4	2.8	5.6	6.9	4.2	6.9
E	Experienced the event five times or more	1.4	38.9	31.9	37.5	43.1	38.9

N.B. The 'Valid *N'* is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Q26 What are the most common weather or climate events that have happened in your lifetime?

			Yes	No
		N	%	%
A	Severe rain storms	70	33.3	63.9
B	Dust storms	70	63.9	33.3
C	Floods	70	63.9	33.3
D	Drought	69	61.1	34.7
E	Heatwaves	69	52.8	43.1
F	Bushfires	70	55.6	41.7
G	Cyclones	70	12.5	84.7
H	Water scarcity	70	18.1	79.2
I	Other	70	1.4	95.8

Q27. Over your lifetime, at what time do these events normally happen during the year? Qualitative response.

Q28. Was it like that last year?

	% (N=31)
Yes	23.6
No	19.4
No answer	56.9

Q29. Have there been more or less of these events lately?

	% (N=54)
More	29.2
Less	16.7
The same	29.2
No answer	25.0

Q30. If things have changed, what do you think has caused it to happen? Qualitative response.

Country and Weather

Q31. How much do you agree or disagree with the following statements regarding unusual weather/climate changes?

	Valid N	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing data %	*M*	*SD*
A Weather changes are caused by Dreamings going the wrong way, because people aren't following the Law.	50	8.3	20.8	6.9	19.4	13.9	25	5.6	2.86	1.37
B Weather changes are caused by Aboriginal people not looking after the Country properly.	58	11.1	27.8	6.9	19.4	15.3	9.7	9.7	3.00	1.39
C My country will be affected by weather changes.	64	11.1	56.9	1.4	15.3	4.2	5.6	5.6	3.63	1.06

N.B. The 'Valid *N'* is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Q32. Are there any good things that could happen? Qualitative response.

Q33. In what ways has the country changed in your lifetime? Qualitative response.

Q34. At the moment are things looking good and healthy or is the land suffering a bit, or changing in other ways? Qualitative response.

Q35. Are you aware of any environmental changes or changes to country that you think have been caused by humans?

	% (N=37)
Yes	16.7
No	34.7
No answer	48.6

Q36. How much do you agree or disagree with the following statements regarding weather changes?

		Valid N	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing data %	*M*	*SD*
A	I am worried about climate change and the negative effects it will have on my Country.	65	19.4	43.1	8.3	9.7	9.7	6.9	2.8	3.58	1.25
B	I am worried about financial problems caused by changes in climate, weather and country.	64	15.3	36.1	11.1	12.5	13.9	2.8	8.3	3.3	1.34
C	I am worried about health problems caused by changes in climate, weather and country.	66	12.5	62.5	4.2	4.2	8.3	1.4	6.9	3.73	1.06
D	I am worried about conflict and arguments becoming more of a problem due to changes in climate, weather and country.	67	9.7	48.6	11.1	12.5	11.1	1.4	5.6	3.36	1.20
E	I am worried about family breakdowns caused by changes in climate, weather and country.	66	6.9	51.4	8.3	15.3	9.7	1.4	6.9	3.33	1.17
F	I am someone who is very worried about these changes to country.	68	12.5	54.2	6.9	8.3	12.5	0	5.6	3.49	1.23
G	What happens on country matters to some old people but not me.	66	8.3	38.9	2.8	16.7	25.0	2.8	5.6	2.88	1.44
H	I have noticed a lot of changes to the land around here.	65	16.7	58.3	9.7	2.8	2.8	2.8	6.9	3.92	0.84
I	I am worried about government telling us we have to leave and deciding on where we live if climate change becomes worse.	64	9.7	34.7	4.2	18.1	22.2	4.2	6.9	2.91	1.43
J	I am worrying more these days about what is happening to my country with these weather and season changes.	66	12.5	43.1	9.7	13.9	12.5	1.4	6.9	3.32	1.28

N.B. The 'Valid *N*' is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Q37. What kinds of things are people in your community saying about how the country and the weather are changing? Qualitative response.

Impacts on Plants, Animals and Country [e.g. biodiversity, habitat loss, species extinction]

Q38. What kinds of plants and animals would you hunt or collect at this time of year? Qualitative response.

Q39. Have you noticed any changes in the time of flowering, fruiting of some plants?

	% (N=61)
Yes	30.6
No	52.8
Don't know	1.5

Q40. Qualitative response to Q39

Q41. Have you noticed any changes in fish, birds, animals, plants? [number and kind]

	% (N=62)
Yes	47.2
No	37.5
Don't know	1.4

Q42. Qualitative response to Q41.

Q43. Have you noticed that some of the animals are having their young earlier or later in the season?

	% (N=52)
Yes	13.9
No	56.9
Don't know	1.4

Q44. Qualitative response to Q43.

Q45. Are there some plants, animals or birds that you don't see so much anymore, or have completely gone?

	% (N=54)
Yes	31.9
No	41.7
Don't know	1.4

Q46. Qualitative response to Q45.

Q47. If so, why do you think that might be? Qualitative response.

Q48. How worried are you that each of the following environmental threats might directly affect you, your family, or your local environment in the future?

		Valid N	4. Very worried %	3. Some worry %	2. Not so worried %	1. Not worried at all %	Missing data %	*M*	*SD*
A	Severe storms	67	19.4	37.5	25.0	11.1	6.9	2.70	0.94
B	Dust storms	67	11.1	40.3	27.8	13.9	6.9	2.52	0.89
C	Floods	67	20.8	38.9	23.6	9.7	6.9	2.76	0.92
D	Droughts	67	13.9	54.2	16.7	8.3	6.9	2.79	0.81
E	Heatwaves	65	18.1	50.0	13.9	8.3	9.7	2.86	0.85
F	Bushfires	67	29.2	41.7	15.3	6.9	6.9	3.00	0.89
G	Cyclones	66	8.3	19.4	23.6	40.3	8.3	1.95	1.02
H	Damage to plants	66	18.1	47.2	16.7	9.7	8.3	2.80	0.89
I	Hurt local animals	68	19.4	55.6	11.1	8.3	5.6	2.91	0.82
J	Hurt local fish	67	20.8	48.6	12.5	11.1	6.9	2.85	0.91
K	Degrade the land	68	26.4	43.1	16.7	8.3	5.6	2.93	0.90
L	Cause soils to erode	66	23.6	40.3	16.7	11.1	8.3	2.83	0.95
M	Cause greater salinity in soils	65	22.2	41.7	15.3	11.1	9.7	2.83	0.95
N	Cause bad drinking water	64	33.3	27.8	16.7	11.1	11.1	2.94	1.01
O	Be bad for camping places, bush tucker places, scared sites and hunting places	65	30.6	40.3	13.9	5.6	9.7	3.06	0.86
P	Will damage cattle stations	68	16.7	38.9	27.8	11.1	5.6	2.65	0.91
Q	Will hurt mining activities in this region	66	8.3	18.1	41.7	23.6	8.3	2.12	0.90
R	Will prevent tourists from coming to this region	67	9.7	26.4	38.9	18.1	6.9	2.30	0.91

Q 49. How much do you agree or disagree with the following statements?

		Valid N	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing data %	*M*	*SD*
A	Changes in the weather have made the animals change their patterns	62	15.3	38.9	8.3	13.9	9.7	5.6	8.3	3.42	1.28
B	I have changed the timing of my hunts because the animals have changed the time they're around.	61	15.3	26.4	6.9	25.0	11.1	4.2	11.1	3.11	1.37

N.B. The 'Valid *N'* is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Infrastructure and Housing Questions

In thinking about your house or yard...

Q50. How much do you agree or disagree with the following statements?

		Valid N	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing data %	*M*	*SD*
A	My house is too hot in summer.	68	47.2	25.0	2.8	13.9	5.6	1.4	4.2	4.00	1.29
B	My house is too cold in winter.	69	40.3	31.9	4.2	11.1	8.3	0	4.2	3.88	1.31
C	I rely on air-conditioning to get through summer.	68	30.6	43.1	4.2	4.2	12.5	0	5.6	3.79	1.31
D	I camp outside most of the time in summer.	67	18.1	34.7	5.6	25.0	9.7	0	6.9	3.28	1.34
E	I heat my house in winter.	66	15.3	40.3	4.2	13.9	18.1	0	8.3	3.23	1.42
F	I would move away from where I live if things became too hot or too cold.	68	0	13.9	2.8	36.1	41.7	0	5.6	1.88	1.03
G	I have town water in my house.	67	15.3	66.7	2.8	4.2	4.2	1.4	5.6	3.91	0.88
H	I drink town water.	69	16.7	54.2	1.4	9.7	13.9	0	4.2	3.52	1.30
I	I have enough drinking water all year round.	66	16.7	66.7	2.8	2.8	2.8	1.4	6.9	4.00	0.78
J	I can afford my electricity bills at the moment.	63	11.1	55.6	6.9	8.3	5.6	2.8	9.7	3.67	1.03
K	I have changed the way I use appliances in my house to keep electricity costs down.	65	13.9	41.7	6.9	12.5	15.3	2.8	6.9	3.29	1.36

L	I expect power bills to keep getting more expensive.	61	19.4	54.2	5.6	4.2	1.4	9.7	5.6	4.02	0.81

N.B. The 'Valid *N'* is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Q51(a). If it gets hotter in summer how would you change your house to make it more comfortable in summer? Qualitative response.

Q51(b). If it gets colder in winter how would you change your house to make it more comfortable in winter? Qualitative response.

Q51(c). What will you do when power bills go up? Qualitative response.

Q52. How much do you agree or disagree with the following statements?

		Valid N	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing data %	*M*	*SD*
A	I would prefer to be outside in the summer in the shade than inside.	67	27.5	45.8	4.2	5.6	0	0	6.9	4.24	0.80
B	I would prefer to live in an air-conditioned place.	68	9.7	36.1	11.1	19.4	18.1	0	5.6	3.00	1.34
C	I prefer to sleep outside in summer.	65	25.0	33.3	8.3	20.8	2.8	0	9.7	3.63	1.21
D	I can't cook inside because it's too hot.	65	8.3	29.2	5.6	26.4	20.8	2.8	6.9	2.75	1.37
E	I personally worry a lot about paying my power bills.	65	15.3	41.7	1.4	22.2	9.7	1.4	8.3	3.34	1.31
F	I am worried about heat stroke.	66	11.1	37.5	13.9	15.3	13.9	0	8.3	3.18	1.29

G	I have changed the way I live in my house and yard due to extreme weather events.	64	5.6	31.9	16.7	19.4	15.3	2.8	8.3	2.92	1.24
H	The Government should encourage people to change the way they live.	59	12.5	51.4	8.3	4.2	5.6	11.1	6.9	3.75	1.01

N.B. The 'Valid *N'* is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Q53. How much do you agree or disagree with the following statements?

		Valid N	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing data %	*M*	*SD*
A	I worry about having enough drinking water.	67	9.7	38.9	4.2	22.2	18.1	0	6.9	3.00	1.37
B	I worry about the quality of my town water getting worse in the future	68	13.9	44.4	6.9	13.9	15.3	0	5.6	3.29	1.34
C	I would use more water if I could.	68	5.6	52.8	12.5	18.1	5.6	0	5.6	3.37	1.05
D	I regularly water my garden.	67	9.7	58.3	5.6	16.7	2.8	0	6.9	3.60	1.00
E	I think we need more restrictions on our local water use.	62	9.7	29.2	15.3	18.1	13.9	4.2	9.7	3.03	1.29
F	The hose is a good way to keep cool in summer.	65	19.4	59.7	4.2	5.6	1.4	0	9.7	4.00	0.81
G	If I had to pay for water I would use less.	64	20.8	52.8	6.9	6.9	1.4	2.8	8.3	3.95	0.88
H	My local water makes me sick.	65	11.1	19.4	6.9	29.2	23.6	1.4	8.3	2.62	1.40

I	I am worried about mosquito diseases.	67	36.1	38.9	6.9	4.2	6.9	0	6.9	4.00	1.16

N.B. The 'Valid *N'* is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Miscellaneous Questions

Q54. How much do you agree or disagree with the following statements?

		Valid N	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing data %	*M*	*SD*
A	I have had direct experience with climate change.	62	12.5	29.2	13.9	22.2	8.3	8.3	5.6	3.18	1.25
B	I have not had direct experience with climate change but know its happening because I've read about it or seen in on TV, radio, and the internet.	62	11.1	44.4	8.3	15.3	6.9	6.9	6.9	3.44	1.17
C	I don't trust what scientists, the media and Government say about climate change.	58	11.1	29.2	22.2	9.7	8.3	12.5	6.9	3.31	1.17

N.B. The 'Valid *N'* is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

Q55. How much do you agree or disagree with the following statements?

		Valid N	5.Strongly Agree %	4. Agree %	3. Neither agree or disagree %	2.Disagree %	1.Strongly Disagree %	No idea/ Don't know %	Missing data %	*M*	*SD*
A	I think environmental groups should be responsible for taking action against climate change.	53	18.1	33.3	12.5	8.3	1.4	15.3	11.1	3.79	1.01
B	I think all people should be responsible for taking action against climate change.	60	30.6	43.1	6.9	1.4	1.4	6.9	9.7	4.20	0.80
C	I think companies should be responsible for taking action against climate change.	57	26.4	43.1	6.9	1.4	1.4	9.7	11.1	4.16	0.80
D	I think shire/town councils should be responsible for taking action against climate change	58	27.8	44.4	6.9	0	1.4	8.3	11.1	4.21	0.74
E	I think the government should be responsible for taking action against climate change.	60	29.2	45.8	6.9	0	1.4	6.9	9.7	4.22	0.74

N.B. The 'Valid *N'* is the number of participants that responded to the actual six-point rating scale, i.e., from 'Strongly Agree' to 'Strongly Disagree'.

