



The Impacts of CLIMATE CHANGE on Australian Tourism Destinations

DEVELOPING ADAPTATION AND RESPONSE STRATEGIES





The Impacts of Climate Change on Australian Tourism Destinations

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Sustainable Tourism Cooperative Research Centre (STCRC) is established under the Australian Government's Cooperative Research Centres Program. STCRC is Australia's largest dedicated tourism research organisation, with over \$187 million invested in tourism research programs, commercialisation and education since 1997. The aim of STCRC research is to underpin the development of a dynamic, internationally competitive and sustainable tourism industry. STCRC is a not-for-profit company owned by its industry, government and university partners.

STCRC falls under the Commonwealth CRC program, which aims to turn Australia's research and innovations into successful new products, services and technologies, making our industries more efficient, productive and competitive.

The program emphasises the importance of collaboration between business and researchers to maximise the benefits of research through an enhanced process of utilisation, commercialisation and technology transfer.

STCRC's objectives are to enhance:

- the contribution of long-term scientific and technological research and innovation to Australia's sustainable economic and social development
- the transfer of research outputs into outcomes of economic, environmental or social benefit to Australia
- the value of graduate researchers to Australia
- collaboration among researchers, between researchers and industry or other users
- efficiency in the use of intellectual and other research outcomes.

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ON AUSTRALIAN TOURISM DESTINATIONS

Preface

This report is a summary of the scoping study *The Impacts of Climate Change on Australian Tourism Destinations: developing adaptation and mitigation strategies* which has been undertaken by Sustainable Tourism Cooperative Research Centre (STCRC). It highlights the findings of the scoping study which received additional funding support from the Department of Resources, Energy and Tourism.

Climate change projections used as the basis for this report were prepared by agencies such as CSIRO and the Intergovernmental Panel on Climate Change and informed by the Garnaut Climate Change Review. STCRC has not undertaken any primary research on potential climate change projections. It is important to note that all of the tourism impacts from climate change contained in this report assume that the base projections will occur and that no new mitigation or adaptation strategies have been implemented.

Introduction

The study has examined the potential impacts of climate change in five Australian tourism destinations over the next 10, 40 and 60 years and scoped likely adaptation and mitigation strategies that will need to be implemented to address a changing destination landscape.

Case study areas were nominated by STCRC following consultation with key stakeholders. The five tourism destinations included in the project were selected on the basis of their varying degrees of vulnerability. They are Tropical North Queensland (TNQ), Kakadu, the Barossa Valley, the Victorian Alps and the Blue Mountains.

To gauge the economic and non-economic impacts of climate change and explore adaptive approaches for these destination communities, stakeholder interviews and social learning workshops were conducted to identify priority actions. Research teams considered regional CSIRO climate change data and examined existing knowledge on anticipated biophysical and socio-economic changes.

The study also sought to identify a process through which additional destinations might proceed with their own activities to identify and develop adaptive approaches to climate change.

The goal of the project was to build a framework to inform and prioritise adaptation and mitigation strategies which can be undertaken by destinations and tourism businesses. To do this, the climate change vulnerability of each destination was assessed, with a focus on the potential impacts on tourism infrastructure, activities and operational costs.

An additional study commenced recently in the Margaret River region of Western Australia using the same methodology. This will be the subject of a further report.

Objectives of Study

The study was intended to ascertain the adequacy of available data and information to enable research specific findings. Based on the current available data, the main objectives of this study were to:

- structure and direct desktop research on climate change in relation to the biophysical and socio-economic characteristics of the five case study regions
- direct field work in each case study region, including semi-structured interviews with tourism, business, government and community representatives

Figure 1: Location of the case study destinations



- undertake social learning workshops with representative groups in each case study region
- develop a model that identifies non-economic impacts and will allow data input and impact projections
- identify adaptation and mitigation options and strategies for each case study region
- estimate economic impacts in the five case study regions—both for tourism’s contribution to gross regional product and regional employment
- develop a model that can be generalised to other destinations
- identify additional knowledge, processes and information gaps to support the development of a comprehensive research agenda for tourism and climate change in Australia
- identify practical tools to respond to the multiple impacts of climate change at key tourism destinations.

Methodology

To facilitate national integration of the results of this study (in addition to identifying regional priorities for adaptation and climate change response) a consistent approach was adopted across four of the five case study destinations. Research teams in Tropical North Queensland, Kakadu, the Blue Mountains and the Barossa Valley applied the following methodology:

- define case study region based on local government area according to Australian Bureau of Statistics

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- conduct desktop reviews of existing knowledge at each destination
- review current knowledge of tourism demand to inform economic analysis
- review current knowledge of climate change in the five case study regions
- review current knowledge of the degree to which tourism is climate dependent
- use a Visitor, Industry, Community and Environment (VICE) model to identify key tourism stakeholders, populate the VICE grid and use a snowballing technique to expand the representation
- conduct semi-structured stakeholder interviews with key individuals to develop adaptation and mitigation strategies and identify knowledge gaps
- apply CSIRO model climate change projections for 2020, 2050 and 2070 to the five tourism destinations to provide some context for the social learning workshops
- conduct workshops in each of the regions to prioritise adaptation and mitigation strategies for the three climate change scenarios which were linked to biophysical changes at each destination
- conduct an economic analysis of tourism for the five destinations for 2020 and examine trends for 2050 and 2070.

The exception to this approach was the Victorian Alps which had already been the focus of a large amount of multi-sectoral climate change research including tourism. By engaging with researchers already undertaking activities in the Victorian Alps region, there was the opportunity to draw on existing data and avoid 'stakeholder fatigue' from additional interviews and workshops. The similar nature of the Victorian Alps group's activities ensured that the aim of national integration of adaptation and response was still able to be achieved.

Chapters highlighting key research, findings and recommendations for each of the case study regions are included in this summary. For some regions there was considerable existing research to inform workshop participants, with less information available for other regions. While this might make the case studies appear somewhat uneven, participants in each region have been able to use existing data to develop significant adaptation and mitigation recommendations.



Aerial wet season, Kakadu NP © Tourism NT

Climate Change in Australia

Climate change is any long-term significant change in the 'average weather' that a given region experiences. Average weather may include average temperature, precipitation and wind patterns. It involves changes in the variability or average state of the atmosphere over durations ranging from decades to millions of years. These changes can be caused by dynamic processes on Earth, external forces including variations in sunlight intensity, and more recently by human activities.¹

It is expected that climate change will result in a number of economic and non-economic impacts throughout Australia. Projections at the national scale suggest significant increases in mean annual temperatures, coupled with reduced annual rainfall in most places. This will place strain on natural resources and many of the industries dependent on these resources for their survival. In addition the increased risk from intense extreme events like bushfires, tropical cyclones, floods and droughts is likely to result in considerable economic costs to the nation.²

In Australia, probably more so than any other nation, tourism relies strongly on natural resources and to this end will be strongly affected by climate change. However, the degree to which climate change impacts on regional tourism activities, in terms of economic and non-economic consequences, depends at least in part on how well Australian tourism and the natural resources on which it relies, can adapt to climate change.

Based on the current widely accepted scientific consensus that the world is entering a period of changing climate, it is important that from a planning perspective, tourism businesses adapt and react now to climate change. While mitigation efforts are undeniably important in terms of slowing the rate of climate change, the fact that the climate system has already changed (and is projected to do so irrespective of mitigation efforts, at least in the short- to medium-term) suggests that investment in climate change adaptation is a sensible course of action. This view applies to all industries that depend on natural assets for their sustainability, including tourism.

Climate Change Adaptation and Mitigation

The report refers to both adaptation and mitigation of climate change, which may be defined as:

- **Adaptation to climate change** consists of initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects^a. Climate change adaptation, as referred to in the technical report, are those strategies that can be implemented to build resilience and resistance in systems, whether they be environmental, social, economic or business systems.
- **Mitigation of climate change** involves taking actions to reduce greenhouse gas emissions and to enhance sinks (any process, activity or mechanism that removes a greenhouse gas or aerosol—such as planting trees—or a precursor of a greenhouse gas or aerosol from the atmosphere aimed at reducing the *extent* of global warming)^b. This is in distinction to adaptation to climate change which involves taking action to minimise the *effects* of climate change.

Adaptation is seen as a more medium to long-term action, while mitigation mechanisms involve the short to medium-term development and deployment of new technologies such as fuels and the like. Both are clearly linked and may act for or against each other. For example, increased use of air conditioning may be an adaptation, but its use of energy (arising from fossil fuels) will act against mitigation. Adaptation strategies can be effective at varying time scales, from the immediate to medium- to long-term planning horizons. Furthermore, adaptation strategies are not necessarily costly to businesses, communities, the environment or people and may in fact yield substantial economic and non-economic benefits. In contrast, mitigation activities will not always yield immediate climate or business/community results, by virtue of the long turnaround time in the climate system.

^a <http://www.ipcc.ch/pdf/glossary/ar4-wg3.pdf>

^b <http://www.ipcc.ch/pdf/glossary/ar4-wg3.pdf>

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Integration of Case Studies

Potential Barriers

It is clear from both the science and stakeholder input that climate change projections will have both economic and non-economic impacts across all five case study destinations. While not all of these changes are necessarily negative, many are and many represent significant adaptive challenges.

In all destinations, the stakeholder workshops revealed that there are considerable institutional, legal, community and resource limitations that inhibit, or at least are perceived to inhibit, the timely implementation of adaptation and mitigation strategies. Interestingly, this is despite the fact that all destinations nominated sustainable use of resources, especially water and energy, as an adaptation strategy which clearly represents best practice and has been shown to save businesses money.

There were a number of often-articulated barriers to implementing the suggested adaptation and mitigation strategies including:

- the scale and uncertainty surrounding climate change projections
- communication within and between regional and national bodies
- concerns regarding the capacity of small to medium tourism enterprises (SMEs/SMTEs) to adapt, relative to governments and larger operators.

While there was some uncertainty and concern regarding the science of climate change and how it is likely to impact on regional communities and industries, all stakeholders recognised that the perceived threat of climate change on destinations, particularly as presented in the media, could significantly reduce tourism demand.

Numerous stakeholders indicated that the inaccuracy of climate change projection modelling resulted in considerable uncertainty on their part in terms of how much time and money they were willing to invest into climate change adaptation and mitigation. In terms of evaluating priority actions within their destination, many participants felt that it would be necessary for regional-scale projections to be created to assist with the planning and response processes.

Workshop participants commented that there was enough scepticism in the community to prohibit rapid uptake of adaptation and mitigation strategies.

Communication and community involvement

There was an overwhelming view that local communities and stakeholders would need to be heavily involved in the planning and implementation of adaptation and mitigation strategies. Adding to that view was the sentiment that a national approach would not consider adequately the importance of the local community in creating, influencing and contributing to the 'sense of place' that makes tourism possible.

'Resources' were frequently identified as a limiting factor in the local 'grass roots' approach. There was a consistent view that locals know their destinations best and they, therefore, should be the ones coordinating and implementing adaptation and mitigation.

Communication and inclusion also appeared to be important in the successful implementation of an adaptation and mitigation plan. Many respondents expressed their concern about the number of and overlap between climate change research projects, initiatives and granting schemes. Specifically, some stakeholders had been involved in multiple climate change workshops and felt that more collaborative coordination and communication was required within all levels of government, tourism industry groups and operators, local community groups and researchers.

Adaptive capacity of tourism—a sector built around SMEs

One of the major perceived limitations to adaptation and mitigation was the high proportion of SMEs that characterise regional tourism. Specifically, concern revolved around the fact that these smaller enterprises operate on small overheads with little or no capital or capacity to implement major adaptation and mitigation strategies.

Very few SMEs are able to plan on time frames longer than a couple of years. As a result, making changes now (with associated costs) to address threats that may or may not eventuate in 10, 40 or 60 years time is not something that many of these smaller operators are willing (or able) to do.

The overwhelming view across destinations was that bigger operators were more likely to be planning and implementing adaptation and mitigation strategies now as they have more resources and may have a responsibility to their stakeholders to manage the risks of climate change impacts on business operations and bottom lines.

In Summary

The common points across the regions were:

- There are significant knowledge gaps around climate change resulting in a level of uncertainty about adaptation and mitigation.
- To avoid duplication, there needs to be better communication across all sectors including all levels of government, tourism organisations and businesses, communities and researchers on the likely impacts of climate change and adaptation and mitigation strategies.
- The importance of community needs to be considered in terms of creating, influencing, and contributing to the 'sense of place' and making tourism possible.
- Changing landscapes could result in a reduction in tourism demand which would impact the regional economies and community spirit.
- Larger operators who have the resources and a responsibility to shareholders are more likely than smaller operators to be implementing adaptation and mitigation strategies.
- If adaptation and mitigation strategies are to be implemented successfully, they need to be simple, cheap and effective with clear benefits.
- Local communities are seen as being central to the adaptation of the region as they provide the raw materials from which the visitor experience is packaged, marketed and sold.
- Climate change is recognised as a threat to communities and the cultural practices that give tourism in the regions character.



Green tree frog in the Daintree © Tourism Qld

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Future Actions Applicable to All Regions

Despite the concerns and limitations outlined, climate change adaptation was seen as a necessary precautionary principle by participants in all five case study destinations. Because tourism is one of a number of activities that occurs within communities—all of which draw on natural resource capacities and local infrastructure—workshop participants recognised that adaptation for tourism destinations should be part of the general community management processes.

With state and local authorities holding statutory risk management responsibilities there was an identified need for these bodies to accommodate the ongoing integration of tourism activities within their broader mandate. Further, climate change adaptation, and to a lesser extent mitigation, needs to be incorporated as part of the ongoing processes of 'destination management' and (community /resource) 'risk management'.

To develop and advocate a tourism focus, local lead tourism agencies (STOs, STICs, RTOs and LTOs) need to be proactive in integrating destination management into local government statutory planning processes. The VICE framework has provided a simple framework for integrating stakeholder views into such processes.

The strategies required to address both the overarching adaptive capacity and the range of individual climate change impacts need to be tailored for each type of business and within each region. The majority of tourism businesses are SMEs and the long term impacts of climate change may be quite different from one product to another.

Some businesses have built infrastructure which may be very costly or difficult to upgrade or alter, some are mobile operators that have the capacity (over time) to amend tour programs in response to destination changes, and some have no physical assets (e.g. cultural walks and talks) and could therefore more easily transition what is being interpreted and where the product might be situated, possibly at little or no cost.

While the regions identified some area-specific actions, many of the adaptive approaches identified were relevant to all regions. These actions outlined below have been categorised to represent key stakeholders within the sector, however as identified by workshop participants, successful implementation of these strategies requires a collaborative and collective contribution from all parties.

Actions Government May Lead

- Conduct climate change risk assessments of natural assets and develop strategies to minimise risk, including emergency evacuation policies.
- Promote integrated regional planning approaches across the areas of tourism, climate, agriculture, natural resources, energy, water, infrastructure and health. Resource local governments to deliver regional development coordination.
- Support research to improve the accuracy of climate models and reduce the uncertainties in climate projection at the local level. Assist in funding this research and develop long term monitoring.
- Plan for and implement high priority adaptation strategies identified from the workshops.
- Develop and implement policy for land planning, building codes and infrastructure development informed by good research. Clear actions, timelines and targets need to be identified, monitored and reported to the community.
- Provide appropriate funding for low carbon emission infrastructure development (e.g. roads, telecommunications, wharves, airports etc.) that support tourism. Use this as a marketing opportunity.
- Involve tourism operators and representative bodies in the development of 'water policy'.
- Develop appropriate conflict resolution processes in anticipation of conflicts between competing users of water resources within the region.
- Make a concerted effort to plan for water use for 2020, 2050 and 2070 (e.g. water recycling, changed irrigation techniques).

- Provide information about the new carbon economy to enable tourism operators to assess the impact on their business; standardise a system of calculating emissions; develop a 'carbon' audit for the sector.
- Provide incentives for best practice management to assist operators to reduce their environmental impact, through rebates, tax benefits etc.
- Develop incentive schemes to support innovation and promote 'model' tourism businesses and organisations wanting to adapt to climate change.
- Reduce carbon footprint across the sector—hotels and restaurants required to purchase locally or pay surcharge on products sourced elsewhere.
- Adaptation and mitigation strategies need to be simple, cheap and effective with clearly identified needs and benefits.

Actions Businesses May Lead

- Keep up-to-date with the latest research and adapt accordingly.
- Consider how the new carbon market could impact business practices.
- Reduce environmental impact by moving to more efficient use of water, means of transport, taking up renewable energy sources, reducing energy consumption, improving waste management practices and keeping informed of future climate projections.
- Obtain environmental accreditation—assistance needs to be provided for operators including auditing, education and certification.
- Diversify products to cope with future environmental and market changes.
- Develop resource sharing among operators.
- Build accommodation and transport needs for visitors in the next 10, 40, 60 years.
- Price products so they are competitive and affordable to attract visitors.



