

Peel-Harvey Catchment Council

People Working Together for a Healthy Environment

Adapting to climate change in the Peel region

Improving local government emergency
management and biodiversity
conservation services



Peel Climate Change Adaptation Project Report
Peel-Harvey Catchment Council
June 2010 Revised May 2012



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Australian Government
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Disclaimer

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This document is a summary of the major findings of the project. The inclusion of the Australian Government and Peel Development Commission logos is purely to acknowledge the funding source and is in no way a suggestion that the contents of this document are endorsed positions of the Australian Government or Peel Development Commission except where explicitly stated.

Preferred reference

Peel-Harvey Catchment Council (2012), *Adapting to climate change in the Peel region: Improving local government emergency management and biodiversity conservation services*, a report by Kim Byrnes to the PHCC, edited by Andrew Del Marco, Mandurah, Western Australia.



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Acronyms

BOM	Bureau of Meteorology
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CCP	Cities for Climate Protection
DCC	Department of Climate Change
DEC	Department of Environment and Conservation
EMA	Emergency Management Australia
FESA	Fire and Emergency Services Authority
ICLEI	International Council of Local Environmental Initiatives
IPCC	Intergovernmental Panel on Climate Change
LBS	Local Biodiversity Strategy
LEMC	Local Emergency Management Committee
NCCARF	National Climate Change Adaptation Research Facility
NRM	Natural Resource Management
PDC	Peel Development Commission
PHCC	Peel-Harvey Catchment Council
SWCC	South West Catchments Council
WALGA	Western Australian Local Government Association
WAPC	Western Australian Planning Commission

Summary

This report summarises the findings of the Peel Climate Change Adaptation Project. The Project was designed to assist Local Governments to adapt to the impacts of climate change. The report is both a summary of the Project and a reference guide for local governments to improve emergency management and biodiversity conservation policies and practices.

The Project is a strategic initiative of the Peel-Harvey Catchment Council, the City of Mandurah, the Shire of Serpentine-Jarrahdale and the Peel Development Commission and involved the five Local Governments of the Peel region: the City of Mandurah and Shires of Boddington, Murray, Serpentine-Jarrahdale and Waroona.

The Project involved a:

- Policy and initiatives review with respect to climate change and local government;
- Survey of Peel local governments to identify key issues for policy development;
- Policy development workshops, including a gap and impact analysis with respect to emergency management and biodiversity conservation;
- Development of adaptation strategies related to emergency management and biodiversity conservation; and
- A Regional Summit on Climate Change Adaptation.

The Project recognises the changes that have already occurred in average rainfall and temperature in south west Western Australia over the past 30 years and the predictions of long-term future climate change for Western Australia. These predictions, presented in Section 2, have been modelled by the Commonwealth Scientific and Industrial Research Organisation and Bureau of Meteorology and are supported by the vast majority of international research (e.g. Intergovernmental Panel on Climate Change, 2007). The Project did not address potential causes of climate change, or focus on climate change mitigation strategies, given that these were outside of the project scope.

Through the Project, two key areas of local government service delivery were identified to be significantly impacted by climate change: emergency management and biodiversity conservation.

Climate change impacts on emergency management are related to predicted increases in the frequency and intensity of bushfires, changes to the frequency, duration and ferocity of storms, and greater storm surge impacts on vulnerable infrastructure.

Biodiversity¹ is likely to be impacted by climate change through the added stress that it places on the survival of native species, increases in bushfire frequency and intensity and changing hydrology. A warming and drying climate will require species to either move to more suitable habitat, adapt to the changes, which is difficult given the predicted accelerated rate of climate change, or become locally extinct.

¹ Biodiversity is the natural variety of life including native species, ecological communities and their genetic make-up.

The Project, through the workshop outcomes, has recommended a number of strategies to assist local governments respond to the impacts of predicted climate change on emergency management and biodiversity conservation.

Emergency management actions for the strategies recommended to assist local governments respond to predicted climate change include:

- EM1** Identify and map areas vulnerable to climate related extreme events (erosion, flood, bushfire risk, etc.) This information should form the basis for planning and development related policy and should set minimum building requirements to increase individual and community resilience to climate change emergency.
- EM2** Incorporate climate change risk mapping and responses in all land use documents (town planning), including for example the local planning strategy and local planning policies².
- EM3** Lobby for State and Federal Government support for local government to translate new climate change land use information into reality. Adequate resourcing for access to high resolution digital mapping on which to base planning decisions, assistance in implementing and interpreting policy and translating it into planning controls, and legislated power for local governments to enforce planning decisions are essential.
- EM4** Extensive areas of high fire danger should be declared 'Bushfire Prone Areas'. This mandates additional building requirements under the Building Code of Australia.
- EM5** Encourage community and individual resilience through education programs about bushfire designated areas and minimum requirements.
- EM6** Identify areas of potential inundation resulting from climate change and designate them appropriately to enable climate appropriate planning and development in coastal and wetland areas.
- EM7** Develop partnerships with research institutions to address gaps in our understanding of the changing nature of climate change risks as they relate to emergency management.
- EM8** Lobby the State Government to develop extreme event forecasting tools, early warning systems and fine scale maps suitable for use by local government.
- EM9** Identify major risks in the area of emergency response and undertake climate change risk management assessments and cost benefit analysis of adaptation options.
- EM10** Strategically place utilities and emergency evacuation centres in areas of low risk with good access.

² Currently there is little detailed information on how to do so other than the NSW Sea Level Rise document.

- EM11** Conduct regular regional emergency event practice drills and inter-agency/local government communications plans to ensure clear and consistent operational response across agencies.
- EM12** Identify and map water resources for fire fighting and investigate legal authority for dam and reservoir access in emergency situations.
- EM13** Identify available emergency resources within the private sector (mining and timber companies, etc.) suitable for emergency response activities. Maintain accurate records of resources and contact details.
- EM14** Encourage community preparedness through education and information relating to climate change and the predicted impacts of climate change on extreme weather events. Seek innovative ways of spreading emergency information quickly, such as telephone trees and warning systems, and distribute them to community and volunteer organisations.
- EM15** Develop a regional reward scheme for volunteers and employers including Mayoral awards for emergency services volunteer of the year and group of the year.
- EM16** Ensure that all volunteer agencies are supplied with best practice resources including suitable communications equipment such as mobile communication devices, GPS and identification in vehicles and with teams.

Biodiversity conservation actions for strategies recommended to assist local governments respond to predicted climate change include:

- B1** Clearly define Council's 'biodiversity position' to maximise funding opportunities.
- B2** Maintain support for Natural Resource Management, 'Friends Of' and other groups. These groups provide valuable capacity to maintain and improve natural areas in the Peel region and are a source of local knowledge.
- B3** Support a regional environmental peak body to keep highly skilled environmental practitioners and their expertise in the region (e.g. Peel-Harvey Catchment Council) to provide regional and localised information and resources.
- B4** Identify regional priority areas for conservation (as per South West Biodiversity Project Guidelines) and develop a regional management plan, work plan and budget to ensure that these areas are protected. Formalise and resource to protect a comprehensive and representative array of landscapes, ecosystems and species in the Peel. Landscape diversity and connectivity of habitats should be represented in reserves and in other land tenures.
- B5** Establish biodiversity targets such as:
 - purchase of significant areas
 - strategic rehabilitation and revegetation management throughout the catchment
 - revegetation of degraded areas to increase diversity and connectivity

- multiple use landscapes
- management for transformation of ecosystems
- increased connectivity, especially in and between diverse landforms.

- B6** Develop innovative subdivision options. Provide incentives to developers to protect significant natural areas and planning for management costs as part of the development process. Incentives should be provided to owners where natural areas remain in private hands.
- B7** Develop and implement private land conservation initiatives – including formal conservation covenants (National Trust, Department of Environment and Conservation [DEC] or Department of Agriculture and Food Western Australia [DAFWA]) and the less formal ‘Land for Wildlife’ scheme. Covenanted land should be consistent with the Local Planning Scheme because any inconsistency will favour the Local Planning Scheme (Molloy et al., 2007).
- B8** Provide financial incentives, such as rates rebates, or investigate tax incentives for conservation initiatives.
- B9** Encourage retention of, and minimise clearing of, remnant native vegetation through development of, or incorporation into, native vegetation policies.
- B10** Adequately fund a regional campaign to manage existing weed and pest threats and identify and develop management plans for emerging pest and weed species.
- B11** Inform the community and landholders about existing and emerging weeds and best practice management techniques.
- B12** Identify and pursue opportunities in carbon sequestration for native biodiversity plantings to facilitate natural resource management. Revenue generated through the sale of carbon credits to be returned to natural resource management activities to fund ongoing management.
- B13** Identify areas of significant biodiversity and incorporate these natural areas into town planning schemes, and district and regional plans to ensure they are adequately considered and incorporated into planning activities.
- B14** Prepare a biodiversity policy and associated guidelines to inform planning. The process outlined in the Perth Biodiversity Project is ideal for this purpose. Biodiversity policies should include such things as protection, offsets, mitigation of biodiversity loss due to development, and community involvement in planning matters.
- B15** Integrate existing plans, such as the *Peel-Yalgorup Ramsar Site Management Plan* (Peel-Harvey Catchment Council, 2009), into local planning schemes.
- B16** Develop a regional ‘recreational activity framework’ to identify locations suitable for a range of activities (such as trail bikes). Combine this with an education program and incentives/disincentives to discourage activities from environmentally sensitive locations.

- B17** Develop a regional funding scheme (e.g. Peel Region Environmental Levy to be implemented under the Local Government Act 1995) to fund:
- identification and implementation of regional biodiversity conservation priorities and development of annual work plans and regional budget;
 - incentives programs for private land conservation schemes; and
 - stakeholder engagement, community information and awareness – advising people about what the levy is being used for and seeking input into developing priorities.
- B18** Provide budget support for dedicated Conservation Officers to enable community initiatives to be undertaken.
- B19** Integrate fire management practices that maintain levels of public safety whilst conserving biodiversity. This can be achieved through fire management plans developed for natural areas in consultation with FESA and local governments and land managers.
- B20** Identify opportunities to partner with research organisations to ensure that policy development and implementation is based on locally relevant research.
- B21** Implement the *Water Quality Improvement Plan for the Rivers and Estuary of the Peel-Harvey System – Phosphorus Management* (EPA 2008) and ensure that Water Sensitive Urban Design guidelines are implemented in development proposals.
- B22** Undertake a regional strategic review of coastal, wetland and waterways management plans and develop regionally consistent guidelines for managing these areas.
- B23** Manage groundwater levels and water flow requirements for healthy wetland and waterways habitats through bore licence allocation, waterwise education, stormwater capture and reuse.
- B24** Adopt the *Peel-Yalgorup Ramsar Site Management Plan* and adequately budget for staff to implement recommendations.
- B25** Develop partnerships with research institutions to minimise gaps in our understanding of climate change on species and ecosystems in the Peel.
- B26** Develop an understanding of the impact of climate change on probable changes in pest species and their distribution throughout the region.
- B27** Implement a Community Education Strategy: successfully managing climate change impacts on biodiversity will need to involve all sectors of society, hence it is vital that members of the community understand:
- conservation values and principles and the role of ecosystem services;
 - climate change is a significant driver of biodiversity change;

- the need to manage for a changing environment;
- that mitigation is vital to ensure that minimal adaptation is required.

B28 Establish monitoring sites, such as photo reference points and objective measurement systems, to develop a greater understanding of change occurring.

B29 Establish information recording protocols; especially using non-technical specialists in the region. Involve schools and community groups in local monitoring programs.

All of the above recommended strategies will reduce the risks, impacts and potential liabilities for local government created by climate change. However, many of the strategies also reinforce the importance of the activities and service standards that local governments may already provide, or are aiming to provide.

Since the conclusion of this, the Peel Climate Change Adaptation Project (June 2010), three Peel region local governments have entered into the Peron – Naturaliste Partnership³ project and two local governments have endorsed policies specifically on climate change. These new initiatives demonstrate that the Project has empowered local governments to continue working in this important issue and to adapt to climate change.

³ See <http://peronnaturaliste.org.au/>

1. Introduction

This report summarises the findings of a 15-month project over 2009-2010, 'Peel Climate Change Adaptation' (the Project) to assist Local Governments adapt to the impacts of climate change. It provides both a summary of the Project and a reference guide for information on climate change with relevance to the Peel region, especially with regard to emergency management and biodiversity conservation.

The Project involved the Peel-Harvey Catchment Council and five Local Governments of the Peel region: the City of Mandurah and Shires of Boddington, Murray, Serpentine-Jarrahdale and Waroona. Funding support was provided by the Australian Government's Department of Climate Change and the Peel Development Commission.

The main aim of the Project has been to assist local governments to incorporate climate change considerations in their policies and planning for emergency management and biodiversity conservation. The term 'policy' is used in this report in a broad sense to include all documents, decisions, positions and precedents that are consistently applied (e.g. by a local government) when making decisions, investments or preparing plans.

Whilst the public debate continues on the reality and causes of climate change, a changing climate is a real and current issue for the Peel region, as evidenced by declining rainfall and inflow into Perth's dams over the past three decades (Figure 4). This is having an impact on streamflow, soil moisture, vegetation health and a prolonged and more intensive fire season. Local governments are having to deal with the current realities of a changing climate and need to cautiously plan and prepare for further changes.

Under future climate change predictions, the Peel region is expected to become hotter and drier with further significant changes to average rainfall (Section 2.3). Coastal and estuarine areas are predicted to experience sea level rise exacerbated by storm surges and the region is likely to experience more extreme weather events such as storms and floods. Bushfire risk is also expected to worsen. Adapting to changing climatic conditions is essential to minimise the impacts on the local environment, economy and community.

Local governments through their role as key providers of community infrastructure and services are highly vulnerable to the impacts of a changing climate. They face potential impacts across the full suite of service provision including road maintenance and drainage provision, emergency management and management of public open space. Failure to consider climate change impacts on a local area may expose Local Governments to greater liability and risk.

1.1 Climate change adaptation and mitigation

This report focuses on climate change adaptation rather than climate change mitigation. In broad terms, mitigation and adaptation are the two types of management responses to climate change.

Climate change **adaptation** describes actions that can be carried out in response to actual or projected climate change impacts that lead to a reduction in risks or a realisation of benefits.

Examples of adaptation strategies include assessing the viability of civil works to withstand the impacts of storm surges, increasing the resilience of natural systems against reduced rainfall and increased fire risk, or improving the preparedness of organisations to deal with emergency incidents.

In many cases, adaptation measures reflect best practice in the relevant field, whether it be emergency management planning, biodiversity conservation or community support services.

The adaptive capacity of an organisation or system is a measure of its ability to adjust to climate change (including changes in variability and extremes) so as to moderate potential damages, take advantage of opportunities, or cope with the consequences through changes in its characteristics or behaviour.

Adaptation accepts that climate change is occurring, but does not enter into the discussion of the potential causes of climate change.

Mitigation approaches are human interventions aimed at reducing human-induced climate change. They include strategies to reduce greenhouse gas sources and emissions or enhance greenhouse gas sinks. Retention of native vegetation, revegetation and carbon capture technologies are examples of mitigation approaches.

Mitigation, by reducing gases that contribute to an enhanced greenhouse effect reduces the likelihood of exceeding the adaptive capacity of natural systems and human societies.

Addressing potential climate change mitigation strategies was beyond the scope of this Project and report.

1.2 Project methodology

This report presents the findings of the Peel Climate Change Adaptation Project carried out between 2009 and 2010. The Project was coordinated through the Peel-Harvey Catchment Council and direction was provided by a steering group with representatives from:

- Local Government (City of Mandurah and Shire of Serpentine-Jarrahdale);
- Peel-Harvey Catchment Council;
- Peel Development Commission; and
- Western Australian Office of Climate Change.

A representative of the Western Australian Local Government Association also attended steering committee meetings as a guest.

The main components of the project methodology are summarised in Figure 1.

The methodology placed an emphasis on information gathering early in the Project and included an extensive consultation process.

A key decision-point in the Project occurred once the Project Officer and Steering Committee assessed the results of the Local Government Survey and an initial Policy and Initiatives Review. This focused the Project on two areas of local government: emergency management and biodiversity conservation.

Reviews of relevant policies and initiatives occurred at two stages in the Project. An initial review of policies and initiatives relevant to climate change adaptation responses was carried out by the Project Officer following a survey of local government staff. This 200 hour review resulted in the policies and initiatives listing provided in Appendix 3.

A second stage review was carried out as part of the focus on emergency management and biodiversity conservation.

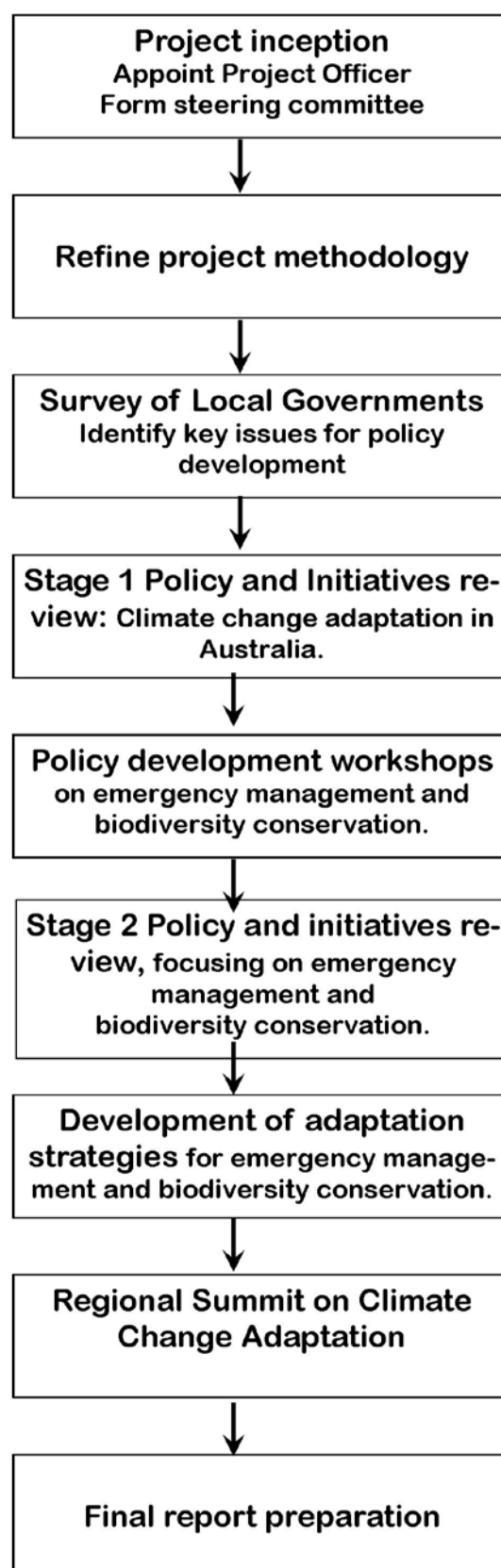


Figure 1: Project methodology

The development of adaptation strategies for emergency management and biodiversity conservation included a workshop process where participants prioritised strategies according to level of risk and extent to which the strategies addressed a vision for the future. The vision for the future, including goals, was also developed as part of the workshop process.

Regular formal reports throughout the Project were provided to the Australian Government's Department of Climate Change, the Peel Development Commission and the Peel-Harvey Catchment Council.

Demonstration and communication activities were carried out with Councils, the local community and specific organisations at various stages. These included:

- presentations to Local Governments, the Peel Zone Meeting, the Sustainability Officers Network Group and the Peel Development Commission Board;
- community information displays and presentations
 - display and information at the Centro Mandurah Shopping Centre for World Wetlands Day 2010;
 - presentation and discussion group at the Fairbridge Festival 'Shout Sustainability' workshops
 - display and information at the Lake Clifton Festival. Approximately 450 people attended the festival; and
- provision of briefing notes to Peel-Harvey Catchment Council Board and Peel Development Commission Board.

1.3 The Peel region

The Peel region is located in the south west of Australia and is situated approximately one hour south of Perth, Western Australia (Figure 2). It covers 5600 square kilometres and includes the local government areas of Mandurah, Serpentine-Jarrahdale, Murray, Waroona and Boddington. The region is one of the fastest growing areas in Western Australia. Originally inhabited by the Pinjarup dialect group of the Nyungar people, the area attracted settlement from the earliest days of the WA colony. Agriculture, mining, forestry, fishing, equine industries and recreation contribute to an economy supporting a population of around 113,500⁴ people.



Figure 2: The Peel Region

Geographically, the Peel region forms a large part of the Peel Inlet-Harvey Estuary catchment and extends from the coast, across the Swan Coastal Plain westwards to the Darling Scarp and Ranges and inland to the Albany Highway. It boasts internationally significant environments including wetlands of national and international importance and includes the largest estuary in the south west of Western Australia (the Peel-Harvey Estuary is over 130 square km, more than twice the size of the Swan estuary system).

⁴ As at 2011, from: Peel Development Commission, Quick Peel Statistics

The region is included in the south west bioregion, recognised as one of the world's biodiversity hotspots because of the number of endemic⁵ flora and fauna and the level of threat to these species (Myers et al, 2000). Broad-scale ecosystems in the region include extensive forests and woodlands of jarrah, marri, tuart and wandoo, with understory of banksia, peppermint, sheoak, hakea and acacia. Casuarina and salt water paperbark are common to the foreshores of the Peel-Harvey Estuary; with samphire marshes in low-lying areas.

The Peel-Harvey Estuary and surrounding wetlands provide habitat for over 80 species of resident and migratory birds and has been recognised internationally for their values under the Ramsar Convention. The waterways also provide habitat for many fish and crustaceans and sustain the largest professional and amateur estuarine fishery in Western Australia. The value of the Peel waterways is estimated to be between \$360 million and \$1 350 million (Economic Consulting Services, 2008). Large areas of the Peel region, especially on the coastal plain, have been extensively cleared and modified for commercial agriculture, industry, roads and service corridors and human settlement.

1.4 Peel region's climate

The Peel region exhibits a Mediterranean style climate.

The summer months tend to be hot and dry with temperatures ranging from approximately 18 degrees minimum to 29 degrees maximum but can reach beyond 40 degrees. Winds tend to be dry easterlies with sea breezes cooling coastal areas most afternoons. Storms and decaying tropical cyclones can bring heavy rainfall, but generally little rain falls over the summer months.