APPENDIX 2 – TABLED QUALITATIVE RESPONSES TO OPEN-ENDED SURVEY QUESTIONS

1.1 *Qualitative responses to item 14. "Have you seen changes to the weather patterns over the past 10 years or so compared to earlier years?" "How has it changed?"*	
ID No	Responses
9	Hotter summer. Longer, colder winter.
14	Once rained around November and stayed until March
41	Hotter now and colder before. Lot more grass around today. In times past the old people would burn it but not now. Years ago it was green all the time. Much less rain now. Got to look at TV now for [weather report]. We used to have rain makers in the old days.
45	In winter when I was a boy it was really hot to cold. It's been the same - it hasn't changed at all.
1	Seasons are changing, especially in summer. It's hotter
12	In those years we used to know the seasons. These days I don't know how to predict it.
13	Rain would stay for months before now it's only weeks. Rain would come at end of year. In the 50s and 70s we knew when the rainy season was coming. Now we don't. Need to rely on weather forecast on TV. More consistent before.
17	Haven't seen many changes really in that time
21	Getting much colder now. Also much hotter in Summer. Now more rain.
28	Years ago we'd get big winter rains but not now. Waterholes down the Georgina have been full from winter rains (1960s). I don't think it's got any colder or hotter. Cold was killing the birds (1960s) and the castly wouldn't work. Gotta be out there to know what's going on. Daylight's the coldest.
36	Sometimes it's hotter here not now though. It feels the same to me.
37	It seems like temperature is the same but rains are more now. Desert here so it's not. Camooweal is black soil
38	Similar to this and even worse back in the 50's and 60's. 5 inches of rain is good for this country. SA in 50s Northern NSW in 60s.
Qualitative responses to item 14. "Have you seen changes to the weather patterns over the past 10 years or so compared to earlier years?" "How has it changed?" (Continued)	
46	Same. It's colder now.
48	It's changing cause they're still getting Nokija (conkleberries, blackberries) but it's not the right time. They should be at Christmas time
57	We could nearly predict last 3 years. We predict by watching birds, crocs (laying early), ants flying. You can feel the rain coming in your

	skin.
67	Back in our day when it was summer it was just right. A lot different now. Funny things changing.
3	Changing
5	Getting colder now in June
10	Hotter in summer, colder in Winter
19	Might be hotter
22	Colder in winters, before winter round here not so cold
32	Comes and goes, talk about it when it's different
34	But used to know the weather but now you can't tell. When I was a boy it was hotter in Summer and in Winter it was really cold. But these days it can be hot and cold.
39	Yes, getting drier, possibly warmer and wetter here but rains are scattered now. Rains come from North (Darwin), sometimes from WA - not East.
52	Weather seems to be changing a lot. Less predictable now.
54	Same
63	We had big wets before that. 2008 - 2009 good wet, 2009 - 2010 good wet, 2010 - 2011 good wet
68	Not sure; flood like last year didn't happen before
70	Seasons are changing; especially in summer. It's hotter
Qualitative responses to item 14. "Have you seen changes to the weather patterns over the past 10 years or so compared to earlier years?" "How has it changed?" (Continued)	
72	It was really hot before
24	Hot then cold then hot
27	Dry and hot; when a little fella there was green country and good weather - summer not too hot
56	It's cold in the morning but hot in the afternoon
2	Changing now. Cold 2-3 months, May - August. Now getting hot in August.
4	Not as cold in winter as it used to be.
6	...of year ago (may) heat wave down Georgina.
7	Been changing.
8	In old days good steady rain. Not pelting down like now. Christmas time 2 years ago I had to wear a coat to go Christmas shopping. That's

	not normal for around here.
11	Hotter
15	Winters are not as cold as they used to be. There was frost on the ground but not much now. Lot more dust storms back then.
16	Warmer then
18	Used to rain in Dec, now in Jan.
20	Hotter and drier 10 years ago - 2009 rain
26	Summer - much hotter; winter - colder mornings than it used to be. Carmel W: lot warmer; early 1990s there were frosts in winter - wearing a coat for weeks and weeks. No coat over the last 6 years
29	Yes
33	Cooler back then
35	Hotter now
Qualitative responses to item 14. "Have you seen changes to the weather patterns over the past 10 years or so compared to earlier years?" "How has it changed?" (Continued)	
40	Yes changes - more grass and trees where used to be plains, water in creek beds, rushing through, hail at times
42	Rain comes later now than it usually does, and it's getting hotter
43	Dusty and hot before [compared to now].
44	Looking at different - different weather, come to September last year, lots of rain but getting hot. Different-different climate - bit of heat. Rodeo [in Mt Isa in early August] used to be cold weather. We used to go with plenty of blankets, swags. Now in May it's getting cold, then warm again. At Carlton Downs there's black rock with bubbles on rock like lava - it'll probably come back again. The country is getting too changed about. Like Japan - we might get that volcano under the sea. Or like Tennant Creek that had the earthquake (when the gas pipeline was put in). We're getting ice coming from down South - gotta wear lots of coats.
49	Seems to be hotter and also colder in winter. Never used to be changeable like this. The change is too quick.
50	It's mother nature; once, more than 10 years ago, cold frost in winter made ground too cold to walk on
51	Everyone goes to the Georgina for Easter. The grass is high and more now than before.
55	It's been colder in winter and colder in summer
61	On and off - it has varied

1.2 *Qualitative responses to item 17. "Why do you think these changes in weather patterns and extreme weather events are happening?"*	
ID No	**Responses**
14	Really don't know. Could be melting of the ice at the North pole and South Pole. Lots of changing going on.
25	Hard to tell hey. I wouldn't know anything with that stuff.
41	No more rain makers. They used to make rain every year (1960s). Each Christmas the manager would give people a killer [bullock] and tell em to make rain. So they would have grass after Christmas.
12	Scientists created the problem. I watch the weather channel on TV and they keep talking about the ozone layer.
13	More people in this world than before. It all goes into the air and changes the pattern. More cars etc.
21	Don't know
28	Nature goes through cycles every hundred years. Everything's up and down. Might get 2 hot days then 1 cold day. Oil is creating the problem.
36	Before we used to know when the rain came but now we don't know.
37	Our people could tell by looking at the stars and things and predict the weather. Now they watch TV weather to know.
38	Natural phenomena. We can't stop it. People are making it worse.
46	It's the same, so no.
48	Things have changed because of the weather. You can get rain all around but not here. I listen to TV all the time. How many ice ages have there been? I reckon it's just nature doing it's thing.
53	Pollution and more people
57	Maybe the human emissions are to do with it.
67	I reckon the time is coming. The end of the world.
5	Mother nature
Qualitative responses to item 17. "Why do you think these changes in weather patterns and extreme weather events are happening?" (Continued)	
10	Not talking.
22	Don't know
32	Mining, smoke - pollution

34	Growing up with my people they were the weather people. They could change the weather. I've seen it myself. You may not believe me but they've all gone and they didn't pass it on to us. They had songs for cyclone, wind etc. You could ask them for help. Good for hunting. The old people could have controlled the seasons.
39	There's earthquakes caused by shifting platelets, can't say that the polar ice is melting for climate change reasons - might be natural
52	No idea. I watch the news and don't have enough knowledge. I don't understand too much about climate change. I just go with what the weather throws our way.
54	Global warming, mining, CO2 emissions, population increases, cars etc
63	Mother earth is rejecting us. Too many mines, too many people.
68	In May I thought it's winter just like every other year but it's warmer. Easter 2008 it was cold early.
72	No idea. Rain used to come at right time now you can't tell.
24	Don't know, maybe one day tornado will blow the top off - it's so hot here
27	Harder to predict - might be that rain coming but it just happen like that might be a dust storm
2	Something up with the top. In the satellite dish.
4	No
6	A bit - about next...where summer rains didn't come.
8	Pollution has a lot to do with it. The days of the moon/windy - wind like a dust storm over old people and they shouldn't have done that. I remember I came out of hospital after having my Alan (fourth child).
11	When we look at the news and we see islands disappearing because the ice is melting...and the north pole, all that ice melting; trees being cut down over there in Brazil, smoke from all those chimneys overseas (coal stations?), cars with their carbon...what do you call it? People have more health problems that they didn't have before.
Qualitative responses to item 17. "Why do you think these changes in weather patterns and extreme weather events are happening?" (Continued)	
15	Green house gases caused by human activity are causing climate change.
16	Don't know
18	Pollution; don't know
20	Don't know
26	Weather is going queer. We never had this sort of weather years ago.
29	People are damaging the ozone layer

33	Don't know, summer coming quicker
35	Don't know
42	I'm not too sure. I think it's the ozone layer
44	Maybe the sun is moving away not warm on country. Moon is getting brighter, coming too close - lots of people are saying that. [Re predicting weather:] (crescent moon shaped like a dish means a dry month coming; tipped on its side, tipping water means wet month coming. Also his wife added that some people can change the weather: Around Tobermorey there was an old lady who would pluck the blue leaves from a big tree and shake them around - make the wind settle. Asked Jundoo [old woman sitting nearby] who said the name of the tree was 'nukata nukata')
49	I think the scientists are causing it. Send all the satellites up into the atmosphere. We used to get winter rain in the 1950s and 1960s when we were halfway down the droving track. June, July, every year was the same.
50	Mother nature and also growing population might be affecting climate. When it was drought the river went dry in the 1960s and 70s. We used to walk around and pick up mussels - we had no water just bore water. It's much wetter and hotter since then.
55	I don't know. All depends on weather. If you get good rain everything is good. It it is too dry then there's no decent winter. You need some moisture in the ground to have a good winter.
Qualitative responses to item 17. "Why do you think these changes in weather patterns and extreme weather events are happening?" (Continued)	
59	Pollution
61	Yes
65	Global warming
66	Don't know, could be global warming
23	Cyclones (big rains) bring more water. We have had much drought recently
30	People in bush don't believe in climate change and that everything is in a cycle. It (climate change) has been a "greenie" cause and no country people are against climate change.
58	Taking down forest. Too many houses and other electrical things, gases, fuel.
60	Because of all the things happening outside of Australia
62	Too much pollution. Emissions and stuff
64	People ain't looking after the earth

1.3 *Qualitative responses to item 19. :"What are the stories"? This question follows from item 18 "Are there stories going round about what might be causing these weather and season changes"?*
Responses
People have to look after the country. Can't expect government to fix. I blame rockets and all these things, satellites circling the air. Gotta do something to weather.
Only talk about it after rainy season. Can't get kangaroos but can get tortoise and turkey. We talk to kids. It's green time, turkey, goanna. Rain fish. Haven't seen since I was a kid. Once in Boulia it was crabs. Urandangie, Once was to show us where there was a water-filled cavity in a drought (uncle's dreaming site) 'Mamanyu' tree full of yellow belly.
If the rainmakers were still alive they could fix it. Still there are some people who can do it near Alice Springs.
They don't talk about it
The old days when we were kids there were rain makers who used to know all about the weather. They could predict droughts and rains by watching the animals and birds etc.
No
Ozone layer has got a big hole in it
I don't really listen too much. Late wet and cold winter.
Blackfella way - they sing the rain, dancing around to bring the rain; my dad used to do that - they still do in Borroloola to stop the rain to stop the cyclone; you can't stop the hot weather
I don't know. Not really
Some say 'everything's changing'. Might be one big ocean again when that ice melts - like Noah and the Ark. Change - something's going to happen.
No - just deal with it when it happens
Not really
No stories
Brother rang from Bonya and asked me: Did you see the moon how bright it was? I watched on the news on TV - big moon in Sydney, larger than it ever was before they reckon. People don't talk - no one visits (Q16 you gotta be on your own in Camooweal. Everyone for himself). We just go fishing at Rocklands Station after the kids finish school.
Not really
The government is hiding a lot of things from the world

Qualitative responses to Item #23a	Qualitative responses to Item #23b	Qualitative responses to Item #23c	Qualitative responses to Item #23d
In South Australia they've had more problems than us.	No rain in WA	Maybe because I'm a bushman and love the country. I think about my kids/grandkids.	If good season more work on station
It will be the same	All areas will be affected	Not really	D - Fighting fire maybe
It's bad here. More cold in_____	The coast yes	We'll all suffer	I hear on TV that there will be more jobs
It could affect it a bit	Coast feel it more	Like to know what's going on.	More station work cause its green. Cutting grass etc. More cattle etc
It won't make any difference	Different countries maybe.	Effects everyone in the region	More grass means more cattle. Bushfires create fresh grass.
It will be the same	Father (born (1896) talked about 30 years drought - old stock yards covered by sand (Kidman times of 1930s).	Doesn't bother me	Bullshit stop selling out.
Everyone will be affected	If there's a drought somewhere else it will affect us here re higher prices etc. For example, insurance premiums have gone up for everyone out here due to 2011 floods.		Not here
Qualitative responses to Item #23a (Continued)	**Qualitative responses to Item #23b (Continued)**	**Qualitative responses to Item #23c (Continued)**	**Qualitative responses to Item #23d (Continued)**
Worse for big cities	Does affect us		D - maybe
Same right across Australia	Because of the equator		Maybe
Can't explain why			Mainly in mining. That's the mob making the weather change
Great Barrier Reef for			Be the same

instance is under threat			
Would be different in other places.			Not much they can do
TV - rains in Bangladesh			Probably
Flow on effect with all places affected.			In a way, maybe off roads.
All the same no matter where you go			Might lose jobs - mines can't operate in drought. If long drought comes to Mt Isa I don't think anyone will be here.
It will affect everybody			I hope
Same everywhere			

1.4 *Qualitative responses to item 30. "If things have changed, what do you think has caused it to happen?"*	
Id No	Response
9	There are storms any time now. Sheep run the country. Pollute water too - fall in. Kill vegetation – eat and walk in.
14	Don't know. If rain, more stock work and roadwork washouts.
25	Don't know
45	With all the grass growing has stopped the dust storms
1	Different events at different times. Weather in other parts of the world can affect weather here. Seen on documentary.
12	Don't know. Rains would come consistently at the end of the year.
13	In 1974 I was working at Barkly Station and it was a very big wet. Army had to drop feed to us. More electrical storms these days. Really bad lightning and thunder these days. More floods back in 60s and 70s.
17	Bushfires
21	Don't know. Fires start with lightning from dry storms which come just before the rains

28	Don't know. In the 60s and early 70s there were a lot of droughts. Around that time we had 12 years of drought. Storms would stop at split rock.
36	Don't know
37	Don't know
38	Good seasons grass coverage. Haven't got stock routes flattened and no cattle on the move. With technology it's helped the land. No burn offs happening these days. Worst things are storms. You don't know what's going to happen.
46	There's more floods than before
48	Bushfires are coming. Also more rain. This year there's been more rain so there's more grass which means more bushfires. Wallaroos, red roos etc swimming in the Georgina all travelling north away from something.
53	Don't know
	Qualitative responses to item 30. "If things have changed, what do you think has caused it to happen?" (Continued)
57	Bushfires - there's been a lot of burn off material so more bushfires these days. Dust storms - not sure - wind change perhaps. A lot of the winds have changed I reckon.
67	Not sure
10	Not sure
22	Don't know about why weather changes happen.
32	Maybe every year it's changing
34	The problem is the predictability. If you got no grass to protect the dust storms blow all of the soil away.
52	No idea
63	Don't know
68	More - might be changing e.g. some fellas filled holes in roads after floods rain, dust storms, floods drought heatwaves, bushfires;
72	Bushfires start around the rains. Rains come before Christmas sometimes after.
27	Maybe late storms. Dust storms, floods, droughts, bushfires water scarcity - Christmas time; last year - bushfires; maybe more. Not this year. Sept. Bushfire will burn, now it's a bit too green. Late storm so late bushfires.
56	The weather will change
4	E.g. cyclone. Didn't know about when we were kids. Less dust storms - lots of grass around now e.g., Carandotta - sheep more in the 70s and land like bitumen.
6	10 years ago - biggest lightning and thunder. KM - DJ once electricity (late 70's) lightning storms noisier.