Cairns at dusk © Tourism Qld

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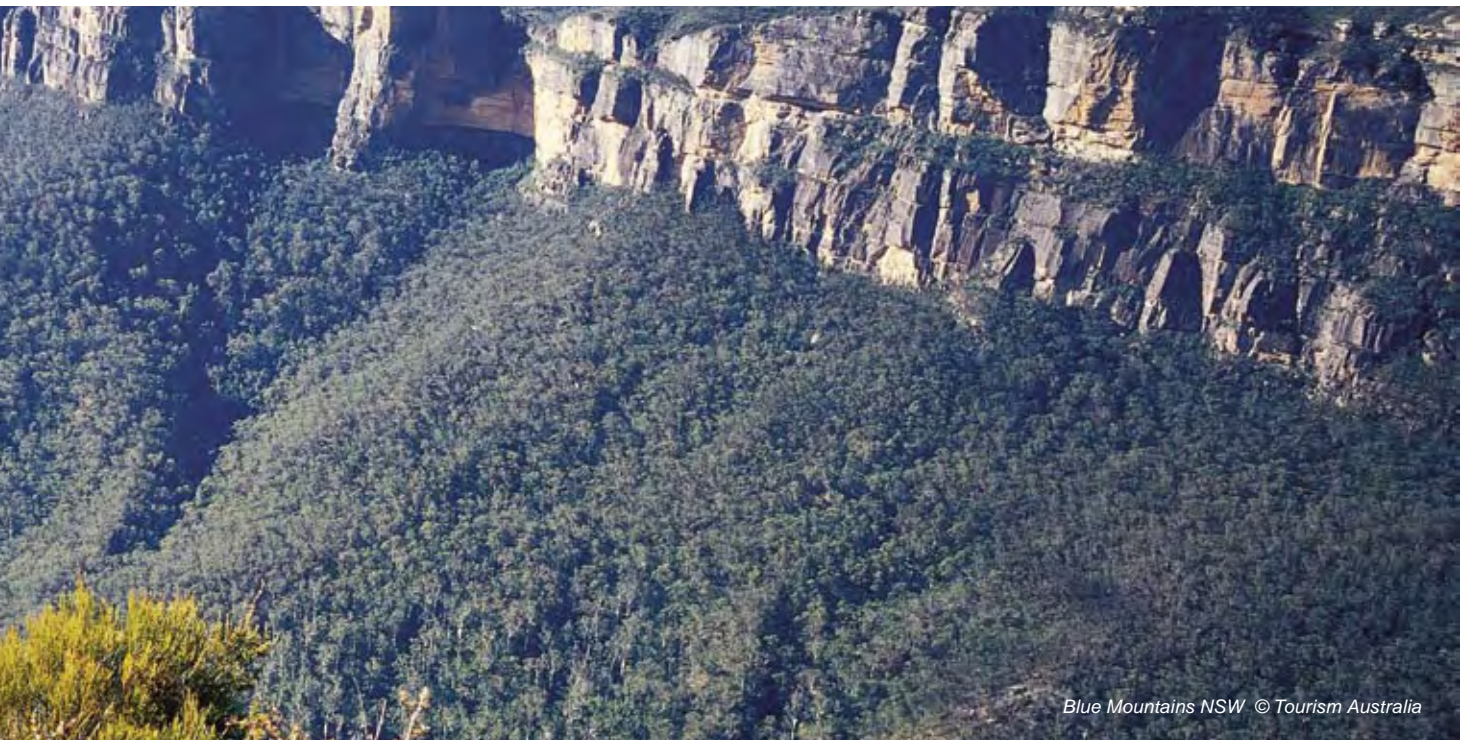
Actions Industry May Lead

- Provide a tourism 'voice' for government planning and resourcing.
- Develop stakeholder networks across the region through which climate change threats and opportunities can be identified, ideas can be generated and disseminated, resources can be pooled, and priority actions can be implemented, monitored, evaluated and communicated back to stakeholders.
- Lobby governments to provide better incentives for operators to shift to 'greener' business practices.
- Communicate relevant policy changes to operators.
- Produce information and guides to assist small tourism operators and organisations to develop and undertake adaptation strategies as a means of supporting the regional economy.
- Develop new tourism products/experiences that have low carbon footprints—improve existing products/experiences to offset climate change impacts.
- Develop and implement offsets or more efficient means of transport.
- Develop and market Australian destinations as 'clean green'—particularly targeting international markets sensitive to the carbon costs of travel such as Europe.
- Work with marketers, agencies and tourism operators to coordinate the region's response to climate change.
- Undertake research into the expected and actual changes in visitor behaviour (e.g. visitation behaviour and intentions) in key markets and in response to changing weather conditions and proposed adaptation plans.
- Develop and deliver visitor information outlining how a region is tackling climate change including the promotion of operators engaging in good business practice.
- Explore opportunities where operators can work with the local community on specific adaptation projects as a means of building relationships and support for tourism.
- Conduct workshops and seminars to update the tourism operators and representative organisations on the likely impacts of climate change and adaptation strategies. Use these to demonstrate new technologies for adaptation.
- Provide training for the tourism workforce and recognise (value) the training so it is retained in the community.



Actions Communities May Lead

- Continue to lobby the government for support in tackling climate change.
- Continue to monitor environmental changes, disseminate findings and encourage further research.
- Understand the beliefs and values of local residents with the view to building support for adaptation in the tourism sector.
- Reduce energy use, water use and carbon footprint.
- Provide greater education of, and communication with, the public, tourism operators and service providers.
- Understand the impact of adaptive responses on the social, economic and biophysical processes.
- Become involved in social mapping exercises to determine community impacts from climate change.
- Continue to build resilience through strategic management of weeds, pests and fire.



Blue Mountains NSW © Tourism Australia

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Climate Change Induced Economic Impacts on Tourism Destinations

The economic modelling undertaken for this study was the first step toward analysing the economic effects of climate change on tourism at the destination level. The objective was to examine the economic implications of climate change on tourism for the five case study regions for three periods (2005–2020; 2005–2050; and 2005–2070).

This is a highly challenging area for analysis. Most economic models rely on recent historical data, however the links between climate change and its impact on tourism demand is based on limited historical observations. A robust analysis of future tourism demand has been difficult to derive. In addition, there will be other structural changes to the economy over the projected time frames, regardless of climate change impacts.

Workshop participants in the case study regions were unable to reach a consensus on projected future tourism demand. Therefore the lead research team was required to develop some educated assumptions on visitor demand projections in order to conduct the economic analysis. STCRC acknowledges that the 'findings' based on these assumptions are contestable.

Future efforts to measure the longer-term economic impacts of climate change on tourism may be better informed through running the modelling across a series of potential scenarios. This initial attempt at modelling the economic impacts of tourism (whilst not providing robust outputs) has provided important insights into the gaps in data that are necessary for this work to be more relevant in the future.

Research Approach

A Computable General Equilibrium (CGE) economic model similar to that used to generate state and territory Tourism Satellite Accounts (TSAs) was used for this study. Importantly, as with the approach adopted in the TSAs, tourism is not treated as a commodity or industry, as visitors consume a wide range of goods and services across many traditional industry sectors.

The study developed three simulations to examine the net economic effects of climate change on tourism destinations. The base case simulation was based on key projected economic growth as outlined in the Garnaut Climate Change Review.

- Simulation 1 added to the base case Tourism Research Australia's growth forecasts for the period 2005–2020 and with projections extrapolated through for the periods 2005–2050 and 2005–2070.
- Simulation 2 added to the projected climate change effects as outlined in the Garnaut Review to Simulation 1.
- In Simulation 3, Tourism Research Australia's growth forecasts and subsequent projections were replaced with the lead research team's assumed estimations of a reduction in tourism demand over the three time periods. As in Simulation 2, Simulation 3 also included the projected climate change effects outlined in the Garnaut Review.

In Summary

Most climate change research investigates time frames between the present and 2020, 2050, 2070 and 2100. These extended time frames presented a challenge for this study as most economic models rely on recent historical data and usually forecast to the immediate future. Current data outlining links between climate change and its impact on visitor behaviour is based on limited historical observations.

Over the extended time frames in which climate change is expected to impact biophysical resources, there will also be other structural changes to the economy that are not necessarily related to the impacts of climate change.

Both of these factors limit confidence in being able to report the long-term economic impacts of climate change for the tourism industry.

Notwithstanding this, the economic model does indicate some important structural issues for tourism. Despite forecasts within the Garnaut Review of population and gross domestic product growth, tourism is expected to retract in regions where there is strong dependence on tourism in regional economies. Most tourism reliant destinations, such as those examined in this study, do not have obvious alternative sources of economic activity which might enable economic diversification in response to the climate change induced impacts on tourism.

In the longer-term, the high labour intensity of the tourism industry can lead to proportionately more job losses in tourism-dependent regional economies. Governments will need to be aware of the vulnerability of these tourism dependent regions to enable appropriate policies to facilitate adaptation and resilience building.

Further research will also need to be undertaken to be able to provide more meaningful potential scenarios of climate change impacts on tourism destinations to form the framework for future economic modelling.



Red Lily Billabong, Kakadu NP © Tourism Australia

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Knowledge Gaps and Future Research

Many of the adaptation strategies outlined in this report represent significant business and community opportunities and, if carefully implemented, can also serve as mitigation strategies. However, there are still many additional strategies that require further investigation, both in terms of their adaptive potential and their capacity to be implemented.

Furthermore, significant science and other knowledge gaps represent risks in the adaptation approach. In addition to further research on areas already touched on in this study, there are substantial additional areas of research and policy effort that require attention in light of the findings and limitations of this study. Some of the research needs revolve around the desire for improved regional projections and predicted impacts on biophysical components of the landscape and tourism demand, including how visitors, communities and economies are likely to respond to climate change. Although not exhaustive, some obvious areas for further investigation in the realm of destination-based adaptive strategies include:

Actions Government May Lead

- Create more regionally specific climate change projections (visitors are generally mobile within a regional destination and broad effects mapping may not take into account of local variations and visitor behaviour, for example, coastal cooling breezes vs. inshore heating).
- Develop more specific time frames for climate change impacts.
- Determine physical changes to the destination landscape.
- Identify the ecological impacts of climate change on wildlife.
- Conduct further research on the health impacts of climate change.
- Develop more knowledge on human and visitor comfort indices and how these might predict behaviour (residents, staff, visitors).
- Develop more extensive economic data on the value of tourism to the region.
- Investigate overseas examples of best practice management.
- Analyse the economic impact of the Emissions Trading Scheme and the costs of adaptation.
- Distribute available information about incentive schemes.
- Develop better interpretive information.

Actions Businesses May Lead

- Implement technologies and other innovations to help mitigate and adapt to climate change.

Actions Industry May Lead

- Provide information about available incentive schemes.
- Educate operators on how to become more resource efficient and promote this to visitors.
- Explore opportunities for product development that 'weatherproof' core visitor experiences.

Actions Communities May Lead

- Understand what visitors want out of the regional experience and how climate change will impact on their experiences.
- Explore how to improve resource efficiencies in tourism—and how to demonstrate such (clean and green) brands.

In Summary

In summary, the capacity for adaptation strategy adoption and implementation will require some, if not all, of the following:

- confidence that the climate is really changing and that increased variability in climate is part of the process
- motivation to avoid risk or take up opportunities
- demonstration of new technologies
- transitional and legislative support from government
- resources from government and private stakeholders
- effective monitoring and evaluation—climate change is a moving target.

Recommendations for Application of the Methodology to Additional Destinations

Comments from the Research Team

We believe this report will be of interest and relevance to any individuals or groups hoping to undertake a similar analysis of climate change impacts and adaptation and mitigation in their regions. To this end, we feel that interested parties from other tourism destinations will benefit considerably from reading the full technical report.

Indeed, the high level of overlap in nominated adaptation and mitigation strategies across the similar destinations in this study will serve as a good pointer for new destinations, as interested parties will be able to identify many relevant adaptation and mitigation strategies.

This study has highlighted the complexities of climate change and the need for more relevant data and information to enable more meaningful analysis to be undertaken for tourism in specific regions. It has also shown that while addressing potential economic impacts 10 years in advance is realistic, estimating economic and visitor impacts further into the future is impractical with currently available data.

Implementation

Local agencies or individuals wishing to implement this approach may do so as the methodology currently stands (at least for the non-economic component of the study). The lead group or individual is likely to be different for each destination. For example, local governments may wish to take the lead as they invest heavily in tourism at the regional scale and increasingly have climate change and/or sustainability officers. However, depending on the size of the region/destination, the sectors involved in the interviews and the relationship of interviewees with the local council, it may be that government bodies are not the best drivers of this process.

Our experience has been that implementation of the methodology used in this study is ultimately dependent on the will of all tourism stakeholders within a destination. The level of scepticism and engagement of these parties is best assessed during the semi-structured interview phase. This will enable the lead individual or organisation to determine the need, or otherwise, for an independent body or facilitator to become involved in the process.

In destinations where vested interests or high levels of scepticism exist, it may be best to engage an independent facilitator and/or research team to ensure that all stakeholders feel equally engaged and are willing to contribute to the process without fear of misrepresentation or distrust.

We recommend that regional authorities wanting to apply the methodology seek out appropriate expert advice and support, in the areas of climate science and regional projections, tourism statistics, economic data collation and modelling, and assessment of relevant stakeholders to be included in the interviews and workshops.



Kakadu National Park



Kakadu National Park Case Study

By Pascal Tremblay and Anna Boustead

Study Area

Kakadu National Park is in the Northern Territory's Alligator Rivers Region, located 150 km east of Darwin, in the wet-dry tropical region of northern Australia.

It is recognised both nationally and internationally for its conservation and cultural importance. Kakadu is World Heritage Listed for both its natural and cultural values, with its wetlands recognised as Ramsar Wetlands of International Significance.³

Kakadu is a major visitor drawcard for the Northern Territory and a cornerstone of Tourism Australia's marketing campaign.⁴

Kakadu National Park is a biodiversity hotspot, containing over one-third of Australia's birds, about one-quarter of Australia's mammals, 1600 plant species, 128 reptile species, an estimated 10,000 species of insect⁵ and at least 50 freshwater fish species.⁶

It is also an important feeding and breeding site for thousands of migratory birds. Some 39 migratory species listed under the Bonn Convention are found in Kakadu which is a critical part of the East Asian-Australasian Flyway.⁷

The region can be classified into three major landscapes: the plateau and escarpment; lowlands; and floodplains.⁸ The floodplains and associated intertidal wetlands cover approximately 217,450 hectares, with 89% freshwater wetlands.

Kakadu National Park is managed by a Board of Management with representatives from both traditional and non-traditional owners. The Board currently consists of 10 traditional owner representatives and five others, including the Director of National Parks, representatives from Parks Australia, a tourism expert and a conservation expert.⁹ Kakadu National Park is managed for use by traditional owners and visitors. For traditional owners, the wetlands provide an important place for hunting and gathering as well as ceremonies and cultural activities, such as fire management.