Winters tend to be cool and damp. Temperatures range from approximately 10 degrees to 18 degrees on the coast with more frosts and cooler minimum temperatures inland. Most of the area's rainfall occurs over the winter period.

The region's climate is influenced by the southern subtropical ridge and cold fronts generated over the southern ocean (Tille *et al.*, 2001 in Land Assessments Pty Ltd, 2005) and the warm southerly flows of the Leeuwin current. These systems have been responsible for reliable seasonal rainfall, with most rain falling between May and September. However there has been a pattern of declining winter rainfall in the south west area since the 1970s.

⁵ Endemic flora and fauna are those species, which are only found within a localised area. Species endemic to the south west of Australia are only naturally found in that geographical area.

2. Climate change predictions for south west Western Australia

This section summarises some of the major actual and predicted changes to the climate of south west Western Australia based on the most widely accepted scientific research and peer-reviewed science. Section 3 describes the primary and secondary impacts of actual and predicted climate change.

2.1 Introduction

Climate is the long-term weather and weather patterns of an area and varies naturally due to many factors. Understanding why climate may be changing is therefore a complex task. However, while there is still public debate over the causes of global climate change, the statistical evidence is clear for Western Australia: over the past three decades average annual rainfall has decreased in south west WA and average temperatures have increased over most of the state (Indian Ocean Climate Initiative, 2005). Since the mid-1970's, south west Western Australia has experienced increased average temperatures, increased number of extreme heat days, lower annual rainfall, changed rainfall patterns, increased evaporation and transpiration, and increased solar radiation (CSIRO & BOM, 2007).

For the south west of Western Australia, including the Peel region, future climate change is predicted to mean:

- further increased average temperatures;
- further decreases in rainfall;
- increased frequency and intensity of storms; and
- sea level rise.

Climate change predictions presented in Sections 2.2 to 2.4 are taken from CSIRO and BOM (2007) and have been generated for Perth. There is currently no predictive data specifically for the Peel region. The Commonwealth Scientific and Industry Research Organisation (CSIRO) and Bureau of Meteorology (BOM) modelling used global climate change scenarios prepared for the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (2007).

In terms of future changes, the rate of change is not likely to be uniform across the region and variation is expected between coastal and inland areas and with changes in landform and elevation. In addition, given the coarse scale at which climate modelling is undertaken (250 km grids) localised landscape features impacting on temperature will not be captured by predictive modelling. Regional variation has been demonstrated by Hick (2006) who found average annual temperatures had increased 1-2 degrees in three out of four sites studied across the Peel (Mandurah, Dwellingup, Wandering, Narrogin).

2.2 Temperature

Since 1910, Australia's annual average surface temperature has increased by 0.9 degrees Celsius. Between 1970 and 1998, all but four years were hotter than the average. These warming trends observed since 1910 may be expected to continue with some models predicting an annual increase of 0.8 degrees by 2030 and 2.7 degrees by 2070 (Figure 3 & Appendix 1). The number of days over 35 degrees, known as extreme heat events, is expected to increase from 28.1 to 35.1 in 2030 and up to 53.8 by 2070 (CSIRO & BOM, 2007). Diurnal temperature variation is also expected to change with an increased frequency of warm days and nights and reduction in cool days and nights.

The impact of small temperature increases is significant. To place temperature increases into perspective, a one degree increase in temperature is equivalent to moving approximately 100 km north (Morgan, 2008). This will have significant impacts on food production, water availability biodiversity, and lifestyle.

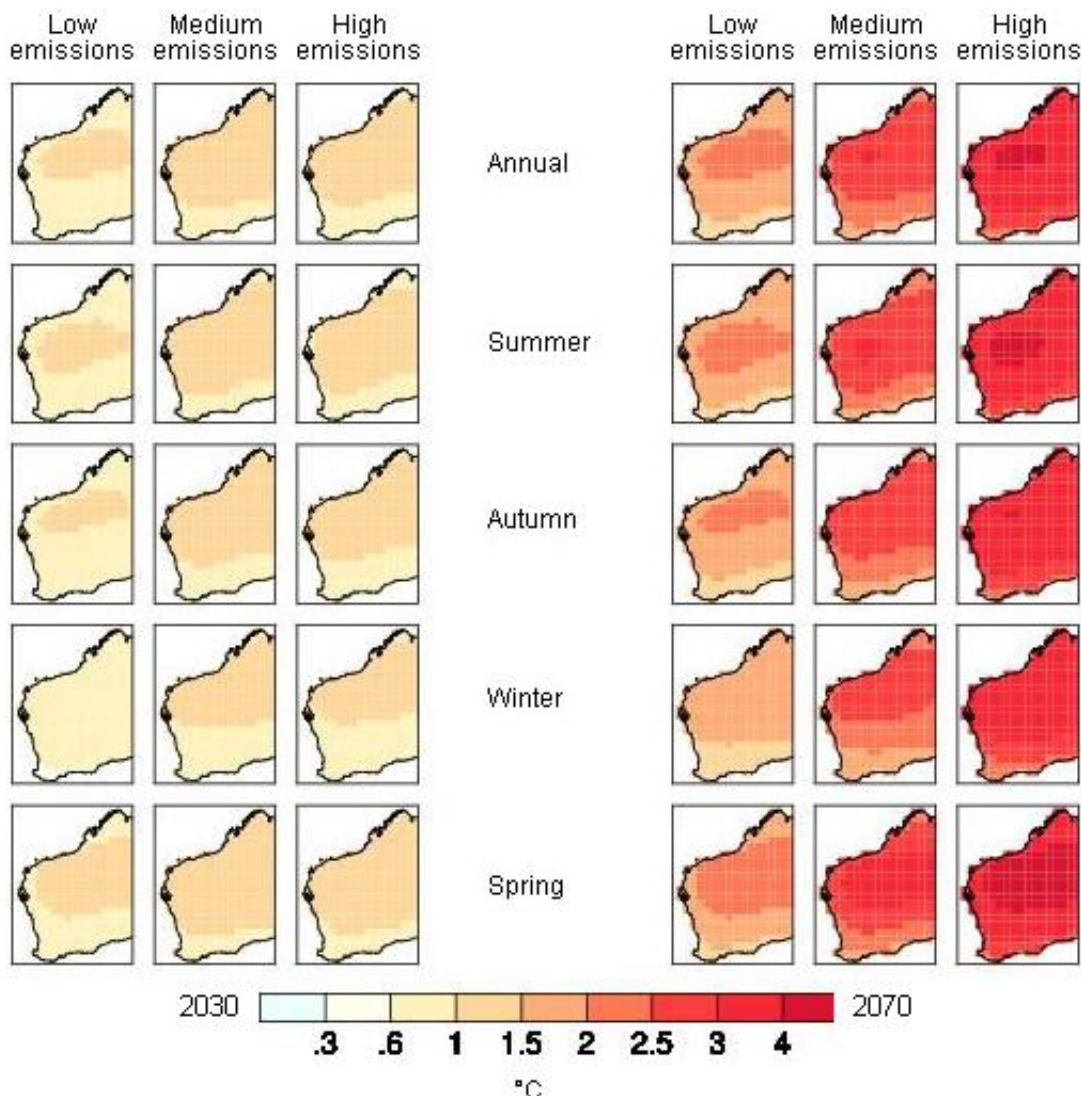


Figure 3: Average Temperature Predictions under Low, Medium and High Emissions Scenarios for 2030 and 2070 (CSIRO & BOM 2007)

2.3 Rainfall

Temperature increases over the last 100 years have been associated with significant changes to global hydrological cycles (Australian Greenhouse Office, 2007) and south west Western Australia has not been immune to these changes. Rainfall patterns in the region demonstrate a stepwise decline since the 1970s and lower than average rainfall since then (Figure 4, Water Corporation, 2008). Stream flow is reduced along with reduced rainfall, and inflow into dams shows similar patterns with a 75% reduction in the average inflow from 2001 to 2006 relative to the 1911 to 1974 average.

Records show a decrease in rainfall by 21 mm per decade since 1910 and almost 24 mm per decade since 1950 accompanied by a decrease in rain days and an increase in extreme rainfall periods.

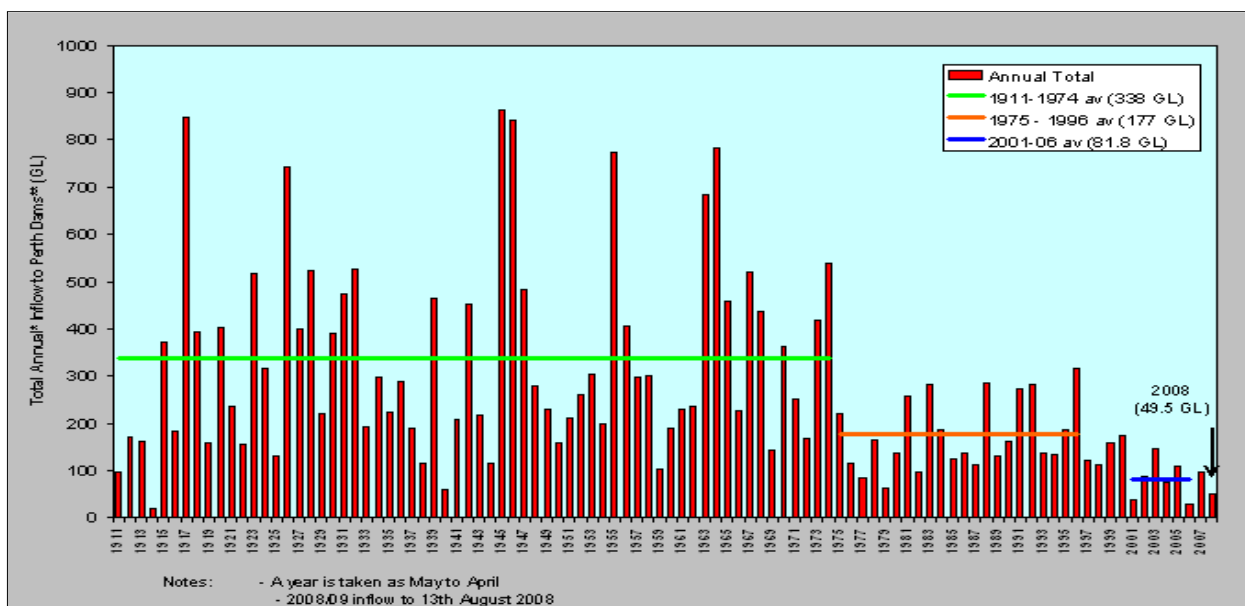


Figure 4: Total Inflow into Perth's Dams

Climate change scenarios for the Perth region indicate that this drying trend is likely to continue with marked changes to seasonal rainfall expected. Annual rainfall predictions indicate a further reduction by 6% and 19% by 2030 and 2070 respectively (Figure 5 & Appendix 1; CSIRO & BOM 2007). However seasonal variation will be most marked in winter and spring where annual average rainfall is expected to decline by 7% in winter and 9% in spring by 2030, and 22% and 27% respectively by 2070.

Reduced rainfall will be exacerbated by increasing evapotranspirational potential and decreasing moisture availability, leading to greater moisture stress on some species.

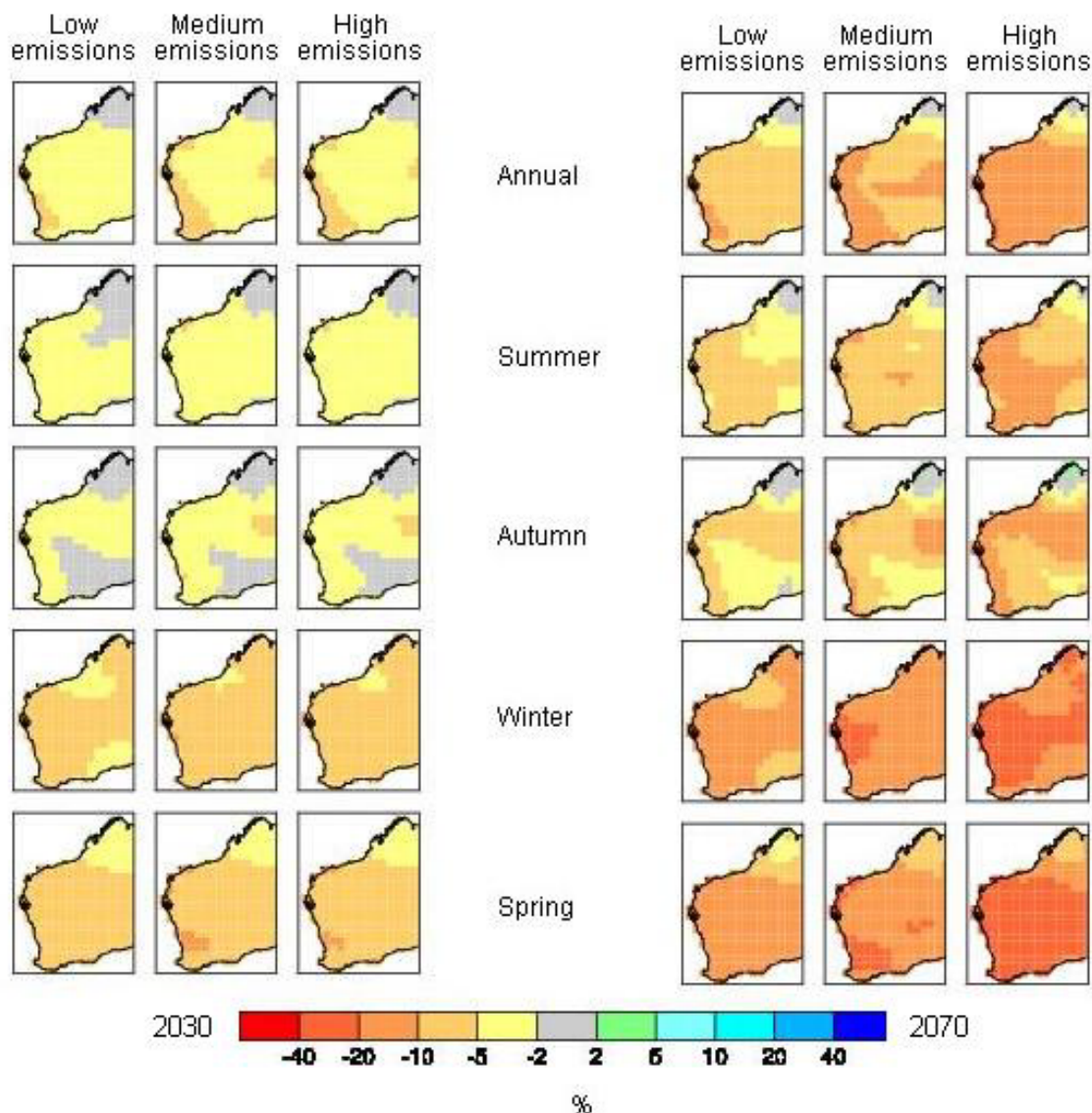


Figure 5: Average Rainfall Predictions under Low, Medium and High Climate Change Scenarios for 2030 and 2070.

2.4 Wind and storms

Extra tropical storms associated with low pressure systems are likely to become more intense and follow higher latitude paths (Pittock, 2009).

There is a possibility of cyclonic activity moving further south and an increase in cool season tornadoes with associated storm damage and flooding

Wind speed predictions for 2030 and 2070 indicate little change to the annual predictions but some seasonal variability. By 2030 wind speeds are expected to increase in summer (+2%) and autumn (+1%) and decrease in winter (-4%) and spring (-1%). This pattern is expected to continue in 2070 with wind speeds increasing in summer (+8%) and autumn (+6%) and decreasing in winter (-14%) and spring (-3%).

2.5 Sea level rise⁶

Observed sea level rise at Fremantle Tide Station is tracking along the upper limit of the IPCC projections of 2 mm per year, outlined in the Fourth Assessment report (Church *et al.*, 2008). Satellite data shows a trend of 3.3 +/- 0.4 mm per year since 1993 and tidal gauge reconstructions slightly less than this (Rhamstorf *et al.*, 2009). The current rate of sea level rise is faster than the 1.7 mm per year recorded in the 19th and 20th centuries.

The majority of sea level rise is attributed to thermal expansion (Figure 6). Oceans are getting warmer because they are absorbing 80% of the additional heat added to the Earth's system arising from global warming (Church *et al.*, 2008). Increasing ocean mass from melting glaciers and polar ice sheets are currently minor contributors to sea level rise although rapid destabilisation of ice sheets, glaciers and so on is possible with continuing increases in global temperature. The impact of Greenland and Antarctic ice sheet melting has not been factored into sea level rise estimates. Ice melt could contribute an additional 10-20 cm to sea level rise by the end of the century.

Extreme high sea levels due to storm surge is likely as is the possibility of increase in peak wave heights as a result of more intense storms (Pittock, 2009).

Acidity is also increasing in marine systems, particularly in southern oceans (Hobday *et al.* in Steffen, 2009) which could lead to irreversible changes to marine ecosystems.

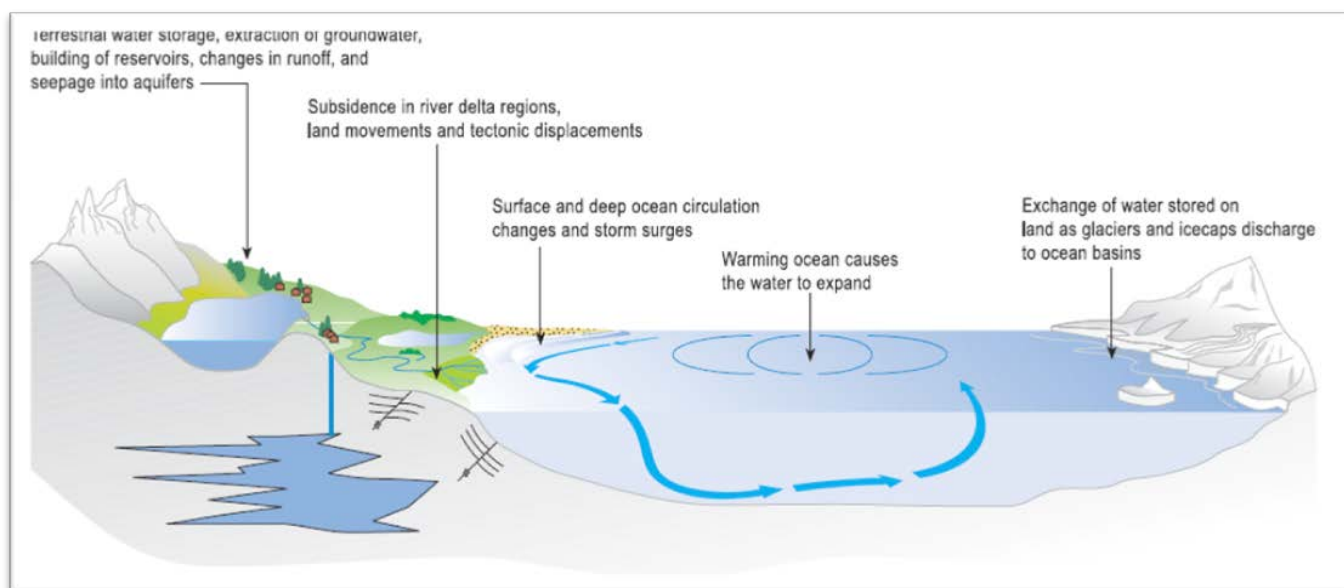


Figure 6: Causes of Sea Level Rise (McMullen & Jabbour, 2009)

⁶ Recent research by Pittock (2009) suggests that the climate change scenarios in the IPCC Fourth Assessment Report and the Commonwealth Scientific and Industry Research Organisation and Bureau of Meteorology may be conservative and that the climate may be changing at a faster rate than predicted. Comparisons of recent climate trends with models used in the 2001 IPCC assessment report found that climate systems are responding faster than models predicted (Rhamstorf *et al.*, 2009) due to rapid development, increasing carbon intensity and more carbon staying in the atmosphere longer because of a reduction in natural carbon sinks (Pittock, 2009).

3. Potential climate change impacts in the Peel region











Section 3 describes the major primary and secondary impacts of predicted climate change. How climate change may impact on a number of areas relevant to local government, with a focus on emergency management and biodiversity conservation is discussed.

The climatic components of actual and predicted climate change are presented in Section 2.

3.1 Overview

Climate change is significant as climate is a primary factor in supporting the agriculture, the environment, our economic activities and our way of life.

To help communicate some of the major impacts of a changing climate on local government, the Project produced a small pamphlet shown in Figures 7 and 8. The key to the symbols use in the pamphlet is provided below.