7	Put pieces together. Goes back to the man who went to the moon. The way things are going - end of the world is coming
8	Can't say. Years ago used to be good rains, 'grass rains'. Now it pours and wrecks the ground.
11	Don't know
15	Changing weather patterns. Water scarcity: I had to truck drinking water in Dajarra couple of years ago. We've had to do it about 3 or 4 times over the last 10 years.
Qualitative responses to item 30. "If things have changed, what do you think has caused it to happen?" (Continued)	
16	Don't know. Flood, drought, heat waves, water scarcity - in summer; last year not dust but hot; don't know why
20	More rain makes it hotter
26	Don't know, storms I suppose. Grass is dry the lightning comes especially chain lightning
29	Ozone layer being polluted
33	Change don't know
40	'It's gotta happen because weather is changing'
42	Bush tucker are growing at the wrong time of year and bush tucker (animals) are coming out of hibernation for a short time or wrong time of year.
43	I hope
44	Big wind – fire started in Tobermorey
47	Weather cycle
51	The flooding has been more frequent. Dust storms have been less. More severe and frequent droughts. We've lived with water scarcity all our lives so it's not really an issue. We do worry about it.
55	Not much rain. No decent wet weather
65	Global warming
66	Don't know
71	Dust storms, rain storms, floods (at Camooweal) drought, heatwaves, bushfires, water scarcity. Last year the bore went dry in Camooweal - also water restriction.
23	Been drier. If they have cyclones and storms around the Gulf area we get the floods coming through here.
30	More events because of climate change
58	Electricity gas fuel. Mining putting chemicals into our atmosphere
60	Building a stronger place for families to live during floods and dust storms

62	Bushfires have occurred because it's drier than usual. More growth when it rains
64	People working together

1.5 *Qualitative responses to item 33. "In what ways has the country changed in your lifetime?"*	
ID No	Responses
9	Trees where there was a scrub (a few fires in a few years).
14	More grass and trees growing now
41	More grass and more trees now. Bigger storms creating this
45	It was dry and dusty and then old.
1	Lots of bush tucker is not in abundance like it used to be.
12	If you look at the country now and think about it when you were a boy. We have many more trees now. When I was a boy there were less. Cattle spread the trees that's why there's more.
13	More trees have come up near waterway etc, mostly bad trees. More plains. Less trees in others.
17	Looked good before and still looks good now
21	More grass, more trees now. Before nothing much. It rains more (every year)
28	Every 7 - 10 years the acacia scrub dries out and dies. A cycle of 10-15 years the coolibah trees were kept down by the goats now there are lots.
36	All drying up
37	Camooweal used to be green back then. Out here was really dry and dusty.
Qualitative responses to item 33. "In what ways has the country changed in your lifetime?" (Continued)	
46	Bushfire burns the country out and then rain comes and it grows new.
48	In the rainy season it's good.
53	More grass now, it was bare in the old days. More trees
57	The last 10 years we've had plenty of rains and grass and trees
67	It's the same
10	Not really

19	Years are different, bit wetter
22	Dry now, trees dying from heat
32	Ampilatwatja - more trees, long grass, no burning
34	All the same. Only change has been more mining activity
39	In the last 25 years the country has come alive - open country has become forest country, thick.
52	A lot less rain in the last few years. Not really drought. More dust storm before from cattle. No such thing as droving cattle anymore now have roads and trucks so it's reduced it. Used to have railway line for cattle.
54	Don't know
63	Old trees along river have been dying
68	More young trees: some old trees died, fell down
70	Lot of bush tucker is not in abundance like it used to be.
72	Less duststorms. Only whirly winds come through here.
24	Dry, no water
27	Dry before now trees grown up. Working on Barkly Station the paddocks were bare. See more grass now
Qualitative responses to item 33. "In what ways has the country changed in your lifetime?" (Continued)	
2	Always stinking hot out in bush (hasn't changed).
4	Lot of wildlife is missing, e.g., kangaroo, turkey, birds still around.
6	Trees die. Drought, And don't come back.
7	A lot more drought, dry now.
8	(see other questions)
11	Hardly any water in the creeks
15	Don't know. More grass on the country now, dams for cattle etc.
16	More trees now down the Georgina river
20	Hasn't changed
26	More trees and more rain, even at river here - not like years ago. Years to come it'll be a big scrub.
29	Summer - getting hotter

33	Different lots of trees, can't get bush tucker close to Ampilatwatja now
35	Grassed up now - about 10 years ago it was as good
40	Dry, when you travel now its green
42	Vegetation, bush tucker/animals
43	Don't know
44	Burnt out; not my secret site – everything still there
49	Back in the good old days there was better grass except where the sheep were. Ardmore family sheep destroyed the grasses and caused dust storms.
50	Dry, need rain for bush potato, bush bananas and bush tomato
Qualitative responses to item 33. "In what ways has the country changed in your lifetime?" (Continued)	
51	The creeks and the billabongs have been filled from the floods. Silting. A lot of trees now whereas there weren't in the past. A lot more fruit trees.
55	Dreamings are not living. Now old people are passed the country has changed. Vanessa Riley sits in house, curses
59	Hotter in summer/colder in winter
61	Not much rain and a little bit drier
65	The amount of floods happening all over the place
66	The weather patterns are different
71	Never changes [her country] still the same. Only thing is that my husband is not there to run it.
23	More grass and trees. More bushfires from people burning in the past.
30	Gone from season to grey area between seasons. Used to get nice big wets (monsoonal rains). Rain now comes from big storms
31	Has not really changed
58	No one cares about our world or even putting a stop to anything.
60	The younger people are knocking down all the old sheds and stuff that was there for years and years
62	Trees growing were there weren't trees before
64	Not much wildlife around

1.6 *Qualitative responses to item 34. "At the moment are things looking good and healthy or is the land suffering a bit, or changing in other ways?"*	
ID No	Responses
9	Best I've seen this country for years.
14	Looking good
25	Country looking OK when it's raining
41	Looking good now.
45	Fellas who make the rain were here.
1	Not as good as when we were growing up.
12	The land is looking good.
13	It's not too bad. In places suffering. Different areas.
17	Looks good
21	Country looking good
28	Country is looking good as I've ever seen it. Biggest body of grass I've seen.
36	Country changed. Not much bush tucker. Country very dry.
37	Looking good
38	Looking healthy
46	Looking good now.
48	It's looking good at the moment
53	In places it's suffering while other places are looking good
57	Looking good and healthy. All dams are full
Qualitative responses to item 34. "At the moment are things looking good and healthy or is the land suffering a bit, or changing in other ways?" (Continued)	
67	Suffering. Pretty dry
5	Struggling a bit.
10	Looking good
19	Good
22	Suffering a bit

21	Good
34	Suffering a little bit
39	Healthy
52	Good and healthy
54	Looking good
63	Things are looking pretty normal
68	Good
70	Not as good as when were growing up.
72	Land is looking OK cause we had rain.
24	Don't get out in the bush much; can't find bush tucker here, don't know the bush foods
27	Pretty good
56	No, because everything is dying not enough rain.
2	Don't go out bush
44	Years ago good. Now, plenty of grass.
Qualitative responses to item 34. "At the moment are things looking good and healthy or is the land suffering a bit, or changing in other ways?" (Continued)	
6	Erosion from stock across the board
7	Dry
8	Erosion, etc. Floods over hills, don't give to roots. Ripping up ground, making tracks, loosing soil.
11	Green, but wrong time
15	I don't think the land is healthy. A lot more wildlife here if the land was healthy.
16	Good
20	Healthy
26	Yes good
29	More natural disasters occurring
33	Good
35	Good - been fired
40	Land is good

42	Suffering because of the changes
43	Good and healthy
44	Pretty good
47	Good
49	Starting to come good. Looking good
50	Good
51	The country is doing pretty good
Qualitative responses to item 34. "At the moment are things looking good and healthy or is the land suffering a bit, or changing in other ways?" (Continued)	
55	Suffering
59	Good and healthy
61	Suffering and changing
65	Good/healthy
66	The land is suffering a bit
71	Good, better than it was.
23	Looking really good
30	Fairly good
31	Looking good
58	The world is suffering everyday
60	Everything's looking good
62	Suffering a bit as it's drier
64	Suffering a bit

1.7 *Qualitative responses to item 37. "What kinds of things are people in your community saying about the how the country and the weather are changing"?*	
ID No	**Responses**
9	Barramundi in Lake Moondarra dying because of lack of oxygen.

14	Getting hotter and colder.
25	This guy's too old
12	Everyone has been talking about the rain. All the grass bring plenty of goanna where as now the yabbies are now even bigger.
13	People mainly talk about the wet. Not as much wild food lately.
21	No one talks about it
48	Haven't heard much about it. They just take it as it comes
67	Don't know
10	Na. don't take much notice.
19	Not really
22	No, they don't say
32	Don't know
34	Healthier in the bush on your own country. Probably just like "it's hot today but it should be cold", or "it's cold today but it should be hot".
39	Getting drier (husband says)
52	No idea
54	n/a
68	might be changing
Qualitative responses to item 37. "What kinds of things are people in your community saying about the how the country and the weather are changing"? (Continued)	
27	Everywhere changes - we don't know when it'll change next
2	No
4	People that much up the country and rivers. Pollutes new hills here.
7	Having trouble...build under a shady tree (see interview).
8	People who have no right to have a say about the cournty, try and speak for the (whole) country.
11	Goanna hibernating now but they don't know what time winter is. We're here in our short sleeves and it's cold in Alice Springs
15	Some people don't put it down to climate change. Some people don't know what climate change means.
16	Nothing - just live day to day
20	Don't know

29	Too much mining and pollution
33	Don't know
35	Real dried out can't get kangaroos.
40	Not really
42	Hotter and shorter winter; rain comes later in the year; vegetation/animal (bush tucker) coming out in the wrong time of year
44	Old people know, gotta look after them – lose old people and you never get any knowledge
50	Older people want the younger people to know how to look after country
66	Not much
23	A few people are saying that the weather is changing.
31	Old people talk about how it wasn't as hot/cold as it was before
58	Sea levels rising. Animals and plants dying.
62	They want more rain. Decent wet season
64	Not many talk about it

1.8 *Open-ended response to question 45 "Are there some plants, animals or birds that you don't see so much anymore, or have completely gone"?*
Responses
Some small kangaroos (kangaroo rats) you don't see anymore. We had lots of fruit bats and rabbits but not anymore. Emus and kangaroos seem to be moving elsewhere.
All the budgies have gone
We used to see the conkleberry but now you don't see them at all
Bush rat back this year. Snakes also back (king brown, black snake).
Sceptical of climate change
Echidna
Still see them around
On the river there used to be lots of pretty flowers after floods, rains - yellow and blue ones. I don't see them now. We used to have cubby houses - make mud-cakes and put pretty flowers on like birthday cake. Same at Utopia
Waverly Creek - Half Mt Isa and Dajarra. Good dinner camp. Used to be good for all hunting.

Year ago - millions of cockatiels (kwarian) and budgerigars. My old granny would throw a stick. Nobody would eat them anymore. Before you could see them nesting in hollow trees but now, not so many of those trees for them.
Budgies, quarians, willywagtails
Plain goanna. Only see him after wet season.
Magpies
Bush turkey and goannas
Emus

1.9 *Qualitative responses to item 47. "If so, why do you think that might be"?*

ID No	Responses
9	Storms affect what you can get - early rains affect what you can get. Changes in birds in G.R. over year. Young fellas - mobs of budgerigars - not now. Threw stick, straight on the coals. Water attracts them. Miss N-W monsoon - used to come to DJ every November. Consistent rain for 2 weeks.
14	White corellas coming, never seen before.
41	Less kangaroos these days. Before they were everywhere.
36	Hard to tell
46	Still the same
53	If you see plagues of grasshoppers, then budgies, it's going to rain. When it's gonna rain you [get] all different sorts of birds.
57	Climate change has caused this
67	Just less
3	We don't know what's going on.
5	We sit down one place, don't go bush much.
54	Hibernating
68	Changing climate maybe
72	After wet season plants will flower.
Qualitative responses to item 47. "If so, why do you think that might be"?	
24	Older woman - doesn't go hunting etc where she now lives. Doesn't know about the changes.