Climate in the Region

The regional climate is characterised by extreme annual cycles, with a cool, dry season (April–October) and a hot, humid season (November–April), during which about 90% of the annual rainfall occurs.¹¹ The mean annual rainfall is 1580 mm, although significant variation occurs from year to year. Daily maximum temperatures are above 30°C year round, ranging from an average of 32°C in June to 38°C in October. Average minimum temperatures range from 18°C in July to 25°C in November.¹²

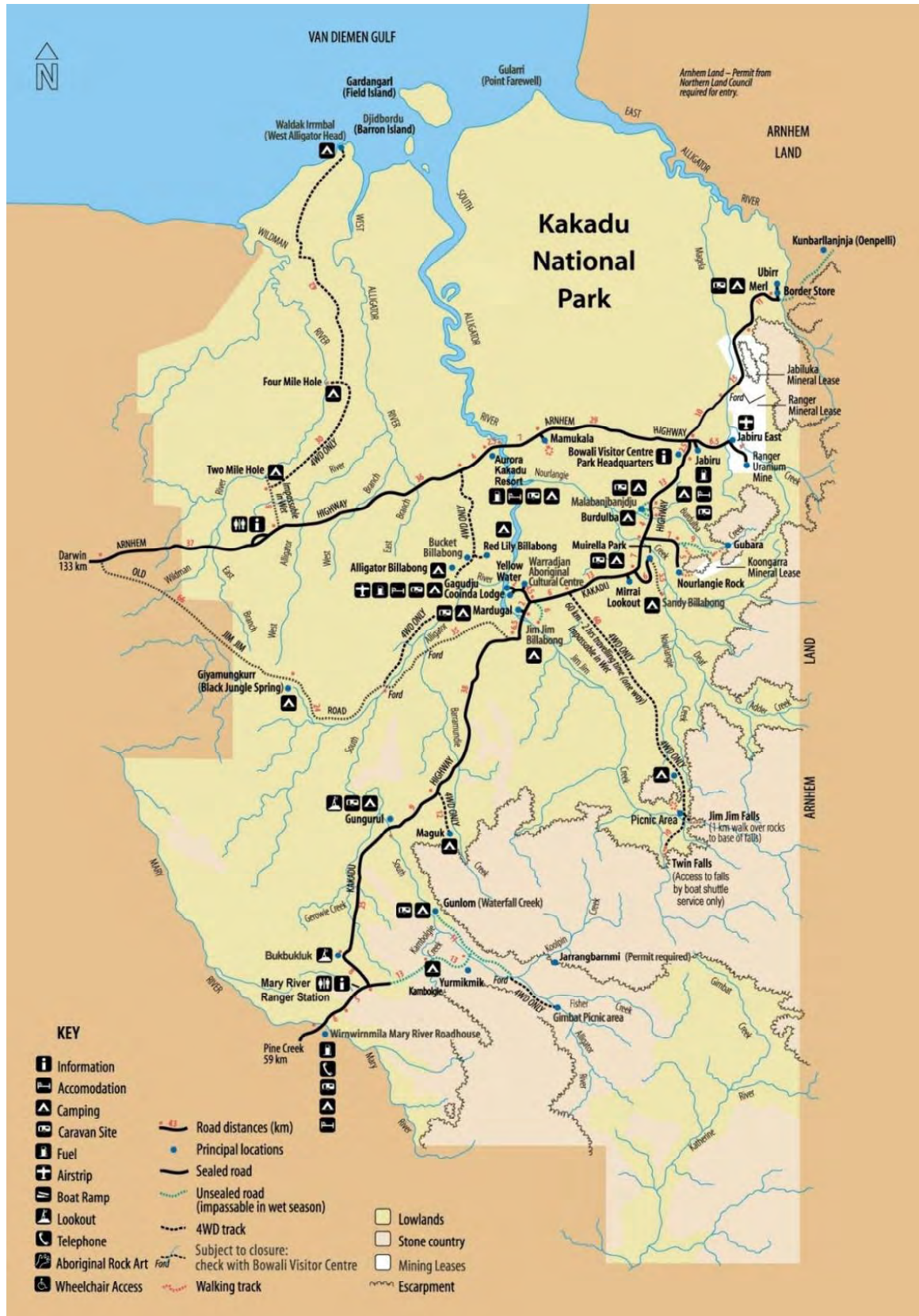


Nourlangie Rock, Kakadu NP © Tourism Australia

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Figure 2: Map of visitor attractions in Kakadu National Park



The peak time for tourism is during the dry season, when weather conditions are comfortable, the rest of Australia is cooler, and most of Kakadu is accessible by road. The low occurs in the wet season, when hot humid weather makes conditions uncomfortable, flooding prevents access to many popular sites in Kakadu and the southern parts of Australia are relatively more attractive.

Tourism's Contribution to the Region

According to a visitor survey, over 42% of all visitors to the Top End included or intended to include Kakadu in their trip.^c Tourism provides the largest number of jobs in the region, followed by conservation and recreation.¹³

In 2004–05, Kakadu attracted 165,300 visitors, who directly contributed about \$58.1 million to the Northern Territory economy.^{14,15} A survey of visitors to Kakadu in 2007 identified that 51.5% of visitors were from interstate and 43% from overseas. The majority of these visitors (73%) stay in Kakadu for 1–3 nights.¹⁶ A Park Visitor Survey¹⁷ found that the top five reasons for visiting Kakadu were:

- to see scenery and wildlife
- to experience Aboriginal culture, people and rock art
- to visit a World Heritage Area
- the Kakadu ecology
- waterfalls.

Tourism Activities

Recent marketing efforts and campaigns have focused on promoting unique natural and Indigenous cultural experiences for Kakadu visitors. Some sources attribute 40–60% of visitation to commercial tour operators,¹⁸ however this proportion has declined over time with an increase in independent travellers.¹⁹

The most popular destinations within the Park include the rock art sites of Ubirr and Nourlangie, as well as the wetland site of Yellow Waters Billabong at Cooina (Figure 2). These sites are easily accessible year-round via sealed road, except for Ubirr rock art site which can be cut off intermittently for 4–6 months per year when wet season rains flood the Magela Creek. Traditionally, about 63% of visitors to Kakadu take the Yellow Waters boat cruise.²⁰

During the dry season, the waterfall sites at Jim Jim and Twin Falls on the escarpment are also very popular with four-wheel drive visitors and commercial tours; however, access to these areas is limited by variable road conditions and closed for extended periods during wet season floods. Bushwalking, four-wheel driving, recreational fishing, bike riding, swimming and bird watching are also well-known popular activities for visitors.²¹

The rich Indigenous culture of Kakadu National Park is a major draw card for many visitors, who come to learn from Aboriginal people, visit rock art sites and experience traditional culture. The cultural and spiritual values of Kakadu are a strong component of marketing the region within Australia and overseas.

The interconnectedness of land and culture in Kakadu mean that any environmental degradation is likely to impact upon Indigenous livelihoods, and possibly on Indigenous tourism, in ways difficult to predict.

^c Northern Territory Travel Monitor

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CSIRO Climate Change Projections for Kakadu National Park —2020, 2050 and 2070

Projections of global climate change for the Kakadu region for 2020, 2050 and 2070 were developed by the CSIRO Division of Marine and Atmospheric Research.²² These were modelled on the period 1961–1990 and based on a mid-range emission scenario for 2020, and on low and high emission scenarios for 2050 and 2070 where the uncertainty is greater.

Table 1: Projected climatic conditions in 2020, 2050 and 2070

Projected trend (relative to average levels for 1980–99)	2020	2050 Low emissions	2050 High emissions	2070 Low emissions	2070 High emissions
Increase in average temp (°C)	0.7	1.2	1.9	1.6	3.1
Increase in number of hot days (>35°C)	26	62	87	78	143
Increase in heavy rainfall intensity (% increase)	3.4	6	9.8	8.2	15.8
Decrease in total rainfall (% decrease)	0.3	0.6	0.9	0.8	1.5
Decrease in number of rain days	0.2	0.4	0.6	0.5	1
Increase in sea surface temp (°C)	0.5	0.9	1.4	1.2	2.3
Sea level rise (cm)	8-14	19	37	32	56

The average number of hot spells (3–5 days over 35°C) in Kakadu is projected to increase significantly, causing additional heat stress to people, plants and animals.²⁴

Rainfall

Despite increased levels of wet season rainfall in north Australia over the past few decades, the effect of climate change on the amount of rain and the number of rain days in the future is likely to be negligible.²⁵ There remains a large amount of uncertainty about future rainfall patterns for the region.

Seasonal Changes

Projections for seasonal average changes in temperature and rainfall were modelled for the year 2020, but these showed very little change in seasonal conditions.

In the longer-term (2050 and 2070), there is a high degree of uncertainty over how climate change may influence the seasonality of the north Australian climate. Given that this would have a major impact on the lifecycles and distributions of species as well as visitor comfort and travel preferences, this is a major knowledge gap when attempting to determine the impact of climate change on tourism.

Extreme Weather Events

Increases in rainfall intensity, sea surface temperatures and the number of hot days are likely to increase the number of extreme weather events in Kakadu, including floods, duration of the dry season, heat waves, cyclones and storm surges.²⁶

The intensity of severe (Category 3–5) cyclones is projected to increase in the future due to warmer sea surface temperatures. Given the low number of cyclones that develop in the Top End region (average of one per year in the Arafura and Timor Seas), there is currently not enough data to project future changes to frequency or tracking of cyclones with any confidence.²⁷

Cyclones are also associated with storm surges, which cause damage to coastal areas and contribute to saltwater inundation. An increase in ocean temperatures and melting of land-based ice will also contribute to a significant rise in sea level, which will exacerbate the effects of storm surge.²⁸

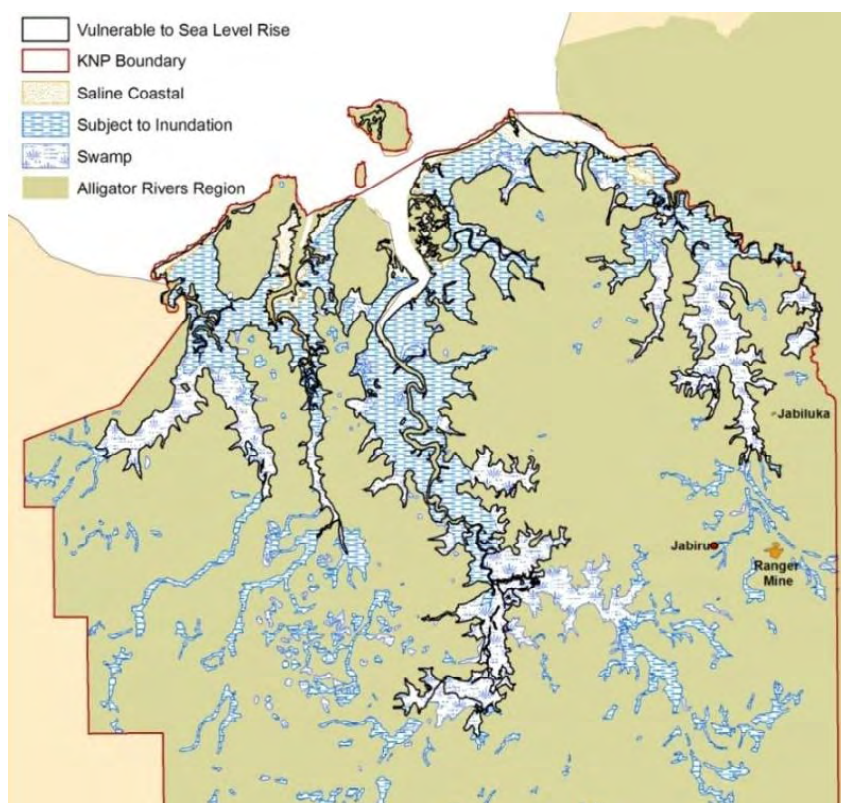
Sea Level Rise

The Kakadu coastline is of very low elevation, from 0.2–1.2 m above sea level²⁹ and even a small degree of sea level rise is very likely to cause significant saltwater inundation of freshwater wetland systems (Figure 3). Within the freshwater habitat in the Alligator River Region, 176,596 ha (72%) is currently assessed as vulnerable to a 30 cm sea level rise.

Sea level rise projections for Kakadu

- 8–14 cm by 2020
- 19–37 cm by 2050
- 32–56 cm by 2070

Figure 3: Wetland habitats at risk of salt water inundation due to sea level rise³⁰



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Possible Impacts of Climate Change on Tourism

To help inform this study, the research team has conducted comprehensive desktop research on climate change in relation to the biophysical and socio-economic characteristics of the case study region. This summary highlights the key findings from this process, with more detailed information available within the full technical report.

A lack of appropriate scientific research, historical data and robust bioclimatic models for the region make it difficult to predict the potential ecological impacts of climate change with any certainty. Although the Kakadu wetlands have undergone major ecological change over the past few decades, this has not provided sufficient impetus to thoroughly investigate the complex hydrology of the region³³ with insufficient knowledge of interaction between wetland plant communities and changes in hydrological and depositional conditions. A lack of tidal and stream gauges and no permanent water level gauges in van Diemen Gulf means there is scarce hydrological data available.³⁴

Despite an ongoing scientific effort focusing on the effects of climate change on the wetlands of Kakadu, research is needed to address current knowledge gaps including more comprehensive climate change scenarios, baseline data, a collation of existing data and biophysical and social processes.³⁵

Human Impacts of Climate Change

Changes in climate will affect the distribution and spread of pathogens. Northern Australia is particularly vulnerable to mosquito-borne diseases such as malaria, dengue fever and avian influenza.³⁶ An increase in mosquitoes, accompanied by a change in distribution of mosquito vectors carrying disease will increase health risks for both visitors and residents.³⁷

The contamination of food and water supplies from flooding and cyclones will also increase the risk of spread of some infectious diseases such as gastroenteritis and melioidosis.³⁸ An increased incidence of water-borne disease associated with contaminated water caused by extreme rainfall events is also likely.³⁹

Longer, more frequent, extremely hot spells will make it more uncomfortable for people visiting and living in Kakadu, as well as increasing incidences of heat stress. The elderly, young children and those with cardiovascular disease are particularly at risk from heat-related death by heatstroke or heart attack due to exposure to extreme temperatures. A significant increase in the number of hot spells places these people at further risk.^{40,41} An increase in average temperatures and the number of hot days could further compromise the health of people with respiratory disease such as asthma.⁴²

Attracting suitable employees is already identified as a significant issue for many businesses in the Northern Territory. Less comfortable conditions are likely to make it even more difficult to attract skilled employees to staff tourism operations and services.

Indigenous Tourism

The social impacts of climate change on Kakadu National Park cannot be projected. However, it is likely that the impact of loss of wetland areas, increased extreme weather events and increased heat-related, vector-borne and water-borne illness may have a negative impact upon Aboriginal communities in the region.⁴³ However, the extent of these impacts and of the adaptive capacity of various Aboriginal groups is not well understood.

Infrastructure Impacts

Impact of increased temperatures

Infrastructure such as machinery, vehicles and power stations may be stressed and roads can melt under extremely high temperatures which would increase the cost of maintenance.

An increase in power consumption is likely to occur as a result of increased use of air conditioning. Given that an average of 50% of energy consumption in hotels is attributable to air conditioning, this is likely to result in a significant increase in operation costs.⁴⁴ An increase in power outages as existing infrastructure struggles to fulfil demand would also inconvenience visitors and add to business costs.⁴⁵

Impact of increased rainfall

More intense high rainfall events will increase the severity and inundation time of severe floods, resulting in a greater risk of damage to infrastructure including roads, bridges, accommodation facilities and ablution blocks. Services and supplies to Cooinda and Jabiru would be disrupted for longer periods as roads are cut off by floods.

Access to popular four-wheel drive tracks and waterfall sites such as Jim Jim Falls may also be cut off for longer periods in the early dry season due to more severe floods. However, higher evaporation rates may compensate for longer inundation times to an extent.

The inability to access areas of Kakadu may contribute to a decrease in visitation and visitors' enjoyment of the experience as their trip is unable to fulfil expectations. This may decrease the likelihood of visitors making a return trip.

Impact of more intense cyclones

A relatively small increase in the intensity of cyclones may exceed current thresholds of infrastructure in the future, resulting in greater injury and building damage. Insurance Australia Group found that an increase in peak gust wind speeds from 40–50 knots to 50–60 knots resulted in a 650% rise in building damage claims.⁴⁶

An increase in claims is likely to increase the cost of insurance premiums, further adding to operation costs. A further risk is that the cost of claims will rise so high that the insurance industry will not be able to afford to continue to underwrite damage costs resulting from natural disasters in the future.⁴⁷

Since infrastructure is built to withstand current extreme weather conditions, a more severe cyclone may compromise infrastructure in the future, requiring building standards to be revisited.

Environmental Impacts

Wetlands

Large storm surges caused by intense cyclones exacerbate the effects of sea level rise, causing sudden saltwater inundation of coastal areas to a depth of several metres. This is an additional threat to the viability of freshwater wetlands. Saltwater intrusion from a rise in sea level is likely to promote salt-tolerant systems such as mudflats and mangroves at the expense of freshwater wetland species.⁴⁸ This has been seen along the South Alligator and Mary Rivers, where wetland habitat has been displaced by saltwater intrusion.

Higher rates of evaporation and higher temperatures may result in inundated floodplain areas drying out at a faster rate in the dry season. This may impact on wetland plant and animal species by forcing birds to migrate earlier, cause turtles to hibernate earlier and reduce the amount of plant foods available such as water lilies and water chestnut. This may result in a decline in abundance, and change in distribution, of iconic species such as magpie geese and a reduction in the aesthetic appeal of wetlands.

Land management

Climate change will alter the distribution and abundance of feral animals and weed species. It is therefore likely that good land management activities such as pest control, weed control and fire management will become even more important in increasing resilience of landscapes to climate change.⁴⁹

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Reptiles

Higher temperatures may impact negatively on the abundance of reptiles by increasing the proportion of females to males for temperature-dependent sex determination species such as crocodiles and turtles.⁵⁰ Storm damage to crocodile nests from more intense storms could reduce their breeding success.

Past surveys of participants in the Yellow Waters wetland cruise found that the number of crocodile sightings was a key determinant of visitor satisfaction.^d

Fires

Climate change is likely to create conditions suitable for fire, through increased evaporation rates, higher temperatures and increased drought. When combined with increased fuel through the spread of invasive grasses such as Gamba grass, this is likely to result in a higher intensity and frequency of fire.^{51,52}

Industry Input to Scoping Study

Semi-Structured Interviews

A Visitor, Industry, Community and Environment (VICE) model was used to gain maximum representation of organisations involved or affected by tourism activities. Fifteen senior representatives responsible for policy or practice from each sector took part in semi-structured interviews.

Table 2: VICE table for Kakadu case study

Visitor	Industry	Community	Environment
Tourism consultant	Kakadu culture camp	Amateur Fishing Association NT	WWF
Tourism NT	Gagadju Association	Northern Land Council	Parks Australia North
Parks Australia North	Indigenous Business Association	NT Government	Parks NT
	Tourism Top End	NT Youth Roundtable	
	Animal Tracks		

Respondents were asked a series of questions including:

- Have you heard people talking about climate change?
- What are the positive/negative impacts of climate change?
- How do you think tourism stakeholders should respond to climate change?
- What climate change adaptations are happening now?
- What climate change adaptations need to happen now?