Key:		Asset Management		Community Development
		Planning		Emergency Management
		Environment/NRM		Economic Development
		Health Services		Event management
		Water/Sewerage		Water in the environment

<p>Bushfire</p>  <p>Predicted decreases in rainfall, increases in wind speed and a drying climate will likely increase the bushfire risk by:</p> <ul style="list-style-type: none"> •increasing bushfire potential – the Fire Danger Index is predicted to increase 4-25% by 2020 and 15-70% by 2070; •increasing fuel loads; •reducing the number of days suitable for prescribed burns to reduce fuel loads; and •reduced water availability may also impact on bushfire suppression. <p>Increasing bushfire risk places additional stress on volunteer and career fire-fighters, resources and natural systems.</p> <p>Potential damage and loss of infrastructure and the risk of injury and loss of life increases along with more frequent or extreme bushfire occurrence.</p>	<p>Biodiversity</p>  <p>Each one degree of warming is equivalent to moving approximately 100 km north, this will increase pressure on species unable to migrate or rapidly adjust to the changing climate and exacerbate existing threatening processes and alter species mix and composition.</p> <p>Climate change is expected to act as a disturbance event and favour pest species. Some sleeper weeds will find environmental conditions more favourable; existing species are expected to expand their ranges; and new pest, weed and diseases are expected to colonise new areas.</p> <p>Declining water levels will expose potential acid sulphate soils with resulting impacts on local biodiversity.</p> <p>There may be increased costs in maintaining biodiversity and green spaces, however there may be opportunities to generate carbon credits through revegetation works.</p>
<p>Emergency Management</p>  <p>Changing climatic conditions are expected to change the frequency, duration and ferocity of storms. There is a possibility of cyclonic activity moving further south and an increase in cool season tornadoes with associated storm damage and flooding. Bushfire risk is also expected to increase.</p> <p>Extreme weather events are also expected to disrupt energy and fuel sources and transport in affected areas. Increasing storm/fire/flood frequency and severity will place additional stress on emergency services staff and volunteers and Council staff in preparation for extreme weather events and in clean-up.</p>	<p>Sea Level Rise</p>  <p>Research indicates sea levels rising by up to 2 mm per year. This increase will need to be considered along with the individual and combined impacts of storm and tidal surges. This is expected to affect coastal processes and increase coastal erosion. Rising sea levels will cause the temporary and permanent inundation of wetlands and saline intrusion into riverine and freshwater wetlands and groundwater supplies.</p> <p>This is expected to influence marine, riverine and wetland biodiversity with a loss of some migratory feeding habitats and impact the Ramsar listed wetlands in the Peel-Yalgorup system.</p>

Figure 7: Summary of climate change impacts (Project Pamphlet Side A)

<p>Hydrology</p>  <p>Reduced rainfall and reduced number of rainfall days will result in less rain falling overall and quantities falling in short time frames. This may lead to localised flooding and a reduction in water quality through nutrient and pollution run-off and sedimentation.</p> <p>Many areas of the Peel have potential acid sulphate soils; drying of wetlands will expose acid sulphate soils with negative consequences to the environment and infrastructure.</p> <p>Biodiversity will be impacted through inundation of wetlands, altered stream and river flows and reduced groundwater availability. Changes to water availability will affect species composition and biodiversity in the region.</p>	<p>Built Environment</p>  <p>Expected changes in the frequency and severity of extreme weather events such as storms, bushfires and floods may require a review of planning and development frameworks to ensure that they take account of climate change. Increased maintenance and/or replacement of infrastructure damaged as a result of extreme weather events will increase organisational costs.</p> <p>Energy costs may increase if additional cooling is required to combat increasing temperatures. Public open spaces and streetscapes may require additional shading to reduce urban heat island effects and improve community comfort. Drying soil conditions may lead to subsidence and exposure to acid sulphate soils with associated damage to infrastructure.</p>
<p>Public Health</p>  <p>It is likely that rising sea levels and temperature increases will make large areas of the Peel more suitable for mosquito breeding and increase the risk of vector borne disease. Increasing wind speeds may also limit the number of days suitable for pest spraying.</p> <p>Gastro-intestinal ailments arising from reduced water quality and temperature related food illness may increase the pressure on local health care facilities.</p> <p>Heat stress arising from an increase in the number of extreme heat days and warmer night time temperatures are likely to affect the elderly, very young and outdoor workers. An increase in UV potential may also increase the risk of sunburn and skin disease.</p>	<p>Community/Social</p>  <p>The transition to a warmer, drier climate will change the way the community interacts with the surrounding environment. Outdoor activities may need to change venues and/or time to manage heatwave events. The ability to maintain green spaces will be affected and sea level rise will impact on coastal and marine facilities.</p> <p>Business will be impacted by changing temperature and rainfall regimes, particularly in agriculture and tourism sectors. However there is potential to develop green tech business.</p> <p>Many community support and emergency services are run and or supported by significant levels of volunteer engagement. Increased need for these services may require additional financial and in-kind support to enable services to meet community need and expectations.</p>
<p>Governance</p>  <p>Local governments will need to consider climate change implications in planning decisions to reduce the risk of litigation. The change to a carbon constrained economy and rising energy and fuel costs will also impact on local governments directly and indirectly.</p>	

Figure 8: Summary of climate change impacts (Project Pamphlet Side B)

3.2 Natural emergencies

'The frequency and scale of humanitarian emergencies resulting from natural disasters has increased and research suggests that there may be more of such disasters as a result of climate change' (various authors in Oloruntoba, 2009).

'In Australia 19 of the 20 largest property losses in the previous 40 years have been weather related' (Sullivan, 2008).

While it is difficult to quantify the extent to which climate change may affect the incidence of natural emergencies, the literature generally indicates that there is likely to be an increase in the frequency and intensity of extreme weather events and a proportional increase in the risks of natural emergencies, including cyclones, storms, drought, heatwaves, bushfire and floods (Pearce *et al.*, 2009).

Australia has traditionally been particularly vulnerable to four types of natural emergency: cyclones, storms, floods and wildfires (Ellis *et al.*, 2004 in McLennan & Birch, 2005), all of which are experienced in the Peel region.

Leroy (2006, p 11) expects disasters to increase as a result of population increases and colonisation of marginal areas.

'Worldwide, the threefold increase in the occurrence of extreme weather events between the 1960s and 1990s has been accompanied by a ninefold increase in damages. With this in mind, it is essential that we plan now.' (Esplin, 2009, p. 81).

3.2.1 Bushfire

Bushfires have been identified as *'one of the most deadly types of climate related extreme weather events'* (Steffen, 2009 in Yates & Bergin, 2009). Globally, fire risk is expected to increase under a changing climate, with Australia moving from moderate to high fire potential with a lengthening of the fire season (Liu *et al.*, 2010).

Climate change can affect fire weather scenarios in two ways (Lucas, 2005):

- Firstly, a warming and drying climate can exacerbate the fire risk on a given day leading to more frequent or intense fires. For example, Forest Fire Danger Index ratings are likely to increase between 4-25% by 2020 and 15-75% by 2050 (Hennessey *et al.*, 2005 in Baum *et al.*, 2009) consistently across Australia (Pitman *et al.*, 2007).
- Secondly, a warming and drying climate can increase the length of the fire season whilst reducing the number of days suitable for prescribed burns. Reduced water availability may also hinder fire suppression activities.

The potential risk of property loss to bushfire is greatest at the urban-bushland interface (McAneney, 2009). Increasing fire risk has already led experts to recommend that two new categories of risk are included: extreme and catastrophic fire conditions (Bruce Esplin, Department of Premier and Cabinet, 2009, p. 81).

‘...in terms of property loss, the potential is greatest at the urban-bushland interface and quantifying this threat is essential for developing rational planning regulations and fair and realistic insurance premiums’ (McAneney, 2009, p. 2819).

An example of extreme weather conditions causing catastrophic fire conditions occurred in the 2009 Victorian bushfires, where 173 people died and numerous properties were destroyed. In Western Australia, ‘severe to catastrophic fire weather warnings’ have already been issued at times for parts of Western Australia, including December 2009 when the town of Toodyay in Perth’s eastern region lost 38 homes in a fire that burnt through more than 2900 hectares (Noetic Solutions Pty Ltd, 2010).

3.2.2 Storms, storm surges and cyclones

Climate change predictions indicate that the Peel region may experience increased storm activity from extra tropical low pressure systems moving further south, and changes to rainfall patterns. This may increase the risk of flooding to low-lying areas and storm damage.

Between 1910 and 2004 there were 14 tropical cyclones that impacted on the Perth region through gales or wind related property damage (not including decaying cyclones causing rain only). These storms occur later in the cyclone season peaking in March (70% between March and April). Cyclones accelerate as they move south and can reach speeds of 70 km per hour, compared to the usual 10-15 km per hour (<http://www.bom.gov.au/weather/wa/cyclone/about/perth/index.shtml>).

The coastline between Bunbury and Mandurah is considered to be very susceptible to coastal erosion over the next century (Jones *et al.*, 2005) with some 60% of Western Australia’s vulnerable residential buildings lying between Rockingham and Busselton (between 11 220 and 7 340 homes) (Figure 9) (Department of Climate Change, 2009).

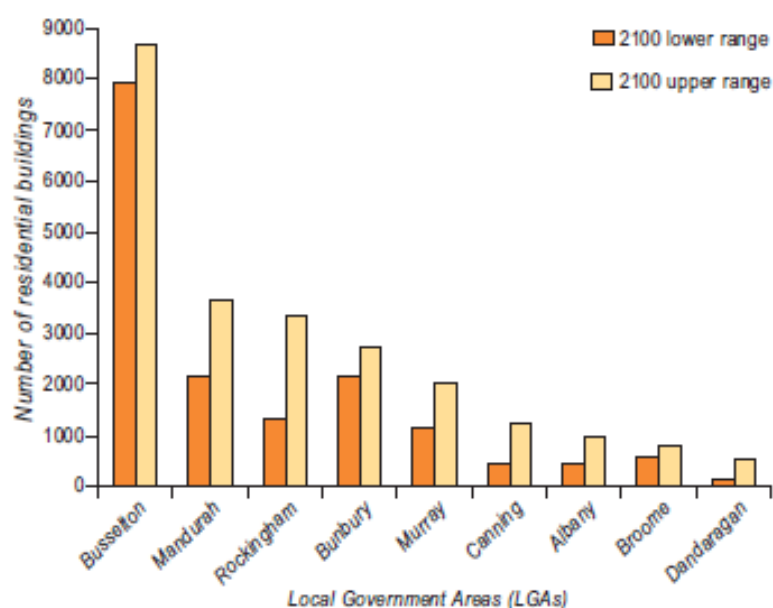


Figure 9: Estimated Number of Existing Residential Buildings in WA at Risk of Inundation from a Sea Level Rise of 1.1 m (DCC 2009)

3.2.3 Emergency service volunteers

'It is estimated that Australia relies on some 500,000 emergency services volunteers (Ruddock 2005), of whom approximately 220,000 are fire agency volunteers (McLennan, 2004a)' (in McLennan & Birch, 2005).

Volunteers play an essential role in the planning and response to natural emergencies in the Peel region. The Peel region reflects the trend of a reliance on volunteers to fight fires, with the ratio of career firefighters to volunteers in the order of 1:130 to 1:150 Australia-wide. (McLennan & Birch, 2005). Women and non-English speaking backgrounds are under-represented in volunteer fire fighter numbers and many volunteers are aged over 55 years. (McLennan & Birch, 2005).

Any increase in the frequency or intensity of climate related extreme weather events in the Peel region will place additional stress on volunteer and career emergency services personnel, including fire brigades, state emergency services and community support services, and may result in increased costs for the provision of equipment and personnel (including funding and equipment for volunteer organisations).

Volunteer services are generally supported by local governments via professional and technical assistance and the state-administered Emergency Service Levy. Estimates of the value of volunteers in the emergency services is around \$9 000 each per annum, thus saving Australian governments some \$2 billion annually (at 2005) (McLennan & Birch, 2005).

Volunteers may also suffer personal stress (including financial) as a result of attending an increasing number of emergency events. McLennan and Birch (2005) found *'anecdotal reports that some employers are increasingly reluctant to release employees who are fire service volunteers to attend emergencies during working hours because of business profitability or safety concerns'* (p. 104).

McLennan and Birch (2005) identified three key operational difficulties for volunteer emergency service organisations:

1. Declining membership in small remote communities;
2. Low volunteer rates in recently developed areas that were previously rural; and
3. Peri-urban areas with volunteers unable to respond to emergencies in business hours or on weekdays.

Additionally, the role of emergency services volunteers goes beyond the boundary of responding to incidents, including community education and prevention activities. With the current trend towards coastal and peri-urban living, community education and awareness activities are likely to grow in importance.

3.2.4 Other considerations

An increase in the number and frequency of natural emergencies places greater stresses on those directly affected and the wider community. The following are a number of considerations that should be borne in mind when assessing the impact of more and more intense emergency events in the region:

1. The population of the Peel region is rapidly growing, and many of the people are moving into low-lying or bushfire prone areas. This exacerbates the risks to large numbers of people and may result in increased dependence on agencies to prepare for, respond to and recover from, climate-related extreme weather events, as studied by Yates & Bergin (2009).
2. *'...in terms of property loss, the potential is greatest at the urban-bushland interface and quantifying this threat is essential for developing rational planning regulations and fair and realistic insurance premiums'* (McAneney et al., p. 2819).
3. The average age of our population is increasing, and this may mean a greater reliance on others for assistance when preparing and responding to emergencies.
4. Current emergency management systems and infrastructure are based on known past events, (for example, flood protection setbacks based on 1 in 100 year event or similar). Climate change will change the statistics upon which these calculations are made, leading to the predicted failure of existing systems or the need to reevaluate risk.
5. Loss of private and public infrastructure as a result of an emergency event will contribute substantially to financial stress on individuals and organisations, particularly those without insurance, which tends to be those already under pressure. Significant increase to the bushfire risk in some areas may also result in increased insurance costs or withdrawal of insurance services.
6. In terms of bushfires, reduced air quality via smoke and particulates in the atmosphere during fire periods can lead to health complications in turn leading to increased pressure on health services. Water contamination can also occur following bushfire when sediments wash into waterways because of a loss of ground cover and streamside vegetation. Increasing sedimentation may affect potable water supplies and contribute to altered stream flows and increased flood risk.

In summary, the changing nature of natural disasters as a result of climate change requires proactive planning that considers the need to plan for larger, more complex and more frequent disasters *that cross local government boundaries*. *'Development in hazard-prone areas and inadequate development and building controls are major contributing factors to the growing exposure of Australians to the impacts of climate change'* (Yates & Bergin, 2009). Planning decisions made today that fail to take climate change predictions into account may well leave a trail of legacy and liability issues for the future.

3.3 Environment and biodiversity

'The impact of humans on the biotic systems of the earth is dramatic and is accelerating. A global analysis of these changes revealed that over 60% of the services, or societal benefits, provided by biotic systems has been diminished through human activities, with the greatest loss occurring just during the past 50 years' (Millennium Ecosystem Assessment in Mooney et al., 2009).

'Australia's (and the world's) biodiversity is facing a threat equivalent to those of abrupt geological events that triggered the great waves of extinction in the past' (Hughes et al., 2009).

Natural systems in the Peel region are already under stress from clearing, habitat loss, fragmentation and degradation, pest species, eutrophication and water constraints. Climate change is likely to exacerbate many threatening processes or pressures including modification of habitat, invasive species, changed fire regimes, disease, and changed hydrology and water quality, and is likely to become the dominant driver of biodiversity loss this century (Hughes *et al.*, 2009). Risk assessments undertaken by the Department of Climate Change (2009) also indicate that Australia's natural systems are also vulnerable to changes in the frequency and scale of extreme weather events (e.g. drought, heatwaves, bushfires, floods, storms and coastal inundation).

The threat to biodiversity is of particular concern to the south west of Western Australia, as it is one of the world's 25 biodiversity hotspots and home to a large number of regionally restricted flora and fauna species, threatened ecological communities, wetlands of international importance listed under the Ramsar Convention, and areas of social and cultural significance (Myers *et al.*, 2000)..

These natural systems also provide ecosystem services, such as clean air, fresh water and coastal buffers, have significant economic benefit to industry and tourism, contribute to social well-being and have intrinsic or existence values. Human impacts have diminished over 60% of the ecosystem services provided by natural systems with most occurring over the last 50 years (Millennium Ecosystem Assessment in Mooney *et al.*, 2009).

Species have several options to adapt to change: altering phenological or physiological responses, adapting via natural selection, migrating to more suitable climates or habitats, or going extinct (Davis & Shaw, 2001 in Vitt *et al.*, 2010).

However, the rate of change in climate, rather than the magnitude of change, may be the limiting factor for some species, exceeding a species' ability to adapt.

3.3.1 Habitat connectivity

Habitat connectivity of a bushland area refers to its proximity to other natural areas and the quality of the linkage between them. Connectivity is important in allowing animals and plants to move through a landscape to meet all of their habitat requirements (feeding, resting, breeding) as well as avoid predators or natural disasters, including bushfire. Connectivity is also critical for species that are having to move through the landscape to find more suitable habitat as a result of habitat change due to a changing climate. It has been estimated that every degree of warming is equivalent to

moving north 100 km (Morgan, 2008). This places significant pressure on plants and animals located at the extremes of their habitat to move or evolve or they will become locally extinct.

Pittock (2009) notes that some biological systems are moving polewards some 5-10 km per decade and spring events are occurring 2-3 days earlier per decade as a result of warming. For plant and animal species this means moving to higher elevations, or moving southwards. Habitat fragmentation, coastlines, mountains and the mobility and adaptability of species hinder the ability of species to migrate to suitable habitats as the climate changes. The need to migrate to more suitable climate and/or habitat may see species move out of protected areas to unprotected areas as climate change impacts become evident.

Habitat connectivity in the Peel region is a critical issue on the Swan Coastal Plain where the majority of native vegetation has been cleared, and cleared areas have been converted to farmland or settlements and include numerous roads. Planning for the seasonal and long-term migration of fauna in east-west and north-south directions would appear to be a priority objective for biodiversity conservation and sustainable development.

3.3.2 Pests and weeds

‘Invasive plants pose a significant threat to ecosystems worldwide (Mack et al., 2000; Mooney and Hobbs, 2000; Pimental et al., 2001; Baskin, 2002) and human-induced climate change may exacerbate the threat (Dukes and Mooney, 1999; Sutherst, 2000; Westbrooks, 2001)’ (in Crossman, Byran & Cooke, 2008).

Climate change has the potential to act as a disturbance event by stressing populations (Southeast *et al.* in Low, 2008) and creating opportunities for more tolerant species to displace native ones. Weed and pest species are generally highly tolerant and easily dispersed, making them excellent opportunists of disturbed areas. Some weed species that occur in small pockets or limited distributions may become much more prolific in their distribution and reproductive success as the habitat and climatic conditions become more favourable. Many invasive weed species – both grassy and shrubby weed – increase fuel loads and facilitate bushfire spread.

3.3.3 Forests

‘Responses of forest ecosystems to rising temperatures are highly non-linear and exhibit strong thresholds beyond which there is often no return’ ‘Climate change could fundamentally alter the composition, structure, and biogeography of forests in many regions of the world by causing increases in tree mortality associated with climate induced physiological stress and through interactions with other climate-mediated processes such as insect outbreaks and wildfire’

(Parks & Bernier, 2010, p. 657).

The impact of other climate related events such as increasing bushfire risk and storm damage will reduce forest resilience resulting in changes to their composition, structure and biogeography. Once changes have occurred and thresholds are reached, it may be impossible for forests to return to a previous state (Parks & Bernier, 2010). Losing forests also releases carbon sequestered in them, contributing to escalating greenhouse gas emissions in the atmosphere.

3.3.4 Fire

'...due to its increasing frequency, scale and ferocity, fire can now be considered one of the most serious threats to nature in southern Australia' (The Wilderness Society, 2009).

Whilst the focus of wildfires remains on protecting people and property, the need to consider environmental impacts and management should not be underestimated.

Given the link between fire and weeds, increased weed distribution may increase fuel loads and fire intensity. For example, weed species that occur in small pockets or have limited distributions may become much more prolific in their distribution and reproductive success as habitat and climatic conditions become more favourable. Many invasive weed species – both grassy and shrubby weed – increase fuel loads and facilitate bushfire spread. Bushfire is considered to be a serious threat to biodiversity in southern Australia (The Wilderness Society, 2009) and all indicators suggest that the fire season will be longer and the fire risk higher.

3.3.5 Other impacts

Climate change may lead to a number of other significant environmental management issues.

1. **Increase in spread of *Phytophthora cinnamomi* (dieback).** *Phytophthora* (dieback) is a key threatening process under the *Environmental Protection and Biodiversity Conservation Act 1999*, which is expected to become more prolific as rainfall moves to warmer summer months. *Phytophthora* affects many plant species and any increase to distribution will impact on natural areas through the loss of susceptible species. Widespread infections can change the vegetation structure of an area and remove food and habitat for native species.
2. **Decrease in drainage and nitrate leaching.** Both drainage and nitrate leaching have sharply decreased due to the lower rainfall in the last 30 years. It can be expected that this reduction in drainage will reduce the rate at which dryland salinity spreads in the region due to the close correlation between deep drainage and dryland salinity (George *et al.*, 1997; McFarlane & Ruprecht, 2005 in Ludwig *et al.*, 2009).
3. **Increased Acid Sulphate Soil risk.** Undisturbed acid sulphate soils (ASS) present little problem; however, disturbance by drainage or excavation develops sulphuric acid which leads to changes in surface and ground water with associated biodiversity changes. Acid sulphate soils are expected to become more prevalent in areas where groundwater is reduced as a result of a drying climate. Eutrophication of waterways may also occur with drying of wetlands and the resultant increase in nutrient concentration.

3.3.6 Conclusion

The complex nature of interactions makes it difficult to determine exactly how natural areas will individually react to changing climatic conditions. Whilst fine scale modelling is required to translate broad climate change predictions to locally specific information, many strategies designed to enhance biodiversity adaptation are an extension of existing best practice natural resource management techniques. These include the protection and revegetation of linkages between natural areas, and bushland management to increase the resilience of areas against weeds.

4. Local Government survey

A survey of Peel region local government staff was developed and undertaken to determine those issues related to climate change adaptation that were of concern to Peel local governments. The survey format was developed from previous surveys conducted by the Australian Local Government Association, the Western Australian Local Government Association and other local government associations across Australia. Surveys were sent to the five local governments in the Peel region, WALGA and the Office of Climate Change.

4.1 Survey results

The survey asked participants to:

- | | |
|-------------|--|
| Question 1A | Indicate their level of knowledge of climate change; |
| Question 1B | Score the level of importance placed by their organisation on policy development across a range of areas, including bushfire, hydrology, public health, infrastructure and governance; |
| Question 2 | Indicate what actions their Council has or is undertaking to mitigate or adapt to climate change. |
| Question 3 | Indicate where their Council is undertaking any educational programs on climate change with their communities; |
| Question 4 | Indicate whether their Council has an Environmental Management System (EMS) in place; and |
| Question 5 | Indicate whether their Council has undertaken any form of risk assessment relating to the impacts of climate change. |

A complete copy of the survey is included in Appendix 2.

A statistical summary of survey results for Questions 1A and 1B is provided in Table 1 for each of the five Peel region local governments. The climate change issues of importance from a policy development perspective are ranked in Table 1 in order of highest to lowest priority.

The issues that averaged the highest scores and displayed a relatively low standard deviation (indicating that responses are close to the mean) are listed below:

- reduced water quality and water availability;
- increasing frequency and or intensity of extreme weather events;
- change in species composition in green spaces, etc.;
- weed and pest invasion;
- increased bushfire risk; and
- exposure of acid sulphate soils.