56	Because the weather has changed and they only come out at night time because it's cool
2	Come when there - e.g., galah, corellas i.e., after rain.
4	Karni/frill-necked – don't see many.
6	Transport, hunting out areas.
7	Hardly seen bush tomatoes - because of climate change – affects things.
8	Gun license - more than changes.
42	Yes to all above; don't know really what's behind it all. Probably the ozone layer. Weather is changing, winter is shorter. One month ago went over 100kms to get kangaroo - nothing; and no goannas. No bush tucker - bush orange, bush banana Reasons might be the mines or too many people - the roo shooters frighten.
43	Noticed no changes
55	They hibernate (yellow goanna the same) when it's too dry. Come out with the rains
23	Same
30	Reason: Increase in rainfall at different times of the year. No drought since 1990 but 1 year no rain - 2000.
58	Climate change
62	Bushfires burning nesting grounds making it harder to reproduce
64	Because of the changes

APPENDIX 3 – FLORA AND FAUNA DATA FOR UPPER GEORGINA RIVER BASIN

Common Fauna in the Mount Isa Inlier Bioregion

Scientific name		Common name
1.	Dromaius novaehollandiae	Emu
2.	Coturnix pectoralis	Stubble Quail
3.	Coturnix ypsilophora	Brown Quail
4.	Pavo cristatus	Peafowl
5.	Dendrocygna arcuata	Wandering Whistling-Duck
6.	Dendrocygna eytoni	Plumed Whistling-Duck
7.	Oxyura australis	Blue-billed Duck
8.	Cygnus atratus	Black Swan
9.	Chenonetta jubata	Australian Wood Duck
10.	Nettapus pulchellus	Green Pygmy-Goose
11.	Anas superciliosa	Pacific Black Duck
12.	Anas rhynchotis	Australasian Shoveler
13.	Anas gracilis	Grey Teal
14.	Malacorhynchus membranaceus	Pink-eared Duck
15.	Aythya australis	Hardhead
16.	Tachybaptus novaehollandiae	Australasian Grebe
17.	Poliocephalus poliocephalus	Hoary-headed Grebe
18.	Podiceps cristatus	Great Crested Grebe
19.	Anhinga melanogaster	Darter
20.	Phalacrocorax melanoleucos	Little Pied Cormorant
21.	Phalacrocorax varius	Pied Cormorant
22.	Phalacrocorax sulcirostris	Little Black Cormorant
23.	Phalacrocorax carbo	Great Cormorant
24.	Pelecanus conspicillatus	Australian Pelican
25.	Egretta novaehollandiae	White-faced Heron
26.	Egretta garzetta	Little Egret
27.	Ardea pacifica	White-necked Heron
28.	Ardea alba	Great Egret
29.	Ardea intermedia	Intermediate Egret
30.	Ardea ibis	Cattle Egret
31.	Nycticorax caledonicus	Nankeen Night Heron
32.	Ixobrychus flavicollis	Black Bittern
33.	Plegadis falcinellus	Glossy Ibis
34.	Threskiornis molucca	Australian White Ibis
35.	Threskiornis spinicollis	Straw-necked Ibis
36.	Platalea regia	Royal Spoonbill
37.	Platalea flavipes	Yellow-billed Spoonbill
38.	Ephippiorhynchus asiaticus	Black-necked Stork
39.	Pandion haliaetus	Osprey
40.	Elanus axillaris	Black-shouldered Kite
41.	Lophoictinia isura	Square-tailed Kite
42.	Hamirostra melanosternon	Black-breasted Buzzard
43.	Milvus migrans	Black Kite
44.	Haliastur sphenurus	Whistling Kite
45.	Haliaeetus leucogaster	White-bellied Sea-Eagle
46.	Circus assimilis	Spotted Harrier

47.	Circus approximans	Swamp Harrier
48.	Accipiter fasciatus	Brown Goshawk
49.	Accipiter cirrhocephalus	Collared Sparrowhawk
50.	Aquila audax	Wedge-tailed Eagle
51.	Hieraaetus morphnoides	Little Eagle
52.	Falco berigora	Brown Falcon
53.	Falco longipennis	Australian Hobby
54.	Falco hypoleucos	Grey Falcon
55.	Falco subniger	Black Falcon
56.	Falco peregrinus	Peregrine Falcon
57.	Falco cenchroides	Nankeen Kestrel
58.	Grus antigone	Sarus Crane
59.	Grus rubicunda	Brolga
60.	Gallirallus philippensis	Buff-banded Rail
61.	Porzana pusilla	Baillon's Crake
62.	Porphyrio porphyrio	Purple Swamphen
63.	Gallinula tenebrosa	Dusky Moorhen
64.	Gallinula ventralis	Black-tailed Native-hen
65.	Fulica atra	Eurasian Coot
66.	Ardeotis australis	Australian Bustard
67.	Turnix velox	Little Button-quail
68.	Gallinago megala	Swinhoe's Snipe
69.	Limosa limosa	Black-tailed Godwit
70.	Numenius minutus	Little Curlew
71.	Tringa stagnatilis	Marsh Sandpiper
72.	Tringa nebularia	Common Greenshank
73.	Tringa glareola	Wood Sandpiper
74.	Actitis hypoleucos	Common Sandpiper
75.	Calidris melanotos	Pectoral Sandpiper
76.	Calidris acuminata	Sharp-tailed Sandpiper
77.	Irediparra gallinacea	Comb-crested Jacana
78.	Burhinus grallarius	Bush Stone-curlew
79.	Himantopus himantopus	Black-winged Stilt
80.	Recurvirostra novaehollandiae	Red-necked Avocet
81.	Charadrius ruficapillus	Red-capped Plover
82.	Elseyornis melanops	Black-fronted Dotterel
83.	Erythogonys cinctus	Red-kneed Dotterel
84.	Vanellus miles	Masked Lapwing
85.	Stiltia isabella	Australian Pratincole
86.	Larus novaehollandiae	Silver Gull
87.	Sterna nilotica	Gull-billed Tern
88.	Sterna caspia	Caspian Tern
89.	Chlidonias hybridus	Whiskered Tern
90.	Chlidonias leucopterus	White-winged Tern
91.	Columba livia	Rock Dove
92.	Phaps chalcoptera	Common Bronzewing
93.	Ocyphaps lophotes	Crested Pigeon
94.	Geophaps plumifera	Spinifex Pigeon
95.	Geopelia cuneata	Diamond Dove
96.	Geopelia placida	Peaceful Dove
97.	Geopelia humeralis	Bar-shouldered Dove
98.	Calyptorhynchus banksii	Red-tailed Black-Cockatoo

99.	Eolophus roseicapillus	Galah
100.	Cacatua sanguinea	Little Corella
101.	Cacatua leadbeateri	Major Mitchell's Cockatoo
102.	Cacatua galerita	Sulphur-crested Cockatoo
103.	Nymphicus hollandicus	Cockatiel
104.	Trichoglossus haematodus	Rainbow Lorikeet
105.	Psitteuteles versicolor	Varied Lorikeet
106.	Aprosmictus erythropterus	Red-winged Parrot
107.	Platycercus venustus	Northern Rosella
108.	Barnardius zonarius	Australian Ringneck
109.	Melopsittacus undulatus	Budgerigar
110.	Cuculus pallidus	Pallid Cuckoo
111.	Cacomantis variolosus	Brush Cuckoo
112.	Chrysococcyx osculans	Black-eared Cuckoo
113.	Chrysococcyx basalis	Horsfield's Bronze-Cuckoo
114.	Eudynamys scolopacea	Common Koel
115.	Scythrops novaehollandiae	Channel-billed Cuckoo
116.	Centropus phasianinus	Pheasant Coucal
117.	Ninox connivens	Barking Owl
118.	Ninox novaeseelandiae	Southern Boobook
119.	Tyto alba	Barn Owl
120.	Podargus strigoides	Tawny Frogmouth
121.	Eurostopodus argus	Spotted Nightjar
122.	Aegotheles cristatus	Australian Owlet-nightjar
123.	Apus pacificus	Fork-tailed Swift
124.	Alcedo azurea	Azure Kingfisher
125.	Dacelo leachii	Blue-winged Kookaburra
126.	Todiramphus macleayii	Forest Kingfisher
127.	Todiramphus pyrrhopygia	Red-backed Kingfisher
128.	Todiramphus sanctus	Sacred Kingfisher
129.	Merops ornatus	Rainbow Bee-eater
130.	Eurystomus orientalis	Dollarbird
131.	Climacteris melanura	Black-tailed Treecreeper
132.	Malurus coronatus	Purple-crowned Fairy-wren
133.	Malurus lamberti	Variegated Fairy-wren
134.	Malurus leucopterus	White-winged Fairy-wren
135.	Malurus melanocephalus	Red-backed Fairy-wren
136.	Stipiturus ruficeps	Rufous-crowned Emu-wren
137.	Amytornis dorotheae	Carpentarian Grasswren
138.	Pardalotus rubricatus	Red-browed Pardalote
139.	Pardalotus striatus	Striated Pardalote
140.	Smicrornis brevirostris	Weebill
141.	Gerygone fusca	Western Gerygone
142.	Acanthiza apicalis	Inland Thornbill
143.	Acanthiza chrysorrhoa	Yellow-rumped Thornbill
144.	Acanthagenys rufogularis	Spiny-cheeked Honeyeater
145.	Philemon argenticeps	Silver-crowned Friarbird
146.	Philemon citreogularis	Little Friarbird
147.	Entomyzon cyanotis	Blue-faced Honeyeater
148.	Manorina flavigula	Yellow-throated Miner
149.	Lichenostomus virescens	Singing Honeyeater
150.	Lichenostomus unicolor	White-gaped Honeyeater

151.	Lichenostomus keartlandi	Grey-headed Honeyeater
152.	Lichenostomus plumulus	Grey-fronted Honeyeater
153.	Lichenostomus flavescens	Yellow-tinted Honeyeater
154.	Lichenostomus penicillatus	White-plumed Honeyeater
155.	Melithreptus gularis	Black-chinned Honeyeater
156.	Melithreptus albogularis	White-throated Honeyeater
157.	Lichmera indistincta	Brown Honeyeater
158.	Grantiella picta	Painted Honeyeater
159.	Ramsayornis fasciatus	Bar-breasted Honeyeater
160.	Conopophila rufogularis	Rufous-throated Honeyeater
161.	Certhionyx pectoralis	Banded Honeyeater
162.	Certhionyx niger	Black Honeyeater
163.	Certhionyx variegatus	Pied Honeyeater
164.	Myzomela obscura	Dusky Honeyeater
165.	Epthianura tricolor	Crimson Chat
166.	Epthianura aurifrons	Orange Chat
167.	Microeca fascinans	Jacky Winter
168.	Petroica goodenovii	Red-capped Robin
169.	Melanodryas cucullata	Hooded Robin
170.	Poecilodryas superciliosa	White-browed Robin
171.	Pomatostomus temporalis	Grey-crowned Babbler
172.	Daphoenositta chrysoptera	Varied Sittella
173.	Oreoica gutturalis	Crested Bellbird
174.	Pachycephala rufiventris	Rufous Whistler
175.	Colluricincla woodwardi	Sandstone Shrike-thrush
176.	Colluricincla harmonica	Grey Shrike-thrush
177.	Myiagra inquieta	Restless Flycatcher
178.	Grallina cyanoleuca	Magpie-lark
179.	Rhipidura rufifrons	Rufous Fantail
180.	Rhipidura fuliginosa	Grey Fantail
181.	Rhipidura rufiventris	Northern Fantail
182.	Rhipidura leucophrys	Willie Wagtail
183.	Coracina novaehollandiae	Black-faced Cuckoo-shrike
184.	Coracina papuensis	White-bellied Cuckoo-shrike
185.	Coracina maxima	Ground Cuckoo-shrike
186.	Lalage sueurii	White-winged Triller
187.	Oriolus sagittatus	Olive-backed Oriole
188.	Artamus leucorhynchus	White-breasted Woodswallow
189.	Artamus personatus	Masked Woodswallow
190.	Artamus superciliosus	White-browed Woodswallow
191.	Artamus cinereus	Black-faced Woodswallow
192.	Artamus minor	Little Woodswallow
193.	Cracticus torquatus	Grey Butcherbird
194.	Cracticus nigrogularis	Pied Butcherbird
195.	Gymnorhina tibicen	Australian Magpie
196.	Corvus coronoides	Australian Raven
197.	Corvus bennetti	Little Crow
198.	Corvus orru	Torresian Crow
199.	Corcorax melanorhamphos	White-winged Chough
200.	Struthidea cinerea	Apostlebird
201.	Chlamydera maculata	Spotted Bowerbird
202.	Chlamydera nuchalis	Great Bowerbird

203.	Mirafra javanica	Horsfield's Bushlark
204.	Anthus novaeseelandiae	Australian Pipit
205.	Passer domesticus	House Sparrow
206.	Taeniopygia guttata	Zebra Finch
207.	Taeniopygia bichenovii	Double-barred Finch
208.	Poephila acuticauda	Long-tailed Finch
209.	Poephila cincta	Black-throated Finch
210.	Neochmia phaeton	Crimson Finch
211.	Emblema pictum	Painted Finch
212.	Lonchura castaneothorax	Chestnut-breasted Mannikin
213.	Heteromunia pectoralis	Pictorella Mannikin
214.	Dicaeum hirundinaceum	Mistletoebird
215.	Hirundo neoxena	Welcome Swallow
216.	Hirundo nigricans	Tree Martin
217.	Hirundo ariel	Fairy Martin
218.	Acrocephalus australis	Australian Reed-Warbler
219.	Megalurus gramineus	Little Grassbird
220.	Eremiornis carteri	Spinifexbird
221.	Cinclorhamphus mathewsi	Rufous Songlark
222.	Cinclorhamphus cruralis	Brown Songlark
223.	Cisticola exilis	Golden-headed Cisticola

Note: Species listed here are in general for the whole bioregion

(Source: **(Australian Natural Resources Atlas; www.anra.gov.au; sighted 21/02/2013)**

Common Fauna in the Mitchell Grass Down Bioregion.