Stakeholders felt that the response to climate change had to be driven and supported by government with some adding that it was the responsibility of industry bodies to communicate and coordinate the response by operators. Community stakeholders felt that all sectors should drive the response but that industry should take the lead rather than relying on government to respond.

^d Braithwaite, R., Reynolds, P. & Pongracz, G. (1996) *Wildlife Tourism at Yellow Waters*. CSIRO, Northern Territory University.

Workshop Process

The workshop was broken into two activities. In Activity 1, participants were divided randomly into groups and presented with one of three possible scenarios for 2020, 2050 and 2070. They were then presented with a range of adaptation and mitigation strategies extracted from the interviews and asked to rank them according to what should happen for that time period.

In Activity 2, participants were divided according to their VICE sector and the activity was repeated for all scenarios. Participants were then brought together in a plenary session.

Plenary session

The plenary session highlighted several issues of high concern for participants, including a lack of good data on climate change impacts, coordination of an adaptation and mitigation strategy and program, managing the perception of Kakadu in the context of climate change and how to increase the environmental reputation of tourism operators in the region.

The main issues highlighted included the need to address the lack of information about the impacts of climate change on the region with monitoring required to provide baseline data and measure the success of adaptation and mitigation strategies. Participants also discussed the need for better coordination of research, adaptation and mitigation strategies. With the number of current overlapping climate change-related projects there were concerns of fragmentation and poorly used funding. Participants therefore noted the importance of a coordinated effort in pulling all of this information and knowledge together.

Some barriers to implementation that were identified included lack of funding and coordination and ownership of the issues.



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Priority Adaptation and Mitigation Strategies for Kakadu

These recommendations are informed by semi-structured interviews conducted with participants, the workshop and a review of the literature. Some are specific to tourism and others are necessary if the community and the region is to support sustainable tourism in the future. Primarily they are the high priority adaptation and mitigation strategies identified during this study.

To organise the diversity of actions and suggestions emerging out of this study, the recommendations have been classified by the stakeholder groups most closely aligned with implementation.

Actions Government May Lead

- Provide incentives for best practice management to assist operators to reduce their environmental impact, through rebates, tax benefits etc.
- Provide information on a new carbon economy so that operators can assess the impact on their business.
- Review the limitations and life of current assets, infrastructure and services within the Kakadu and Top End region.
- Consider relocating or updating current assets, infrastructure and services in the future, in consideration of the projected increased intensity of floods and cyclones and rise in sea level.
- Continue to resource research, planning and land management activities within the Park.
- Provide incentives such as training and resources for traditional owners to continue working on land management or small-scale tourism enterprises.
- Continue to support carbon offset programs with regional benefits, such as the Western Arnhem Land Fire Abatement project.
- Involve all stakeholders in the range of research and other climate change-related activities within the Park.
- Better resource local government so that it can adequately coordinate regional development.

Actions Businesses May Lead

- Improve business practices and reduce environmental impact by updating their vehicles.
- Take up renewable energy sources, reduce consumption and improve waste management practices.
- Consider participating in an environmental accreditation scheme which includes auditing, education and certification.
- Seek to take advantage of available government incentives to improve business practice.
- Consider diversifying products to cope with future environmental and market changes.
- Consider rescheduling or shifting products around climate change impacts.
- Become informed of future climate projections for the region.
- Inform visitors and industry stakeholders involved in information dissemination about how Kakadu is tackling climate change.
- Promote high standards of business practice.
- Consider potential accommodation and transport needs of visitors in the next 10–20 years.
- Consider how the new carbon market could impact on business practices.
- Participate in discussions with agencies about climate change.

Actions Industry May Lead

- Create and disseminate readable, relevant information for visitors and operators on the possible impacts of climate change on Kakadu and the broader NT region.
- Communicate relevant policy changes to operators.
- Lobby government to provide better incentives for operators to shift to 'greener' business practices.
- Provide a tourism 'voice' for government planning and resourcing.

- Work with marketers, agencies and tourism operators to coordinate the region's response to climate change.
- Support the Kakadu Tourism Consultative Committee in coordinating a Tourism Climate Change Adaptation Strategy.
- Consider a coordinated campaign to market the Kakadu region as a clean, green destination, particularly targeted at international markets sensitive to the carbon costs of travel, such as Europe.
- Work with tourism operators to manage the shift in perception to ensure the campaign is consistent and coordinated.
- Promote accreditation schemes suitable to fit businesses in the region.
- Consider how changes in the landscape could affect future marketing campaigns and keep up-to-date with the latest research.

Actions Communities May Lead

- Compile readable, relevant information for potential visitors about how climate change could impact upon Kakadu.
- Continue to support carbon offset programs with regional benefits, such as Western Arnhem Land Fire Abatement Project and make available to operators.
- Develop a tourism strategy to deal with climate change in conjunction with the Kakadu Tourism Consultative Committee.
- Continue to promote small tourism operations involving Indigenous land management activities in remote areas and support with proper training, infrastructure and resources.

Actions Park Management May Lead

- Review the limitations and life of current assets, infrastructure and services.
- Consider relocating or updating current assets, infrastructure and services in the future, in consideration of the projected increased intensity of floods and cyclones and rise in sea level.
- Involve all stakeholders in designing and implementing the Kakadu National Park Climate Change Strategic Plan.
- Continue to build resilience of the Park through strategic weed, pest and fire management.
- Build capacity for traditional owners to drive tourism activities within the Park.
- Continue to monitor environmental changes within the Park and encourage further research.
- Keep up-to-date with the latest research, particularly regarding the ecological impacts of climate change.
- Focus on maintenance of refuge areas for wildlife, including popular visitor sites.

Conclusion

There is a danger in committing excessive resources to the early phases of the causal process (climate science itself and preoccupations with raw biophysical calculations) and too little towards the behavioural aspects of visitor reactions, industry's ability to innovate and build resilience, and the nature of and impact on destination attractiveness.

It must be noted that while participants in the workshop were asked to consider how existing climate projections were likely to affect tourism performance in the region, none felt that they were in a position to support any projected scenario because of the large number of knowledge gaps, as well as the complex nature of the issues.

The authors of this case study can only concur with stakeholders about the magnitude of the knowledge-building requirements, and agree that attempting to predict how climate change will ultimately affect tourism in a specific region such as Kakadu is premature.

An underwater photograph of a vibrant coral reef. The foreground is dominated by dense, yellowish-orange branching coral. In the middle ground, there are large, rounded, brownish coral structures. The background shows a clear blue sea with a few small fish swimming. The overall scene is bright and colorful, showcasing the biodiversity of the reef.

Tropical North Queensland

Tropical North Queensland Case Study

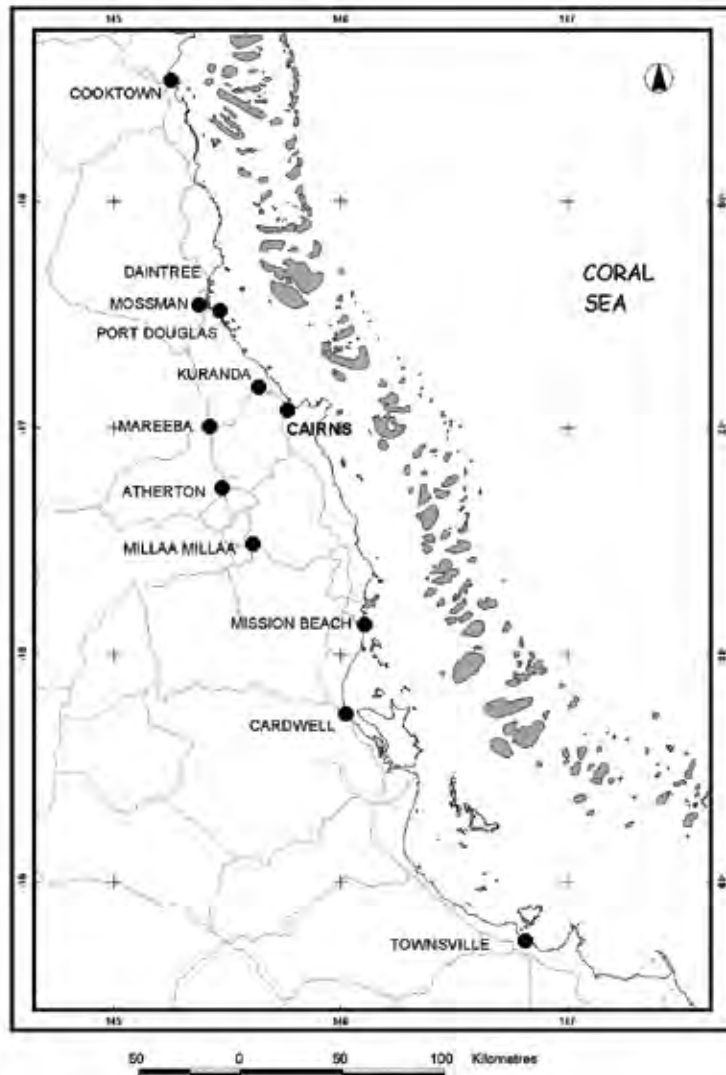
By Robyn Wilson and Stephen Turton

Study Area

For the purpose of this study, the Tropical North Queensland (TNQ) case study region encompasses the land and reef areas from Cape Tribulation in the north to Cardwell in the south and extends west to Mareeba and Atherton Tablelands.

The land area covers some 74,005 km² and includes the local government areas (prior to the amalgamation of the shires in 2008) of Atherton, Cardwell, Cairns, Douglas, Eacham, Johnston and Mareeba.^e

Figure 4: Map of the TNQ region



^e ABS Statistical Local Areas/LGA 2006 Census

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Tropical North Queensland is ranked as the sixth most visited region in Australia, highlighting the importance it holds for visitors and the economy.⁵³ It has two World Heritage Areas, the Wet Tropics and the Great Barrier Reef, both of which face serious threats from climate change this century, in particular in relation to rises in temperature.

Within the Great Barrier Reef, the structure and condition of the reef will be degraded by increasing water temperature and acidity.⁵⁴ In the Wet Tropics, rainforest habitat is likely to change to drier forest with cool-adapted species declining or disappearing.⁵⁵ If tourism is to survive in the region it will need to adapt to such changes.

Climate in the Region

The climate in TNQ is typical of a tropical monsoonal area, with the south-east trade winds dominating most of the year. These are replaced in the summer months by the north-west monsoon.⁵⁶

The region receives the highest rainfall in Australia, with annual rainfall along the wet tropical coast (including adjacent mountain ranges) between Cooktown and Cardwell commonly between 2000–8000 mm.

Typically in excess of 60% of mean annual rainfall occurs from December to March.⁵⁷ Rainfall over reef areas east of Cairns is typically 1500–2500 mm per year.

Annual average rainfall over the past 50 years has varied across the region; rainfall has increased north of Cairns and decreased to the south. In comparison, coastal areas south of Cardwell have experienced a significant decline in average rainfall over the same period.

Average temperatures in the region over the past 50 years have increased at a slower rate than other parts of eastern Queensland, with an observed warming of about 0.3°C.

Data suggests that the region has been 'buffered' to some extent from climate change patterns experienced in other parts of Queensland (e.g. Southeast Queensland), and this may impact on people's perceptions of the likely future climate changes for the region.

Tourism's Contribution to the Region

A large proportion of the population is involved directly and indirectly in tourism in the region. TNQ tourism generates approximately 30,000 jobs and contributes to more than a third of the region's gross revenue.⁵⁸

Most of the TNQ community benefits in some way from tourism. The most obvious stakeholders are the tour operators who provide access to the Great Barrier Reef, and hotel, restaurant and shop staff. Local residents also benefit from the 'existence value' of the Great Barrier Reef, simply knowing it is there, and using it for recreational purposes. Residents also benefit from the restaurants, retail outlets and transport systems that support tourism. Local and state government departments are also involved in tourism as they manage the infrastructure, policy and emergency response.

Visitor stay and spend

In order to understand current patterns of tourism and the degree to which it might adapt to climate change in the future, data on domestic and international visitors in the region such as numbers, expenditure and activities was collated. For the year ending December 2007 there were 1.428 million domestic visitors to TNQ,⁵⁹ spending 7.68 million nights in the region.⁶⁰ The expenditure of overnight domestic visitors for the year ending December 2007 was \$1.5 billion, which represented 13% of total domestic tourism in Queensland.⁶¹ Domestic visitors dominate tourism in the region. However,

international visitors stay more nights on average than domestic visitors. Both groups make similar contributions to the regional tourism revenue.

Tourism activities

A visitor survey revealed that taking a holiday is the main reason for visiting the region.^{62,63} Holiday travel is highly sensitive to the climate of the region and visitors may be readily diverted elsewhere if the region can no longer offer its climate-dependent attractions, such as reef and rainforest.

Tourism business profiles

Most of the tourism businesses in the TNQ region are based in Cairns City and most of these are non-employing businesses. In the regional area, Johnston is the largest business centre followed by Mareeba.⁶⁴

Great Barrier Reef

The importance of tourism to the Great Barrier Reef is evidenced by the economic contribution it makes to the economy.⁶⁵ In 2005–2006 the total direct and indirect economic contribution of Great Barrier Reef tourism, including commercial fishing and recreational activity, was \$6.9 billion.^{66,67}

Visitation, excluding commercial fishing and recreational activity, represented approximately 87% of the gross product of \$6.9 billion for the region.⁶⁸ A visit to the Great Barrier Reef is rated among the top three must do activities in international surveys⁶⁹ indicating the importance of the Great Barrier Reef to holidaymakers on a global scale. Between 1994 and 2007 there was an average of 909,417 visitors per year to the region.⁷⁰

The TNQ region represents less than 20% of the coast of the Great Barrier Reef, but attracts approximately half of the visitors. The greatest motivation for visiting the region is to visit the Great Barrier Reef.⁷¹

Most tourism operations to the reef operate out of Port Douglas or Cairns. Tourism associated with the Great Barrier Reef employs about 66,000 full-time equivalent people with 30,000 of those positions in the TNQ region.^{72,73,74} There were approximately 730 tourism operators permitted to operate in the Great Barrier Reef Marine Park in 2003,⁷⁵ with approximately 60% utilising their permits.

Survey material collected in 2003 from small and large operators from Port Douglas to the Whitsundays found that the most popular activities were snorkelling, swimming, semi-submersible tours and glass bottom boats.⁷⁶

Tourism associated with the Great Barrier Reef is recognised as highly sensitive to climate change.^{77,78} The coral ecosystems for which the Great Barrier Reef is known are extremely important to the survival of tourism, commercial and recreational fisheries, the communities and the economy of the region.

Wet Tropics

Within the Wet Tropics there is a network of roads consisting of forestry tracks, single lane roads and highways that extend for 1427 km.⁷⁹ This extensive road network is costly to maintain. Climate change is likely to put pressure on infrastructure and may lead to road closures which could disrupt tourism to some iconic locations.

A survey⁸⁰ of activities undertaken by visitors (including visiting locals) at 10 sites across the Wet Tropics in the wet and dry seasons found the top five reasons for visiting were scenery, short walks less than an hour, relaxing, photography and wildlife observation. A study in 2007⁸¹ reported that World Heritage listing was found as 'not important' to 83% of 826 visitors surveyed, with 69% indicating that they would still visit the region if no rainforest existed in the Wet Tropics.

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CSIRO Climate Change Projections for TNQ —2020, 2050 and 2070

Projections of global climate change for the region for 2020, 2050 and 2070 were developed by the CSIRO Division of Marine and Atmospheric Research.⁸² These were modelled on the period 1961–1990 and based on a mid-range emission scenario for 2020, and on low and high emission scenarios for 2050 and 2070 where the uncertainty is greater.

Table 3: Projected climatic conditions in 2020, 2050 and 2070⁸³

Variable	Scenario 1 2020	Scenario 2 2050	Scenario 3 2070
Temperature (min. and max.)	0.6°C ↑	1-1.6 °C ↑	1.3-2.5 °C ↑
Sea level & storm surge risk	8–14 cm	19–37 cm	35–56 cm
Increase in days over 35°C	+1	+ 4–8	+ 5–28
Total rainfall (%)	-0.7	-1.9	-3.0
Number of rain days	0.0 Little change	-0.1 Little change	-0.1 Little change
Percentage increase in heavy rainfall	1.8	5.1	8.2
Cyclone intensity of category 3–5		60% ↑	140% ↑
Atmospheric CO ₂		500 ppm	
Sea surface temperature (°C)	0.5 ↑	1.3 ↑	2.1 ↑

Temperature

Maximum temperatures are expected to rise at a lesser rate than minimum temperatures, a global trend that has already been observed over the past 50 years.