4.2 Discussion of survey results

The survey showed that:

- a) Most participants indicated a reasonable knowledge of climate change, ranging from average to high. However, given some of the responses in the remainder of the survey, some issues may not be well understood even though respondents felt they had a high level of knowledge on climate change.
- b) Climate change mitigation and adaptation actions are being undertaken by a number of the local governments in the Peel region. The most common actions are:
 - seeking grants;
 - preparation of planning instruments;
 - conducting workshops (undertaken by three councils);
 - policy development;
 - commissioning or preparing reports;
 - development of management plans (undertaken by two councils);
 - research;
 - measures to record changes;
 - inclusion of climate change in State of the Environment reporting; and
 - participating in the Cities for Climate Protection program.
- c) Other local government actions included:
 - development of a climate change strategy in 2009/2010;
 - developing a climate risk strategy;
 - development of an environmental strategy; and
 - greenhouse gas emissions reductions.
- c) Education about climate change mitigation and adaptation is being done on an individual council basis. Community education, business/industry education, retrofit of facilities and provision of information on websites are each occurring at one local government. Committees and community/business retrofit or subsidy programs were established at two local governments.
- d) Two councils surveyed have an Environmental Management System in place and three have undertaken some form of climate change risk assessment.
- e) There was a mixed response to the question of the preferred method of communication about the Project, with a fairly even split between newsletter, formal letter to council and email update to the project contact officer.
- f) Participants also indicated that other assistance that would be beneficial to local governments in the Peel region included:
 - making available assistance to undertake the works listed in the survey;
 - focusing effects of climate change outside of Mandurah foreshore;
 - doing some work on the ground rather than surveys; and
 - provision of data and research.

Table 1: Climate change survey results.

	Score by local government						mean	Med	stdev
Question 1A									
Knowledge of climate change	8	8	7	5	6.5	7	6.9	7.0	1.1
Question 1B									
Reduce rainfall leading to reduced water availability and altered water quality	9	7	8	8	7	8	7.8	8.0	0.8
Increasing frequency and or intensity of extreme weather events	7	6	8	8	7	9	7.5	7.5	1.0
Change in species composition in green spaces, etc.	8	10	3	8	6	8	7.2	8.0	2.4
Carbon pollution reduction scheme	8	0	5	10	9	9	6.8	8.5	3.8
Weed and pest invasion	6	8	9	8	2	7	6.7	7.5	2.5
Increased bushfire risk	10	2	7	8	7	6	6.7	7.0	2.7
Acid sulphate soils exposure	10	4	1	10	8	7	6.7	7.5	3.6
Reduced insurance coverage	8	0	5	10	7	9	6.5	7.5	3.6
Injury, illness or death through heat stress	10	0	4	10	6	8	6.3	7.0	3.9
Permanent or regular inundation of low-lying areas	1	5	6	9	8	8	6.2	7.0	2.9
Uncertainty about impacts on local government	8	1	2	10	7	9	6.2	7.5	3.8
Altered river and stream flows with changed sediment and nutrient dynamics	8	0	7	8	7	6	6.0	7.0	3.0
Altered coastal, estuarine and riverine biodiversity	9	0	8	8	2	9	6.0	8.0	3.9
Extinctions and loss of keystone species	10	0	8	8	2	8	6.0	8.0	4.0
Changing plant and animal behaviour	9	0	8	8	2	8	5.8	8.0	3.8
Change in species composition	9	0	8	8	2	8	5.8	8.0	3.8
Increase in incidence of disease from climatic conditions becoming favourable for a wider range of vector, food and water borne disease	10	3	3	10	2	7	5.8	5.0	3.7
Exposure to legal liability on planning decisions	8	0	5	10	2	9	5.7	6.5	4.0
Increased incidence of dams being constructed or modified without development approvals	10	9	1	4	2	7	5.5	5.5	3.7
Injury and or death from increased flooding	7	0	3	10	4	8	5.3	5.5	3.7
Damage to heritage and Indigenous sites by flooding and sea level rise	9	0	3	10	2	8	5.3	5.5	4.2
Reduced water quality leading to illness and disease	9	0	1	10	2	8	5.0	5.0	4.5
Salt water intrusion into wetlands	3	0	5	10	5	6	4.8	5.0	3.3

	Score by local government						mean	Med	stdev
and groundwater sources									
Loss or damage to infrastructure from extreme storm events	8	0	3	8	2	8	4.8	5.5	3.6
Financial impacts – reduced property prices in some locations	8	0	0	10	5	6	4.8	5.5	4.1
Disruption to electricity and fuel supplies as a result of extreme weather events	9	0	3	7	2	7	4.7	5.0	3.5
Infrastructure failure causing flooding	10	0	3	6	2	7	4.7	4.5	3.7
Sea level rise causing flooding and damage to coastal infrastructure	0	0	6	10	3	8	4.5	4.5	4.2
Increased rate of spread of plant disease	6	0	3	8	2	7	4.3	4.5	3.1
Increased coastal, estuarine and stream bank erosion leading to loss of facilities and infrastructure	0	0	6	10	2	8	4.3	4.0	4.3
Displaced populations resettling	9	0	1	6	2	8	4.3	4.0	3.8

4.3 Identification of emergency management and biodiversity conservation as key themes

In terms of priorities for policy development, the issues or themes that emerged from the local government survey as important were:

- reduced rainfall leading to reduced water availability and altered water quality;
- increasing frequency and or intensity of extreme weather events (e.g storms, exceptional rainfall events, and storm surges);
- change in species composition in natural areas (bushland, wetlands etc);
- a carbon pollution reduction scheme;
- weeds and pest invasion; and
- increased bushfire risk.

These themes were grouped into three broad areas:

- Biodiversity conservation (species composition, weed and pest invasion);
- Emergency management (extreme weather events, bushfire); and
- Decrease in rainfall and increase in extreme weather events.

These groupings reflected two areas where local governments can act (biodiversity conservation and emergency management) and a third area which is beyond control. Hence, the two themes selected by the Project Steering Committee for draft climate change policy development were “Biodiversity” and “Emergency Management”.

5. Review of policy and initiatives

“The predicted impacts of climate change need to be taken into account; maintaining a business-as-usual approach may result in the disaster risk in Australia becoming more extreme” (Yates & Bergin, 2009).

5.1 Introduction

Review of policy, research and initiatives relevant to climate change adaptation occurred at two stages in the Project. An initial review of policy and initiatives was conducted early in the Project following the survey of Local Governments (Stage One). This was to ensure that the Project could quickly learn from the approaches taken in other jurisdictions across Australia.

The second stage of policy review was carried out following the decision to focus the Project on the areas of emergency management and biodiversity conservation. This second stage review focused on identifying the current gaps in policy faced by Peel region local governments.

The second stage policy and initiatives review included:

- A review of all Peel region local government policies for relevance to biodiversity and emergency management;
- A review of the WALGA policy service;
- A review of relevant Federal and State legislation; and
- A search of the ‘Science Direct’ journal articles database focusing on terms such as ‘climate change’ and ‘Australia’ with the search string ‘bushfire’ or ‘emergency management’ or ‘biodiversity’ and ‘local government’. The search was restricted to the period 1990-2010.

The purpose of the review was to determine the gaps in the current framework of legislation and policies and identify the opportunities and priorities for new policy or strategic approaches.

5.2 Stage One review: Climate change policy and initiatives overview

A desktop analysis of climate change research, policy and initiatives was undertaken early in the Project to ensure that Peel local governments could learn from the experiences of local governments elsewhere in Australia. The results of this review are presented in Appendix 3.

The review shows that climate change is clearly on the agenda of local governments Australia-wide and is increasingly seen as more than an environmental issue.

As adaptation becomes more important, local governments are seeking to identify climate change risks and adaptation options. Resource and time constraints are driving the development of tools to prioritise risks and adaptation options. Examples include:

- Kur-ring-gai Council’s *Cost Benefit Analysis Model*; and

- South West Catchments Council's *Risk and Vulnerability Assessment tool for biodiversity and natural resource management*.

At a state and federal level, local governments are being assisted by government initiatives and local government association programs.

In Western Australia, the WA Local Government Association (WALGA) has developed a Climate Change Management Toolkit. The toolkit includes numerous resources including:

- **LAND USE PLANNING GUIDELINES** - *Draft Adaptation Planning Policy Guideline: Guidelines for Incorporating Climate Change impacts into the Local Government Planning* (Essential Environmental, undated);
- **LEGAL ADVICE** - *Climate change policy legal risks* – a report by Freehills lawyers to WALGA; includes a summary of potential legal ramifications for Local Government if they improperly consider climate change risks (Freehills, 2010);
- **CLIMATE CHANGE POLICY STATEMENT** – *A template for a Local Government policy on climate change* (WALGA, 2012a);
- **CONSULTANCY PANEL** for climate change (WALGA, 2012b); and
- **CHECKLIST** for local governments preparing a climate change adaptation plan.

The WALGA Climate Change Checklist is particularly useful to local governments and encourages the following staged approach for local government climate change adaptation planning:

Step 1 AUTHORITY: Establish authority for the local government to embark on adaptation planning.

Step 2 RESEARCH: Research and collate information on climate change, and translate it into 'what it means for our local area', and identify existing tools and approaches in the local government and beyond for adaptation.

Step 3 BUILDING RELATIONSHIPS: Coordinate actions across local governments and with partners; develop and implement a process to engage the community.

Step 4 RISK ASSESSMENT: Establish decision-making criteria for risk assessment, assess risks and identify the most significant risks.

Step 5 ADAPTATION RESPONSES: Identify and appraise adaptive options for those risks, choosing measures that are no-or-low regret, incremental and build adaptive capacity.

Step 6 ACTION PLAN: Prepare and implement an action plan.

Whilst the Project has generally exposed the Peel local governments to the concepts suggested in each of the above Steps, the Toolkit per se wasn't in existence during the Project. It is recommended that each local government needs to re-visit each step and consider them in greater depth than the Project provided.

The above is a summarised version of the WALGA checklist; for full details go to <http://www.walgaclimatechange.com.au/adaptation-plan-checklist.htm>

Local governments have also been working for a number of years on mitigation strategies to reduce greenhouse gases. These include the International Council of Local Environmental Initiatives (ICLEI) Cities for Climate Protection (CCP) program. More recently local governments have been undertaking climate change risk assessments through the Federal Government *Local Adaptation Pathways Program* and similar self-funded risk assessment processes.

5.3 Peel region climate change policies and initiatives

In the Peel region, all Local Governments have been actively participating in greenhouse gas reduction programs since 2008 through involvement in ICLEI's Cities for Climate Protection program. Most local governments have continued efforts to reduce gas emissions and some have factored energy efficiency guidelines into planning policies.

In terms of incorporating climate change adaptation into council policy, each local government has taken a different approach based on their local issues and internal capacity.

The City of Mandurah has developed a climate change risk assessment for coastal zones. This includes a:

- Coastal Zone Climate Change Risk Assessment and Adaptation Plan, and
- Strategic Risk Assessment report.

The project was funded by the Department of Climate Change Local Adaptations Pathways Project. Data arising from this Project is contributing to the development of council policies.

The City of Mandurah, Shire of Murray, Shire of Waroona and a number of other local governments have come together to form the Peron Naturaliste Partnership (PNP). The partnership covers all local governments with coastline from Rockingham to Busselton. The vision of the PNP is to empower a resilient regional community to reduce risks and optimise opportunities presented by climate change.

Other notable achievements for local governments in the region are:

- The Serpentine Jarrahdale Shire has endorsed a council policy on climate change, similar to the WALGA policy template (Serpentine-Jarrahdale, 2011);
- The Shire of Murray has signed the WALGA Climate Change Declaration (www.murray.wa.gov.au);
- The Shire of Boddington is developing a risk management project that aims to identify bushfire risk areas within the shire.

5.4 Current policy context for emergency management

Local governments' responsibilities for emergency management are either directly issued via State legislation, or indirectly devolved by the Fire and Emergency Services Authority of Western Australia (FESA).

At the state level, the Fire and Emergency Services Authority (FESA) coordinates emergency services. Their role includes response, preparedness and recovery at the regional scale. FESA was established under the *Fire and Emergency Services of Western Australia Act 1998* and is responsible for administering several acts, including:

- *Fire and Emergency Services Authority of Western Australia Act 1998;*
- *Fire Brigades Act 1942;*
- *Bush Fires Act 1954;*
- *Emergency Services Levy Act 2002; and*
- *Emergency Management Act 2005.*

FESA supports local governments to ensure that they are supported and properly equipped to meet their responsibilities to reduce the incidence of fire and emergencies and plan and respond when they occur. They do this through:

- Operational assistance to plan for and respond to bushfires and other emergencies;
- Technical advice, such as jointly preparing with guidelines for *Planning for Bush Fire Protection* – which specifies the bushfire protection measures to be incorporated into sites being developed where there is a bushfire risk (WAPC & FESA, 2010); and
- Financial assistance, by distributing funds to local government and volunteer bushfire services gathered under the Emergency Service Levy.

Local governments' emergency management responsibilities are set out under the *Emergency Management Act 2005* and *Bush Fires Act 1954*. Each local government has a responsibility under the *Emergency Management Act 2005* to prepare and maintain effective emergency management arrangements for its area, manage recovery following an emergency, establish Local Emergency Management Committees (LEMC) and ensure that a copy of the local emergency management arrangements are kept in the local government offices.

The *Bush Fires Act 1954* identifies local government responsibilities in relation to bushfire prevention, control, extinguishment and creation and management of volunteer fire brigades. This includes the enforcement of regulations in regard to maintenance of firebreaks, compliance with fire management plans and support of local Volunteer Bushfire Services.

Volunteer bushfire brigades and state emergency services volunteers are supported by the Emergency Services Levy. The levy was introduced on 1 July 2003 (replacing an earlier system). Collected by local governments via rates notices, the levy funds are forwarded to Fire and Emergency Services (FESA) and are used to fund emergency services and purchase equipment, and support the operational expenses of local volunteer emergency services through provision of quarterly grants to local governments.

Local governments are also involved in Local Emergency Management Committees (LEMC). These committees are established under the *State Government Emergency Management Policy* to develop, test and review local emergency management arrangements. Individuals from agencies, community groups and organisations with expertise in identifying and assessing hazards and risks form the committees. The Shires of Boddington, Murray, Serpentine-Jarrahdale and Waroona and the City of Mandurah form the Peel Emergency Management District.

Increasingly the emergency management focus has evolved from preparedness and response to one of risk reduction through a process of prevention, planning, response and recovery. Local governments have a direct responsibility to undertake risk assessment and planning activities to ensure that their local government area is prepared for emergencies or disasters.

Following the declaration of a 'natural disaster', communities can access relief and recovery assistance under the Western Australia Natural Disaster Relief and Recovery Arrangements (WANDRRA). The Federal Government supports the States in developing capacity to respond to emergencies through Emergency Management Australia and providing assistance during disasters.

Whilst various Peel region local governments have policies that indirectly relate to emergency management, there is no policy that directly addresses emergency management or the potential impact of climate change on the provision of emergency management services.

5.5 Current policy context of biodiversity conservation

Local governments' efforts in the Peel region to conserve biodiversity are regulated by a number of State and Federal Acts and guided by numerous state-level policies. The wide range of legislative and policy instruments, plus the disconnection between Planning and Environmental Protection legislation, often make it challenging for local governments to strategically conserve biodiversity. Some of the key legislation and policy related to biodiversity conservation is listed in Appendix 4.

However, the most powerful way for local governments in the Peel region to conserve biodiversity is to prepare a local biodiversity strategy (LBS) and integrate this into their local planning schemes. The preparation of these strategies is supported by the State Government and WA Local Government Association. These strategies offer a means for local governments to identify significant natural areas and plan for their protection. This should include planning for the protection of significant natural areas against the impacts of climate change and making these areas more resilient to changes in climate.

The Shire of Serpentine Jarrahdale has prepared a LBS, a draft LBS has been prepared in the City of Mandurah and the Shire of Murray is in the early stages of LBS preparation.

Under a local biodiversity strategy, all of the other plans and activities that local governments carry out to conserve biodiversity should be made more strategic, meaningful and cost-effective. Examples of such plans and activities are:

- reserve management plans;
- assessment of bushland protection in proposed new developments;

- protection of biodiversity through a local government's planning scheme and local planning strategy;
- assessment of the impact of fire management plans on native vegetation; and
- weed and pest management policies and control programs.

5.5.1 National advice for conserving biodiversity in a changing climate

When preparing a local biodiversity strategy or preparing any biodiversity conservation policy, local governments should consider advice provided by the Australian Government's Department of Climate Change in regard to biodiversity conservation. In its 2009 report targeted at policy makers, the Department has recommended the following (Department of Climate Change, 2009):

- Reform our management of biodiversity: we need to adapt the way we manage biodiversity to meet existing and new threats – some existing Strategy Framework and management tools remain effective, others need a major rethink, and new approaches need to be deployed in order to enhance the resilience of our ecosystems.
 - The National Reserve System needs to be enhanced substantially and integrated with off-reserve conservation.
 - Enhance resilience by reducing the impact of existing stressors.
 - Facilitate self adaptation across multiple pathways to spread the risk.
- Strengthen the national commitment to conserve Australia's biodiversity: climate change has radical implications for how we think about conservation. We need wide public discussion to agree on a new national vision for Australia's biodiversity, and on the resources and institutions needed to implement it.
 - A broader and deeper base of support for biodiversity conservation is required.
 - Change the goal from maintaining historical species' distribution and abundance to one, which maintains well-functioning ecosystems to deliver ecosystem services and maximise native species and ecosystem diversity.
- Invest in our life support system: we are pushing the limits of our natural life support system. Our environment has suffered low levels of capital reinvestment for decades. We must renew public and private investment in this capital.
 - *'Climate change intensifies the need for an urgent and sustained increase in investment in the environment'* (p. 20).
 - On-ground activities should be carried out within an active adaptive management framework.
 - Establish a monitoring network via a collaborative program with commitment to ongoing adequate resourcing.
- Build innovative and flexible governance systems; our current governance arrangements for conserving biodiversity are not designed to deal with the challenges of climate change. We need to build agile and innovative structures and approaches.
 - Strengthen national leadership to support a reform agenda.
 - Work on *'Devolving responsibilities and resources to the most local, competent level, and building capacity at that level'*.
 - Establish interactive regional governance arrangements, which are sensitive to local conditions.
 - Establish new partnerships with other groups.

- Improved Strategy Framework integration across climate change, environmental protection and commercial natural resource use is required nationally, including across jurisdictional boundaries.
- Meet the mitigation challenge: Australia’s biodiversity has only so much capacity to adapt to climate change, and we are approaching that limit. Therefore, strong emissions mitigation action globally and in Australia is vital – but this must be carried out in ways that deliver both adaptation and mitigation benefits.
 - The more we can reduce emissions the more we can slow the rate of climate change and reduce the impacts on biodiversity.
 - Mitigation actions need to be supportive of biodiversity outcomes; for example, monocultures for carbon sequestration have minimal biodiversity outcomes.

5.6 Gaps and barriers for local government

Through consultation with local governments, and research carried out for the Project, barriers to adaptation by local government were identified. Barriers generally fell into three categories:

1. Gaps in research and technical information,
2. Lack of existing tools and policies; and
3. Capacity, understanding and attitudes.

Since 2010, some of these gaps have been partially addressed, especially with the creation of the WALGA Climate Change Toolkit. Each of these three gaps and barriers is discussed below.

5.6.1 Research and technical information

Whilst information on climate change and predicted impacts is rapidly evolving, local governments require finer scale data and predictions to assist in developing adaptation options and minimising risk associated with planning decisions. For example, LiDAR mapping (light detection and ranging) has recently been undertaken for coastal zones in the Peel region. This high resolution mapping will contribute to accurate assessments of storm and flood risk in these areas.

5.6.2 Tools and policies

The Western Australian Local Government *Climate Change Policy Statement* provides an ideal starting point for local governments to begin including climate change considerations in their policy framework. The development of adaptation strategies through this the Peel Climate Change Adaptation Project will also assist local governments to develop a higher level of climate change awareness and skills.

In late 2010, the Serpentine-Jarrahdale Shire endorsed a Council Policy on Climate Change, making it the first Peel region local government to have such a policy. However, no Peel region local government has endorsed or amended a biodiversity or emergency management policy which specifically addresses climate change adaptation. The Federal Government’s ‘Biodiversity and Climate Change’ report (Department of Climate Change, 2009) provides excellent guidance in this regard for biodiversity conservation policy-makers.

5.6.3 Capacity, understanding and attitudes

McBean and Ajibade (2009) and Mosser (2009) identified technological, financial, cognitive, behavioural and knowledge barriers to climate change adaptation; which is also perceived to be a big and unprecedented management challenge (Dovers, 2009). The Peel local governments are looking for leadership at state and federal government levels.

Whilst climate change in the Peel region is considered to be an important issue for local governments, resourcing adaptation and mitigation actions remains a major barrier. There are a limited number of people working within local government who have a thorough understanding of climate change science, mitigation, adaptation and the emerging regulatory framework. Often these skilled people are snapped up by industry who can offer significant financial incentives with which councils cannot compete. Project based initiatives often only fund 'on-ground' works; much of the work of a climate change officer falls outside of this framework.

Resource constraints also inhibit the ability of councils to conduct and participate in regionally relevant research and modelling to reduce the uncertainty surrounding predicted impacts, and facilitate the development of science based policy.

There remains uncertainty about business risk and liability risk associated with climate change. A survey undertaken by Protiviti (a global business and risk consulting firm) found that *'48% of managers were unable to undertake long term business planning and 44% had delayed implementing a comprehensive risk management framework for their organisation'* (The New Lawyer, 2009). The lack of certainty around business risks is contributing to slow action to address climate change.

The uncertainty surrounding the Australian Government's proposed carbon pollution reduction scheme also created confusion for local governments with many not understanding the flow-on implications to government. Local government adaptation attempts via a planning framework can also be hindered by overriding state and federal planning policies that are contrary to adaptation initiatives.

Climate change is a politically charged topic and is suffering from a credibility crisis and there are concerns about *'investing in what is considered an abstract problem with low probability of occurrence, at the expense of other immediate and urgent needs'* (McBean & Ajibade, 2009 p. 182). Contributing factors include errors revealed in the Intergovernmental Panel on Climate Change's Fourth Assessment Report, the University of East Anglia's Climatic Research Unit e-mail scandal, lack of progress at Copenhagen in December 2009, and the policy of many media outlets to give 'equal time' to climate sceptics, despite the vast majority of the scientific community agreeing that the science is valid. A 2010 survey by British market research company, Populace, which compared results with an earlier BBC phone survey in November 2009 revealed that the number of people who thought global warming was a fact was down from 50% to 34% and some 25% of respondents thought that climate change was not happening at all, up from 15%.