Scientific name		**Common name**
1.	*Dromaius novaehollandiae*	Emu
2.	*Coturnix pectoralis*	Stubble Quail
3.	*Coturnix ypsilophora*	Brown Quail
4.	*Dendrocygna eytoni*	Plumed Whistling-Duck
5.	*Stictonetta naevosa*	Freckled Duck
6.	*Cygnus atratus*	Black Swan
7.	*Chenonetta jubata*	Australian Wood Duck
8.	*Anas superciliosa*	Pacific Black Duck
9.	*Anas rhynchotis*	Australasian Shoveler
10.	*Anas gracilis*	Grey Teal
11.	*Anas castanea*	Chestnut Teal
12.	*Malacorhynchus membranaceus*	Pink-eared Duck
13.	*Aythya australis*	Hardhead
14.	*Tachybaptus novaehollandiae*	Australasian Grebe
15.	*Poliocephalus poliocephalus*	Hoary-headed Grebe
16.	*Anhinga melanogaster*	Darter
17.	*Phalacrocorax melanoleucos*	Little Pied Cormorant
18.	*Phalacrocorax varius*	Pied Cormorant
19.	*Phalacrocorax sulcirostris*	Little Black Cormorant
20.	*Phalacrocorax carbo*	Great Cormorant
21.	*Pelecanus conspicillatus*	Australian Pelican
22.	*Egretta novaehollandiae*	White-faced Heron

23.	*Egretta garzetta*	Little Egret
24.	*Ardea pacifica*	White-necked Heron
25.	*Ardea alba*	Great Egret
26.	*Ardea intermedia*	Intermediate Egret
27.	*Nycticorax caledonicus*	Nankeen Night Heron
28.	*Plegadis falcinellus*	Glossy Ibis
29.	*Threskiornis molucca*	Australian White Ibis
30.	*Threskiornis spinicollis*	Straw-necked Ibis
31.	*Platalea regia*	Royal Spoonbill
32.	*Platalea flavipes*	Yellow-billed Spoonbill
33.	*Ephippiorhynchus asiaticus*	Black-necked Stork
34.	*Elanus axillaris*	Black-shouldered Kite
35.	*Lophoictinia isura*	Square-tailed Kite
36.	*Hamirostra melanosternon*	Black-breasted Buzzard
37.	*Milvus migrans*	Black Kite
38.	*Haliastur sphenurus*	Whistling Kite
39.	*Circus assimilis*	Spotted Harrier
40.	*Circus approximans*	Swamp Harrier
41.	*Accipiter fasciatus*	Brown Goshawk
42.	*Accipiter cirrhocephalus*	Collared Sparrowhawk
43.	*Aquila audax*	Wedge-tailed Eagle
44.	*Hieraaetus morphnoides*	Little Eagle
45.	*Falco berigora*	Brown Falcon
46.	*Falco longipennis*	Australian Hobby
47.	*Falco hypoleucos*	Grey Falcon
48.	*Falco subniger*	Black Falcon
49.	*Falco cenchroides*	Nankeen Kestrel
50.	*Grus rubicunda*	Brolga
51.	*Porzana pusilla*	Baillon's Crake
52.	*Porzana tabuensis*	Spotless Crake
53.	*Porphyrio porphyrio*	Purple Swamphen
54.	*Gallinula tenebrosa*	Dusky Moorhen
55.	*Gallinula ventralis*	Black-tailed Native-hen
56.	*Fulica atra*	Eurasian Coot
57.	*Ardeotis australis*	Australian Bustard
58.	*Turnix velox*	Little Button-quail
59.	*Turnix pyrrhothorax*	Red-chested Button-quail
60.	*Pedionomus torquatus*	Plains-wanderer
61.	*Tringa stagnatilis*	Marsh Sandpiper
62.	*Tringa nebularia*	Common Greenshank
63.	*Tringa glareola*	Wood Sandpiper
64.	*Actitis hypoleucos*	Common Sandpiper
65.	*Calidris acuminata*	Sharp-tailed Sandpiper
66.	*Calidris ferruginea*	Curlew Sandpiper
67.	*Burhinus grallarius*	Bush Stone-curlew
68.	*Himantopus himantopus*	Black-winged Stilt
69.	*Recurvirostra novaehollandiae*	Red-necked Avocet
70.	*Charadrius ruficapillus*	Red-capped Plover
71.	*Peltohyas australis*	Inland Dotterel
72.	*Elseyornis melanops*	Black-fronted Dotterel
73.	*Erythogonys cinctus*	Red-kneed Dotterel
74.	*Vanellus tricolor*	Banded Lapwing

75.	*Vanellus miles*	Masked Lapwing
76.	*Stiltia isabella*	Australian Pratincole
77.	*Larus novaehollandiae*	Silver Gull
78.	*Sterna nilotica*	Gull-billed Tern
79.	*Sterna caspia*	Caspian Tern
80.	*Chlidonias hybridus*	Whiskered Tern
81.	*Columba livia*	Rock Dove
82.	*Phaps chalcoptera*	Common Bronzewing
83.	*Phaps histrionica*	Flock Bronzewing
84.	*Ocyphaps lophotes*	Crested Pigeon
85.	*Geophaps plumifera*	Spinifex Pigeon
86.	*Geopelia cuneata*	Diamond Dove
87.	*Geopelia placida*	Peaceful Dove
88.	*Geopelia humeralis*	Bar-shouldered Dove
89.	*Calyptorhynchus banksii*	Red-tailed Black-Cockatoo
90.	*Eolophus roseicapillus*	Galah
91.	*Cacatua sanguinea*	Little Corella
92.	*Cacatua leadbeateri*	Major Mitchell's Cockatoo
93.	*Cacatua galerita*	Sulphur-crested Cockatoo
94.	*Nymphicus hollandicus*	Cockatiel
95.	*Psitteuteles versicolor*	Varied Lorikeet
96.	*Aprosmictus erythropterus*	Red-winged Parrot
97.	*Platycercus adscitus*	Pale-headed Rosella
98.	*Barnardius zonarius*	Australian Ringneck
99.	*Psephotus haematonotus*	Red-rumped Parrot
100.	*Psephotus varius*	Mulga Parrot
101.	*Melopsittacus undulatus*	Budgerigar
102.	*Cuculus pallidus*	Pallid Cuckoo
103.	*Cacomantis variolosus*	Brush Cuckoo
104.	*Cacomantis flabelliformis*	Fan-tailed Cuckoo
105.	*Chrysococcyx osculans*	Black-eared Cuckoo
106.	*Chrysococcyx basalis*	Horsfield's Bronze-Cuckoo
107.	*Chrysococcyx lucidus*	Shining Bronze-Cuckoo
108.	*Scythrops novaehollandiae*	Channel-billed Cuckoo
109.	*Centropus phasianinus*	Pheasant Coucal
110.	*Ninox novaeseelandiae*	Southern Boobook
111.	*Tyto alba*	Barn Owl
112.	*Podargus strigoides*	Tawny Frogmouth
113.	*Eurostopodus argus*	Spotted Nightjar
114.	*Aegotheles cristatus*	Australian Owlet-nightjar
115.	*Apus pacificus*	Fork-tailed Swift
116.	*Dacelo novaeguineae*	Laughing Kookaburra
117.	*Dacelo leachii*	Blue-winged Kookaburra
118.	*Todiramphus pyrrhopygia*	Red-backed Kingfisher
119.	*Todiramphus sanctus*	Sacred Kingfisher
120.	*Merops ornatus*	Rainbow Bee-eater
121.	*Eurystomus orientalis*	Dollarbird
122.	*Climacteris affinis*	White-browed Treecreeper
123.	*Climacteris picumnus*	Brown Treecreeper
124.	*Climacteris melanura*	Black-tailed Treecreeper
125.	*Malurus cyaneus*	Superb Fairy-wren
126.	*Malurus splendens*	Splendid Fairy-wren

127.	*Malurus lamberti*	Variegated Fairy-wren
128.	*Malurus leucopterus*	White-winged Fairy-wren
129.	*Malurus melanocephalus*	Red-backed Fairy-wren
130.	*Stipiturus ruficeps*	Rufous-crowned Emu-wren
131.	*Amytornis striatus*	Striated Grasswren
132.	*Pardalotus rubricatus*	Red-browed Pardalote
133.	*Pardalotus striatus*	Striated Pardalote
134.	*Chthonicola sagittata*	Speckled Warbler
135.	*Smicrornis brevirostris*	Weebill
136.	*Gerygone fusca*	Western Gerygone
137.	*Gerygone olivacea*	White-throated Gerygone
138.	*Acanthiza apicalis*	Inland Thornbill
139.	*Acanthiza uropygialis*	Chestnut-rumped Thornbill
140.	*Acanthiza reguloides*	Buff-rumped Thornbill
141.	*Acanthiza chrysorrhoa*	Yellow-rumped Thornbill
142.	*Acanthiza nana*	Yellow Thornbill
143.	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater
144.	*Plectorhyncha lanceolata*	Striped Honeyeater
145.	*Philemon corniculatus*	Noisy Friarbird
146.	*Philemon citreogularis*	Little Friarbird
147.	*Entomyzon cyanotis*	Blue-faced Honeyeater
148.	*Manorina melanocephala*	Noisy Miner
149.	*Manorina flavigula*	Yellow-throated Miner
150.	*Lichenostomus virescens*	Singing Honeyeater
151.	*Lichenostomus keartlandi*	Grey-headed Honeyeater
152.	*Lichenostomus plumulus*	Grey-fronted Honeyeater
153.	*Lichenostomus penicillatus*	White-plumed Honeyeater
154.	*Melithreptus gularis*	Black-chinned Honeyeater
155.	*Melithreptus brevirostris*	Brown-headed Honeyeater
156.	*Melithreptus albogularis*	White-throated Honeyeater
157.	*Lichmera indistincta*	Brown Honeyeater
158.	*Grantiella picta*	Painted Honeyeater
159.	*Conopophila rufogularis*	Rufous-throated Honeyeater
160.	*Certhionyx niger*	Black Honeyeater
161.	*Certhionyx variegatus*	Pied Honeyeater
162.	*Epthianura tricolor*	Crimson Chat
163.	*Epthianura aurifrons*	Orange Chat
164.	*Epthianura crocea*	Yellow Chat
165.	*Ashbyia lovensis*	Gibberbird
166.	*Microeca fascinans*	Jacky Winter
167.	*Petroica goodenovii*	Red-capped Robin
168.	*Melanodryas cucullata*	Hooded Robin
169.	*Eopsaltria australis*	Eastern Yellow Robin
170.	*Pomatostomus temporalis*	Grey-crowned Babbler
171.	*Pomatostomus halli*	Hall's Babbler
172.	*Psophodes cristatus*	Chirruping Wedgebill
173.	*Cinclosoma castaneothorax*	Chestnut-breasted Quail-thrush
174.	*Daphoenositta chrysoptera*	Varied Sittella
175.	*Oreoica gutturalis*	Crested Bellbird
176.	*Pachycephala rufiventris*	Rufous Whistler
177.	*Colluricincla harmonica*	Grey Shrike-thrush
178.	*Myiagra inquieta*	Restless Flycatcher

179.	*Grallina cyanoleuca*	Magpie-lark
180.	*Rhipidura fuliginosa*	Grey Fantail
181.	*Rhipidura leucophrys*	Willie Wagtail
182.	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike
183.	*Coracina papuensis*	White-bellied Cuckoo-shrike
184.	*Coracina maxima*	Ground Cuckoo-shrike
185.	*Lalage sueurii*	White-winged Triller
186.	*Oriolus sagittatus*	Olive-backed Oriole
187.	*Artamus leucorhynchus*	White-breasted Woodswallow
188.	*Artamus personatus*	Masked Woodswallow
189.	*Artamus superciliosus*	White-browed Woodswallow
190.	*Artamus cinereus*	Black-faced Woodswallow
191.	*Artamus cyanopterus*	Dusky Woodswallow
192.	*Artamus minor*	Little Woodswallow
193.	*Cracticus torquatus*	Grey Butcherbird
194.	*Cracticus nigrogularis*	Pied Butcherbird
195.	*Gymnorhina tibicen*	Australian Magpie
196.	*Strepera graculina*	Pied Currawong
197.	*Corvus coronoides*	Australian Raven
198.	*Corvus bennetti*	Little Crow
199.	*Corvus orru*	Torresian Crow
200.	*Corcorax melanorhamphos*	White-winged Chough
201.	*Struthidea cinerea*	Apostlebird
202.	*Chlamydera maculata*	Spotted Bowerbird
203.	*Chlamydera nuchalis*	Great Bowerbird
204.	*Mirafra javanica*	Horsfield's Bushlark
205.	*Anthus novaeseelandiae*	Australian Pipit
206.	*Passer domesticus*	House Sparrow
207.	*Taeniopygia guttata*	Zebra Finch
208.	*Taeniopygia bichenovii*	Double-barred Finch
209.	*Poephila cincta*	Black-throated Finch
210.	*Neochmia modesta*	Plum-headed Finch
211.	*Emblema pictum*	Painted Finch
212.	*Lonchura castaneothorax*	Chestnut-breasted Mannikin
213.	*Heteromunia pectoralis*	Pictorella Mannikin
214.	*Dicaeum hirundinaceum*	Mistletoebird
215.	*Hirundo neoxena*	Welcome Swallow
216.	*Hirundo nigricans*	Tree Martin
217.	*Hirundo ariel*	Fairy Martin
218.	*Acrocephalus australis*	Australian Reed-Warbler
219.	*Megalurus gramineus*	Little Grassbird
220.	*Eremiornis carteri*	Spinifexbird
221.	*Cinclorhamphus mathewsi*	Rufous Songlark
222.	*Cinclorhamphus cruralis*	Brown Songlark
223.	*Cisticola exilis*	Golden-headed Cisticola
224.	*Sturnus vulgaris*	Common Starling

Source: **Australian Natural Resources Atlas; www.anra.gov.au; sighted 21/02/2013.**

Note: Species listed here are in general for the whole bioregion

Common Fauna in the Tanami Bioregion.