The region can also expect more days over 35°C rising from four per year at present to over 20 per year by 2070. The predicted increase in hot days is significantly lower than that expected in other parts of tropical Australia. In comparison, by 2070 it is expected that Townsville will experience more than 150 days over 35°C with Darwin experiencing more than 220 days above 35°C.

With higher maximum temperatures higher evaporation rates are expected and hence greater risks for droughts and bush fires in the region.

Sea Surface Temperatures and Sea Levels

Sea surface temperatures are likely to increase at a slightly slower rate than air temperatures leading to more frequent bleaching of the Great Barrier Reef and significant loss of biodiversity by 2020.^{84,85}

Modelling shows that under current conditions a one in 100 year storm event results in a 2.3 m sea level height.⁸⁶ With a doubling of carbon dioxide, the sea level height of the region during a one in 100 year storm event will increase to about 2.6 m. This will increase to about 2.7–3.0 m with the additional rise in mean sea level of 10–40 cm.

Rainfall

Little overall change in rainfall is predicted for the TNQ region by 2020 based on mid-range estimates, but seasonality in rainfall is expected to increase. Over the next 30–60 years the models generally predict a small decline in rainfall in the region, expected to be more significant in areas to the south of the case study area. Dry season rainfall is expected to decline with longer dry seasons, while wet season rainfall is expected to become more variable from year to year.⁸⁷

Tropical Cyclones

Tropical cyclone frequency is unlikely to change over the next 60 years, but the intensity of severe (Category 3–5) cyclones may increase by 60% by 2030 and by 140% by 2070.⁸⁸ This has significant implications for tourism during the cyclone season (November–April) with severe cyclones cause considerable structural damage to the reef and infrastructure.

Increasing floods associated with cyclones will result in run-off that will affect inshore and offshore reefs by delivering increased sediments, nutrients and pesticides to the reef environment.

Visitors may stay away to avoid cyclones during the wet season.



Cape Tribulation © Tourism Qld

The Impact of CLIMATE CHANGE

ON AUSTRALIAN TOURISM DESTINATIONS

Possible Impacts of Climate Change on Tourism

To help inform this study, the research team conducted comprehensive desktop research on climate change in relation to the biophysical and socio-economic characteristics of the region. This summary document highlights the key findings from this process, with more detailed information available within the full technical report.

Great Barrier Reef

Of the activities conducted on the Great Barrier Reef, tourism is among the most sustainable; however, it is also among the most vulnerable as it is highly dependent on the health and quality of the marine ecosystem.⁸⁹

Degradation in the quality of reef ecosystems, diminished visibility and limited access due to unfavourable weather conditions are likely with climate change, and will have negative impacts on tourism. The ability of tourism operators to adapt to the impacts of climate change will affect the sustainability of tourism in the region.⁹⁰

The predicted physical and biological impacts of climate change on the Great Barrier Reef are numerous. The two most threatening are increased sea temperatures and ocean acidification.^{91,92,93} Other physical factors include sea level rise, storm and cyclone damage and discharge from floods.^{94,95} Biological impacts include stress, disease, and outbreaks of Crown of Thorns starfish.^{96,97}

A recent paper by a group of marine scientists considered that, although the projected increase in carbon dioxide levels and temperatures of the oceans over the next 50 years exceeds conditions in the past, the reefs will change rather than disappear entirely.⁹⁸

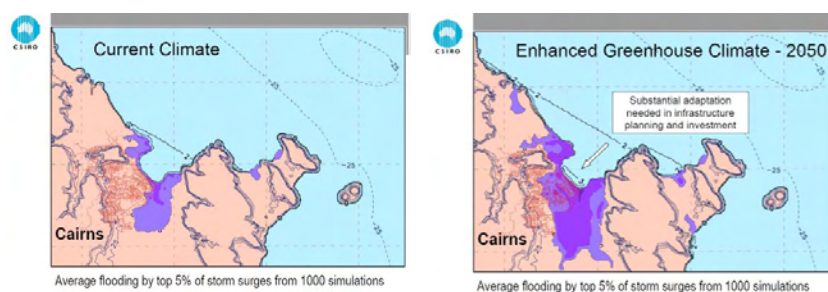
Due to the size and unique position of the Great Barrier Reef, it is possible that in the future the Great Barrier Reef may be the only location in the world for visitors to see a functioning coral reef ecosystem.

Wet Tropics World Heritage Area

More intense, drier conditions will result in a loss of rainforest habitat in the region, which may reduce visitor appeal. Associated with the drying and a loss of habitat there will be a reduction in biodiversity, with many of the mammals and amphibians in the region predicted to become extinct.^{99,100,101} These fauna are an important part of the tourism experience in the region.¹⁰²

Drier, warmer conditions are likely to create a higher fire risk, with more frequent and intense fires. Repeat events will cause fire scars on the landscape and a change in forest structure. Fires will have a negative impact on tourism, as people do not want to see fire-scarred landscapes.¹⁰³

Figure 5: Average flooding in Cairns under the current climate and with enhanced greenhouse climate conditions¹⁰⁴



Infrastructure

The sea level height of the region during a one in 100 year storm event will increase to about 2.6 m. This will further increase to about 2.7–3.0 m with the additional rise in mean sea level of 10–40 cm.

Cairns city is low-lying and prone to flooding on a high tide during the wet season. The Cairns airport is constructed 3 m above sea level in a mangrove swamp. The predicted sea level rise will result in the likelihood of a considerable area of Cairns being inundated by sea water during a one in 100 year storm and may be sufficient to flood the airport. Waves associated with these intense storms are likely to cause damage to infrastructure and buildings in low lying areas.

Sea level rise is likely to have a major impact on tourism infrastructure in low-lying areas of the coast.¹⁰⁵ A major issue is Queensland government policy that allows building at elevations 1–2 m lower than the total ocean inundation occurring during a one in 100 year storm.¹⁰⁶

Most of the large resorts in Cairns and Port Douglas are in the block closest to the coast to maximise beach access. Cairns' central business area already floods on a high tide, inundating low -lying streets and underground car parks, most of which are associated with hotels.¹⁰⁷

Backpacker Tourism

Backpackers form an important part of the mix of visitors to the region. In research undertaken in 2006,¹⁰⁸ backpackers ranked Cairns as the most satisfying destination above Sydney, Fraser Island and the Whitsundays. Most reported visiting the region for the reef with a significant number also participating in land-based activities.

In this research, climate was rated as one of the top influential reasons for visiting the region with the weather being one of the most attractive features. However, one of the top worst experiences was hot, wet, humid weather, which may be a driver in departures during the wet season.

Climate change is predicted to bring hotter and wetter conditions in the wet season which may deter visitors during this time of the year in the future.

Hotels and Resorts

Visitors most probably add more to human generated greenhouse gas emissions than residents as they are travelling further and using resources more than they would at home, for example, hotel laundry (sheets and towels) and air conditioning. A study in 2002¹⁰⁹ identified carbon dioxide emissions per visitor bed in the Cairns region averaged 748.8 kg per year. Of the 38 establishments included in the study, 15 had above average CO² emissions.

The CSIRO data developed to support this study has identified that the temperature and number of days over 35°C are predicted to increase in the future. Thermal comfort may be a major issue for tourism in the region, with more of the cheaper and modest accommodation providing air conditioning in the future.

Community Resilience—Socio-economic Indices

Socio-economic indicators help to identify local government areas (LGAs) that are vulnerable or less able to cope with change and those that can. Local government areas that perform well on socio-economic indicators are more likely to adapt to climate change.

On the index of education and occupation, Cairns, Port Douglas, Atherton and Eacham were in the top 50% of LGAs in Australia. This should be advantageous in addressing the impacts of climate change as a well educated and skilled population is better able to problem solve and adapt.

The Impact of CLIMATE CHANGE

ON AUSTRALIAN TOURISM DESTINATIONS

Industry Input to Scoping Study

Semi-Structured Interviews

A Visitor, Industry, Community and Environment (VICE) model was used to gain maximum representation of organisations involved or affected by tourism activities. Semi-structured interviews were conducted with senior representatives responsible for policy or practice from each stakeholder sector. As tourism in the region revolves around both the reef and the rainforest, representatives from both areas were included in the VICE model.

Table 4: VICE table for the TNQ study

	Visitors	Industry	Community	Environment
Policy	Federal and regional tourism organisations	State and regional tourism organisations: QTIC, TTNQ	Elected Member of Parliament for Barron Electorate	Land and reef management agencies: WTMA, GBRMPA
Practice	Large tour companies	Large accommodation provider	Community board members	Land and reef management agencies: Marine Parks / EPA / QPWS
Practice	Small tour operators	Tourism consultants; ecotourism peak body: Marine and Reef AMPTO	City regional planner, SES	Non-government organisation CAFNEC
Acronyms	<i>GBRMPA = Great Barrier Reef Marine Park Authority, WTMA = Wet Tropics Management Authority, QTIC = Queensland Tourism Industry Council, EPA/QPWS = Environmental Protection Agency / Queensland Parks and Wildlife Service, AMPTO = Association of Marine Parks Tourist Operators, CAFNEC = Cairns and Far North Environment Centre</i>			

Twenty-four interviews were conducted. Interviewees were asked to respond from their corporate perspective, that is, to represent their particular area of the VICE model and not their personal views.

The questions were designed to gain an understanding of the participants' knowledge of 'weather' and 'climate', and how this would impact on tourism. To assist responses, respondents were asked to consider both positive and negative impacts.

The questions addressed by the respondents were:

- Are people in TNQ talking about changing weather patterns and climate change?
- What types of positive and negative effects do you think climate change will have on tourism in the region in relation to the reef, rainforest, infrastructure, land, operational costs, community/social life?
- What is happening now to address the impacts of climate change on tourism?
- What needs to happen?
- Do you believe that the region can adapt to the likely effects of climate change?
- What time frames are required to properly respond and adapt to climate change in the region?
- What do you need to know in order for tourism in the region to adapt to climate change? Consider information in the areas of human resources to support tourism, infrastructure and building, natural environment and the community.

It was identified that for tourism to adapt to climate change there was the need for government to take a stronger community leadership role. In addition, the development of an efficient communication system that includes government, operators, researchers and the general community is required.

Workshop Process

Findings from the semi-structured interviews were used to develop a table of adaptation strategies to be prioritised during the workshop. A total of 50 adaptation responses and strategies were identified addressing the themes of natural environment, coastal, visitors, infrastructure, community and policy.

The workshop commenced with a presentation providing an overview of climate change in Australia and climate change projections for the region for 2020, 2050 and 2070.

To assist participants in prioritising the adaptation strategies, a scenario table developed from the desktop review was used to define the likely conditions in the region under the three time frames (Table 5).

Table 5: Projected climatic conditions in 2020, 2050 and 2070

	2020	2050	2070
Great Barrier Reef			
Disturbance from climate change	Minor	Moderate–Severe	Severe
Bleaching	More frequent; some loss of coral diversity Bleaching < 1 every ten years	Reef bleached; 95% loss of coral reefs > once every 5 years	Reef bleached; 95% loss of coral reefs annual event
Coral structure	No major damage	Structural damage; 50% decline in iconic coral species and shift to crusting forms	Rubble; total loss of coral structure
Macro algal cover	Minor coverage—isolated	High coverage across reefs	Very high—extensive coverage
Invertebrates	Little change	Major decline	Few rubble inhabitants
Obligate reef fish (10% of total fish speciation; small colourful species)	Little change—decline on some reefs	Major decline	Total loss and 70% decline in pre-existing fish
Herbivorous species of fish	Little change	Increase	Dominant type but also a decline in species
Sea birds	Decline in nesting colonies	Major decline	Colonies crashed (loss of pelagic food source)
Impact on visitors	Some decline at some sites	Major loss of popular sites especially near shore and shallow reefs	Reef severely degraded; total loss of visual amenity. Possibly interest due to size of destruction and algae
Chance/likelihood for 'average visitor' of: seeing good coral, seeing turtles, seeing whales, and/or catching fish	High	Very low	Extremely low

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	2020	2050	2070
Rainforest			
Core habitat remaining	85% ↓	55 – 68% ↓↓	40% ↓↓↓↓
Extent of rainforest	Slight reduction on current extent	Significant loss—drier forest type; rainforest isolated to patches at higher altitude, and coast	Major reduction—isolated to highest peaks, and coast
Loss of endemic vertebrates e.g. rainforest ringtail possums and tree kangaroos, birds and frogs (upland endemics)	0	1–4	4–12 Extinction of all or most of these <i>spp.</i>
Occurrence of forest fires	Slight increase	Moderate increase	Large increase
Cairns city—extent of storm inundation	32 km ² inundated	71 km ² inundated (most of downtown)	>71 km ² inundated
Likelihood of flood event during wet season (flooding causing highway closure to Tablelands and south of Cairns)	Increase	Moderate to high increase	Moderate to high increase
Change in the proportion of these habitats (compared with present time)			
Notophyll forest (highlands)	Slight decline	Major loss	Major loss
Mesophyll (uplands)	Little change	Moderate loss	Major loss
Woodlands	Slight increase	Moderate increase	Major increase

Data sourced from literature review



During the first stage of the workshops, participants joined mixed groups from each of the VICE sectors. Each group was asked to consider just one of the climate change time periods and to prioritise each of the adaptation strategies as high, medium or low, and provide support for their decisions.

During the next stage of the workshop, participants were grouped into their VICE sectors and asked to reconsider the adaptation strategies for each of the climate change scenarios, ranking them from their VICE group's perspective as high, medium or low.

Plenary session

The final stage of the workshop was a plenary session in which all participants were involved. During this session, participants identified the major issues, who needed to be involved in implementing the adaptation strategies and if there was a lead agency or organisation to do so. Key outcomes of this session included agreement that as tourism is represented in a broad cross-section of industry sectors, it needs to inform and gain support from the wider community in order to influence government policy and funding. This approach could help to spell out the benefits of particular government strategies, including the introduction of incentives that would benefit not only tourism but others as well.

There are many small independent players within tourism. While they can be a part of the adaptation process, it is government who will have to take the lead role in funding and leading change. A partnership across all groups is required to help coordinate tourism adaptation strategies.



Green Island © Tourism Qld

The Impact of CLIMATE CHANGE

ON AUSTRALIAN TOURISM DESTINATIONS

Priority Adaptation and Mitigation Strategies for TNQ

These recommendations are informed by semi-structured interviews conducted with participants, the workshop and a review of the literature. Some are specific to tourism and others are necessary if the community and the region is to support sustainable tourism in the future. Primarily they are the high priority adaptation strategies identified during this project.

There was agreement from all parties that action is needed now to plan for and implement the high priority adaptation strategies identified.

Actions Government May Lead

- Fund research and long-term monitoring from reputable scientists.
- Develop sound policy informed by the research for planning, building codes and infrastructure development.
- Implement policy with clear actions, timelines and targets. These need to be monitored and reported to the community.
- Conduct a meaningful program with involvement by all stakeholders—possibly a regional climate change department within a tourism portfolio to broker knowledge and work with the community, lobby groups and the media. This would be a place of data storage and dissemination.
- Update legislation for the region to address the conditions expected with climate change.
- Develop an emergency evacuation policy—risk assessment and plan for emergency events.
- Develop a standardised system of calculating Emissions Trading Scheme and carbon footprint for tourism operations.
- Develop and implement offsets or more efficient means of travel.
- Conduct a risk assessment of natural assets under climate change and develop strategies to minimise risk.
- Research the impact of climate change on endemic species.
- Lead a concerted effort to plan for water use for 2020, 2050 and 2070—such as water recycling and changed irrigation techniques.
- Introduce a carbon dioxide sequestration program—tree planting, community restoration programs. Continue to focus on riparian restoration in the catchments.
- Develop wildlife corridors throughout the landscape.
- Support best practice in plant husbandry to reduce habitat loss, degradation and control exotic pests (weeds and feral animals).
- Build infrastructure that has low carbon emissions and use this in marketing.
- Continue to update coastal planning—new approach to coastal management to address acid sulphate soils, salt incursions, flooding, sea level rise, erosion, pests and disease.
- Rethink/respond to where building approvals are given. No development or sale of land in flood prone areas.
- Provide appropriate funding for infrastructure development—roads, telecommunications, wharves, airports etc that support the tourism.
- Provide funding for retrofitting buildings to cope with worse case scenarios, such as Category 4–5 cyclones.
- Provide incentives for businesses to move to new, energy efficient technologies.

Actions Businesses May Lead

- Encourage resource sharing among operators.
- Support the purchase of local produce—hotels and restaurants should be required to purchase locally or pay a surcharge on products sourced elsewhere.
- Investigate alternative fuel for transport—buses and boats move to energy efficient fuels and technology.
- Price products so they are competitive and affordable to attract visitors.
- Build infrastructure that has low carbon emissions and market same.
- Identify new activities (diversify the product) in a changing landscape.