<http://www.theaustralian.com.au/news/nation/leaked-email-scandal-means-climate-doubters-outweigh-rest/story-e6frg6nf-1225827622177> accessed 8/02/10)

The rapidly evolving policy environment creates challenges for local governments to maintain current knowledge of new policies and their application to their council's increasing workload, and resource competition; for example, should you mitigate or adapt or both? Councils also experience difficulties in resourcing, attracting and retaining skilled and qualified specialist staff.

6. Risk assessment and policy priorities

To develop policy and strategies for the two focus areas of emergency management and biodiversity conservation, a series of workshops were held with local government staff and elected members to:

- assess climate change risks relevant to the two focus areas (Sections 7 and 8);
- reach agreement on the desired regional vision and goals for emergency management and biodiversity responses (Section 6.3) (Vision statements for emergency management and biodiversity conservation are presented in Sections 7.2 and 8.2 respectively); and
- develop strategies to address adaptation response for emergency management and biodiversity conservation (presented in Sections 7.3 and 8.3).

Officers attending the workshops were drawn from a range of local government functional areas including environmental services, emergency services, planning, and occupational health and safety.

The risk assessment process followed the *Climate Change Impacts and Risk Management Guide* (Australian Greenhouse Office, 2007) and was consistent with the Australian Standard for Risk Management AS 4360:2004. The workshop:

- identified the specific risks towards emergency management and biodiversity conservation; and
- assigned a level of risk (or risk priority) by assessing the likelihood of the risk and the consequence of the risk occurrence.

Participants formed three groups (two groups for biodiversity and one group for emergency management). The biodiversity workshop groups focused on identifying risks to biodiversity arising from specific climate change impacts (e.g. sea level rise, temperature increase), whilst the Emergency Services workshop identified risks to local government provision of emergency services arising from climate change.

The complete list of risks, and the assessment of risk priority, is presented in Appendix 5 for emergency management and Appendix 6 for biodiversity conservation, and discussed in Sections 6.1 and 6.2 below.

6.1 Assessment of risks for emergency management

Seventy-one risks were identified in the Emergency Management workshop (see Table 2 below).

Table 2: Categories of risk identified in the Emergency Management workshop.

Risk Rating	No. of risks identified
Extreme	8
High	35
Medium	18
Low	10

As there were only eight extreme risks identified, both the extreme and high risks were sorted into focus areas for policy development (see Table 3 below).

Table 3: Focus areas for policy development.

Emergency Management Risk Focus Areas
Water
Communication and networks
Post-incident support
Access
Utilities
Fire, flood and storm
Volunteers
Business continuity (local government)
Natural resource management for emergencies
Resources

The experiences of staff involved in managing emergency services within local governments proved to be a benefit but also contributed to confusion. Several participants felt that existing risk assessment outputs should have been used for the workshop. Further clarification was required to provide a distinction between emergency management risk assessment per se and the purpose of the workshop, which was identifying and considering the risks posed by climate change to the provision of emergency management services by local government. This focus was key to ensuring that the risks identified were relevant to the development of climate change adaptation policy options.

Significant discussion took place at the workshops regarding the links between biodiversity and emergency management, with particular reference to managing the sometimes conflicting needs of biodiversity and bushfire prevention. The groups concluded that there were significant threats to biodiversity arising from emergency and extreme weather events.

Although mosquito breeding was identified as a high risk in the workshops, the Steering Committee identified it as a public health issue and therefore outside the immediate scope of the focus areas of biodiversity and emergency management. Significant work on the health impacts of climate change has been undertaken, including the impacts of mosquitoes (see Spickett, Brown & Katscherian 2007).

A full list of identified risks to emergency management and their ratings can be found in Appendix 5.

6.2 Assessment of risks to biodiversity conservation

Eighty-eight risks were identified at the biodiversity workshop ranging from low to high risk (see Table 4 below).

Table 4: Categories of risk identified in the Biodiversity workshop.

Risk Rating	No. of risks identified
Extreme	34
High	40
Medium	11
Low	3

In line with risk priority levels outlined in *Climate Change Impacts and Risk Management Guide* (Australian Greenhouse Office, 2007), the extreme risks required urgent attention. The 34 risks were reviewed and due to similarities, were grouped into focus areas for policy development (see Table 5 below).

Table 5: Risk focus areas for biodiversity.

Biodiversity Risk Focus Areas
Flora/fauna and fire, flood and extreme weather events
Water supply and quality
Ramsar-listed wetlands (water quality)
Species composition, abundance and distribution
Salinity, acid sulphate soils
Green Design, town planning and community services
Finance – costs and opportunities
Food sustainability
Mosquito breeding

A full list of identified risks to biodiversity and their ratings can be found in Appendix 6. Mosquito breeding was later considered to be primarily an environmental health issue and not considered further in addressing biodiversity conservation policy-making.

6.3 Vision and goals

The workshops also included a visioning exercise to identify the desired regional goals for emergency management and biodiversity conservation with respect to adaptation. Focus areas identified during the risk assessment process were used to assist participants visualise and describe their vision for the region in the future in regard to the focus areas. Vision statements are expressed as a number of goals in Sections 7.2 and 8.2.

6.4 Development of adaptation strategies

Workshop participants also assessed the various policy options, or adaptation strategies, that would best address the risk focus areas for emergency management and biodiversity conservation. This assessment was carried out using a multi-criteria analysis framework for assessing policy options against the key risk focus areas, and the objectives for either emergency management or biodiversity conservation.

The strategies developed through this process are presented in Section 7.2 (emergency management) and Section 8.2 (biodiversity conservation).

7. Adaptation strategies for emergency management

‘Taking account of changing-climate-induced disasters should be core business, not just to the work of our emergency services, but also to land use planners and those responsible for major infrastructure projects’ (Yates & Bergin, 2009).

7.1 Introduction

Planning for climate related emergency events should be core business for emergency services, land use planners and people responsible for infrastructure projects (Yates & Bergin, 2009). Local government has a responsibility under the *Emergency Management Act 2005* to prepare and maintain effective emergency management arrangements for its area, manage recovery following an emergency, establish local emergency management committees (LEMCs) and ensure that a copy of the local emergency management arrangements are kept in the local government offices.

Emergency management can be described as the organisation and management of resources for dealing with emergencies, including planning, structures and arrangements, and can include government, volunteers and agencies.

An emergency is an event, either actual or imminent, which endangers or threatens to endanger life, property and/or the environment, and which requires a significant and coordinated response (WALGA <http://emtoolbox.walga.asn.au/what>), and is caused by hazards meeting community vulnerabilities. Disasters occur when the coping capacity of communities is exceeded. Climate change is expected to increase the frequency and intensity of extreme weather events and increase the risks of natural disasters, including cyclones, storms, drought, heatwaves, bushfire and floods (Pearce *et al.*, 2009).

By reviewing the potential risks associated with climate change, strategies can be implemented to reduce community vulnerability and increase resilience to natural emergencies.

7.2 Vision, goals and principles

Through the workshops with local government representatives and other Project participants, a vision statement was developed as three goals from which to develop strategies and related to management of natural emergencies (EM).

Emergency Management Vision statement:

- EM Goal 1. A community that is well prepared for, rapidly responds to and recovers from climate related emergency events;
- EM Goal 2. Strategically located resources that facilitate preparedness, response and recovery; and
- EM Goal 3. Well-manned volunteer emergency services that are adequately resourced and supported.

The objectives that sit behind these goals are to:

1. Reduce exposure of people and property to climate change related emergencies through identification of hazards associated with climate change and assessing community vulnerability and risk;
2. Reduce exposure and sensitivity through adaptive risk management and building resilience; and
3. Increase adaptive capacity by designing and implementing measures that enhance community ability to respond to hazard/emergency events and recover quickly; planning for continuity of services, recovery planning and preparedness.

It is also important to ensure that climate change adaptation policies and strategies for emergency management are consistent with the principles outlined in the State Emergency Management Strategy Framework No 2.5 'Emergency Management in Local Government Districts'. These principles are as follows:

- a. Community Based – focused on local government areas;
- b. Use of Existing Resources – generally utilising existing resources and organisations;
- c. Capabilities and Legal Responsibilities – local emergency management plans;
- d. Emergency Functions – responsibilities should be consistent with state emergency management arrangements;
- e. All Hazards – comprehensive and integrated approach; and
- f. Community Emergency Risk Management (ERM) Process – stakeholder engagement in risk treatment.

7.3 Strategies for local government

Based on all of the research, consultation and analysis undertaken for the Project, the following strategies have been developed for the consideration of local government.

The strategies apply to the following local government functions:

- Land use planning;
- Bushfire prevention, planning and response;
- Flood risk designation;
- Information for decision-makers;
- Preparedness; and
- Volunteer support and recognition.

7.3.1 Land use planning incorporating climate change risks

The changing nature of natural disasters as a result of climate change requires proactive planning that considers the need to plan for larger, more complex and more frequent disasters that cross local government boundaries. *‘Development in hazard-prone areas and inadequate development and building controls are major contributing factors to the growing exposure of Australians to the impacts of climate change’* (Yates & Bergin, 2009). Planning decisions made today that fail to take climate change predictions into account may well leave a trail of legacy and liability issues for the future.

‘...in terms of property loss, the potential is greatest at the urban-bushland interface and quantifying this threat is essential for developing rational planning regulations and fair and realistic insurance premiums’ (McAneney et al., p. 2819).

Table 6 presents three strategies which local governments can employ to address risks within their local planning system, including their local planning strategy.

Table 6: Strategies to be applied through the local land use planning system.

Strategy No.	Action
Strategy EM1: Identify and map areas vulnerable to climate related extreme events	Identify and map areas vulnerable to climate related extreme events (e.g. erosion, flood, bushfire risk) This information should form the basis for planning and development related policy and should set minimum building requirements to increase individual and community resilience to climate change emergency.
Strategy EM2: Incorporate risk mapping into local planning system	Incorporate climate change risk mapping and responses in all land use documents (town planning), including for example the local planning strategy and local planning policies. Currently there is little detailed information on how to do so other than the NSW Sea Level Rise document.
Strategy EM3: Lobby for State and Federal Government technical and planning support	Lobby for State and Federal Government support for local government to translate new climate change land use information into reality. Adequate resourcing for access to high resolution digital mapping on which to base planning decisions, assistance in implementing and interpreting policy and translating it into planning controls, and legislated power for local governments to enforce planning decisions are essential.

7.3.2 Bushfire prone area designation

A drying climate, reduced rainfall and reduced moisture availability are leading to higher fire danger indices for south west Western Australia. See Section 3.2 for some of the predicted impacts of climate change on bushfires and other natural emergencies. Table 7 presents two strategies to address this risk.

Table 7: Strategies to be applied through designation of areas as ‘Bushfire Prone Areas’.

Strategy No.	Action
Strategy EM4: Declare Bushfire Prone Areas	Areas of significant high fire danger should be declared ‘Bushfire Prone Areas’. This mandates additional building requirements under the Building Code of Australia.
Strategy EM5: Educate landholders in bushfire designated areas	Encourage community and individual resilience through education programs about bushfire designated areas and minimum property preparedness requirements.

7.3.3. Sea level rise and flood risk designation

Rising sea levels, storm surges and changing rainfall patterns will have significant effects on coastal and low-lying areas. Table 8 presents a strategy for local governments with areas of coastal foreshore, estuarine areas or low-lying areas.

Table 8: Strategy to address increased risk of emergencies due to sea level rise and increased incidence of serious storm events.

Strategy No.	Action
Strategy EM6: Map areas of potential inundation	Identify areas of potential inundation resulting from climate change and designate them appropriately to enable climate appropriate planning and development in coastal and wetland areas.

7.3.4 Informed decision making

Climate change is rapidly evolving with many implications for local government through its role of delivering community services. Effective policy requires informed decision makers. Table 9 presents strategies to collect new information relevant to assessing local risk and cost-benefit analyses.

Table 9: Strategies to improve Council decision-making

Strategy No.	Action
Strategy EM7: Partner with research institutions to better assess local risks	Develop partnerships with research institutions to address gaps in our understanding of the changing nature of climate change risks as they relate to emergency management.
Strategy EM8: Lobby the State Government for additional technical support	Lobby the State Government to develop extreme event forecasting tools, early warning systems and fine scale maps suitable for use by local government.
Strategy EM9: Undertake cost benefit analysis of adaptation options	Identify major risks in the area of emergency response and undertake climate change risk management assessments and cost benefit analysis of adaptation options.

7.3.5 Preparedness

Adequate preparation for emergency situations can increase resilience and recovery. This applies to governments, emergency organisations and the community. Table 10 recommends a number of measures to increase a local government's preparedness for emergency events.

Table 10: Strategies to increase the preparedness of local governments and communities

Strategy No.	Action
Strategy EM10: Location of utilities and emergency evacuation centres	Strategically place utilities and emergency evacuation centres in areas of low risk with good access.
Strategy EM11: Training and communications	Conduct regular regional emergency event practice drills and inter-agency/local government communications plans to ensure clear and consistent operational response across agencies.

Strategy No.	Action
Strategy EM12: Map water sources for fire fighters	Identify and map water resources for fire fighting and investigate legal authority for dam and reservoir access in emergency situations.
Strategy EM13: Identify available emergency resources within the private sector	Identify available emergency resources within the private sector (mining and timber companies, etc.) suitable for emergency response activities. Maintain accurate records of resources and contact details.
Strategy EM14: Community education and information	Encourage community preparedness through education and information relating to climate change and the predicted impacts of climate change on extreme weather events. Seek innovative ways of spreading emergency information quickly, such as telephone trees and warning systems, and distribute them to community and volunteer organisations.

7.3.6 Volunteer support and recognition

Australia relies heavily on volunteers for emergency response, with approximately 130-150 volunteer fire-fighters for every one career fire-fighter in Australia (McLennan & Birch, 2005). Volunteers play a vital role in supporting their communities in emergency situations and in the recovery period following such events. Increasing climate change risks are placing additional stress on already stretched services.

In their review of potential emergency response capacity in Australia's bushfire volunteers, McLennan and Birch (2005) found *'anecdotal reports that some employers are increasingly reluctant to release employees who are fire service volunteers to attend emergencies during working hours because of business profitability or safety concerns'* (p. 104). Recognising employers who support emergency service volunteers as well as the volunteers themselves may encourage broader community involvement in volunteer agencies.

Table 11: Strategies to support and recognise volunteers

Strategy No.	Action
Strategy EM15: Regional reward scheme for volunteers and employers	Develop a regional reward scheme for volunteers and employers including Mayoral awards for emergency services volunteer of the year and group of the year.
Strategy EM16: Adequately resource volunteer organisations	Ensure that all volunteer agencies are supplied with best practice resources including suitable communications equipment such as mobile communication devices, GPS and identification in vehicles and with teams.

7.4 Milestone framework

Based on the strategies presented above, local governments could be encouraged to participate in a Milestone program where they are rewarded following various achievements (Table 12)⁷. A similar approach has operated successfully for energy efficiency and water management programs targeting local governments

Table 12: Potential Milestone Framework for Climate Change Adaptation in Emergency Management

Milestone	Activities	Details
Milestone 1: Commitment	<ul style="list-style-type: none"> Local government commitment to the emergency management adaptation project Establish steering committee & working groups 	Council report to seek commitment to the project and select membership of the steering committee and working group
Milestone 2: Informed decision making	<ul style="list-style-type: none"> Identify areas of High Risk <ul style="list-style-type: none"> Bushfire Risk Areas Flood Risk Areas or floodways Best practice building codes/planning for high risk areas Determine emergency services capabilities and requirements with respect to identified risks 	<p>University partnership to undertake required research This project may involve several local governments</p> <p>Prepare risk maps of high risk areas</p>
Milestone 3: Communication and consultation	<ul style="list-style-type: none"> Assess risk maps against current policies Develop discussion paper/s Councillor and community education 	Prepare and endorse at council level and then circulate for public consultation (or vice versa as appropriate)
Milestone 4: Implementation examples	<ul style="list-style-type: none"> Develop a local planning policy for bushfire risk areas Develop a local planning policy for flood risk areas Consider amendments to the local planning scheme to show Bushfire Prone Areas and floodways as Special Control Areas. 	

⁷ This Milestone framework, developed in 2010 is not dissimilar to the WALGA Climate Change Management Checklist (Section 5.2) that was released some time afterwards.

8. Adaptation strategies for biodiversity conservation

8.1 Introduction

In practice, local governments' responsibility to conserve biodiversity means the protection of bushland, natural areas and native vegetation across private lands and council managed lands. The aim of this is to conserve native plant and animal species and ensure they can continue to exist and evolve. Local Governments can protect biodiversity on private lands by controlling development and offering support to landowners who have bushland on their properties. Local governments also manage a variety of local reserves with bushland, wetland, riverine and estuarine areas for public enjoyment.

8.2 Goals and principles

Agreement was reached on seven goals that should be used to develop strategies and actions to ensure biodiversity management (B) addresses the challenges posed by climate change:

- B Goal 1. Resilient natural systems that are able to self-adapt to climatic changes and provide protection against extreme events
- B Goal 2. Well-connected local and regional ecological linkages
- B Goal 3. Adequate resources for natural resource management
- B Goal 4. Well-managed water supplies that contribute to environmental flow requirements to meet conservation objectives
- B Goal 5. Well-managed water and vegetation that prevents and repairs damage by salinity and acid sulphate soils
- B Goal 6. Well-managed wetlands that maintain diversity and character
- B Goal 7. Planning that incorporates biodiversity values

In addition, the Project recommends that all policies and strategies to address climate change adaptation for biodiversity conservation should have regard to the following principles:

1. Manage biodiversity for existing and new threats: climate change will exacerbate existing threats to biodiversity, change the nature and extent of threatening processes and will itself act as a stressor.
2. Demonstrate a strong commitment to biodiversity conservation with a focus on ecosystem services and diversity.
3. Provide adequate levels of investment for the management of natural systems.
4. Adopt a regional approach to adaptive biodiversity management with a focus on partnerships and collaboration.
5. Continue mitigation actions to reduce the extent of adaptation required.

8.3 Strategies for local government

While the drivers for climate change are global, adaptation options are often best achieved at the local level. Hence local governments play an important role in climate change adaptation because they are closer to where the consequences of climate change will be felt and the potential to influence both adaptation and mitigation actions is large.

Biodiversity management is a core function of local government through its roles in natural resource management, planning and land use management, water management and through support of community groups managing natural systems. Many of the adaptation responses identified for local government are an extension of work already being undertaken.

The following strategies have been developed in consultation with local government officers in the Peel region, representatives from the Western Australian Local Government Association, the Office of Climate Change (WA), the Peel Development Commission and the Peel-Harvey Catchment Council, and are consistent with the Federal Government policy direction outlined in *Australia's Biodiversity and Climate Change* (2009).

8.3.1 Regional collaboration for biodiversity adaptation

Climate change effects on biodiversity will not be contained within local government boundaries and will require collaborative efforts to manage impacts and increase adaptive capacity. Regional collaboration will share the costs and benefits across a number of councils/partners and will demonstrate commitment and an established partnership approach; increasingly important in the competitive grants sector. Table 13 includes strategies to encourage regional partnerships.

Table 13: Strategies to encourage regional collation and partnerships to integrated adaptation into biodiversity conservation

Strategy No.	Action
Strategy B1: Publicly state Council's biodiversity policy	Clearly define Council's 'biodiversity position' to maximise funding opportunities (e.g. grants).
Strategy B2: Maintain support for Natural Resource Management framework	Maintain support for Natural Resource Management, 'Friends Of' and other groups. These groups provide valuable capacity to maintain and improve natural areas in the Peel region and are a source of local knowledge.
Strategy B3: Support a regional environmental peak body	Support a regional environmental peak body to keep highly skilled practitioners and their expertise in the region (e.g. PHCC) to provide regional and localised information and resources.

8.3.2 Maintain functioning natural ecosystems: connectivity and diversity

Highly diverse ecosystems are more resilient and are expected to adapt better to changing climatic conditions. Habitat connectivity allows for 'self' adaptation and movement of species into more suitable habitats as climatic conditions change. *'In many cases it may be more cost-effective to direct funds towards measures which help species adapt and survive in-situ, such as enhancing ecosystem resilience, allowing for genetic translocation to boost evolutionary potential or providing refuges from extreme weather'* (Isaac, 2010). Habitat clearing remains one of the most significant effects on loss of biodiversity. In heavily settled or modified habitats, assisted migration or establishment of migration corridors may be required to enhance species survival.

Table 14 presents strategies to maintain functioning natural ecosystems.

Table 14: Strategies to maintain ecological diversity and connectivity

Strategy No.	Action
Strategy B4: Develop a Peel regional biodiversity plan and budget	Identify regional priority areas for conservation (as per South West Biodiversity Project Guidelines) and develop a regional management plan, work plan and budget to ensure that these areas are protected. Formalise and resource to protect a comprehensive and representative array of landscapes, ecosystems and species in the Peel. Landscape diversity, patches and connectivity of habitats should be represented in reserves and in other land tenures.
Strategy B5: Establish biodiversity targets	Establish biodiversity targets such as: <ul style="list-style-type: none">• purchase of significant areas• strategic rehabilitation and revegetation management throughout the catchment• revegetation of degraded areas to increase diversity and connectivity• multiple use landscapes• management for transformation of ecosystems• increased connectivity, especially in and between diverse landforms.
Strategy B6: Develop innovative subdivision options	Develop innovative subdivision options. Provide incentives to developers to protect significant natural areas and planning for management costs as part of the development process. Incentives should be provided to owners where natural areas remain in private hands.

Strategy No.	Action
Strategy B7: Develop and implement private land conservation initiatives	Develop and implement private land conservation initiatives – including formal conservation covenants (National Trust, Department of Environment and Conservation (DEC) or Department of Agriculture and Food Western Australia (DAFWA)) and the less formal ‘Land for Wildlife’ scheme. Covenanted land should be consistent with the Local Planning Scheme because any inconsistency will favour the Local Planning Scheme (Molloy <i>et al.</i> , 2007).
Strategy B8: Provide financial incentives for private land conservation	Provide financial incentives, such as rates rebates, or investigate tax incentives for conservation initiatives.
Strategy B9: Establish strong vegetation protection policies	Encourage retention of, and minimise clearing of, remnant native vegetation through development of, or incorporation into, native vegetation policies.

8.3.3 Manage environmental stressors

Climate change is expected to favour species that are highly adaptable to change, which are often pest and weed species. Climate change will exacerbate existing stressors, encourage new stressors and act as a stressor in its own right.

Table 15 presents strategies to manage environmental stressors.