Scientific name	Common name
1. *Dromaius novaehollandiae*	Emu
2. *Coturnix ypsilophora*	Brown Quail
3. *Dendrocygna eytoni*	Plumed Whistling-Duck
4. *Cygnus atratus*	Black Swan
5. *Chenonetta jubata*	Australian Wood Duck
6. *Anas superciliosa*	Pacific Black Duck
7. *Anas gracilis*	Grey Teal
8. *Malacorhynchus membranaceus*	Pink-eared Duck Hardhead
9. *Aythya australis*	Australasian Grebe
10. *Tachybaptus novaehollandiae*	Hoary-headed Grebe
11. *Poliocephalus poliocephalus*	Great Crested Grebe
12. *Podiceps cristatus*	Darter
13. *Anhinga melanogaster*	Little Pied Cormorant
14. *Phalacrocorax melanoleucos*	Pied Cormorant
15. *Phalacrocorax varius*	Little Black Cormorant
16. *Phalacrocorax sulcirostris*	Australian Pelican
17. *Pelecanus conspicillatus*	White-faced Heron
18. *Egretta novaehollandiae*	White-necked Heron
19. *Ardea pacifica*	Great Egret
20. *Ardea alba*	Intermediate Egret
21. *Ardea intermedia*	Nankeen Night Heron
22. *Nycticorax caledonicus*	Glossy Ibis
23. *Plegadis falcinellus*	Straw-necked Ibis
24. *Threskiornis spinicollis*	Royal Spoonbill
25. *Platalea regia*	Yellow-billed Spoonbill
26. *Platalea flavipes*	Black-shouldered Kite
27. *Elanus axillaris*	Black-breasted Buzzard
28. *Hamirostra melanosternon*	Black Kite
29. *Milvus migrans*	Whistling Kite
30. *Haliastur sphenurus*	Spotted Harrier
31. *Circus assimilis*	Brown Goshawk
32. *Accipiter fasciatus*	Collared Sparrowhawk
33. *Accipiter cirrhocephalus*	Wedge-tailed Eagle
34. *Aquila audax*	Little Eagle
35. *Hieraaetus morphnoides*	Brown Falcon
36. *Falco berigora*	Australian Hobby
37. *Falco longipennis*	Grey Falcon
38. *Falco hypoleucos*	Black Falcon
39. *Falco subniger*	Peregrine Falcon
40. *Falco peregrinus*	Nankeen Kestrel
41. *Falco cenchroides*	Brolga
42. *Grus rubicunda*	Black-tailed Native-hen
43. *Gallinula ventralis*	Eurasian Coot
44. *Fulica atra*	Australian Bustard
45. *Ardeotis australis*	Little Button-quail
46. *Turnix velox*	Marsh Sandpiper
47. *Tringa stagnatilis*	Common Greenshank

48.	*Tringa nebularia*	Common Sandpiper
49.	*Actitis hypoleucos*	Red-necked Stint
50.	*Calidris ruficollis*	Sharp-tailed Sandpiper
51.	*Calidris acuminata*	Black-winged Stilt
52.	*Himantopus himantopus*	Red-capped Plover
53.	*Charadrius ruficapillus*	Oriental Plover
54.	*Charadrius veredus*	Black-fronted Dotterel
55.	*Elseyornis melanops*	Red-kneed Dotterel
56.	*Erythogonys cinctus*	Masked Lapwing
57.	*Vanellus miles*	Oriental Pratincole
58.	*Glareola maldivarum*	Australian Pratincole
59.	*Stiltia isabella*	Silver Gull
60.	*Larus novaehollandiae*	Gull-billed Tern
61.	*Sterna nilotica*	Whiskered Tern
62.	*Chlidonias hybridus*	Rock Dove
63.	*Columba livia*	Common Bronzewing
64.	*Phaps chalcoptera*	Flock Bronzewing
65.	*Phaps histrionica*	Crested Pigeon
66.	*Ocyphaps lophotes*	Spinifex Pigeon
67.	*Geophaps plumifera*	Diamond Dove
68.	*Geopelia cuneata*	Peaceful Dove
69.	*Geopelia placida*	Red-tailed Black-Cockatoo
70.	*Calyptorhynchus banksii*	Galah
71.	*Eolophus roseicapillus*	Little Corella
72.	*Cacatua sanguinea*	Major Mitchell's Cockatoo
73.	*Cacatua leadbeateri*	Cockatiel
74.	*Nymphicus hollandicus*	Princess Parrot
75.	*Polytelis alexandrae*	Australian Ringneck
76.	*Barnardius zonarius*	Mulga Parrot
77.	*Psephotus varius*	Budgerigar
78.	*Melopsittacus undulatus*	Pallid Cuckoo
79.	*Cuculus pallidus*	Black-eared Cuckoo
80.	*Chrysococcyx osculans*	Horsfield's Bronze-Cuckoo
81.	*Chrysococcyx basalis*	Channel-billed Cuckoo
82.	*Scythrops novaehollandiae*	Pheasant Coucal
83.	*Centropus phasianinus*	Southern Boobook
84.	*Ninox novaeseelandiae*	Barn Owl
85.	*Tyto alba*	Tawny Frogmouth
86.	*Podargus strigoides*	Spotted Nightjar
87.	*Eurostopodus argus*	Australian Owlet-nightjar
88.	*Aegotheles cristatus*	Fork-tailed Swift
89.	*Apus pacificus*	Red-backed Kingfisher
90.	*Todiramphus pyrrhopygia*	Sacred Kingfisher
91.	*Todiramphus sanctus*	Rainbow Bee-eater
92.	*Merops ornatus*	Splendid Fairy-wren
93.	*Malurus splendens*	Variegated Fairy-wren
94.	*Malurus lamberti*	White-winged Fairy-wren
95.	*Malurus leucopterus*	Red-backed Fairy-wren
96.	*Malurus melanocephalus*	Rufous-crowned Emu-wren
97.	*Stipiturus ruficeps*	Striated Grasswren
98.	*Amytornis striatus*	Red-browed Pardalote
99.	*Pardalotus rubricatus*	Striated Pardalote

100.	*Pardalotus striatus*	Weebill
101.	*Smicrornis brevirostris*	Western Gerygone
102.	*Gerygone fusca*	Inland Thornbill
103.	*Acanthiza apicalis*	Chestnut-rumped Thornbill
104.	*Acanthiza uropygialis*	Slaty-backed Thornbill
105.	*Acanthiza robustirostris*	Yellow-rumped Thornbill
106.	*Acanthiza chrysorrhoa*	Banded Whiteface
107.	*Aphelocephala nigricincta*	Spiny-cheeked Honeyeater
108.	*Acanthagenys rufogularis*	Yellow-throated Miner
109.	*Manorina flavigula*	Singing Honeyeater
110.	*Lichenostomus virescens*	Grey-headed Honeyeater
111.	*Lichenostomus keartlandi*	Grey-fronted Honeyeater
112.	*Lichenostomus plumulus*	Yellow-tinted Honeyeater
113.	*Lichenostomus flavescens*	White-plumed Honeyeater
114.	*Lichenostomus penicillatus*	Black-chinned Honeyeater
115.	*Melithreptus gularis*	Brown Honeyeater
116.	*Lichmera indistincta*	White-fronted Honeyeater
117.	*Phylidonyris albifrons*	Rufous-throated Honeyeater
118.	*Conopophila rufogularis*	Grey Honeyeater
119.	*Conopophila whitei*	Black Honeyeater
120.	*Certhionyx niger*	Pied Honeyeater
121.	*Certhionyx variegatus*	Crimson Chat
122.	*Epthianura tricolor*	Orange Chat
123.	*Epthianura aurifrons*	Jacky Winter
124.	*Microeca fascinans*	Red-capped Robin
125.	*Petroica goodenovii*	Hooded Robin
126.	*Melanodryas cucullata*	Grey-crowned Babbler
127.	*Pomatostomus temporalis*	White-browed Babbler
128.	*Pomatostomus superciliosus*	Chiming Wedgebill
129.	*Psophodes occidentalis*	Varied Sittella
130.	*Daphoenositta chrysoptera*	Crested Bellbird
131.	*Oreoica gutturalis*	Rufous Whistler
132.	*Pachycephala rufiventris*	Grey Shrike-thrush
133.	*Colluricincla harmonica*	Restless Flycatcher
134.	*Myiagra inquieta*	Magpie-lark
135.	*Grallina cyanoleuca*	Grey Fantail
136.	*Rhipidura fuliginosa*	Willie Wagtail
137.	*Rhipidura leucophrys*	Black-faced Cuckoo-shrike
138.	*Coracina novaehollandiae*	White-bellied Cuckoo-shrike
139.	*Coracina papuensis*	Ground Cuckoo-shrike
140.	*Coracina maxima*	White-winged Triller
141.	*Lalage sueurii*	White-breasted Woodswallow
142.	*Artamus leucorhynchus*	Masked Woodswallow
143.	*Artamus personatus*	White-browed Woodswallow
144.	*Artamus superciliosus*	Black-faced Woodswallow
145.	*Artamus cinereus*	Little Woodswallow
146.	*Artamus minor*	Grey Butcherbird
147.	*Cracticus torquatus*	Pied Butcherbird
148.	*Cracticus nigrogularis*	Australian Magpie
149.	*Gymnorhina tibicen*	Australian Raven
150.	*Corvus coronoides*	Little Crow
151.	*Corvus bennetti*	Torresian Crow

152.	*Corvus orru*	Horsfield's Bushlark
153.	*Mirafra javanica*	Australian Pipit
154.	*Anthus novaeseelandiae*	Zebra Finch
155.	*Taeniopygia guttata*	Painted Finch
156.	*Emblema pictum*	Pictorella Mannikin
157.	*Heteromunia pectoralis*	Mistletoebird
158.	*Dicaeum hirundinaceum*	White-backed Swallow
159.	*Cheramoeca leucosternus*	Tree Martin
160.	*Hirundo nigricans*	Fairy Martin
161.	*Hirundo ariel*	Little Grassbird
162.	*Megalurus gramineus*	Spinifexbird
163.	*Eremiornis carteri*	Rufous Songlark
164.	*Cinclorhamphus mathewsi*	Brown Songlark
165.	*Cinclorhamphus cruralis*	Golden-headed Cisticola
166.	*Cisticola exilis*	

Note: Species listed here are in general for the whole bioregion

***(Source:* Australian Natural Resources Atlas; www.anra.gov.au; sighted 21/02/2013)**

Table 9: Flora currently at risk in the Upper Georgina River Basin

Bioregion	Species group	Species name	Status
Mount Isa Inlier	Vascular plants	*Hakea fraseri* (Gnarled Corkbark; Fraser's Hakea)	Vulnerable
Mitchell Grass Downs	Vascular plants	*Mukia* A90788	Vulnerable
		Nymphaea immutabilis	Vulnerable

(Source: (Australian Natural Resources Atlas; www.anra.gov.au; sighted 21/02/2013).

Note: No vascular plants currently at risk in the sub-region 3 of Tanami bioregion

Table 10: Dominant trees and shrubs in the Upper Georgina River Basin and their potential vulnerability to climate changes (from Low 2011).

Bio-region	Low Vulnerability	Medium Vulnerability	High Vulnerability
North West High-lands	*Acacia aneura* (Mulga) *Acacia cambagei* (Gidgee) *Atalaya hemiglauca* (Whitewood) *Corymbia aparrerinja* (Ghost gum) *C. terminalis* (Western bloodwood) *Eucalyptus camaldulensis* (River red gum) *Ventilago viminalis* (Vine tree)	*Acacia georginae* (Georgina gidgee) *Acacia shirleyi* (Lancewood) *Corymbia aspera* (Rough-leaved ghost gum) *C. capricornia* (Bloodwood) *C. grandifolia* (Large-leaved cabbage gum) *C. polycarpa* (Long-fruited bloodwood) *Eucalyptus leucophloia* (Snappy gum) *E. leucophylla* (Cloncurry box) *E. microtheca* (Coolabah) *E. normantonensis* (Normanton box) *E. pruinosa* (Silver-leaved box) Mataranka palm (*Livistona rigida*) *Lophostemon grandiflorus* (Northern swamp box) *Lysiphyllum cunninghamii* (Bauhinia) *Melaleuca leucadendra* (Weeping paperbark)	*Corymbia bella* (North-west ghost gum) *C. ferruginea* (Rusty bloodwood) *C. ptychocarpa* (Swamp bloodwood) *Eucalyptus miniata* (Darwin woollybutt) *E. melanophloia* subsp. *Dajarra* (Silver-leaved ironbark)
Mitchell Grass Downs	*Acacia aneura* (Mulga) *Acacia cambagei* (Gidgee) *Acacia cyperophylla* (Red mulga) *Acacia georginae* (Georgina gidgee) *Acacia victoriae* (Gundabluie) *Atalaya hemiglauca* (Whitewood) *Chenopodium auricomum* (Queensland bluebush) *Corymbia Terminalis* (Western bloodwood) *Eremophila freelingi* (Limestone fuchsia bush) *Eucalyptus camaldulensis* (River red gum) *E. coolabah* (Coolabah) *Lysiphyllum gilvum* (Bauhinia) *Muehlenbeckia florulenta* (Lignum) *Senna artemisioides* (Limestone cassia)	*Acacia peuce* (Waddywood) *Acacia shirleyi* (Lancewood) *Archidendropsis basaltica* (Dead finish) *Eucalyptus normantonensis* (Normanton box) *Grevillea striata* (Beefwood)	*Acacia harpophylla* (Brigalow)

Note: Species listed here are in general for each of the bioregions and not specific for the UGRB.

Table 11: Fauna currently at risk in the Upper Georgina River Basin, with species group, botanical name, common name (in parentheses) and status.

Bioregion	Species group	Species name	Status
Mount Isa Inlier	Mammals	*Macroderma gigas* (Ghost Bat)	Vulnerable
		Petrogale lateralis purpureicollis (Purple-necked rock-wallaby)	Vulnerable
		Rhinonicteris aurantius (Pilbara Leaf-nosed Bat)	Vulnerable
		Hipposideros stenotis (Northern leaf nosed-bat)	Vulnerable
		Taphozous troughtoni (Troughton's sheathtail-bat)	Endangered
	Birds	*Malurus coronatus* (Purple-crowned fairy-wren)	Vulnerable
		Neochmia phaeton phaeton (Crimson finch)	Vulnerable
		Cacatua leadbeateri (Major Mitchell's Cockatoo)	Vulnerable
		Epthianura crocea (Yellow chat)	Vulnerable
		Erythrura gouldiae (Gouldian Finch)	Endangered
		Malurus coronatus (Purple-crowned fairy-wren)	Vulnerable
		Neochmia phaeton (Crimson finch)	Vulnerable
		Neochmia phaeton phaeton (crimson finch (western form))	Vulnerable
			Vulnerable
		Polytelis alexandrae (Princess Parrot, Alexandra's Parrot)	Endangered
		Pterodroma arminjoniana arminjoniana (Herald petrel)	Vulnerable
			Vulnerable
Mitchell Grass Downs	Birds	*Rostratula benghalensis* (Painted Snipe)	Vulnerable
		Stictonetta naevosa (Freckled Duck)	
	Mammals	*Pedionomus torquatus* (Plains-wanderer)	Vulnerable
Tanami		*Macrotis lagotis* (Greater Bilby)	

(Source: Australian Natural Resources Atlasa; www.anra.gov.au; (sighted 21/02/2013).