Actions Industry May Lead

- Develop technology appropriate to address climate change in the tropics and make available to the community.
- Use climate change as a trigger to promote sustainable activities.
- Develop a marketing strategy where visitors come because of the approach to energy efficiency and reduced carbon emissions. Position the area as 'green and clean', marketing positive changes as they arise.
- Promote that there will be less extreme temperature increases in the region which make it more amenable than other destinations.
- Provide training for the tourism workforce and recognise (value) the training so it is retained in the community.
- Implement a planet safe partnership in the region with multiple stakeholder membership.
- Develop low footprint tourism—offset systems, design and adapt attitudes; change advocacy.
- Develop a carbon dioxide sequestration program—tree planting, community restoration programs. Continue to focus on riparian restoration in the catchments.
- Consider a monorail from the Cairns airport to the city.
- Identify and build a tourism group that supports small operators providing information and assistance in planning and coping with climate change.
- Diversify the market—make more of the diverse local cultures.
- Support agriculture to plant appropriate crops for the climate conditions, that is, consider water needs, herbicide and pesticide applications and potential plagues of grasshoppers and locusts.
- Continue to support efforts to protect tourism activities related to the Great Barrier Reef.
- Continue to monitor the health of reefs used by visitors and prepare to relocate tourism operations.
- Support research into techniques to mitigate the impacts of climate change on the reef.

Actions Communities May Lead

- Continue to lobby the government for support in tackling climate change.
- Conduct a social mapping exercise to understand how climate change impacts the community.
- Increase efficiency in how the community and visitors function—reduce energy use, water use and carbon footprint.
- Encourage alternative transport—use more rail, bike tracks, walking tracks and public transport.

Conclusion

The community is yet to see big impacts from climate change in their region, so even if individuals are not sceptical, they may not see the need to act or adapt just yet. There needs to be recognition that climate change is an incremental change. To take the adaptation and mitigation strategies outlined forward requires a partnership across all groups within tourism. Because tourism is so broad and diffuse, tourism practitioners cannot take the lead—but they should have a voice in the broader process.



Blue Mountains

The Impact of CLIMATE CHANGE

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The region is an iconic visitor destination for national and international visitors, as well as day-trippers. Multiple government agencies are involved in the management of the GBMWA and the Blue Mountains region, with the Blue Mountains Region of the National Parks and Wildlife Service, Blue Mountains City Council, Road and Traffic Authority NSW and the Botanic Gardens Trust most directly engaged with tourism.

Tourism's Contribution to the Region

The Blue Mountains National Park is Australia's most visited National Park. It is home to the most diverse network of walking tracks in Australia with over 200 km of walking tracks used by some 300,000 people each year. There are two main pillars for tourism in the region: nature tourism and cultural tourism. Cultural tourism includes visits to Aboriginal cultural heritage sites and tours, European settlement experiences and lifestyle activities including cafes and arts. A growing sector is adventure tourism which includes rock climbing, canyoning and hang-gliding.

Nature tourism is also a key attraction for day-tripper visitors. Research from Tourism NSW revealed that overall, 19% of visitors include a national park visit in their trip with 20% engaging in bush or rainforest walks during their stay.

Previous research highlights the importance of the natural environment to international visitors for whom the main activities were visiting a national or state park (81%), followed by eating out (75%) and bushwalking (74%).^f

Tourism is highly localised along the two transport routes. Over half of the GBMWA is wilderness and receives very little visitation with the majority of visitors having insufficient time and interest in accessing remote areas by walking. Instead, most appreciate the vast wilderness of the area through the many lookouts that are easily accessed by road or a short walk.

Visitor profiles

For the period 2004–2008, domestic day-trippers steadily increased from approximately 1.3 million in the financial year ending June 2004 to approximately 1.9 million in the year ending June 2008, an increase of 43.8%.¹¹¹ In contrast, domestic overnight visitors during the same period only showed a small increase of 3.8% with domestic visitor nights increasing 9.2%. Sydney is the main point of origin of domestic overnight visitors, accounting for 61.7% of visitors and 55.7% of nights.⁹

The number of international visitors have varied over this same period, but jumped considerably from 58,000 in the year ending June 2007 to 72,000 in the year ending June 2008, an increase of 14.3%. Of the international visitors, most (25%) were from the United Kingdom, followed by the United States of America (10%), Germany (10%) and New Zealand (10%). A large proportion of the remainder (25%) were from other European countries.¹¹² In terms of activities during their stay, most overnight visitors ate out at restaurants and engaged in general sightseeing. Close to one-third visited friends and relatives.

Tourism business profiles

The bulk of the tourism businesses are non-employing, followed by micro-businesses.¹¹³ With 83% of businesses employing less than five people, there are resource implications when planning for climate change mitigation or adaptation. These businesses may not have the time or people to effectively respond to the demands of climate change without significant outside support and guidance.

^{f, g} Tourism Research Australia (2008a) 'Tourism Profiles for local government areas in regional Australia: New South Wales, City of Blue Mountains, three or four year average to June 2007', www.tra.australia.com

CSIRO Climate Change Projections for the Blue Mountains —2020, 2050 and 2070

Projections of global climate change for the region for 2020, 2050 and 2070 were developed by the CSIRO Division of Marine and Atmospheric Research.¹¹⁴ These were modelled on the period 1961–1990 and based on a mid-range emission scenario for 2020, and on a low and high emissions scenario for 2050 and 2070 where the uncertainty is greater.

Table 6: Climatic conditions in 2020, 2050 and 2070

Variable	Scenario 1 2020	Scenario 2 2050	Scenario 3 2070
Temperature (min. and max.)	0.6–0.7 °C ↑	1.1–1.9 °C ↑	1.5–3.1 °C ↑
Increase in days over 35°C	0.2	0.4–1.0	0.7–2.2
Decrease in days less than 2°C	-12.7	-17.5 to -26.3	-24.0 to -34.1
Total rainfall (%)	-1.7	-4.9	-7.9
Number of rain days	-2.3	-4.0 to -6.5	-5.4 to -10.5
Percentage increase in heavy rainfall	0.1	0.4	0.7



Scott's Main Range © Tourism NSW

The Impact of CLIMATE CHANGE

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Possible Impacts of Climate Change on Tourism

To help inform the study, the research team conducted comprehensive desktop research on climate change in relation to the biophysical and socio-economic characteristics of the case study region. This summary highlights the key findings from this process, with more detailed information available within the full technical report.

Fire Impacts

Understanding how the ecosystems of the Blue Mountains will be affected by climate change centres on the following concepts:

- higher temperatures and declining rainfall resulting in increased frequency and intensity of bushfires
- species loss and unpredictable changes in species hierarchies associated with these changes in climate and fire regimes.¹¹⁵

In the town of Richmond there are currently, on average, 13.3 days when the Forest Fire Danger Index is 'very high' or 'extreme'. This number is predicted to increase to 13.8–16.3 days by 2020 and 14.5–23.6 days by 2050.¹¹⁶ These projections suggest that fire activity in the Blue Mountains is likely to become an increasing concern in the near future.¹¹⁷ The length of the fire season could also expand under climate change. Currently, bushfires typically occur in the Blue Mountains from early October to mid-January, but this season could expand from late July to mid-February by 2050.

If climate change leads to an increase in the frequency and scale of fires in the region, there is clearly going to be an impact on tourism and access to the national park. This lack of reliability and uncertainty of access could impact visitation, particularly from international visitors due to limited time and less familiarity with fire. Uncertainty and perceived risk could have a significant impact on tourism in the region.

Ecosystem Impacts

Research suggests there will be 7–35% increase in the frequency of unplanned fires in the Blue Mountain region and a 20–25% increase in the occurrence of crown fires (high intensity fires) that have the potential to cause the greatest ecological and property damage.¹¹⁸

Importantly, research also suggests that the risk to fire-sensitive habitats, particularly rainforest, will be heightened in the future.

Local plant extinctions can occur in a high-frequency fire regime, where the fire return time is shorter than the time required for a species to mature and replenish its seed bank, or when fires of extreme intensity burn large areas, affecting the forest canopy and thus impacting on arboreal fauna.¹¹⁹

In summary, the most likely ecosystem impacts in response to climate change in the Blue Mountains include:

- differential pressure on the persistence of certain plants, animals and habitats, with fire-sensitive flora and fauna (particularly seeders, arboreal mammals, rainforest habitat) possibly most at risk
- some changes in the distribution of species and composition and ecosystems (of unknown rate, extent and nature)
- lower yield and quality of water from fire-affected catchments
- changing opportunities for exotic species to invade natural areas.

Tourism Impacts

Significant impacts on natural resources in the Blue Mountains may in turn affect tourism by impacting on the natural environments on which tourism depends.^h

The relationships between tourism and climate change in the Blue Mountains are highly related to fire risk and perceived fire risk, as well as potential environmental consequences resulting from shifts in fire regimes and other climatic changes.

Impacts could range from decreased visitation due to perceptions of high fire risk, road and park closures, and biophysical changes leading to less attractive environments for visitors.

The Role of the Media

The Grose Valley Fire Forum¹²⁰ addressed the critical role of the media during a bushfire incident and the need to have better processes in place to ensure accurate presentation of fire incident information through the media.

When there is no real risk to visitors, it is important to mitigate the negative impact of the media on visitation to the region during or after a fire. State level media was noted to be more problematic than local media.

^h Scott, D., Jones, B. & Konopek, J. (2007) 'Implications of climate and environmental change for nature-based tourism in the Canadian Rocky Mountains: A case study of Waterton Lakes National Park', *Tourism Management*, 28: 570-579.



Hangin' Rock Lookout © Tourism Australia

The Impact of CLIMATE CHANGE

ON AUSTRALIAN TOURISM DESTINATIONS

Industry Input to Scoping Study

Semi-structured Interviews

A Visitor, Industry, Community and Environment (VICE) model was used to gain maximum representation of organisations involved or affected by tourism activities. Semi-structured interviews were conducted with senior representatives responsible for policy or practice from each sector. Nineteen interviews were conducted.

Table 7: VICE table for the Blue Mountains study

	Visitors	Industry	Community	Environment
Policy	Blue Mountains City Tourism	Tourism NSW		Blue Mountains Region, NPWS
	Blue Mountains City Council	Blue Mountains City Council		
	Lithgow Visitors Centre			
Practice	Tread Lightly Eco Tours	The Carrington Hotel	Blue Mountains World Heritage Institute (BMWHI)	Blue Mountains President Conservation Society
	YHA Hostel			Environmental Consultant
	Blackheath Rhododendron Festival			Blue Mountains World Heritage Institute (BMWHI)
	Majestic Tours Lithgow and Board Member, Blue Mountains Tourism Ltd			
	Zig Zag Railway			
	Blue Mountains Adventure Company			

The questions were designed to gain an understanding of the participants' knowledge of 'weather' and 'climate', and how these would impact on tourism. To assist responses, respondents were asked to consider both positive and negative impacts.

The questions addressed by the respondents were:

- Are people in the Blue Mountains talking about changing weather patterns and climate change?
- What types of positive and negative effects do you think climate change will have on tourism in the region in relation to infrastructure, land, operational costs, community/social life?
- What is happening now to address the impacts of climate change on tourism?
- What needs to happen?
- Do you believe that the region can adapt to the likely effects of climate change?
- What time frames are required to properly respond and adapt to climate change in the region?
- What do you need to know in order for the tourism sector in the region to adapt to climate change? Consider information in the areas of human resources to support the tourism industry, infrastructure and building, natural environment and the community.

From these interviews, 17 potential high priority adaptation strategies were identified.

Workshop Process

Only 10 of the invitees were able to attend the full day workshop. To assist participants in prioritising the adaptation and mitigation strategies, a scenario table developed from the desktop review was used to define the likely conditions in the region under the three time frames (Table 8).

Table 8: Projected climatic conditions in 2020, 2050 and 2070

Types of environmental & socio-economic change	Scenario 1 2020	Scenario 2 2050	Scenario 3 2070
Temperature	0.6% increase	1.1 – 1.8% increase	1.5 – 3% increase
Number of hot days	0.2 day increase	0.4 – 1 day increase	0.7 – 2 day increase
Number of cold days	13 day decrease	18 – 26 day decrease	24 – 34 day decrease
Rainfall	2% decline	3 – 5% decline	4 – 8% decline
Frequency and scale of forest fire	5% increase	10% increase	30% increase
Area of park burnt	10% increase	25% increase	50% increase
Number of extreme fire hazard days	11 days (currently 9)	15 days	24 days
Road closures due to fire	No change	Moderate increase	Large increase
Areas of park / walking tracks closed due to fire	No change	Moderate increase	Large increase
Campground (including swimming hole) evacuations due to fire	No change	Moderate increase	Large increase
Chance of a campfire ban during your visit	10%	33%	75%
Aboriginal rock art	Increased fire intensity impacts rock art	Further erosion of sites & loss of artefacts	Little / no evidence of sites & artefacts

Participants were divided into three groups to represent the three time frames of 2020, 2050 and 2070. These groups were asked to discuss and prioritise the adaptation and mitigation strategies. The second stage of the workshop was a plenary session where the group addressed the major issues that needed to be considered, the limitations identified, who should be involved and how the process should proceed.

Those strategies that were consistently rated as high priority were:

- marketing the Blue Mountains so that it can be visited in a sustainable way; in part this is in response to the increasing demand for non-environmentally friendly preferences for air conditioning and spa baths
- adoption of strategies to reduce the environmental impact, such as greywater systems, solar heating and energy efficient lighting
- increased public education.

Support was also expressed for:

- creating an integrated climate change management plan involving all areas of government and lead agencies
- promoting the use of the train for transport to the Blue Mountains, and lobbying for improved services and facilities
- providing education and support for businesses to adopt more sustainable practices, such as installation of solar water heating.

The Impact of CLIMATE CHANGE

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Priority Adaptation and Mitigation Strategies for the Blue Mountains

These recommendations are informed by semi-structured interviews conducted with participants, the workshop and a review of the literature. Some are specific to tourism and others are necessary if the community and the region is to support sustainable tourism in the future. Primarily they are the high priority adaptation strategies identified during this project.

Actions Government May Lead

- Continue to focus on the impact of fire on the destination.
- Integrate management planning across agencies and industries for the Blue Mountains region (draw in state-level information as necessary).
- Develop education programs on the impacts of climate change in the region.
- Consider the challenges of micro businesses to respond and adapt to climate change—it is hard to be 'green' when you are in the 'red' (i.e. making a loss).
- Remove legislative impediments and barriers.
- Explore the role of trains into the future—with 83% of visitors driving to the region this represents a large market opportunity.

Actions Businesses May lead

- Adapt over time through the use of new technologies.
- Make businesses more environmentally sustainable.
- Link to Blue Mountains City Council Sustainable City.



Jenolan Caves House © Tourism NSW

Actions Industry May Lead

- Develop increasing consumer awareness of climate change.
- Promote energy efficiency for all tourism operators (mitigation)—this can help create a niche market (adaptation).
- Increase knowledge of potential climate change in the region and its impact on tourism.
- Encourage involvement from other organisations including Blue Mountains City Council (for strong local leadership), major retailers such as Coles, Woolworths, K-Mart etc., Roads and Traffic Authority, CityRail and the Chambers of Commerce across the mountains.

Actions Communities May Lead

- Educate school students, who are future consumers, on climate change and its potential impacts on the region.
- Promote the Blue Mountains as the entry to regional Australia west of Sydney.
- Maintain the balance within the Blue Mountains of uniqueness of product, place and planning (e.g. heritage, nature).
- Focus on the region as a future tourism destination. As Sydney grows and becomes hotter, Sydney residents will seek cooler places to visit for day trips and short breaks.
- Respond to planning strategies such as the North West Strategy and the push for 7000 dwellings at the foot of the mountains.
- Overcome adaptation and mitigation barriers.
- Seek community feedback and distribute to Blue Mountains City Council and Blue Mountains Tourism, including Chief Executive Officers and General Managers.

Conclusion

The project demonstrated that despite the Blue Mountains being considered to have low vulnerability to climate change, its vulnerability to changes in bushfire regimes due to climate change puts the Blue Mountains in a highly vulnerable position.

In addition, as Blue Mountains tourism is dominated by day-trippers mostly from the adjoining Sydney basin, the volatility of visitation can be magnified by the threats and perceptions of the risk of bushfire. Media management is necessary with or without climate change.

The adaptation and mitigation strategies identified by participants reflect the need for integrated management plans across regions to be designed. This need is magnified by the number of climate change workshops conducted in the Blue Mountains region, including this project. The lack of coordination may confuse stakeholders as to who is doing what, and where their focus should be placed. This increases the need for greater education and communication with the public, tourism operators and other key stakeholders.

With most tourism businesses being micro and small businesses, any adaptation strategies need to be simple, cheap and effective, with the need and benefits clearly identified. Many of these businesses are not thinking in time frames of 2020, 2050 and 2070; their planning time frames are short-term, possibly only out to a maximum of one or two years. Maintaining awareness and urgency of climate change requires effective and ongoing communication to penetrate the economic debates.