Table 15: Strategies to manage environmental stressors

Strategy No.	Action
Strategy: B10: Regional weed and pest campaign	Adequately fund a regional campaign to manage existing weed and pest threats and identify and develop management plans for emerging pest and weed species.
Strategy: B11: Weed management information	Inform the community and landholders about existing and emerging weeds and best practice management techniques.

8.3.4 Carbon Sequestration

Vegetation acts as a carbon sink and is a nett accumulator of carbon. Vegetation clearing or mis-management releases stored carbon into the atmosphere and also reduces the capacity of the system to store greenhouse gases.

The protection and planting of vegetation is one method of carbon sequestration, the process of storing carbon dioxide in a solid material through biological or physical processes.

Carbon sequestration is a climate change mitigation strategy, and was supported through the workshops and consultation process.

Table 16 presents a strategy for carbon sequestration.

Table 16: Strategies to sequester carbon

Strategy No.	Action
Strategy B12: Pursue opportunities to sequester carbon through native vegetation plantings	Identify and pursue opportunities in carbon sequestration for native biodiversity plantings to facilitate natural resource management. Revenue generated through the sale of carbon credits is to be returned to natural resource management activities to fund ongoing management.

8.3.5 Strategic planning directions

The Peel is a vibrant and growing area. Demand for housing and infrastructure is placing increasing pressure on natural areas and may contribute to rising greenhouse gas emissions through poor planning and construction. Balancing social, environmental and economic demands will require a thorough understanding of natural areas and the expected effects of climate change, and this knowledge will need to be incorporated into planning processes.

Table 17 presents strategies to integrate climate change adaptation into land use planning.

Table 17: Strategies to integrate climate change adaptation into land use planning

Strategy No.	Action
Strategy B13: Identify and protect significant natural areas	Identify areas of significant biodiversity and incorporate these natural areas into town planning schemes, and district and regional plans to ensure they are adequately considered and incorporated into planning activities.
Strategy B14: Prepare a Peel region biodiversity policy	Prepare a biodiversity policy and associated guidelines to inform planning. The process outlined in the Perth Biodiversity Project is ideal for this purpose. Biodiversity policies should include such things as protection, offsets, mitigation of biodiversity loss due to development, and community involvement in planning matters.
Strategy B15: Integrate existing plans into local planning schemes	Integrate existing plans, such as <i>Peel-Yalgorup Ramsar Site Management Plan</i> , into local planning schemes.

Strategy B16: Develop a regional 'recreational activity framework'	Develop a regional 'recreational activity framework' to identify locations suitable for a range of activities (such as trail bikes). Combine this with an education program and incentives/disincentives to discourage activities from environmentally sensitive locations.
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8.3.6 Resources and funding

Funding for natural resource management activities has typically been low and disjointed which inhibits long-term planning and consistency of approach, and creates disillusionment within the industry and volunteers.

Table 18 presents strategies to ensure adequate resources and funds are available for biodiversity conservation.

Table 18: Strategies to ensure adequate resources and funds are available for biodiversity conservation.

Strategy No.	Action
Strategy B17: Develop a regional funding scheme for biodiversity conservation	<p>Develop a regional funding scheme (e.g. Peel Region Environmental Levy to be implemented under the <i>Local Government Act 1995</i>) to fund:</p> <ul style="list-style-type: none"> • identification and implementation of regional biodiversity conservation priorities and development of annual work plans and regional budget; • incentives programs for private land conservation schemes; and • stakeholder engagement, community information and awareness – advising people about what the levy is being used for and seeking input into developing priorities.
Strategy B18: Provide budget support for dedicated Conservation Officers	Provide budget support for dedicated Conservation Officers to enable community initiatives to be undertaken.

8.3.7 Integrate biodiversity and fire management

Fire is a natural part of the Australian ecosystem; however, the impacts on biodiversity of predicted increases to fire risk and an increasing number of fire days need to be better understood and more carefully managed at a regional and subregional level.

Fire management plans for natural areas, including bushfire response plans, need to sensibly balance the need to protect people and property with the need to conserve biodiversity. Fire management plans for specific sites and estates are usually developed with the involvement of the local government, land manager and FESA.

Frequency of fire in natural areas impacts the assemblage and composition of species in an area. Overly frequent fires will generally benefit opportunistic/weed species over native species. Physical disturbance of the ground, such as newly built fire access tracks, or vegetation clearing, can create new areas for weeds to take hold if not properly managed. In turn many weeds have annual life cycles which significantly increase fuel loads in summer.

Table 19 presents strategies to support fire management being carried out in balance with biodiversity and having access to the best available research.

Table 19: Strategies to integrate fire management and biodiversity conservation

Strategy No.	Action
Strategy B19: Revise and develop fire management plan for natural areas.	Integrate fire management practices that maintain levels of public safety whilst conserving biodiversity. This can be achieved through fire management plans developed for natural areas in consultation with FESA and local governments and land managers.
Strategy B20: Locally-based research of inter-relationships between fire management and biodiversity	Identify opportunities to partner with research organisations to ensure that policy development and implementation is based on locally relevant research.

8.3.8 Waterways and wetland management

Wetlands and waterways in the Peel region provide habitat and feeding grounds for many species including migratory birds. In recognition of its importance, the Peel-Yalgorup wetland system has been recognised internationally under the Ramsar Convention as a wetland of international importance. Wetlands and waterways are also popular with people, and development pressure is an ever present threat.

The key tools used to manage wetlands, especially those in development areas are the protection of buffers and development setbacks, and the preparation of foreshore management plans. It is important that foreshore management plans ensure that coastal and riverine development maintains a balance between

environmental and social needs, and that development setbacks and wetland buffers leave room for climate change related sea level rise.

Table 20 presents strategies to increase the resilience of wetlands, especially estuarine and riverine wetlands, against climate change related impacts.

Table 20: Strategies to increase the resilience of wetlands and waterways

Strategy No.	Action
Strategy B21: Implement regional plans and guidelines which protect wetlands and waterways	Implement <i>the Peel-Harvey Water Quality Improvement Plan</i> and ensure that Water Sensitive Urban Design guidelines are implemented in development proposals. Implement the Department of Planning's draft <i>Guideline for the Determination of Wetland Buffer Requirements</i> (2005).
Strategy B22: Conduct a regional strategic review of foreshore management plans	Undertake a regional strategic review of coastal, wetland and waterways management plans and develop regionally consistent guidelines for managing these areas with respect to potential climate change impacts.
Strategy B23: Manage environmental flows for waterways and wetlands	Manage groundwater levels and water flow requirements for healthy wetland and waterways habitats through bore licence allocation, waterwise education, stormwater capture and reuse.
Strategy B24: Adopt the Ramsar Management Plan	Adopt the <i>Peel-Yalgorup Ramsar Site Management Plan</i> and adequately budget for staff to implement recommendations.

8.3.9 Informed management

Regionally specific, relevant and accurate information is vital for the management of biodiversity and a well informed community. Developing a sound understanding of what biodiversity resources are available, how things are changing, and which management practices are effective (or not) is vital.

Table 21 presents strategies to support more informed decision making.

Table 21: Strategies to support more informed decision making

Strategy No.	Action
Strategy B25: Develop partnerships to conduct research	Develop partnerships with research institutions to minimise gaps in our understanding of climate change on species and ecosystems in the Peel.
Strategy B26: Develop an understanding of climate change on pest species	Develop an understanding of the impact of climate change on probable changes in numbers of pest species and their distribution throughout the region.
Strategy B27: Implement a Community Education Strategy	<p>Implement a Community Education Strategy: successfully managing climate change impacts on biodiversity will need to involve all sectors of society, hence it is vital that members of the community understand:</p> <ul style="list-style-type: none"> • conservation values and principles and the role of ecosystem services; • climate change is a significant driver of biodiversity change; • the need to manage for a changing environment; • that mitigation is vital to ensure that minimal adaptation is required.
Strategy B28: Establish monitoring sites to develop a greater understanding of change	Establish monitoring sites, such as photo reference points and objective measurement systems, to develop a greater understanding of change occurring.
Strategy B29: Record and publish information	Establish information recording protocols; especially using non-technical specialists in the region. Involve schools and community groups in local monitoring programs.

9. Regional summit

9.1 About the Summit

The Peel Climate Change Adaptation Regional Summit provided an opportunity for elected members and local government officers to listen to a range of expert speakers and consider the draft strategies presented in Sections 7.2 and 8.2. Regional action on climate change was discussed and consensus on a regional policy/action response was sought.

The Summit was held at the Leonda Function Centre, South West Highway, Mundijong WA on Friday 12 March 2010 between 8.30 am and 3.30 pm. The summit was well attended by elected members and staff from all five local governments in the Peel region.

The presentations given by guest speakers at the Summit have been reproduced in the Regional Summit Report, a separately bound publication available on the Peel-Harvey Catchment Council website. The Report also includes a summary of feedback received from participants, including comments on future possible regional climate change initiatives.

Summit participants recognised that climate change was an important issue in the region and is considered to be a major factor in biodiversity and emergency management.

There was a high level of agreement that local government has a role to play in climate change mitigation and adaptation initiatives which could be achieved through planning and policy, community awareness and engagement, and advocacy and leadership. There was some agreement that initiatives can be incorporated into current business practices, although some participants were neutral or disagreed.

Feedback from participants indicated that there was a high level of awareness about the Project and its objectives, and knowledge and awareness of climate change had increased over the life of the Project.

Participants also indicated that they had experienced difficulty in finding locally relevant data and that more information is needed on where local governments can access climate change resources.

Opportunities for developing partnerships to address climate change concerns also generated strong support amongst participants.

9.2 Key issues

Five (5) key issues were raised through the Summit workshops. These covered concerns in regard to:

- Resourcing climate change initiatives;
- Climate Change Action, Planning, Development and Building Codes;
- Locally relevant Information for Decision Making;
- The use of 'uncertainty' as an argument to 'do-nothing';
- A general difficulty in enforcing policies in regard biodiversity conservation.

Each of these issues is expanded upon below.

9.2.1 Resourcing

Resourcing climate change initiatives was a concern expressed by several local governments. With the demise of the WA Sustainable Energy Development Office (SEDO), there is little opportunity for local governments to source funding for climate change mitigation or adaptation initiatives. Several people expressed frustration in their ability to attract and retain experienced staff, when many were being lured to private industry because of attractive remuneration packages.

9.2.2 Climate change action, planning, development and building codes

Local governments need state government support to encourage more sustainable building codes based on evidence of climate change. There is a need to encourage and/or to lobby for building codes that are more suited to the changing climate, to improve energy and thermal efficiency and improve the ability to withstand changing extreme conditions. For example, changing from a dark coloured roof to a light coloured one can result in energy cost savings for home cooling of between 30-70%. There needs to be consistency and support from the State Administrative Tribunal (SAT) for local government attempts to encourage more environmentally sustainable development.

There was also a feeling that additional expectations were being placed upon local governments without provision of the necessary funding.

Also, local governments do not feel that they have control over where residential developments are located in regards to emergency risk.

Planning for new developments and retrofitting existing areas needs to consider climate change at all stages of the development process. This will help to ensure that developments address changing climate risks and are sustainable within a changing climate; however, this is generally not the case. For example, areas of increasing fire danger need to be identified, and planning needs to be more aware of these changing conditions.

9.2.3 Information for decision-making

While there is sufficient certainty in current climate trends and future modelled trends for local governments to act, there is often insufficient information at the local scale to make planning or operational decisions. Greater clarity is required on expected future events (one in 100 year events, etc.), particularly in

a local context, in order to make better decisions. Local governments also need to base their policies on the best-available science. Ideally, finer scale research and science is needed for locally based decisions.

9.2.4 Uncertainty

Caution should be applied to the use of the term ‘uncertainty’ in climate change discussions. Scientific consensus tells us that climate change is occurring and will continue to occur. The uncertainty lies in exact magnitude and precise nature of the changes, and this should not be used as an excuse for failure to manage the risks of a changing climate.

9.2.5 Biodiversity

Many policies and/or strategies relating to biodiversity conservation are not enforceable or change on political whim. For example, funding for the South West Biodiversity Project (SWCC) has been discontinued. There needs to be consistency and legislative backing for local government policy development and resourcing for implementation.

Sourcing funding for Natural Resource Management projects is extremely time-consuming, and is often focused on on-ground works without resourcing staff time.

The effects of climate change on local biodiversity need to be studied. For example, researcher Trevor Booth from CSIRO is looking into species movements and what will be a suitable amount of habitat to support viable communities in a drying climate. This research will be based on matching plant requirements with environments.

9.3 Future actions

Despite having the appearance of a large and complex problem outside the expertise of local government, many of the adaptation responses required for emergency management and biodiversity conservation are already occurring within local governments as part of core business (e.g supporting natural resource management groups and volunteer emergency services).

Discussion at the Summit identified four areas of action for future work on climate change and adaptation:

1. **Regional Funding and Collaboration**

Enhance collaboration across local governments to increase knowledge sharing and response capacity. Form an alliance to continue to share information on climate change and develop a regional funding model.

2. **Integration**

Local governments in the Peel region are at different stages in their approach to climate change. Strategies that have been developed will be integrated into existing climate change initiatives and/or used to initiate climate change initiatives.

3. **Implementation**

Assistance to local governments is needed to translate processes into policies within each local government.

4. **Community initiatives and information**

Better decisions are made with an informed community participating in the process. Increase community engagement and initiatives.

10. Project evaluation and review

10.1 Project outcomes

The Peel Climate Change Adaptation Project succeeded in raising the profile of climate change as an issue of importance for Peel region local governments. Feedback received after the Workshops and adaptation Summit indicated that people felt their knowledge of climate change, potential impacts and relevance to local government had increased throughout the life of the Project. It is worth noting that, at the start of the Project, knowledge of climate change and the potential implications to local government ranged from very high knowledge and active involvement in climate change related activities, to it being seen as a topic of little relevance.

The Project was successful in bringing a wide group of council staff and councillors together from all five local governments in the region and establishing a network for sharing climate change information.

The strategies presented in Sections 7.2 and 8.2 will continue to be incorporated into individual local government policy frameworks either as:

- additions to existing policies and/or strategies; or
- in the development of completely new policies.

10.2 Appropriateness of Project methodology

The Project relied upon a number of techniques to meet its objectives and arrive at the recommended adaptation strategies. The appropriateness of these techniques to the Project is discussed below.

10.2.1. Desktop research versus new research

The Project used a desktop research approach on which to base the understanding of climate change impacts on the region. An alternative method may have been to commission new research on local impacts of climate change (e.g impacts on emergency management, vulnerable infrastructure or biodiversity conservation). New research would have been a more costly and time-consuming approach. However, there is a growing need for research on local impacts to be conducted.

In terms of the desktop research carried out for the Project, the use of the 'Science Direct' database and access to peer reviewed journal articles ensured that information was robust and current. This was supplemented by discussions with local governments, research institutions and stakeholders to ensure a local perspective. This approach was adequate for ensuring that the best-available, peer reviewed science was used in the Project.

10.2.2 Risk assessment

The risk management approach is becoming widely used to undertake climate change risk assessments (e.g. via the Local Adaptations Pathways Program) and is an approach that local governments are used to. This familiarity with the process allowed participants to focus on the topic of climate change and the priority themes. The process for risk identification followed that suggested by the *Climate Change Impacts and Risk Management Guide* published by the Australian Government and is consistent with the Australian Standard for Risk Management AS 4306:2004.

10.2.3 Communications

A range of communication tools and techniques were used to communicate with councils to maximise information exchange. The Workshops and Summit aimed to create a collaborative and consultative framework for information sharing, whilst presentations, e-mails, letters and telephone contact were designed to keep stakeholders informed about project progress and to seek additional information.

Whilst the science of climate change is considered robust and credible, and research is being undertaken at finer scales, climate change remains a contentious political topic, which has generally hindered the development of policies and programs.

The Project succeeded in increasing climate change knowledge within local governments in the Peel Region and developed a range of adaptation strategies for emergency management and biodiversity conservation.

10.3 Project transferability

Transferability in the context of this Project refers to the degree to which the approach used to establish, implement and administer the initiative could be applied to other local government areas across Australia.

The risk assessment process is one that is familiar to most local governments. The addition of climate change expertise, either through staff training or external technical support, would ensure that most local governments would be able to undertake similar climate change risk assessments and develop adaptation options.

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Glossary

Adaptation (as in climate change adaptation) – actions that can be carried out in response to actual or projected climate change impacts that lead to a reduction in risks or a realisation of benefits. This can include strategies to increase the resilience of systems, such as reducing pollution and pests for natural ecosystems.

Adaptive capacity – the ability of an organisation or system to adjust to climate change (including changes in variability and extremes) so as to moderate potential damages, take advantage of opportunities, or cope with the consequences through changes in its characteristics or behaviour.

Biodiversity – the variety of all life forms: the different plants, animals and microorganisms, their genes, and the ecosystems and communities of which they are part. Biodiversity is usually recognised at three levels: genetic diversity, species diversity, and ecosystem diversity.

Carbon sequestration – the process of storing carbon dioxide in a solid material through biological or physical processes. It includes revegetation and pumping carbon dioxide into underground rock formations.

Carbon sink – a carbon dioxide reservoir that is increasing in size. The main natural sinks are oceans, and plants and other organisms that use photosynthesis to remove carbon from the atmosphere by incorporating it into biomass and releasing oxygen into the atmosphere.

Climate – the average surface weather conditions in a region over a long period of time, including temperature, precipitation, atmospheric pressure, humidity, sunshine, ultraviolet (UV) levels, wind patterns, and other physical measurements.

Climate change – any change in climate over time, whether due to natural variability or as a result of human activity.

Climate change projection – a set of future conditions, or consequences, based on explicit assumptions about emission rates and concentrations and the response of the climate system to changes in these variables. Climate change projections estimate the response of the climate system to scenarios of greenhouse gases often based upon simulations of the climate system by computer-based mathematical models. Projections are therefore subject to substantial uncertainty.

Climate prediction – an attempt to produce an estimate of the actual evolution of the climate in the future.

Climate scenario – a coherent, plausible but often simplified description of a possible future state of the climate, which has been constructed for explicit use in investigating the potential consequences of human-caused climate change. The IPCC has developed emission scenarios which are based on assumptions including population change, socioeconomic development and technological change.

These IPCC emission scenarios feed into the development of climate change projections. A 'climate change scenario' is the difference between a climate scenario and the current climate.

Climate variability – variations or deviations from the mean state of the climate. The climate system has natural, internal variability, but this could be affected by external factors driving climate change, such as changes in the atmospheric concentration of greenhouse gases.

Critical threshold – a point where a small push away from one state has only small effects at first, but at some 'tipping point' the system can flip and go rapidly into another state, usually because of positive feedbacks.

Ecological engineering (eco-engineering) – the design, construction and management of ecosystems that have value to both humans and the environment.

Ecosystem services – the benefits people obtain from ecosystems, such as food, renewable resources, water supply, recreational opportunities, oxygen, carbon sequestration and erosion control.

El Niño-Southern Oscillation (ENSO) – sustained warming over a large part of the central and eastern tropical Pacific Ocean. Combined with this warming are changes in the atmosphere that affect weather patterns across much of the Pacific Basin, including Australia. These altered weather patterns often help promote further warming of the ocean because of the changes they cause in ocean currents.

Emergency – an event, either actual or imminent, which endangers or threatens to endanger life, property or the environment, and which requires a significant and coordinated response.

Emergency management – is the organisation and management of resources for dealing with emergencies, which can including planning, structures and arrangements and may involve all levels of government, volunteers and agencies.

Enhanced greenhouse effect – increases in the atmospheric concentration of greenhouse gases, such as carbon dioxide, methane and nitrous oxide, due to human activities, leading to an increase in the amount of thermal radiation near the Earth's surface. Most scientists agree that the enhanced greenhouse effect is leading to an increase in global average surface temperature and other changes in the atmospheric environment.

Eutrophication – increase in the concentration of nutrients in waterways, leading to algal blooms, oxygen depletion and reductions in water quality.

Extreme event – weather conditions that are rare for a particular place and/or time, such as an intense storm or heatwave.

Global warming – the increase in the average temperature of the Earth's near-surface air and oceans since the mid-20th century and its projected continuation. It is very likely due to the observed increase in human-caused greenhouse gas concentrations.

Greenhouse effect – the process by which gases in the lower atmosphere, such as carbon dioxide and water vapour, trap radiation released by the Earth's surface after it has been warmed by solar

energy. These gases then radiate heat back towards the ground, adding to the heat the ground receives from the Sun. The surface of the Earth would be about 33°C cooler on average than it is without the natural greenhouse effect. Global warming, a recent warming of the Earth's lower atmosphere, is believed to be the result of an enhanced greenhouse effect due to increased concentrations of greenhouse gases in the atmosphere.

Intergovernmental Panel on Climate Change (IPCC) – a scientific intergovernmental body set up by the World Meteorological Organisation (WMO) and the United Nations Environment Program (UNEP), which provides an objective source of information about climate change.

Kyoto Protocol – a protocol to the International Framework Convention on Climate Change, which has the objective of reducing the emission and atmospheric concentration of greenhouse gases that cause climate change. Agreed 11.12.97, entered into force 16.2.05; Australia signed December 2007 and became a full member in 2008.

Mitigation (as in climate change mitigation) – a human intervention to reduce the human-caused forcing of the climate system; it includes strategies to reduce greenhouse gas sources and emissions, and to enhance greenhouse gas sinks. Mitigation reduces the likelihood of exceeding the adaptive capacity of natural systems and human societies.

Policy (as in local government policy) includes all documents, decisions, positions and precedents that are consistently applied when making decisions, investments or preparing plans.

Phenology – timing of life cycle events, e.g. flowering, migration, spawning.

Physiological adaptation – biological changes in an organism to respond to changing conditions.

Refugia – areas that have escaped or will escape changes occurring elsewhere and so provide suitable habitats for relict species.

Resilience – the capacity of systems to absorb disturbance and reorganise while undergoing change; retaining function, structure, identity and feedbacks. In the context of climate change, resilience refers to the extent to which ecosystems can cope with a changing climate and continue to exist in their current state, in terms of composition, structure and functioning. The related term transformation refers to changes in ecosystem composition, structure and functioning (i.e. a transition to a new state) in response to a changing climate. Application of these terms is scale dependent; i.e. transformation at one scale may be necessary to deliver resilience at higher scales.