APPENDIX 4 – LAND SYSTEMS AND LAND USE GROUPS OF THE UGRB REGION

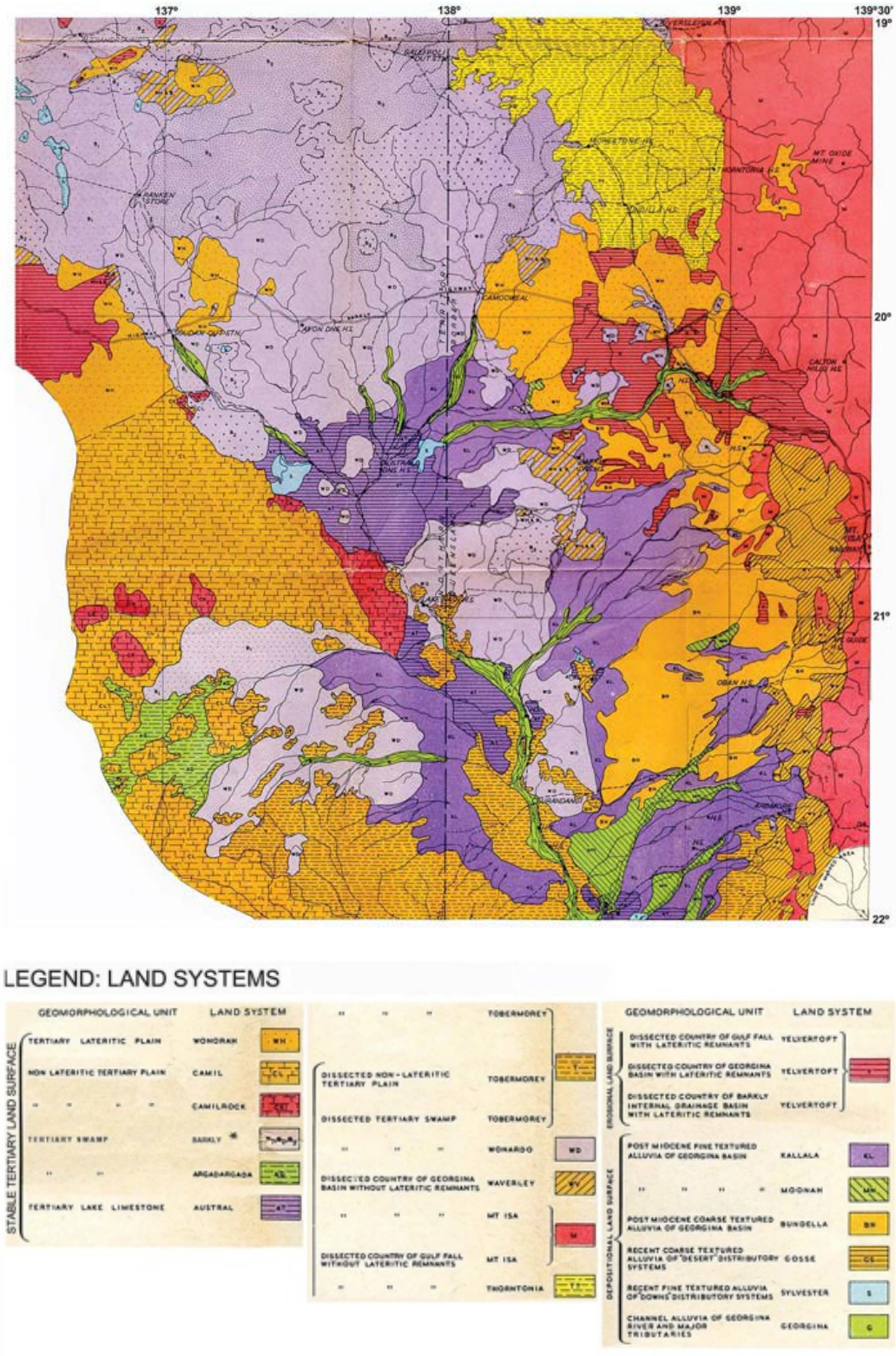
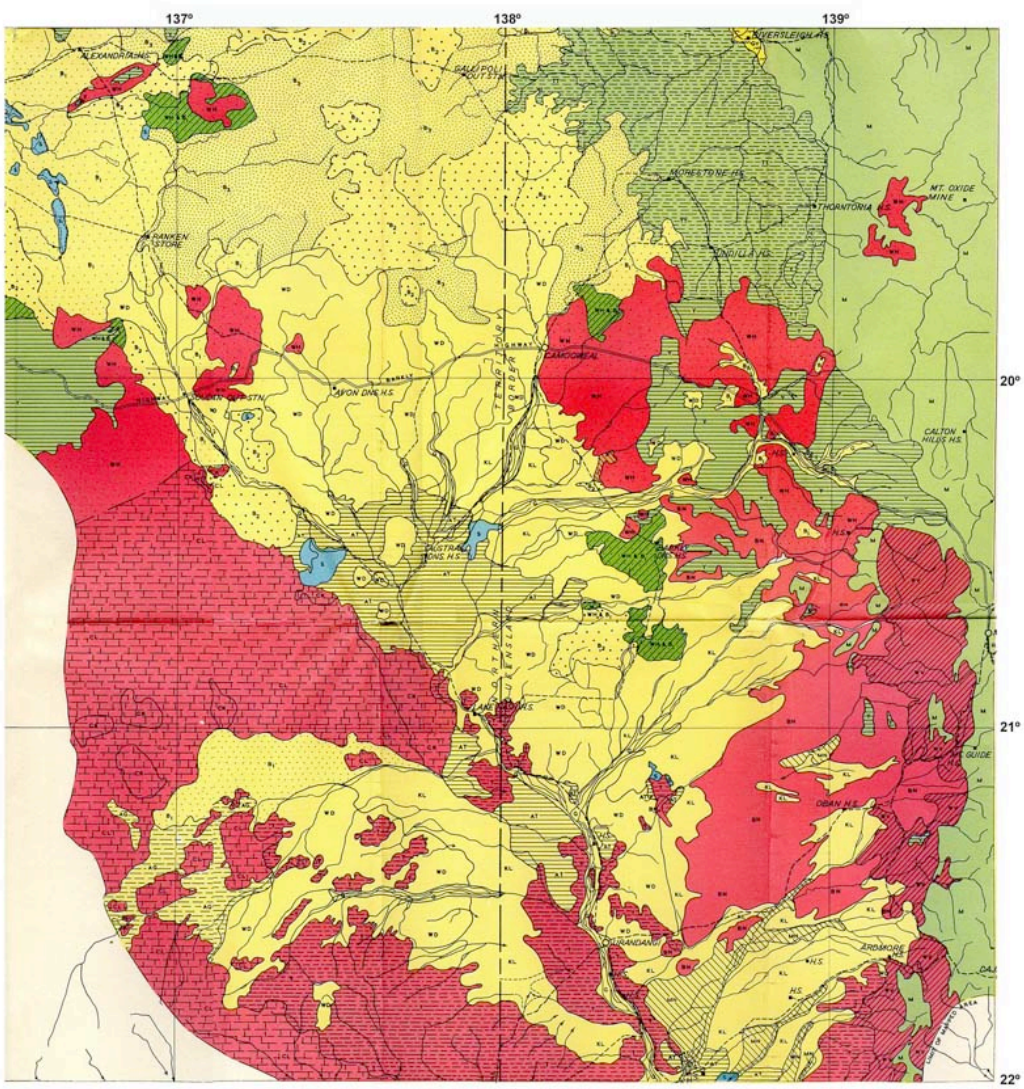


Figure 39: Land Systems of the UGRB Region
(Source: Christian et al, 1954)



LEGEND: LAND USE GROUPS

GROUP	LAND SYSTEMS	AREA SQ. MLS.	DESCRIPTION	WATER SUPPLY	PRESENT LAND USE	POTENTIAL LAND USE
MITCHELL GRASS COUNTRY	Barkly, Wonardo, Austral, Kalala, Georgina, Moonah, Argadargada	28,700	Very large, undulating, heavy soil plains, mostly treeless, Barley Mitchell grass pastures; boggy when wet; scattered gravelly rises; average rainfall 10-17 in. per annum.	Widely spaced non-permanent streams, few permanent water holes, adequate sub-artesian water at less than 500 ft.	Mainly extensive beef cattle raising with production of stores and some fats; some sheep for wool in south-east corner.	Further intensification of beef cattle industry requiring additional bores and fencing, and improved transport; increased turn-off of fats possible.
BLUEBUSH SWAMPS	Sylvester	1,400	Shallow distributary areas within Mitchell grass country receiving water from local streams, flooded for several months each year; bluebush and many herbage species provide excellent stock fattening, very "salty" soils which are boggy when wet; average rainfall 12-15 in. per annum.	The swamps themselves provide water for the early part of the dry season; sub-artesian water at less than 500 ft.	Beef cattle grazing, especially for fattening, but only partially utilized at present.	Could be more fully exploited for cattle raising especially for producing fats if transport facilities were developed; additional bores required.
BROKEN MITCHELL GRASS COUNTRY	Helen Springs, Kilgour, Mitchiebo and mixed land systems	7,000	Patches of Mitchell grass country or inferior Mitchell grass country interlined with areas of skeletal or lateritic soils carrying spinifex; average rainfall 12-25 in. per annum.	Few permanent water holes; sub-artesian water.	Better areas developed for beef cattle; remainder only partially used.	Further development of cattle raising still possible on some less accessible areas.
HILLY COUNTRY	Mt. Isa, Redbank, Robinson, Thorntonia, Roiyat, Ashburton, Tennant Creek, Yelvertoft	29,000	Mostly hilly, some rugged country, with rock outcrops and skeletal soils, some small alluvial valleys, mostly lightly timbered, much spinifex, with more useful pastures in valleys, or on some limestone areas; average rainfall varies from 10-30 in. per annum.	Valleys in northern portion served by springs and permanent waterholes, remainder poorly watered; underground water supplies variable.	Mt. Isa silver lead mines, Tennant Creek gold mines, and several small mines are worked; beef cattle are carried at low rates in better areas.	Little development possible other than mining.
SOUTHERN DESERT COUNTRY	Wonorah, Elliott, Camil, Camilrock, Bundella, Gnose, Prentice, Tobermorey, Waverley	24,700	Undulating country with some rock outcrops; mostly light textured soils with low scrub and spinifex, but small depressions with alluvial soils and better pastures; average rainfall 10-15 in. per annum.	Surface water supply very poor; sub-artesian water generally available.	Not used except where adjacent to better cattle country.	Little development possible except as adjacent to better cattle areas.

Figure 40: Land Use Groups of the UGRB Region
(Source: Christian et al, 1954)

APPENDIX 5 – SIGNIFICANT PLANTS IN THE UPPER GEORGINA RIVER BASIN PHOTOS BY KEITH MARSHALL

Figure 41: Conkerberry (DSF0027 photo by Keith Marshall 2012)

Figure 392: Bush banana (DSF0060 photo by Keith Marshall 2012)

Figure 43: Wild oranges (DSF0071 photo by Keith Marshall 2012)

Figure 44: Gidgee tree (DSF0089 photo by Keith Marshall 2012)

Figure 45: Gidgee pods (DSF0090 photo by Keith Marshall 2012)

Figure 46: Dajarra/Boulia. Caustic Soda medicine bush (DSF0160 photo by Keith Marshall 2012)

Figure 47: Dajarra/Mt Isa. Black Turpentine bush, witchetty grubs, Sugar lerp (DSF0171 photo by Keith Marshall 2012)

Figure 48: Camooweal/Urandangie Road. Bailing grass (DSF0223 photo by Keith Marshall 2012)

APPENDIX 6: FUTURE RESEARCH DIRECTIONS

13.8 Research Publications Mapping

This document presents a preliminary outline and schedule for the publication of journal articles arising from this NCCARF funded project. Organised into five streams, this research project is anticipated to produce a number of peer-reviewed publications in addition to journals. The research streams are:

- Aboriginal perceptions of climate change
- Preparedness for climate change and extreme weather events
- Land and riverine management
- Settlement infrastructure adaptation
- Enterprise development responses

Broadly, there are significant gaps in the scholarly literature when it comes to research that is focussed upon the complex and multifaceted aspects of the impacts of and responses to chronic and acute impacts of climate change on remote Aboriginal communities. This presents a unique opportunity for researchers at the Aboriginal Environments Research Centre (UQ) to draw upon the research undertaken for this scoping study to develop future significant research outputs, in a variety of disciplinary fora. Six research papers have been scoped as a first step in this process and are described below. Each entry below includes an abstract, list of keywords and thematic areas, intended target(s) for submission, the contributing research personnel, and anticipated date of completion.

13.8.1 Proposed Paper 1 on Anticipatory Adaptation in the UGRB

Title: Climate Change, Extreme Weather Events and Anticipatory Adaptation: A case study of the Upper Georgina River Basin.

Authors: James Davidson, Samid Suliman

Research Stream: Preparedness for Climate Change and Extreme Weather Events

Abstract: In February 2011, Tropical Cyclone Yasi adversely affected many parts of northern Queensland. The impacts of TC Yasi were most acute in coastal areas in Far North Queensland, after the cyclone made landfall. Destructive winds and heavy rainfall ensured extensive damage to residential properties, commercial operations and public infrastructure. The size, severity and intensity of the storm tested the capacity of disaster management systems and actors, which were already stretched due to statewide flooding events in the months prior to TC Yasi. According to some accounts, these passed the test with flying colours. However, as the storm degraded into a tropical low and moved westward, some gaps in the disaster management system became evident. These included the lack of local and regional capacity to deal effectively with flood-induced displacements that were intra-regional and cross-jurisdictional in nature. In particular, this article is interested in the absence of a coordinated response to the evacuation of Alpurrurulum (NT). This case, we suggest, highlighted core problems relating to: cross-jurisdictional disaster management, the hierarchical nature of Queensland's disaster management system, and the lack of communication between relevant authorities, actors and communities, and weaknesses in the capacity of local communities to deal with natural disasters in accordance with international best-practice principles. In this article, we argue that a region-specific disaster management plan that accounts for the needs and expectations of communities and authorities is essential to allow remote Aboriginal communities to prepare for and adapt to the expected increase in extreme weather events that are anticipated to occur as a result of anthropogenic climate change.