Barossa Valley

Barossa Valley Case Study

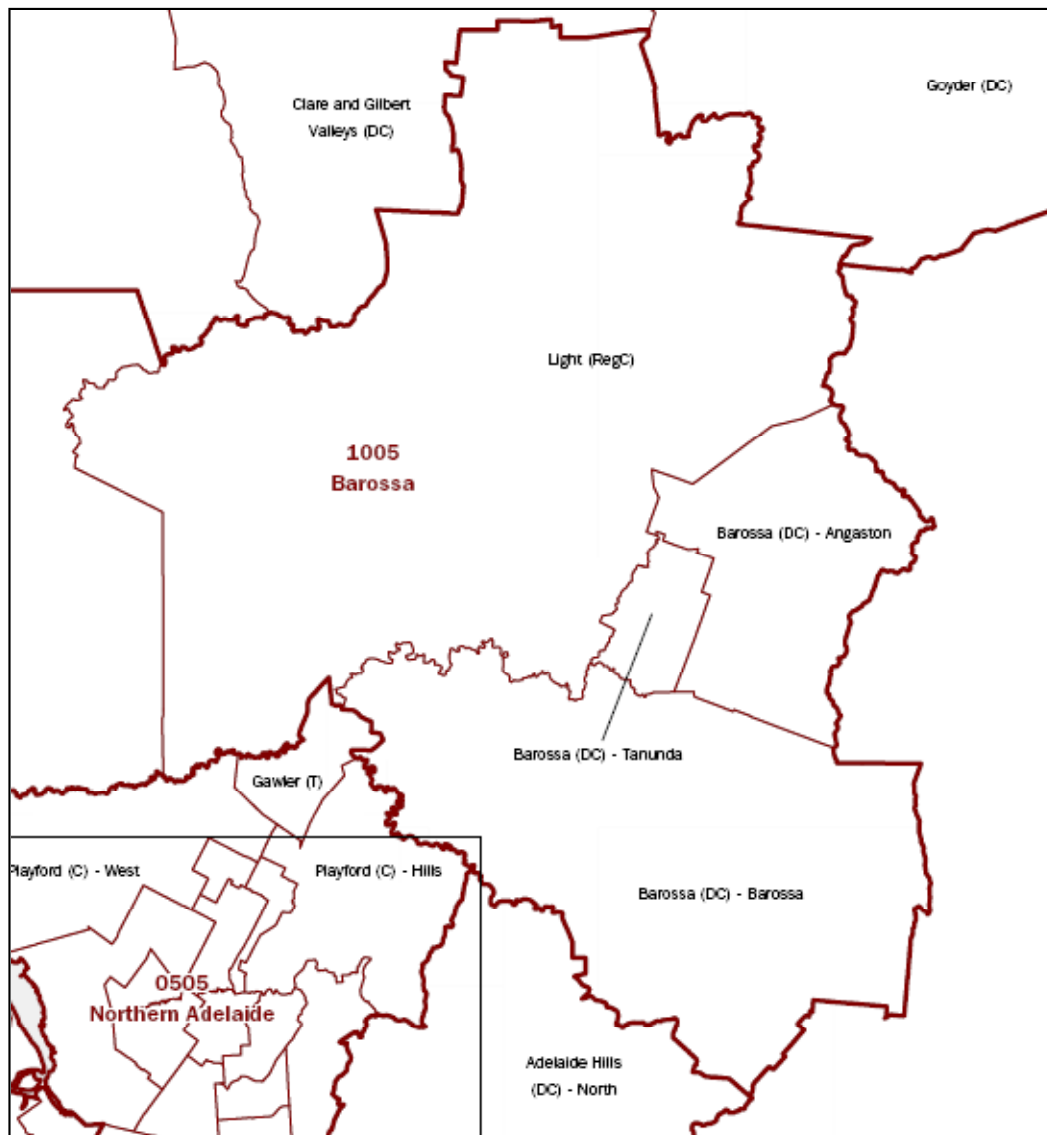
By Bradley Jorgensen, Maureen Rogers, Peter Hayman, Graham Brown and Jenny Davie

Study Area

The Barossa Valley (the Barossa) is just over an hour's drive from Adelaide. The region, defined by Tourism Research Australia, comprises four statistical local areas: Gawler Town, and the Barossa District Councils of Tanunda, Barossa and Angaston (Figure 7).

The Mediterranean climate has helped create a successful wine industry and a growing reputation associated with food production and associated experiences. The production of wine is a major tourism drawcard. A recent survey reported that 'tasting and purchasing wine' was the number one reason given by the majority of visitors (62%) to the Barossa with 82% reporting visiting a winery or cellar door in the region.¹²¹

Figure 7: Australian Bureau of Statistics definition of the Barossa¹²²



The Impact of CLIMATE CHANGE

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Tourism is also based on the scenic qualities of the region, which offer considerable seasonal variations, and its appeal as a living landscape with a distinctive cultural identity. This is characterised by working farms, local markets, events which receive strong local support and marketing initiatives that have helped establish a distinctive position for the region.

Key in the adaptation and mitigation of tourism enterprises to climate change are the Barossa communities who provide the raw materials from which tourism experiences are packaged, marketed and sold. It is important to recognise that tourism demand could be reduced by changes which affect the character of the landscape, the region's economy or the strength of community spirit.

Climate in the Region

The Barossa region is located in South Australia's coastal temperate zone where it experiences a Mediterranean climate not too different to that of Adelaide. Winter monthly temperatures span between a minimum average of 4°C to a maximum of around 14°C. Summers can be hot, with maximum average monthly temperatures of 29°C. The individual summer days can be much hotter, with January temperatures exceeding 35°C on occasion. The region sees moderate average annual rainfall of a little over 500 mm, with around 160 mm falling during the growing season between October and April.

Tourism's Contribution to the Region

Of the six main wine regions in the state in 2003, the Barossa Valley attracted the largest number of cellar door visits at 2.4 million.¹²³ The tourism experience in the region is further enhanced by events associated with wine and food. A recent survey of people who had visited Australian wine regions nominated the Barossa as the most popular.¹²⁴ A visitor survey in 2007¹²⁵ revealed that the most important visitor experiences were:

- food and wine
- relaxation
- time with friends and family
- touring
- history and heritage
- engaging in novel experiences.

Visitor stay and spend

In 2007 an estimated 246,000 overnight visitors spent 754,000 nights in the region. Length of stay varied from two nights for intrastate visitors to four nights for interstate visitors and 8.2 nights for international visitors. Spending by domestic overnight visitors in 2007 was estimated to be \$105 million; an average of \$165 per visitor night. Domestic same-day visitors contributed 927,000 additional visits to the region spending an estimated \$72 million or on average \$78 per visit.¹²⁶ Ninety-three percent of overnight visitors are from Australia with the mix as follows:¹²⁷

- South Australia—38%
- Victoria—23%
- New South Wales—16%
- Queensland—11%
- Western Australia—7%
- ACT—3%
- Tasmania—2%
- Northern Territory—1%

Sixty percent of international overnight visitors come from Europe with Germany and the United Kingdom the top countries of origin. Visitors from non-European countries are dominated by New Zealand and North America.¹²⁸

CSIRO Climate Change Projections for the Barossa Valley —2020, 2050 and 2070

Projections of global climate change for the region for 2020, 2050 and 2070 were developed by the CSIRO Division of Marine and Atmospheric Research.¹²⁹ These were modelled on the period 1961–1990 and based on a mid-range emission scenario for 2020, and on a low and high emissions scenario for 2050 and 2070 where the uncertainty is greater.

Table 9: Projected climatic conditions in 2020, 2050 and 2070¹³⁰

Environmental change (compared with the present)	Scenario 1 2020	Scenario 2 2050	Scenario 3 2070
Annual mean warming (°C)	+0.6	+1.4	+2.0
Number of days below 2°C	-4	-8	-9
Number of days above 35°C	+3	+8	+12
Annual rainfall change (% of mean)	-3.0	-7.3	-10.1
Winter (Jun–Aug) rainfall change (%)	-3.9	-9.5	-13.2
Spring (Sep–Nov) rainfall change (%)	-4.8	-11.7	-16.3
Summer (Dec–Feb) rainfall change (%)	-1.5	-3.5	-4.9
Autumn (Mar–May) rainfall change (%)	-1.2	-2.9	-4.1
Change in rain-days > 1mm (%)	-4.8	-11.8	-16.4
Change in extreme 1 in 100 year rainfall (%)	-1.3	-3.1	-4.4

Rainfall

In addition to temperature changes, the Barossa can expect decreasing rainfall into the future, particularly during winter and spring. Much of the expansion in the Barossa has relied on water imported into the region from the Murray River. The majority of land under irrigation is devoted to growing grapes, and grapes use a relatively large proportion of the available irrigation water.¹³¹

The viticulture and wine-making industries, perhaps more than any other part of the tourism sector, have begun to plan for tougher times, given that trends of decreasing rainfall and increasing temperatures are not conducive to many areas of agriculture.^{132, 133, 134}

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Possible Impacts of Climate Change On Tourism

Wine tourism is particularly important in the Barossa, and a lack of alternative tourism products makes the prospects for tourism very dependent on the viability of the wine industry.

Local industry, government and community representatives participating in this project identified other potential impacts during the interview and workshop process outlined below.

These included the impact of drier conditions on the region's heritage buildings resulting in increased maintenance and repair costs. Also highlighted was the impact of drought on native flora and fauna and the impact of reduced water availability on parks and gardens. Weeds were also seen as a growing problem under changed climatic conditions.

Based on the CSIRO projections, the main impacts of climate change for the Barossa's vineyards take the following form:

- The temperature impact of climate change is likely to directly affect the seasonal growth cycle pushing ripening processes into the warmer period of late summer rather than autumn.
- Changes to extreme high temperatures, such as heat waves, are likely to have a direct impact on physiological processes and water use.
- Changes to extreme low temperatures, such as frosts, are likely to decrease in the long-term. In the short-term, the frequency of extreme low temperatures will depend upon the relative influence of warming, drying and changes to weather patterns. Some regions have already observed high levels of frost risk in recent years arising from drying conditions.
- Changes to the timing and amount of rainfall will influence the water balance and have an impact on disease and quality.
- Changes to the quality and quantity of water available for irrigation are likely to occur.
- Changes to the atmospheric levels of greenhouse gases will influence vine growth.



Winemaker at work © SATC

Industry Input to Scoping Study

Semi-structured Interviews

A Visitor, Industry, Community and Environment (VICE) model was used to gain maximum representation of organisations involved or affected by tourism activities. Semi-structured interviews were conducted with senior representatives responsible for policy or practice from each sector.

The 22 participants interviewed included representatives from the South Australian Tourism Commission, South Australian Wine Industry Association, local government, state government, wineries, accommodation venues, tourism operators, and sustainable development groups and organisations. The questions were designed to gain an understanding of the participants' knowledge of weather and climate and how these would impact on tourism. To assist responses, respondents were asked to consider both positive and negative impacts.

The questions addressed by the respondents were:

- Are people in the Barossa talking about changing weather patterns and climate change?
- What do you need to know in order for tourism in your region to adapt to climate change?
- What types of positive and negative effects do you think climate change will have on tourism in the Barossa Valley?
- How do you think tourism in the Barossa Valley may respond or adapt if the climate changes?
- Do you believe that the Barossa Valley can adapt to the likely effects of climate change?
- What actions are happening now or need to happen now?

All participants believed there were significant knowledge gaps around climate change and adaptation. A strong message expressed in the interviews was that tourism stakeholders will need help to understand what was possible, as well as the risks and the likely consequences of different actions. Some representatives expressed a need for practical solutions and assistance in adaptation and mitigation implementation.

Workshop Process

Participants were initially placed into mixed groups across the different scenarios (2020, 2050, 2050) and later into three VICE combined groups.

The first session required participants to discuss and rank the identified adaptation and mitigation strategies. The second session required identification of the highest priorities from a sector-specific perspective, and identification of the resources needed to implement the different strategies and the barriers to their success.

The final stage of the workshop was a plenary session in which all participants were involved. During this session, they identified the major issues, who needed to be involved in implementing the adaptation and mitigation strategies and if there was a lead agency or organisation to do so.

Most participants believed the Barossa region to be a wine and food destination first and foremost. Wine is the primary reason for tourism and as such adaptation and mitigation strategies need to ensure the sustainability of viticulture into the future, long-term water security, and an ability to be resilient in the face of extreme climatic conditions (e.g. heat, frost and rainfall).

It was also recognised that the Barossa Valley tourism was much more than the vineyards. It represents all the businesses and tourism operators in the Barossa region. All agreed that any response to climate change must reflect the need to maintain the cultural heritage and the premium wine status of the region.

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At the conclusion of the workshops there was the general feeling that a great deal needed to be achieved by 2020 and that once the foundations of cultural change and evolutionary shifts were in place, the Barossa would be able to continue to adapt in the years beyond.

The highest priorities for the Barossa region identified by all three groups were to:

- encourage water conservation throughout the region
- obtain more information about the expected climate change impacts in the Barossa
- breach climate change gaps and skill deficiencies within the industry
- gather local data and develop benchmarks
- develop a collaborative action strategy
- ensure the broad adoption of energy saving devices and water re-use systems.

It was noted by all three groups that much was already being done in terms of water and energy efficiency, but even more could be achieved through a coordinated action strategy, particularly if the region is to be seen as an innovator and leader in the wine and tourism industry. However, it was mainly the larger businesses that have the resources to adopt new practices and install new systems. The challenge, as always, is to engage and resource small operators to become involved in new initiatives that will ultimately be cheaper and more sustainable.



Priority Adaptation and Mitigation Strategies for Barossa Valley

These recommendations are informed by semi-structured interviews conducted with leaders in tourism and the community, the workshop and a review of the literature. Some are specific to tourism and others are necessary if the community and the region is to support sustainable tourism in the future. Primarily they are the high priority adaptation strategies identified during this project.

Actions Government May Lead

- Research the impact of adaptive responses on the range of social, economic and biophysical processes and outcomes in the region.
- Develop a research agenda to support evidence-based decision-making for adaptation and mitigation. This agenda might focus on articulating and reducing the uncertainties in climate projection at the local level.
- Develop appropriate conflict resolution processes in anticipation of conflicts between competing users of water resources within the region.
- Given the importance of tourism businesses (and related service deliverers) as drivers of innovation and adaptation and mitigation, communication programs (e.g. workshops and seminars) might be developed and delivered for these businesses. Where appropriate, these forums might also serve to demonstrate new technologies for the purpose of adaptation and mitigation. Effort should be directed toward groups who may not initially see an obvious interest in adaptation. For example, it may be a challenge to engage tour operators located outside the region in a discussion of climate change issues within the region.
- Develop incentive schemes to support innovation and promote 'model' tourism businesses and organisations who want to succeed in adapting to climate change. These successful examples can encourage others toward adaptation and mitigation, as well as form part of the platform to influence local, state and national decision-making.
- Diversify the marketing image of the region to encompass non-wine experiences and eco-friendly credentials, and especially where there is an opportunity to promote visitation in the shoulder season.
- Planning and implementation of adaptation and mitigation strategies would benefit from an appreciation of non-tourism policy agendas, so as to avoid the duplication of efforts and undertaking activities at cross-purposes. To this end, there is a need to promote integrated regional planning approaches across the areas of tourism, climate, agriculture, natural resources, energy, water, infrastructure and health. Water policy, in particular, is an area in which tourism should be involved, given its current shortages in the region.
- Assess the impact of climate change on local tourism infrastructure (e.g. heritage buildings, roads, public amenities, etc.). This might begin with collecting information on the current state of the infrastructure, estimating the risk of accelerated deterioration (i.e. above the expectations implicit in any existing maintenance regime), and identifying adaptation strategies where required.

Actions Businesses May Lead

- Explore opportunities where operators can work with the local community on specific adaptation projects as a means of building relationships and support for tourism. There may also be opportunities where operators can collaborate with visitors in areas of adaptation.
- Enlist larger tourism organisations who have undertaken adaptation in their enterprises to advise smaller operators who may wish to adapt along similar lines. This type of innovation would be particularly welcome to the extent that it attracts new markets and caters for planned (and unplanned) developments in visitor patterns.

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Actions Industry May Lead

- Develop a sector-wide adaptation plan based on participatory decision-making processes and community involvement. The plan should include (where possible) timelines for the implementation, monitoring and evaluation of key adaptation strategies, and evaluation should span the planning, implementation and outcomes of adaptation. General evaluative criteria might include equitable distribution of costs and benefits, consistency with existing government policies, resource requirements relative to capacity to implement, extent and quality of consultation, and community acceptance. Specific evaluation criteria will depend on the characteristics of the adaptation strategy and the range of interested parties either involved in its implementation or affected by its implementation and outcomes.
- Engage a larger number of tourism stakeholders by communicating the impacts of climate change and potential adaptation strategies noted in this report.
- Research the development of vine strains, agricultural practices and methods of wine production that are suitable for changing climate conditions.
- Research the actual and expected behaviour change of visitors, for example, visitation behaviour and intentions in key markets and in response to changing weather conditions and proposed adaptation plans.
- Produce information guides to assist small tourism operators and organisations to develop and undertake adaptation strategies as a means of supporting the regional economy. The information provided could be tailored to different types of tourism organisations and businesses.
- Develop networks across wine tourism regions at the state, national and international levels to disseminate knowledge, share resources, and broker collaborations around common issues.
- Develop climate change stakeholder networks across the region, through which threats and opportunities can be identified, ideas can be generated and disseminated, resources can be pooled, and priority actions can be implemented, monitored, evaluated and communicated back to stakeholders.