Sensitivity – the degree to which a system is affected, either adversely or beneficially, by climate related variables including means, extremes and variability.

Vulnerability – the degree to which a system or organisation is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate variation to which a system is exposed, its sensitivity and its adaptive capacity.

Appendices



Table 22: CSIRO climate predictions for the Perth region

Variable	Season	2030	2030	2030	2070	2070	2070	2070	2070	2070
		A1B	A1B	A1B	B1	B1	B1	A1FI	A1FI	A1FI
		10p	50p	90p	10p	50p	90p	10p	50p	90p
Temperature (°C)	Annual	0.6	0.8	1.2	1	1.4	2	1.9	2.7	3.8
	Summer	0.6	0.9	1.3	1	1.5	2.2	1.9	2.9	4.2
	Autumn	0.6	0.8	1.2	0.9	1.4	2	1.6	2.7	3.9
	Winter	0.5	0.7	1	0.8	1.2	1.7	1.6	2.3	3.3
	Spring	0.6	0.9	1.3	1	1.5	2.1	1.9	2.9	4.1
No. of days over 35°C (current 28.1)	Annual	33.1	35.1	36.7	36.2	40.5	46.2	44.1	53.8	67.4
Rainfall (%)	Annual	-13	-6	+1	-21	-11	+1	-37	-19	+2
	Summer	-16	-4	+9	-25	-6	+14	-43	-12	+28
	Autumn	-15	-4	+8	-24	-7	+14	-41	-12	+26
	Winter	-14	-7	-1	-23	-12	-1	-39	-22	-2
	Spring	-18	-9	-2	-29	-15	-4	-48	-27	-7
Potential evaporation (%)	Annual	+1	+2	+4	+2	+4	+6	+4	+7	+12
	Summer	+1	+2	+3	+1	+3	+6	+2	+6	+11
	Autumn	+1	+3	+5	+2	+5	+9	+4	+9	+17
	Winter	+2	+5	+9	+4	+8	+15	+7	+16	+28
	Spring	0	+2	+4	0	+3	+7	+1	+6	+13
Wind speed (%)	Annual	-3	0	+2	-5	0	+4	-9	-1	+7
	Summer	-1	+2	+7	-2	+4	+12	-5	+8	+24
	Autumn	-2	+2	+7	-4	+3	+11	-7	+6	+21
	Winter	-10	-4	+1	-17	-7	+2	-34	-14	+4
	Spring	-5	-1	+3	-9	-1	+5	-17	-3	+10
Relative humidity (%)	Annual	-1.3	-0.6	+0.0	-2.1	-1.0	-0.2	-4.0	-2.0	-0.3
Solar radiation	Annual	-0.1	+0.4	+1.0	-0.2	+0.7	+1.7	-0.3	+1.4	+3.3

Appendix 2: Climate Change Survey



Information and Survey

The Peel Climate Change Adaptation Project is an initiative of the Peel-Harvey Catchment Council and is funded by the Australian Government Department of Climate Change and the Peel Development Commission. The project aims to build local government capacity in the Peel region to adapt to the predicted impacts of climate change through policy and/or adaptation development for two or three issues considered to be climate change priority areas.

It is essential to gain an understanding of what your organisation considers to be the priority areas for climate change policy development. Please complete the attached survey and returned by **Monday, 22 June 2009** by e-mail to kim.byrnes@peel.wa.gov.au or fax (08) 9535 2119. Additional comments are welcome.

This brochure identifies some potential impacts on the Peel region to generate discussion and assist in identification of key priority areas for policy development. Further information on current climate change predictions for the Peel region, likely implications and current legal and policy framework is available in the Peel Climate Change Adaptation Project Issues Paper

Climate change is not just an environmental problem. Local governments through their role as key providers of community infrastructure and services will face impacts across the suite of service provision. Adaptation planning will need to draw on the expertise of a wide range of local government sectors. The symbols below indicate the areas of local government functionality that will need to be included in for each identified climate impact area.

The Peel-Harvey Catchment Council has secured funding from the Federal Government Department of Climate Change to undertake a Climate Change Adaptation Project for the Peel Region. The Project aims to develop policy and or adaptation options for two or three issues considered to be climate change priority areas. As a first step in this process it is important to gain an understanding of what your Councils consider to be the priority areas for climate change.

For further information, please contact Kim Byrnes, Project Manager Climate Change on 9535 0033 or kim.byrnes@peel.wa.gov.au.

It is requested that surveys are returned by Monday 22 June 2009.

Thank you for your participation.

Council:

Contact Name/s:

Position Title:

Phone:

Fax:

E-mail:

General

Q1 Please indicate your knowledge of climate change.

1 2 3 4 5 6 7 8 9 10
None  High

Climate Change Issues

Please score the level of importance for each issue listed below for the development of policy in your organisation, where on a scale of one to ten, 1 is very low importance and 10 is very high importance.

Bushfire

Increased bushfire risk due to temperature rise and dying vegetation increasing bushfire fuel loads

Hydrology

Reduced rainfall leading to reduced water availability and altered water quality
Salt water intrusion into wetlands and ground water sources
Altered river and stream flows with changed sediment and nutrient dynamics

Sea Level Rise

Sea level rise causing flooding and damage to coastal infrastructure
Increased coastal, estuarine and stream bank erosion leading to loss of facilities and infrastructure, e.g. boat ramps and jetties
Permanent or regular inundation of low-lying areas

Emergency Management

Increasing frequency and or intensity of extreme weather events
Injury and/or death from increased flooding

Biodiversity

Change in species composition green spaces/public open spaces/natural areas
Increased rate of spread of plant disease
Weed and pest invasion
Changing plant and animal behaviour
Extinctions, loss of keystone species
Change in species composition
Altered coastal, estuarine and riverine biodiversity

Public Health

Reduced water quality leading to illness and disease
Increase in incidence of disease resulting from climatic conditions becoming favourable for a wider range of vector, food and water borne disease
Injury, illness or death through heat stress

Infrastructure

Disruption to electricity and fuel supplies as a result of extreme weather events
Loss of or damage to infrastructure arising from extreme storm events
Ground subsidence as the ground dries out
Increased incidence of dams being constructed or modified without development approvals
Acid sulphate soils exposure
Infrastructure failure causing flooding

Community/Social

Damage to heritage and Indigenous sites by flooding and sea level rise
Displaced populations resettling (local, regional, state, national and international)
Financial impacts, reduced property prices in some locations

Governance

Exposure to legal liability on planning decisions
Reduced insurance coverage
Uncertainty about impacts on local government
Carbon Pollution Reduction Scheme

Other

Please specify and score.

Q2 What action/s has your Council undertaken (or is currently undertaking) to mitigate or adapt to climate change *(place an X in as many boxes as required and please specify in the space provided next to the action)*

Policy development	<input type="checkbox"/>
Research (e.g. coastal mapping)	<input type="checkbox"/>
Commissioning or preparation of reports	<input type="checkbox"/>
Development of management plans	<input type="checkbox"/>
Measures to record changes	<input type="checkbox"/>
Seeking grants	<input type="checkbox"/>
Preparation of planning instruments	<input type="checkbox"/>
Conducting workshops	<input type="checkbox"/>
Inclusion of climate change issues in SoE Reporting	<input type="checkbox"/>
Cities for Climate Protection Program (list current milestone)	<input type="checkbox"/>
Other (please specify)	<input type="checkbox"/>

Q3 Is Council undertaking any of the following educational programs relating to climate change mitigation and/or adaptation? *(place an X in as many boxes as required and please specify further in the space provided next to the program)*

Community	<input type="checkbox"/>
Business/Industry	<input type="checkbox"/>
Retrofit of facilities	<input type="checkbox"/>
Community/business retrofit or subsidy programs	<input type="checkbox"/>
Committees	<input type="checkbox"/>
Other (please specify)	<input type="checkbox"/>

Q4 Does Council have an Environmental Management System (EMS) in place?

Yes	<input type="checkbox"/>
No	<input type="checkbox"/>

Q5 Has Council undertaken any form of risk assessment relating to the impacts of climate change?

Yes	<input type="checkbox"/>
No	<input type="checkbox"/>

Q6 What is your most preferred method of being kept informed about project progress (e.g. summit date, upcoming grant opportunities)? *(the most important should be numbered 1 and so on until you have numbered all 3)*

Newsletter	<input type="checkbox"/>
Formal letter to Council	<input type="checkbox"/>
E-mail to Climate Change Adaptation Project contact officer	<input type="checkbox"/>
Other (please specify)	<input type="checkbox"/>

Q7 Please indicate if there are further measures that the Peel-Harvey Catchment Council should consider to assist your organisation in adapting to climate change. Please list and describe.

Appendix 3: Review of policy relevant to climate change adaptation as at June 2009.

The Peel Climate Change Adaptation Policy and Initiatives review, outlined below in alphabetical order, provides a brief summary of some of the climate change policies and adaptation initiatives relevant to the development of climate change adaptation policy in Western Australia. Time spent on the review was limited to 200 hours.

Adapting To Climate Change: A Queensland Local Government Guide Local Government Association of Queensland (LGAQ) (QLD)

This gives assistance to assess climate change impacts on Queensland local governments and appropriate adaptation responses.

Adapting to the Impacts of Climate Change in the Western Port Region 2005-2006 Projects – Western Port Greenhouse Alliance (WPGA)

The Project was funded by the Victorian Department of Sustainability and Environment to assess the knowledge needs for responding to climate change in the Western Ports area and raise awareness about climate change. Marsden Jacob Associates, CSIRO and the Regional Development Company were engaged to deliver the project. Documents and reports associated with the project are available at http://www.seccca.org.au/project_summary.asp?data_id=11

Australian Local Government Association (ALGA)

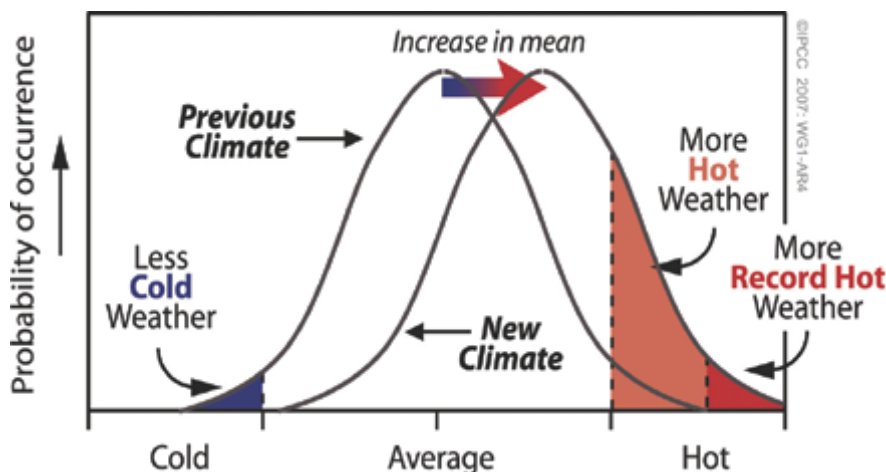
The Australian Local Government Association provides information and resources and represents local government. ALGA has prepared a climate change discussion paper that highlights the wide ranging implications of climate change for local government and identifies issues of relevance to local government, including: access to science and information, potential impacts of the Carbon Pollution Reduction Scheme, planning for the future (the need to review new information and incorporate it into policy etc, actions to support local adaptation, water reform and managing emergencies).

Australia's Biodiversity and Climate Change (Department of Climate Change)

This summarises the strategic assessment of the vulnerability of Australia's biodiversity to climate change. An independent Expert Advisory Group (commissioned by the Natural Resource Management Ministerial Council) conducted the assessment and reported findings to the department of climate change. Key findings include:

- Climate change will exacerbate existing threats to biodiversity as well as having direct impacts
- Effects are already discernable at genetic, species and ecosystem levels
- The magnitude and rate of change is problematic
- *“Management objectives for the future aimed at maintaining all species in their present locations and ecosystems in their present composition will no longer be appropriate. A management priority must be to maintain the provision of ecosystem services through a diversity of well functioning ecosystems, some of which may have no present day equivalent”* (p. 20 summary for policy makers).
- There is a need to build resilience by:
 - managing connectivity of ecosystems

- enhancing the national reserve system
- protecting key refugia
- effective control of invasive species
- fire and disturbance management regimes
- ecological engineering (in some circumstances).
- Risk assessments are needed to identify vulnerable species and ecosystems
- Reorientation of policy and legislative frameworks, reform of institutional and governance frameworks to support novel strategies for biodiversity conservation, e.g. **integrated regional approaches tailored for regional differences in environments, climate change impacts and socio-economic trends are necessary**
- Ongoing mitigation of greenhouse gas is necessary.



Relationship between means and extremes: This graph shows the relationship between a shifting mean and the proportion of extreme events when extreme events are defined as some fixed physiological or life history threshold. Source: (IPCC 2007b).

The report recognises that biodiversity conservation has been underfunded for the last 200 years.

Biodiversity at the Heights (BATH) Project – Gold Coast City Council (QLD)

The Biodiversity at the Heights project is an International project led by Griffith University. The project is undertaking a fauna and insect study in Lamington National Park to identify signs of climate change effects on biodiversity. Information will be used to develop the nature conservation strategy to incorporate adaptation strategies to reduce climate change impacts on vulnerable species and ecosystems.

Capacity Building in Local Government Mitigation and Adaptation Project Local Government Shires Association of New South Wales (LGSA)

This project develops and disseminates information to increase local governments' understanding of climate change scenarios, impacts and mitigation and adaptation opportunities through a strategic approach. The website has information and resources available. Contact: Amy Lovesey, Climate Change Mitigation and Adaptation Policy Officer, amy.lovesey@lgsa.org.au, 02 9242 4128. <http://lgsa.org.au/policy/planning-for-climate-change>

Carbon Pollution Reduction Scheme (CPRS) Draft Legislation (Aust)

Draft legislation for a national emissions trading scheme was released on 10 March 2009. The proposed CPRS is a cap and trade scheme and was due to commence in 2010; however, it has been the subject of a Parliamentary review and this and the recent economic downturn have seen the delay of implementation until 1 July, 2011. The development of a national carbon pollution reduction scheme will be a key driver of greenhouse gas reductions in Western Australia.

Climate Change Planning for Byron Shire – Byron Shire Council (NSW)

In November 2008, Byron Shire Council approved plans to ensure that climate change scenarios were incorporated into council planning frameworks. All planning reports must now include climate change assessments and impacts. A climate change action plan is also being prepared. www.byron.nsw.gov.au

Climate Change Risk Assessment Project – Swan River Trust

The Swan River Trust produced a technical paper in 2007; *Potential Impacts on Swan and Canning Rivers*. A Climate Change Risk Assessment methodology has been developed (with the assistance of City of Perth and based on the Australian/New Zealand Standard (4360:2004)) for Local Governments to assess risks to foreshores and identify adaptation options. This model is currently being used to conduct a risk assessment at Point Fraser (on the Swan River). Mapping is currently being undertaken with the results expected in September 2009. Contact: Christie Atkinson, christie.atkinson@dec.wa.gov.au, 08 9278 0852.

WALGA Climate Change Management Toolkit

The Western Australian Local Government Association has developed toolkit to assist local governments in Western Australia adapt to climate change. The website provides a 7 step process to help local government managers develop climate change adaptation strategies through the provision of information and tools. The toolkit is available at www.walgaclimatechange.com.au

Climate Change Vulnerability Assessment Project – Town of Cottesloe (WA)

This is a pioneering risk assessment project funded by Emergency Management Australia and facilitated by Coastal Zone Management (CZM). The project identified risks to key infrastructure and options available for treatment. It outlines international and Australian best practice. Project reports are available at <http://cottesloe.wa.gov.au>

Climate Change Working Party – Western Sydney Regional Organisation of Councils (NSW)

The Climate Change Working Party was developed to support member councils in responding to climate change through the development of partnerships with researchers and to provide localised and specific climate change information to identify risks and adaptation options. Councils involved in the project include: Auburn Council, Bankstown City Council, Blacktown City Council, Blue Mountains City Council, Fairfield City Council, Hawkesbury City Council, Holroyd City Council, Liverpool City Council, Parramatta City Council, Penrith City Council, Hills Shire Council. Contact: Colin Berryman, WSROC Natural and Built Environment Coordinator.

Information and resources are available at: www.wsroc.com.au

Climate Impacts on Clarence Coastal Areas Project – Clarence City Council (Tas)

Clarence City Council received funding from the Department of Climate Change National Climate Change Adaptation Program, State Government State Emergency Service through the Tasmanian Risk Mitigation Program and Clarence City Council to undertake an assessment of the climate change impacts on coastal areas in the Clarence City Council in response to concerns about flooding in low lying coastal areas.

The report *Integrated Assessment (1A) Climate Change Impacts* is available on the Clarence City Council website and includes draft changes to the planning scheme. Public forums were held to inform the community of the project and the report, and a survey was undertaken to assess community attitudes and knowledge of climate change. Contact: John Stevens, twebb@ccc.tas.gov.au

The project received the (Tasmanian) Premiers Award for Climate Action in 2009.

Coastal Options Project – City of Thuringowa

The City of Thuringowa in partnership with James Cook University undertook a two-year investigation into climate change impacts of sea level rise, coastal erosion and storm surge on coastal communities north of Townsville. The project included a risk assessment on existing and future development and the development of adaptation options.

Coastal Zone Risk Assessment – City of Mandurah (WA)

The City of Mandurah secured funding under the Federal Governments Local Adaptation Planning program to undertake a risk assessment of the coastal zone. Risk assessment and adaptation workshops were undertaken under the facilitation of Coastal Zone Management. Contact: Craig Perry 9550 3777.

Commonwealth Scientific and Industrial Research Organisation (CSIRO) Climate Impacts Group

The Climate Impacts Group was launched in the late 1980s and currently has several divisions engaged in climate change research. Its focus is on providing comprehensive, rigorous science to help Australia understand and plan for climate change. The Climate Adaptation National Research Flagship is developing responses to adapt to the expected impacts of climate change. A new adaptation initiative has recently been announced. The **Online Tool for Community Adaptation to Climate Change** has attracted \$330 000 from the Department of Climate change (announced on 4 March 2009). Contact: Dr Andrew Ash, Director, Climate Adaptation Flagship 07 3214 2346, Andrew.Ash@csiro.au

Cost Benefit Model for Climate Change Adaptation and Mitigation at the Local Scale Ku-ring-gai Council

Ku-ring-gai Council developed a conceptual risk analysis and cost benefit response model that expands on the Australian Greenhouse Office risk assessment model. Ku-ring-gai Council is working with Macquarie University to develop this into a generic planning model suitable for use by local government agencies globally. The cost benefit analysis tool was used to assist with identifying and prioritising adaptation options. Contact: Jennifer Scott, Sustainability Program Leader, 02 9424 0862, jscott@kmc.nsw.gov.au

Department of Agriculture and Food (WA) Climate Change and Adaptation in South West Western Australia: Community, industry and government views on past and future climate change for South West Western Australia (November 2006)

Action 5.5 of the Western Australian Greenhouse Strategy.

Two phases:

1. How residents, organisations, institutions, industries and natural systems have responded to climate changes that began in 1970's
 - historical review 1970-2006
 - stakeholder consultation
 - scoping report
2. A detailed study to assess the vulnerability of the region's various sectors to future climate change and improve adaptation capacity
 - Consultation with stakeholders from community, industry, government.

Future Proofing Perth's Eastern Region: Adapting to Climate Change – Eastern Metropolitan Regional Council (EMRC) (WA)

The Eastern Metropolitan Regional Council is a regional organisation of six councils (Town of Bassendean, City of Bayswater, City of Belmont, Shire of Kalamunda, Shire of Mundaring and City of Swan). The project was funded by EMRC and through the Federal Local Adaptations Pathways program to undertake a regional climate change risk assessment and develop an adaptation plan. Coastal Zone Management facilitated the workshops. Reports are not currently publicly available. Contact: Naomi Rakela, Senior Policy Officer, (08) 9424 2273, Naomi.Rakela@emrc.org.au

Garnaut Review (Aust)

The Council of Australian Governments commissioned a review of the impact of climate change on the Australian Economy. The Review was conducted by Professor Ross Garnaut. The Review report and other documents can be found at <http://www.garnautreview.org.au/>. Following the 2007 federal election, the Commonwealth joined the review and committed to investigating an emissions trading scheme.

Impacts of Climate Change on Human Settlements in the Western Port Region: An Integrated Assessment – Western Port Greenhouse Alliance (WPGA)

This two-year project was funded by the Australian Government Department of Climate Change and the Victorian Department of Sustainability and Environment. It was managed jointly by Marsden Jacob Associates and the Western Port Greenhouse Alliance.

The report builds on the *Adapting to the Impacts of Climate Change in the Western Port Region 2005-2006* project (see above). The project aims to improve the understanding of the economic, social and scientific impacts of climate change on the region, build the capacity of local governments to adapt and develop a strategy that could be used by other local governments in Australia for built environment and local adaptation responses to those impacts. The project follows a risk assessment and adaptation process. Reports are available at:

http://www.wpga.org.au/projects/Final_Risks_and_Adaptation.pdf, or by contacting Greg Hunt, Executive Officer, ph (03) 9705 5129.

'International Council for Local Environmental Initiatives' – Local Governments for Sustainability; (ICLEI) Cities for Climate Protection Program

The Cities for Climate Protection (CCP) program focused on greenhouse gas emissions abatement and mitigation in local governments via a milestone framework. Although the program has now finished, information and resource are available on the ICLEI website.

'International Council for Local Environmental Initiatives' – Local Governments for Sustainability; (ICLEI) Local Government Adaptation Toolkit

The Local Adaptation Toolkit is based on the Federal Government's Climate Change and Risk Management Framework and uses conceptual models to identify information on individual topics. It aims to build capacity within local governments to develop and implement climate change adaptation plans via a milestone process. An adaptation toolbox provides additional information and resources.

Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) is recognised as the leading authority on climate change. It is responsible for reviewing climate change research to '*understand the risk of human induced climate change, its observed and projected impacts and options for adaptation and mitigation*' (IPCC, 2007). The IPCC has been reviewing and summarising climate change data since 1988. The Fourth Assessment Report was released in 2007.

The Fifth Assessment Report is currently being outlined and is due for release in 2014. Additionally, the IPCC is preparing a report on 'Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation' which is due in 2011.

Kyoto Protocol

The Kyoto Protocol is the primary international legal instrument for addressing climate change and has been ratified by 177 countries, including Australia (see below). The protocol includes legally binding targets of at least 5% below 1990 levels for the period 2008-2012.