Keywords: disaster management, cross-jurisdictional governance, climate change adaptation, preparedness

Research Stream: Preparedness for Climate Change and Extreme Weather Events

Proposed journal for submission: *Local Environment: The International Journal of Justice and Sustainability*

13.8.2 Proposed Paper 2 on Emergency Shelter

Title: Capacity, Mobility and Shelter: Improving Emergency Shelter in the Upper Georgina River Basin

Authors: James Davidson, Samid Suliman

Abstract: Emergency shelter is a core aspect of local disaster management planning. Whether in the case of flood, storm, bushfire, or other extreme weather events, the importance of adequate and sustainable emergency shelter cannot be overstated. Despite the increasing susceptibility of the Upper Georgina River Basin to a number of extreme weather and natural disaster events, the region seems to lack sufficient capacity to provide temporary emergency shelter to people who may be adversely affected by such events. In this article, we explore the ways in which extant resources might be mobilised to allow communities in the region to collaborate with government authorities and non-governmental organisations to ensure that the disaster management needs of the region's people might be met efficiently and effectively. Using two case-studies (Dugalunji Camp in Camooweal and Jimbarella Hall in Dajarra), we interrogate the ways in which region-wide capacity to a range of natural disaster and extreme weather events can be strengthened. In particular, we focus upon three important aspects of emergency shelter: physical infrastructure, communication and intra-regional mobility. These, we suggest, are crucial aspects of improving communities' adaptive capacity in the face of climate change.

Keywords: Emergency shelter; disaster management; intra-regional mobility; extreme weather; climate change

Research Stream: Preparedness for Climate Change and Extreme Weather Events

Proposed journal for submission: Policy and Society

13.8.3 Proposed Paper 3 on Aboriginal Environmental Change Knowledge

Title: *Southeast to Northwest: a comparative perspective on Indigenous Knowledge and perceptions of environmental change.*

Author: Daphne Nash

Abstract: Perceptions of environmental change including climate change are indexed to place, reflecting local knowledge, values and practices that may enable or constrain adaptive responses. In a preliminary investigation this paper identifies Aboriginal views on environmental change in two contrasting regions of Australia: the temperate South Coast of NSW and the arid northwest of Queensland. What kind of knowledge do people in these places have about change and how does their knowledge and worldview influence their response?

Despite very different histories these two Indigenous groups show some commonalities in the face of environmental change. Drawing on their histories and local knowledge they represent a kind of relational approach to the changes in which their perception of the environment is integral to their concept of person (Bird-David 1999). I explore the tensions people experience when they reflect on the perceived changes -- how they might be affected and their choices for action -- to argue for a resilience that is grounded in Indigenous worldviews

Keywords: perceptions; climate change; indigenous knowledge; relational approaches; subjectivity

Research Stream: Land and Riverine Management

Proposed journal for submission: Ecology and Society

13.8.4 Proposed Paper 4 on Carbon Farming Enterprises

Title: Climate Change Adaptation and Enterprise Development: Exploring the benefits of carbon farming for communities and country in the Upper Georgina River Basin

Authors: Paul Memmott, James Davidson

Abstract: This paper explores the ways in which Aboriginal traditional owners may employ enterprise development strategies as part of a broader suite of adaptation responses to the challenges posed by climate change. This paper is specifically concerned with the ways in which indigenous knowledges and practices may be incorporated into commercial carbon farming projects in the Barkly region on the Upper Georgina River Basin in Northwest Queensland. The region contains 18 land systems, incorporating Mitchell grasslands, spinifex grasslands, acacia shrublands and riverine corridors, together with long-established cattle pastoralism and recent intense mineral exploration. Large areas in the Upper Georgina River are considered degraded due to uncontrolled wildfire, woody vegetation clearing (including acacia-based woodlands of Acacia cambagei (gidgee), A. shirleyi (lancewood), and riparian vegetation dominated by Eucalyptus camaldulensis (river gums) and invasion by non-native species. This presents opportunities for improving landscape function and developing avenues for carbon farming. Using a collaborative project between the University of Queensland and Myuma Pty Ltd as a case study, this article will outline the benefits that may be accrued to communities in the region by developing fire management regimes that align with the savannah burning offset methodology protocols established by the Department of Climate Change and Energy Efficiency's Carbon Farming Initiative. Such schemes, it is argued, will form a crucial part of a comprehensive regional adaptation strategy insofar as they enable remote Aboriginal communities to utilize local knowledge(s) and gain a greater foothold in carbon market, in order build resilience and adaptive capacity throughout the region.

Keywords: carbon farming; enterprise development; adaptive capacity

Research Stream: Enterprise development responses.

Proposed journal for submission: *Development and Change*

13.8.5 Proposed Paper 5 on Climate Change Perceptions

Title: Aboriginal and Non-Aboriginal perceptions on climate change in the Upper Georgina River Basin: commensurate or contradictory?

Authors: Paul Memmott, Joseph Reser and James Davidson

Abstract: In recent years there has been increasing scholarly attention paid to understanding public perceptions of climate change, as well as associated risk domains. However, there is little research that deals explicitly with Aboriginal perceptions of, and responses to, climate change and associated extreme weather events. This article will first present a review about what is known and not known about indigenous perceptions of (recent) extreme weather events and disasters. This is intended to address some common misperceptions and misunderstandings, as well as provide a more informed context to understand the ways in which Aboriginal people in the Upper Georgina River Basin understand climatic and meteorological changes. In this regard, close attention will be given to cultural, historical and social factors that may influence local perceptions of and responses to the challenges posed by climate change. Such a fine-grained and contextualized analysis is important, as it sheds light upon some disjunctures between Aboriginal perceptions of global climate change and orthodox ways on understanding climate change that may not allow space for non-Western, non-scientific ways on knowing and adapting to changing country. It may also shed some light upon the ways in which Aboriginal perceptions of change may help develop a more comprehensive picture of the scale and scope of the challenges at hand, and thus orient us towards new horizons adapting to climate change.

Keywords: climate change; perceptions; public risk; disaster preparedness

Research Stream: Aboriginal perceptions of climate change

Proposed journal for submission: *WIREs Climate Change*

13.8.6 Proposed Paper 6 on Aboriginal Housing and Infrastructure

Title: Housing, Yards and Infrastructure Planning in Dajarra, Alpurrurulam, Urandangi and Camooweal – Adapting to Climate Change

Authors: Timothy O'Rourke and James Davidson

Abstract: This paper builds on regional surveys of energy and water use (Long 2007) and investigations of infrastructure and service delivery in Dajarra (O'Rourke 2011) across a period of severe drought (2007-09), which identified chronic problems with sub-standard infrastructure, poorly designed housing for the extreme arid climates, inappropriate household technologies, and unnecessarily high demand for utilities. These factors reduced the resilience of arid-zone settlements and their capacity to respond to climatic extremes. The combination of larger scale infrastructure development, smaller scale technical interventions, and changes in patterns of demand require an integrated approach to planning that engages with Aboriginal communities and individuals. Settlement infrastructure and technology response will examine the relationship between climate and uses of buildings, energy (off-grid generators) and water. The paper will use data from the above survey to measure awareness of energy and water consumption in relation to household behaviour across different seasons. The paper will also present case studies of households (Long 2007; O'Rourke 2011) that document existing infrastructure and technologies and measure consumption patterns in proposing ways to reconfigure existing houses for long-term preparedness for climate change and weather extremes.

Keywords: Climate Change, Housing, Infrastructure Planning

Research Stream: Settlement Infrastructure Adaptation

Proposed journal for submission: Architecture Australia, Architectural Science Review

13.8.7 Ongoing research questions for consideration in our papers

The following are a series of propositions and ongoing research-related questions relevant for consideration in future research work.

Questions of how findings compare to the national survey(s): Given that one of the underlying rationales for the research was to examine similarities and differences with respect to public risk perceptions, understandings, and responses – and indeed many other parameters – what are our overall thoughts and conclusions here? Would we discuss differing indigenous community and regions across Australia as well as between indigenous communities as a whole, and mainstream Australia? Can we identify some salient similarities and differences, as well as areas where things are not so clear cut? What have other researchers reported with respect to important similarities and differences, and are these more regional and life circumstance than 'cultural'?

Questions of how UGRB adaptation fits global theoretical models: The larger issue of adaptation to climate change, how this might differ from disciplinary perspectives on adaptation and indeed social and cultural change, etc. Certainly an anthropological and a psychological perspective might be useful here.

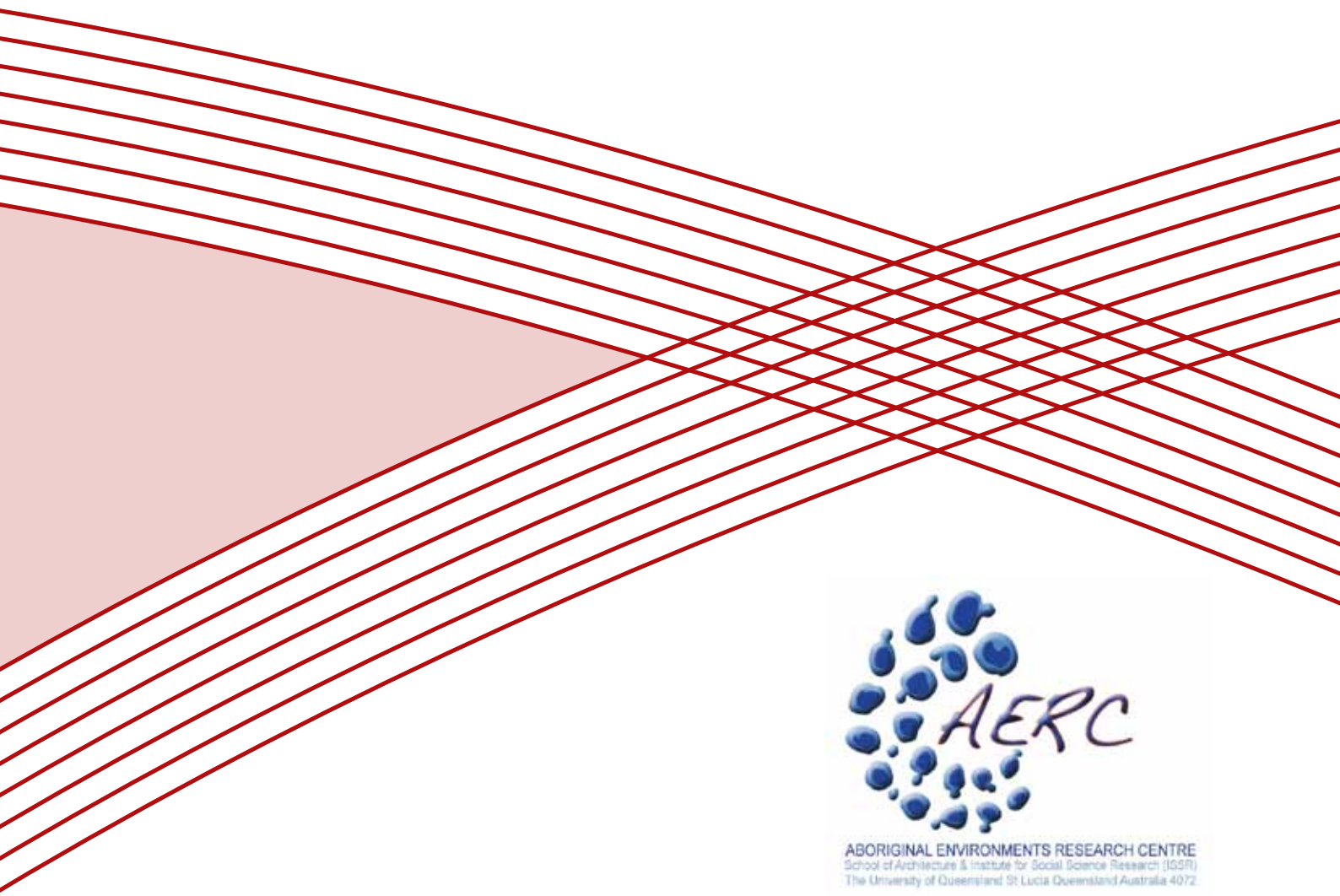
The question of whether there is an 'acculturation' continuum: Are there not dramatic differences across indigenous communities and indeed within indigenous communities? Would it be worth looking at different age cohorts here and relating this to some cultural change arguments? Is there a continuum with respect to the strength of traditional assumptive worlds, cosmologies, risk domains, and causal narratives in the context of climate change across Australia? If so, how would we characterise Upper Georgina Basin indigenous residents? Clearly these communities would seem to comprise a very heterogeneous group of people. What would we wish to say about this, and possibly our sampling? This would seem to be a rather important consideration if we are genuinely addressing current and changing public understandings of and responses to climate change.

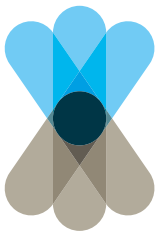
The question of having an attitude regarding an external locus of control: There would appear to be, on the face of it, a rather external and fatalistic perception of climate change and what can be done about it, with relatively low self efficacy and collective efficacy comments and observations in the communities we have researched. We should be reflective and cautious in how we report and discuss this. How good is our data on this? Is there a consensus among us that this is what our convergent data and observations are telling us? Does this reflect, in part, the nature and level of people's causal understandings about climate change? What about other factors? There is the argument that indigenous Australian culture(s) are very external with respect to locus of control and worldview? Do we accept this and how might this apply to our findings and their implications?

The question of spatial and temporal hyperopia: A not unrelated finding is that Georgina Basin residents, on the whole, appear to be spatially and temporally *distancing* the phenomenon and threat of climate change, and seeing it as a greater threat and cause for concern for distant others. This far-sightedness or *hyperopia* bias

can also suggest that individuals are evidencing a fair bit of protection motivation or defense with respect to this arguably unrealistic local optimism on the part of many but globally more accurate risk perceptions and appraisals. Again we have an instance of clear differences here between this Georgina Basin sample and the national data. What interpretations would we make here, and are there conclusions or recommendations to be drawn?

The question of causal explanations, accounts and narratives: Are there emergent climate change causal narratives cum explanations that are worth discussion. In many ways such accounts are very germane to risk perceptions and understandings and can provide a window on differing assumptive worlds and causal understandings. These also relate to anthropogenic forcing and possible cultural biases here. Our sense from examining the survey responses was that there did not appear to be a predominant or clear narrative line, though clearly a number of respondents were very aware of the popular science account and explanation of climate change. So one could argue that a mainstream and science-informed popular culture account of climate change is already out there for a reasonable number of individuals, possibly co-existing with more traditional culture informed accounts of why these changes are taking place and what it all seems to mean. What do our collective research observations and experience tell us here?





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