Actions Communities May Lead

- Make climate change information available to visitors prior to and during their visits as a means of raising awareness, promoting sustainable behaviours, and showcasing current and future adaptation in the region. Some innovation may be required in developing modes of information communication that are consistent with the tourism experience offered by operators and cellar doors.
- Understand the beliefs and values of local residents with the view of building support for adaptation in tourism.

Conclusion

Tourism in the Barossa is closely linked to climate and is very important in the region. Achieving sustainable tourism in the Barossa is inherently tied to the sustainability of the local communities: the wine, the vineyards and other tangible aspects of cultural life. Without these things, it is difficult to consider what else might provide for sustainable tourism into the future.

A photograph of a rocky mountain peak, likely Mount Buffalo, with a yellow semi-transparent banner across the middle containing the text "Victorian Alps". The image shows large, reddish-brown rock formations with some trees growing on top. The sky is blue with some clouds. The overall scene is a scenic view of a mountain range.

Victorian Alps

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Victorian Alps Case Study

By Amanda Lynch, Carolina Roman and Lee Tryhorn

A different research approach was taken for the Victorian Alps case study. The region had already been the focus of a large amount of climate change research, therefore, to avoid 'stakeholder fatigue' information for this region was largely sourced from two Monash University PhD research projects, one of which was completed in early 2008 with the other due for completion by April 2010.

Study Area

The Victorian Alps, also known as Victoria's High Country, is located in north-east Victoria. The Victorian Alps includes sections of the Australian Alps National Park, which stretches from Canberra, through the Brindabella Range in the Australian Capital Territory, to the Snowy Mountains of New South Wales, and along the Great Divide through north-eastern Victoria.¹³⁵

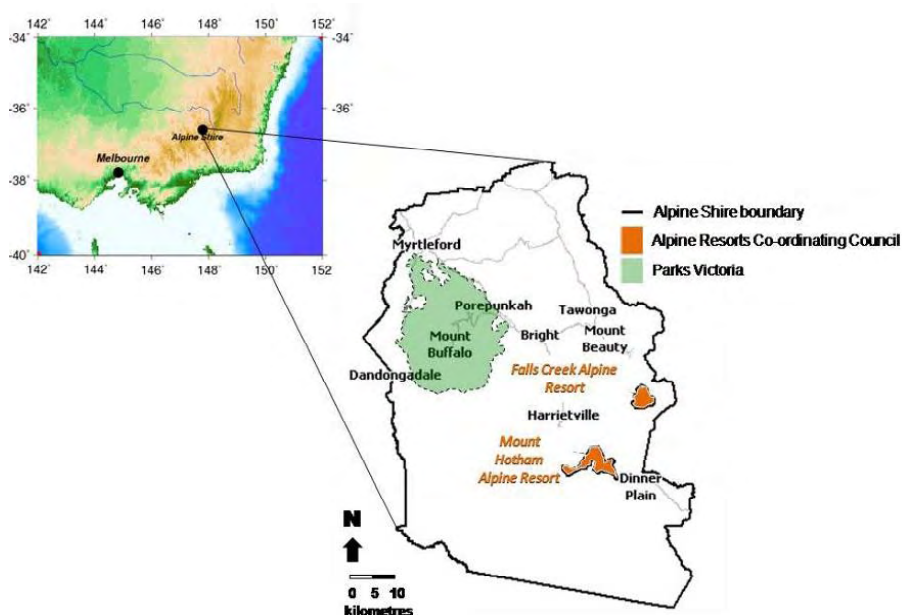
For the purposes of this analysis, only the Alpine Shire local government area, its neighbouring alpine resorts (Falls Creek and Mount Hotham) and Mount Buffalo National Park were included.

The Alpine Shire is located approximately 270 km northeast of Melbourne (Figure 8). The Shire encompasses 4397 km² with a resident population of around 13,000 people. The major urban centres are Bright and Myrtleford in the Ovens Valley and Mount Beauty in the Kiewa Valley.

Approximately 92% of the shire is public land including parts of the Alpine National Park and all of the Mount Buffalo National Park.

The Shire's economy is based on tourism, forestry and agriculture.¹³⁶

Figure 8: Map of Alpine Shire¹³⁷



Climate in the Region

The climate across the Alpine Shire is highly variable. Summers range from mild conditions in the alpine areas (maximum temperatures of 20 to 25°C) to hot on north-western plains with maximum temperatures above 30°C. In winter frost is common throughout the region with snow in the mountains.

The Shire's average rainfall of 1160mm is among the highest in the state. Until recently, residents felt protected from drought, but since 2005, widespread drought has resulted in water restrictions being enforced in many towns.¹³⁸

Over the past 35 years, natural snow conditions have seen a decline given increased maximum and minimum temperatures, and under current climate projections the trend is set to continue. This has created greater reliance by the ski industry on the production of artificial snow to service visitor demand and extend the snow season.

Tourism's Contribution to the Region

Historically, tourism has been an important activity for the Shire by providing local employment opportunities and enhancing the economic development of the region. It remains the Shire's largest employer contributing approximately \$300 million annually to the local economy.¹³⁹

Since the early years of settlement, the Shire has been a popular destination due to its scenic beauty. A key change to tourism in recent years has included the development of accommodation and services on-mountain at the ski resorts. According to a study by the National Institute of Economic and Industry Research Australian alpine resorts generate a combined 2% of total Australian tourism activity.

Tourism in the Alpine Shire is characterised by many small businesses, a large proportion of which only operate during the snow sports season, a period of around four months over winter.¹⁴⁰ The diverse range of tourism products and services include food and wine, festivals and events, sport, nature and adventure-based activities, touring and four-wheel driving, winter tourism to the ski resorts, and historical attractions.^{141,142,143}

In the valley towns and sub-alpine regions, tourism activity is significant across all four seasons of the year, but peaks during the summer months particularly when it coincides with public holidays, school holidays and, most significantly, the events and festivals that are often scheduled in the region.

While winter is not identified as one of the main holiday seasons for the valleys and sub-alpine areas in terms of visitation numbers, there are four areas within the Shire's geographical boundaries that offer snow-based tourism and related activities in winter. These are the two alpine resorts of Mount Hotham and Falls Creek, the ski recreational area within Mount Buffalo National Park and Dinner Plain Village which is located just outside the Mount Hotham Alpine Resort.

It is estimated that the alpine resorts represent approximately 20% of the local shire's gross regional product injecting an additional \$106 million into the local economy.

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Management of Alpine Resorts and Infrastructure

In the state of Victoria, all six alpine resorts are located on permanent Crown land reserves, and are managed by Alpine Resort Management Boards appointed by, and responsible to, the Minister for Environment and Climate Change.¹⁴⁴

In addition there is the Alpine Resorts Coordinating Council which is a statutory body with a coordinating role across all Victorian alpine resorts focused on strategic planning, research, investment prospects and overall resorts promotion.

While the Alpine Resorts Coordinating Council is in charge of the overall strategy pertaining to alpine resorts, it is up to each individual management board to oversee the development, promotion, management and use of the alpine resort for which they have responsibility. This includes areas such as infrastructure, provision of utilities including water and energy supply, sewerage and garbage disposal.¹⁴⁵

The two alpine resorts which fall under the scope of this case study are Mount Hotham and Falls Creek.



Mount Buffalo © Tourism Vic

CSIRO Climate Change Projections for the Victorian Alps —2020, 2050 And 2070

Projections of global climate change for the region for 2020, 2050 and 2070 were developed by the CSIRO Division of Marine and Atmospheric Research¹⁴⁶. These were modelled on the period 1961–1990 and based on a mid-range emission scenario for 2020, and on low and high emission scenarios for 2050 and 2070 where the uncertainty is greater.

Table 10: Projected climatic conditions in 2020, 2050 and 2070 ¹⁴⁷

Variable	Scenario 1 2020	Scenario 2 2050	Scenario 3 2070
Temperature (min. and max.)	0.6 °C ↑	1.0 – 1.8 °C ↑	1.3 – 3 °C ↑
Decrease in days less than 2°C	-17.3	-27.6 to -40.3	-35.7 to -58.0
Total rainfall (%)	-2.3	-6.6	-10.7
Number of rain days	-3.5	-10.1	-16.3
Percentage increase in heavy rainfall	1.3	3.8	6.1

Possible Implications of Climate Change on Tourism

To help inform this study, the research team conducted comprehensive desktop research on climate change in relation to the biophysical and socio-economic characteristics of the region. This summary highlights the key findings from this process, with more detailed information available within the full technical report.

Snow Coverage

At 1740 m elevation on Mt Buller, the annual-average duration of at least 1 cm of snow cover may change from 108 days at present (1979–1998) to 70–102 days by 2020 and 7–89 days by 2050.¹⁴⁸ The peak snow depth at this elevation may decline from 95 cm at present (1979–1998) to 35–85 cm by 2020 and 2–62 cm by 2050.¹⁴⁹

Fires

A substantial increase in fire weather risk is likely, with expected increases in the average number of days when the Forest Fire Danger Index rating is very high or extreme.¹⁵⁰ In January 2003, bushfires burnt through 1.1 million ha (or 5.5% of north-east Victoria) significantly affecting tourism with a reported \$20 million loss of business.¹⁵¹ The fires struck during the summer, a busy time of the year for sub-alpine areas, causing revenue losses for most, if not all, local tourism operators.^{152,153,154}

Again in late 2006 and into 2007, bushfires had a major impact on tourism, with regional tourism officials estimating a \$200 million downturn for the 12 months from December 2006.¹⁵⁵ According to figures by Alpine Shire, these bushfire events resulted in at least a 50% drop in visitor numbers to the Shire, compared to non-bushfire years.

In Summary

With an increase in fires and intense rainfall, there are implications for emergency managers, water authorities, tourism operators and residents. Insurance risk assessments and premiums are also likely to be affected.

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Industry Input to Scoping Study

With respect to identifying socio-economic impacts of climate change, a series of interviews was conducted between May and September 2007, and August and September 2008, as part of an ongoing Monash University PhD research project. The interviews were conducted with a number of Alpine Shire tourism stakeholders both from within the Shire and externally. A wide range of tourism, business, government and community representatives were interviewed from across the region.

The top seven issues identified by the interviewees were:

- **Representation and leadership**—a state-level approach to strategic tourism development is difficult to implement at a local level.
- **Data gaps**—there is a lack of consistency in visitor related data gathering and reporting.
- **Natural disaster management**—there needs to be access to operator support for rebuilding and better management of the media post-event.
- **Business capacity**—there are skills shortages which impact on employability. Business operators need to develop adequate business skills.
- **Tourism infrastructure and transport**—there is a need for better road signage and visitor attraction signage. Public transport options should be further explored.
- **Branding and marketing**—there needs to be greater ownership of Tourism Victoria's 'jigsaw' campaign by individual tourism operators.
- **Exposure to external factors of a macro scale**—there are other impacts on tourism in the Alpine Shire that have the capacity to affect tourism operations. These include changes in the value of the Australian dollar, interest rates, inflation, and fuel prices.

Conclusion

The types of businesses that characterise the Alpine Shire are small to medium sized tourism enterprises. Consequently, many of these have limited resources—financial, human and time—to participate more broadly in the governance of the sector. Furthermore, there are a number of businesses that do not appear to operate as registered businesses, and therefore are excluded from data gathering. The smallest businesses working independently tend to risk operating sub-optimally, particularly where the flow of information and representation is likely to be inadequate. This disconnection can lead to tensions between the day-to-day business priorities of the operators and the aims of regional and local governments.¹⁵⁶

Given the significance of tourism as a prominent contributor to the Shire's economy, and its sensitivity to the impacts of summer hazards such as extensive bushfires, it is critical to assess sub-alpine vulnerability with respect to climate change. This is essential in order to fully characterise the Victorian Alps' long-term adaptive capacity for future sustainable development.

Key Findings Across Regions

There was a high level of awareness of climate change across all sectors in all regions. However, the depth of understanding was highly variable both within and across sectors. To examine the degree to which adaptation strategies were broadly applicable to all destinations examined in this study, all of the strategies nominated were categorised as high priority for each destination, to come up with some general themes. The identified theme areas are listed below.

Theme 1: Green

The Green theme represents those adaptation strategies that were nominated along the 'green and clean' and 'sustainability' lines, including many water and energy saving initiatives that represent best practice for small (and large) businesses. Although many of these strategies are most often thought of as mitigation strategies, many of them were put forward in the context of how the destination could be marketed as a 'green' destination, which represents an adaptation to growing tourist concerns about the tourism footprint.

Theme 2: Data and Knowledge

Adaptation strategies listed under the data and knowledge theme include those that touch on some aspects of data inadequacies, both in terms of businesses and climate change data, and also those which captured the widely held view that there is a real need for increased data collection and improved storage and sharing of data.

Theme 3: Disaster Management

Strategies which sought to improve how disasters are managed fell into this category. They not only included aspects of resource requirements, but also captured concerns about how media treats natural disasters and how media-fuelled hysteria, which can damage a destination's image, needs to be better managed by the tourism sector.

Theme 4: Marketing

Strategies which sought to highlight particular aspects of the destination in brand recognition and marketing initiatives were listed in this theme.

Theme 5: Planning

Many adaptation strategies revolved around the need for improved and better informed planning of both built and natural environments. These strategies fell into the planning theme.

Theme 6: Community

Community-themed adaptation strategies revolved around the idea of local identity, the need to produce food locally (and support it) and the need for strong community-government relationships. Only two of the destinations (Cairns and Barossa Valley) had community-themed adaptation strategies, which not only highlights the local residents' attachment to these destinations, but also the feeling that they would be willing to fight for the businesses and the tourism market in these regions.

Theme 7: Resources

As for planning, many adaptation strategies were nominated that focused on the management of resources, both built and natural and the need for additional resources (in both of these areas) to support the implementation of adaptation strategies.

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Publications of Interest

To be supplied.



Norman river floodplain © Tourism Qld

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ON AUSTRALIAN TOURISM DESTINATIONS

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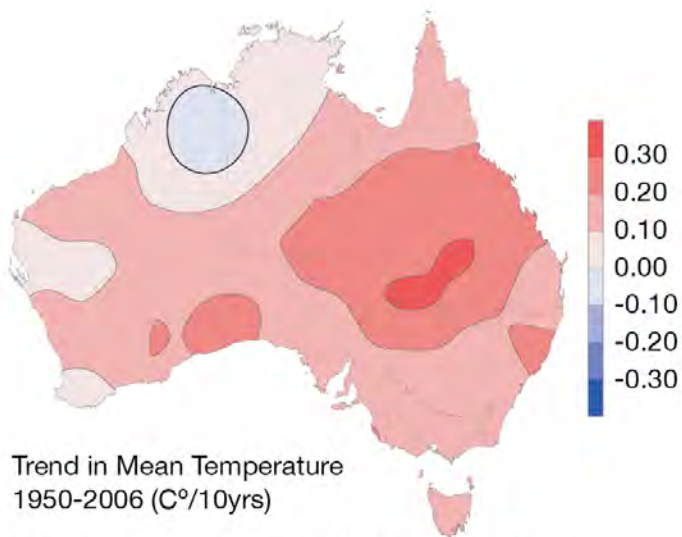
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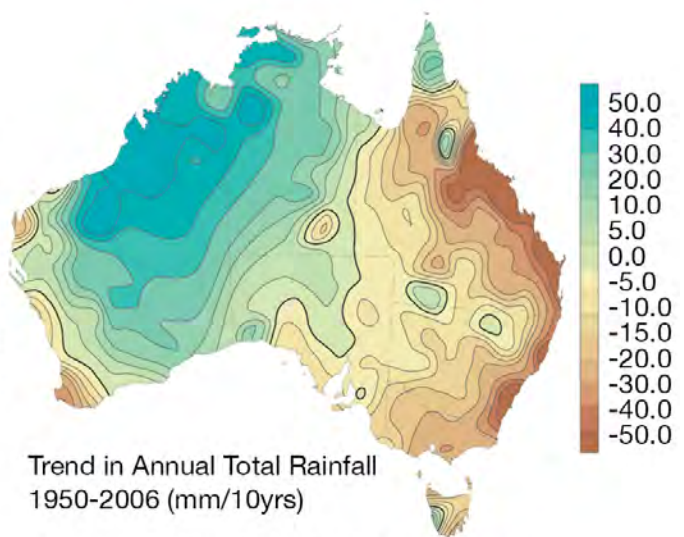
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The Impacts of Climate Change on Australian Tourism Destinations



Trend in Mean Temperature
1950-2006 (C°/10yrs)

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Trend in Annual Total Rainfall
1950-2006 (mm/10yrs)

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