The Rudd Labour Government ratified the Kyoto protocol on 3 December 2007 and became a party to the protocol on 11 March 2008. This means that Australia's commitment to a reduction of 108% of 1990 greenhouse gas levels (Department of Premier and Cabinet 2002) is now binding.

Local Adaptation Pathways Program (Department of Climate Change – Australia)

The Federal Government's Local Adaptation Pathways Program provides funding for local governments to assess climate change risks and develop adaptation strategies. Thirty-three projects were funded in the first round and seven projects were funded in the second round. Projects funded under the first round are nearing completion and information on some projects will become available in the near future.

Local Adaptations Pathways Program (LAPP) Southern Metropolitan Regional Council (SMRC) (WA)

The Southern Metropolitan Regional Council includes the Cities of Canning, Cockburn, Fremantle and Rockingham and Towns of East Fremantle and Kwinana. The LAPP project aimed to identify the climate change risks to participating councils across the suite of council operational areas and implement a risk management framework. The project was funded by the Federal Governments Local Adaptations Pathways program. GHD Australia was contracted to facilitate workshops. The Risk Assessment report has been completed and the Adaptation Report is currently in draft form. The reports are expected to be available in August 2009. Contact: Anis Zaman, anis@smrc.com.au

Managing Science Intensive Public Policy: Institutional Arrangements and Climate Change Policy – Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) (Australia)

This project investigates how science research is integrated into public policy to improve communication amongst scientists and decision makers to facilitate the development and deliverance of targeted public policy that is in the public interest. ACE CRC is collaborating with a number of research, education and government bodies. Contact: Dr Rosemary Sandford, Project Leader, Policy, rosemary.sandford@acecrc.org.au

National Adaptation Research Plan – Emergency Management (Aust)

The National Adaptation Research Plan has been developed to address climate change adaptation needs in the disaster management and emergency services areas. This research plan is currently awaiting ministerial approval. Contact: Florence Crick, f.crick@griffith.edu.au. <http://www.nccarf.edu.au/content/narp-emergency-management>

National Climate Change Adaptation Program (NCCAP)(Aust)

NCCAAP identifies research gaps and tools to be developed to assist governments, industries and community to adapt to climate change. The program was launched under the Australian Greenhouse Office in 2004 and is focused on impacts of climate change.

National Climate Change Adaptation Framework (Australia)

The Council of Australian Governments (COAG) National Climate Change Adaptation Framework identifies a collaborative framework for all levels of government in Australia to adapt to climate change. The COAG Working Group on Climate Change and Water was tasked with accelerating implementation of agreed upon action in the 2007 National Climate Change Adaptation Framework by:

- developing, implementing and reviewing policies and strategies, including regulation, standards and economic instruments. This includes integrating climate change considerations into existing policies and strategies;
- establishing and maintaining community and essential services to deal with the impacts of climate change, including emergency management and health services;
- building adaptive capacity, including providing tools and information, raising awareness of adaptation options, educating key professionals about adaptation and investing in climate change science as well as related social, ecological and economic studies; and

- managing risks from climate change to their own programs, activities and assets, including natural ecosystems for which governments have management responsibility (e.g. crown land, state forest, national parks) and infrastructure (e.g. transport, electricity and water). Implement policies and measures to promote awareness, build adaptive capacity and facilitate adaptation.

National Climate Change Adaptation Research Facility (NCCARF) (Australia)

Hosted by Griffith University, the National Climate Change Adaptation Research Facility is a multi-institutional research collaborative and a focus point for climate change adaptation. \$126 million has been funded by the Department of Climate Change. The facility is developing sector or topic based National Adaptation Research Plans with other institutions and end users with a focus on generating the knowledge required for Australia to adapt to the physical impacts of climate change. www.nccarf.edu.au

New England Strategic Alliance of Councils (NSW) Climate Change Adaptation Project

The New England Strategic Alliance of Councils secured funding under the Federal Local Adaptations Pathways program to develop a regional climate change adaptation strategy. Councils involved in this project include Armidale Dumaresq, Uralla, Walcha and Guyra. This project builds on the work of the NSW Community Climate Consensus Project (2008) and was facilitated by SKM consultants. The draft adaptation report is available at <http://armidale.nsw.gov.au/images/documents/armidale/mig/133741-Climate.pdf>. Contact: **Director Sustainable Planning and Living**, Steve Gow Phone: (02) 6770 3853, sgow@armidale.nsw.gov.au

Ocean Beach Coastline Management Plan – Manly Council (NSW)

This involves the development of a coastal management plan and emergency action plan to direct future management of Manly Ocean Beach which incorporates future climate change impacts into the planning process. The project has developed a 10-20 year strategic plan for the area. A copy of the Management Plan is available on the website at <http://www.manly.nsw.gov.au>.

Office of Climate Change (WA)

The Office of Climate Change was established within the Department of Environment and Conservation in May 2007. It is responsible for a whole of government approach to the economic, environmental and social impacts of climate change in Western Australia.

Renewable Energy (Electricity) Act 2000 (Commonwealth of Australia)

The *Renewable Energy (Electricity) Act 2000* encourages additional renewable energy generation by obligating electricity retailers to source a proportion of their electricity from approved renewable energy sources under mandatory renewable energy targets (MRET) which apply until 2020. Renewable energy certificates (RECs) are generated for each megawatt of renewable energy produced (including small scale renewable energy sources such as photovoltaics, wind generation). Electricity generators must surrender sufficient RECs based on energy used. Failure to surrender sufficient RECs results in financial penalties.

Risk Assessment Model – South West Catchments Council (SWCC) (WA)

GHD has been contracted by the South West Catchments Council to develop a risk assessment model for biodiversity/natural resources management. The risk assessment tool is expected to be available by August. Contact: Fionnuala Hannon, Principal Environmental Consultant, GHD, fionnuala.hannon@ghd.com.au

Sea Level Rise – Gold Coast City Council (QLD)

In 1998 the Gold Coast City Council pioneered the introduction of the impact of sea level rise on town planning to identify implications for future land development. CSIRO modelling was used in the analysis. Consequently an additional 27cm buffer on top of Q100 flood levels was incorporated into plans. Further modelling was commissioned to identify impacts of storm surges and frequency specific to the area.

Start Early, Finish Early Cook Shire Council (Qld)

This is an adaptation initiative where the council has implemented changes to the external workforce working hours to avoid temperature related climate change risks.

United Nations Framework convention on Climate Change (UNFCCC)

The UNFCCC was adopted at the 'Earth Summit' on 4 June 1992 and entered into force on 21 March 1994. It is the primary foundation for international cooperation to address climate change and aims to stabilise *'greenhouse gas concentration in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system'* (United Nations, 1992, p. 4). Parties to the UNFCCC agree to mitigate greenhouse gas emissions, however these commitments are not binding. Binding targets are included in the Kyoto Protocol.

Victorian Climate Change Adaptation Program

This program developed a policy choice framework for decision makers to select policies to assist primary industries adapt to climate change. It involved collaboration between several Victorian Government Departments including: Sustainability and Environment, Primary Industries, Human Services, Premier and Cabinet, and Innovation, Industry and Regional Development. The Victorian Climate Change Adaptation Program undertook a review of climate change policy (high level) to inform climate change policy in Victoria.

Victorian Climate Change Green Paper

The Victorian Government has recently released a Green Paper on Climate Change. Discussion on this draft policy will help shape the Victorian Government's policy response to climate change.

The development of the green paper was influenced by the Victorian Climate Change Summit. The summit was held on 4 April 2008 to gather information to assist in the development of the green paper. One hundred delegates from a range of disciplines attended. Following the summit a discussion paper, *A Climate of Opportunity* was released to continue to raise awareness and generate debate in the community. A copy of the Green Paper can be found at: http://www.climatechange.vic.gov.au/_data/assets/pdf_file/0016/125422/Victorian-Climate-Change-Green-Paper-July-2009.pdf

Appendix 4: Key legislation and policy for biodiversity conservation

The development of Peel Climate Change Adaptation *Biodiversity* strategies are also supported by local government policies, and state and federal government policies and legislation as outlined below:

- International Treaties and Agreements
 - *United Nations Convention on Biological Diversity*. Conservation and sustainable use of biological resources.
 - *Ramsar Convention*. Recognition of wetlands of international importance. Signatories agree to maintain ecological values of listed wetlands.
- Federal Legislation
 - *Environmental Protection and Biodiversity Conservation Act 1999*. Pertains to the assessment of actions significantly impacting on matters of national environmental significance; this includes the ecological character of Ramsar-listed wetlands.
 - *Commonwealth Water Act 2007* and *Water Amendment Act 2008*. Largely focused on the Murray-Darling basin.
 - *National Local Government Biodiversity Strategy 1998*
- State Legislation and Policies
 - *Wildlife Conservation Act 1950*. Protection of Native Species.
 - *Environmental Protection Act 1986 (EP Act)*. Pertains to the need for environmental impact assessment for development proposals that are likely to have significant impacts. The act also gives the State powers to develop environmental protection policies, such as Environmental Protection (Peel Inlet-Harvey Estuary) Policy 1992; and Environmental Protection (Swan Coastal Plain Lakes) Policy 1992.
 - *Clearing of Native Vegetation Regulations 2004*. Sits under the *EP Act* and regulates the clearing of native vegetation.
 - Planning and Development Act 2005; including State Planning Policies, such as State Planning Policy 2.1 Peel-Harvey Coastal Plain Catchment
 - *Conservation and Land Management Act 1984*. Provides for the use, protection and management of public land and water and for the biodiversity upon it.
 - *Agriculture and Related Resources Act 1976*. Allows local governments to control declared pest species on and in relation to land under its control.
 - *Local Government Act 1995*
 - Section 1.3 (3) *In carrying out its functions, a Local Government is to use its best endeavours to meet the needs of current and future generations through integration of environmental protection, social advancement and economic prosperity*
(i.e. local governments have a responsibility under the act to manage their biodiversity assets for the environmental, economic and social good of current and future generations).

Appendix 5: Risk Register for Emergency Management

Table 23: Risk Register for Emergency Management

Climate Change Category	Risk	Likelihood	Consequence	Risk Priority
Health Services	increase in mosquito numbers and therefore disease risk	Almost Certain	Major	Extreme
Health Services	heat stress on people	Almost Certain	Minor	Medium
Health Services	air con use and therefore energy capacity	Almost Certain	Minor	Medium
Health Services	increased algal bloom and nutrient impact	Likely	Minor	Medium
Health Services	food outbreaks	Possible	Minor	Low
Health Services	water quality and availability	Likely	Minor	Medium
Health Services	fire/smoke inhalation and respiratory issues	Likely	Moderate	High
Health Services	dust storms and health	Likely	Minor	Medium
Health Services	skin cancer and heat stress	Likely	Minor	Medium
Health Services	flooding and disease risk	Possible	Moderate	Medium
Health Services	mould	Possible	Minor	Low
Health Services	health ambulance services	Unlikely	Moderate	Medium
Recreation facilities	maintenance of parks and reserves	Possible	Minor	Medium
Recreation facilities	water usage	Likely	Moderate	High
Recreation facilities	power consumption	Likely	Moderate	High
Recreation facilities	increased infrastructure (shade/cover)	Possible	Minor	Medium
Recreation facilities	outdoor pool evaporation	Almost Certain	Minor	Medium
Recreation facilities	lakes and water features evaporation	Almost Certain	Moderate	High
Recreation facilities	OSH issues due to relative humidity	Possible	Minor	Medium
Recreation facilities	increase in staff protection because of solar radiation	Possible	Moderate	High
Recreation facilities	tourism risk because of solar radiation	Unlikely	Minor	Low
Recreation facilities	erosion of foreshore facilities	Likely	Major	High
Waste & Sewerage	landfill gas generation	Unlikely	Insignificant	Low
Waste & Sewerage	increased pests	Likely	Minor	Medium
Waste & Sewerage	cost of collection	Almost Certain	Minor	Medium
Waste & Sewerage	lack of ability to collect			Low
Waste & Sewerage	overflow of sewerage/human waste	Possible	Moderate	Medium

Climate Change Category	Risk	Likelihood	Consequence	Risk Priority
Waste & Sewerage	rising water table - septic	Likely	Minor	Medium
Infrastructure & Property	increased power requirements	Almost Certain	Moderate	High
Infrastructure & Property	fire impact	Likely	Moderate	High
Infrastructure & Property	structural stability	Unlikely	Minor	Low
Infrastructure & Property	increased water consumption	Almost Certain	Major	Extreme
Infrastructure & Property	equipment failure	Unlikely	Minor	Low
Infrastructure & Property	increased power requirements	Almost Certain	Moderate	High
Infrastructure & Property	increased water consumption	Almost Certain	Moderate	High
Infrastructure & Property	dams - increased evaporation	Almost Certain	Major	Extreme
Infrastructure & Property	increased intensity of fire impact	Possible	Major	High
Infrastructure & Property	increase \$ for water consumption	Likely	Moderate	High
Infrastructure & Property	increased water recycling needs	Likely	Moderate	High
Infrastructure & Property	water sensitive design & maintenance	Likely	Moderate	High
Infrastructure & Property	increased fire risk	Likely	Major	High
Infrastructure & Property	decreased water availability	Likely	Major	High
Infrastructure & Property	increased power requirements	Almost Certain	Moderate	High
Infrastructure & Property	road surface degradation	Unlikely	Major	Medium
Infrastructure & Property	erosion of foreshore infrastructure	Likely	Major	High
Infrastructure & Property	impact on foreshore properties	Likely	Major	High
Infrastructure & Property	roads and bridges	Possible	Moderate	High
Infrastructure & Property	canal foreshore walks	Possible	Moderate	High
Infrastructure & Property	resumption of land	Possible	Moderate	High
Planning & Development	communication networks	Almost Certain	Catastrophic	Extreme
Planning & Development	education programs	Likely	Major	High
Planning & Development	loss of house & property	Almost Certain	Catastrophic	Extreme
Planning & Development	loss of council community infrastructure (roads/buildings)	Almost Certain	Major	Extreme

Climate Change Category	Risk	Likelihood	Consequence	Risk Priority
Planning & Development	increased homelessness	Almost Certain	Major	Extreme
Planning & Development	community safety	Likely	Moderate	High
Planning & Development	emotional wellbeing	Likely	Moderate	High
Planning & Development	loss of utilities	Almost Certain	Major	Extreme
Planning & Development	business continuity for LGAs	Almost Certain	Moderate	High
Planning & Development	more community unrest	Possible	Minor	Medium
Planning & Development	heat stress and stroke	Likely	Major	High
Planning & Development	impact on LGA financial stability	Unlikely	Major	Low
Planning & Development	LGA staff OHS	Likely	Moderate	High
Planning & Development	loss of volunteerism	Likely	Major	High
Planning & Development	commercial impact - loss of business	Likely	Moderate	High
Planning & Development	loss of agriculture	Likely	Moderate	High
Planning & Development	tourism	Almost Certain	Moderate	High
Planning & Development	long-term accommodation	Possible	Major	High
Natural Resource Management	erosion of coastal reserves	Almost Certain	Moderate	High
Natural Resource Management	erosion of estuaries	Almost Certain	Moderate	High
Natural Resource Management	change to species in water			Low
Natural Resource Management	change to ph level in water			Low

Appendix 6: Risk Register for biodiversity conservation

Table 24: Risk Register for biodiversity conservation

Climate Change Category	Risk	Likelihood	Consequence	Risk Priority
Sea Level Rise	loss of samphire – key habitat	Likely	Major	High
Sea Level Rise	dune erosion and loss of vegetation	Almost Certain	Major	Extreme
Sea Level Rise	migratory bird habitat impact	Likely	Major	High
Sea Level Rise	change of habitat (estuarine & coastal)	Almost Certain	Moderate	High
Sea Level Rise	mosquito breeding (increase in sites)	Almost Certain	Major	Extreme
Sea Level Rise	loss of tree cover – riverline edge	Almost Certain	Moderate	High
Sea Level Rise	insect changes in quantity and timing	Almost Certain	Moderate	High
Sea Level Rise	estuarine species – loss of habitat	Almost Certain	Moderate	High
Sea Level Rise	amenity & recreation – erosion, character, reserves	Likely	Moderate	High
Sea Level Rise	soil chemistry changes	Likely	Moderate	High
Sea Level Rise	salt water – intrusion further inland	Likely	Major	High
Sea Level Rise	Hydrology changes (surface ground water)	Almost Certain	Major	Extreme
Sea Level Rise	Yalgorup lake system – salinity	Likely	Catastrophic	Extreme
Rainfall – greenspaces	reduction in number and size	Likely	Moderate	High
Rainfall – greenspaces	social need	Likely	Moderate	High
Rainfall - greenspaces	physical activity	Likely	Moderate	High
Rainfall – greenspaces	increased cost of maintenance	Likely	Moderate	High
Rainfall - rehabilitation projects	timing	Likely	Moderate	High
Rainfall - rehabilitation projects	species – water needs	Likely	Moderate	High
Rainfall - rehabilitation projects	increased cost	Likely	Moderate	High
Rainfall - rehabilitation projects	weed control	Likely	Moderate	High
Rainfall - weed/pest invasion	competition with native species	Likely	Moderate	High
Rainfall - weed/pest invasion	number of weeds increase and pesticide use	Likely	Moderate	High

Climate Change Category	Risk	Likelihood	Consequence	Risk Priority
Rainfall - Wetland impacts	change in species composition	Almost Certain	Catastrophic	Extreme
Rainfall - Wetland impacts	abundance	Almost Certain	Catastrophic	Extreme
Rainfall - Wetland impacts	salinity levels	Almost Certain	Catastrophic	Extreme
Rainfall - Wetland impacts	Ramsar listing	Almost Certain	Catastrophic	Extreme
Rainfall - TECs	disappear	Almost Certain	Catastrophic	Extreme
Rainfall - TECs	degrade	Almost Certain	Catastrophic	Extreme
Rainfall - Nutrient Load run-off	increased load into water ways/catchment	Likely	Moderate	High
Rainfall - Nutrient Load run-off	public health	Likely	Moderate	High
Rainfall - Nutrient Load run-off	erosion	Almost Certain	Moderate	High
Rainfall - Nutrient Load run-off	nutrient increase	Almost Certain	Moderate	High
Rainfall - water use	reduction of stream flow	Almost Certain	Moderate	High
Rainfall - water use	ground water availability	Almost Certain	Moderate	High
Rainfall - water use	demand for alternative sources (desal, waste water re-use)	Almost Certain	Moderate	High
Temperature Rise	house design	Almost Certain	Major	Extreme
Temperature Rise	subdivision design	Almost Certain	Catastrophic	Extreme
Temperature Rise	street layout	Almost Certain	Major	Extreme
Temperature Rise	outdoor activities (land)	Almost Certain	Catastrophic	Extreme
Temperature Rise	street scapes	Likely	Moderate	High
Temperature Rise	air conditioning use	Almost Certain	Major	Extreme
Temperature Rise	power supply	Almost Certain	Catastrophic	Extreme
Temperature Rise	water supply	Almost Certain	Catastrophic	Extreme
Temperature Rise	mental health	Almost Certain	Catastrophic	Extreme
Temperature Rise	social well-being/unrest	Almost Certain	Catastrophic	Extreme
Temperature Rise	physical health	Possible	Minor	Medium
Temperature Rise	ocean currents	Possible	Minor	Low
Temperature Rise	ocean temperature	Likely	Minor	Medium
Temperature Rise	fish species	Possible	Moderate	Medium
Temperature Rise	vegetation loss	Almost Certain	Major	Extreme

Climate Change Category	Risk	Likelihood	Consequence	Risk Priority
Temperature Rise	open landscaping management	Almost Certain	Moderate	High
Temperature Rise	bushfire risk	Almost Certain	Catastrophic	Extreme
Temperature Rise	animal migration	Likely	Moderate	High
Temperature Rise	plant migration	Likely	Moderate	High
Temperature Rise	mosquito disease/activity	Almost Certain	Major	Extreme
Temperature Rise	general disease risk	Likely	Major	High
Temperature Rise	OSH	Almost Certain	Major	Extreme
Temperature Rise	equipment & materials design	Likely	Minor	Medium
Temperature Rise	work patterns	Possible	Minor	Medium
Temperature Rise	community infrastructure	Possible	Moderate	Medium
Temperature Rise	community volunteer associations	Likely	Moderate	Medium
Temperature Rise	drought	Likely	Major	High
Temperature Rise	rainfall	Almost Certain	Major	Extreme
Temperature Rise	extreme weather events	Almost Certain	Catastrophic	Extreme
Temperature Rise	tourism	Possible	Major	High
Temperature Rise	permanent residents	Possible	Minor	Medium
Temperature Rise	water based recreation	Likely	Insignificant	Low
Temperature Rise	all waste recycling	Likely	Moderate	High
Temperature Rise	finance resourcing	Almost Certain	Catastrophic	Extreme
Temperature Rise	extinction (fauna)	Possible	Moderate	Medium
Temperature Rise	extinction (flora)	Almost Certain	Moderate	Medium
Temperature Rise	water table	Almost Certain	Major	Extreme
Temperature Rise	salinity	Almost Certain	Catastrophic	Extreme
Temperature Rise	acid sulphate soils	Almost Certain	Catastrophic	Extreme
Temperature Rise	transport (public and private)	Almost Certain	Major	Extreme
Temperature Rise	fauna adaptation	Likely	Minor	Medium
Temperature Rise	food chain	Almost Certain	Major	Extreme
Temperature Rise	agriculture/horticulture	Almost Certain	Major	Extreme
Temperature Rise	aquaculture	Possible	Insignificant	Low
Temperature Rise	eutrophication	Almost Certain	Moderate	High
General Biodiversity	fire increase	Almost Certain	Catastrophic	Extreme
General Biodiversity	general change in species diversity	Almost Certain	Moderate	High
General Biodiversity	woodland decline (tuarts, wandoo, redgum, flooded gum)	Almost Certain	Major	Extreme
General	monitoring of ecosystems	Likely	Major	High

Climate Change Category	Risk	Likelihood	Consequence	Risk Priority
Biodiversity				
General Biodiversity	lack of funding to monitor and manage impact	Likely	Major	High
General Biodiversity	increased plant disease outbreaks	Likely	Moderate	High
General Biodiversity	increase insect damage (e.g. tuart border)	Likely	Moderate	High