

Climate Change Adaptation Action Plan

Prepared for
Batavia Regional Organisation of Councils

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Executive Summary

The mid west region of Western Australia is likely to face a range of climatic changes in the coming decades. The increased temperatures and reduced rainfall projected for the region threaten to adversely impact the farming, fishing and tourism industries, which are amongst the region's main employment generators. Sea level rise also presents major issues for the region's ports and for its coastal towns, home to the majority of the region's population and its vital infrastructure.

The Batavia Regional Organisation of Councils (BROC), comprising the City of Geraldton-Greenough and the Shires of Irwin, Northampton and Chapman Valley, recognised the need for early climate change adaptation planning and received funding under the Australian Government's Local Adaptation Pathways Program to undertake a climate change risk assessment and develop an adaptation action plan.

The BROC Climate Change Adaptation Action Plan project (the 'Project'), focussed on identifying risks and opportunities and developing adaptation actions for the councils in response to the higher temperatures, reduced rainfall and sea level rise projected for the region in the future.

The BROC's climate change risks and opportunities were identified at a risk assessment workshop held on 10 December 2009 and attended by relevant council staff representing the operational areas of Land Use Planning, Infrastructure, Biodiversity and Natural Resource Management, Economic Development and Community Services and Corporate Governance.

Workshop participants evaluated the risks and opportunities to the operations of the councils based on climate change projections related to the years 2030 and 2070.

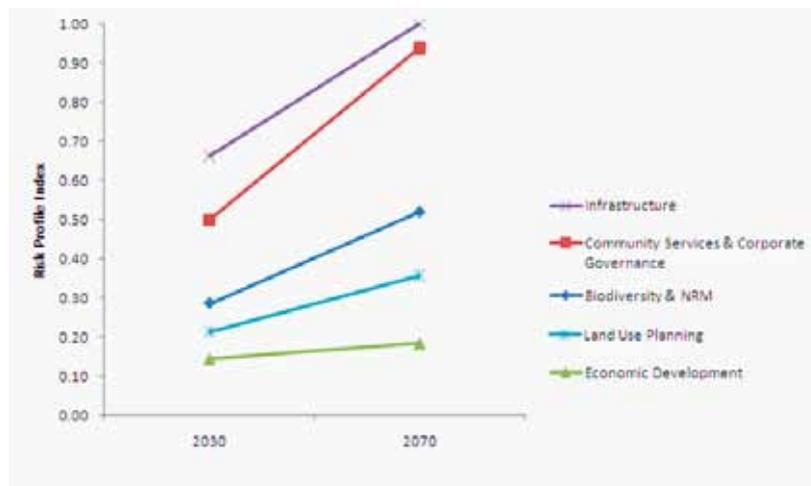
The risk assessment process identified and rated (from 'Low' to 'Extreme') 68 individual risks, as well as highlighting 12 potential climate change related opportunities. Broadly, the BROCs identified climate change risks related to increased maintenance, running, repair, relocation and resourcing costs, loss of amenity and natural assets, human health and safety hazards, and reduced economic viability.

Examples of higher rated risks include:

- Increased maintenance, relocation or litigation costs due to inadequate protection from sea level inundation;
- Diminishing town water supplies and loss of amenity due to a reduction in irrigated landscapes;
- Higher utility costs;
- Loss of the region's natural heritage through damage to coastal and other habitats;
- Reduced viability of the local tourism and farming industries due to sea level inundation and reduced rainfall respectively. In the case of farming, this may also have implications for councils' rate revenues;
- Requirement for councils to provide emergency assistance in case of climate related natural disasters; and
- Increased community demand for 'cooler spaces' resulting in higher costs.

The opportunities identified mostly related to sustainable urban design practices and to new economic possibilities which may present themselves in the region due to the changing climatic conditions. Examples include:

- Economic opportunities from converting farming land into other uses;
- Opportunity to increase the use of solar passive building design and lot orientation practices through councils' statutory mechanisms; and
- Increased opportunities to capture and reuse stormwater.



Using a risk profile index comprising both the number and severity of risks for each operational area, Infrastructure was shown to be the operational area with the highest risk exposure in both the near term and the long term, followed by the Community Services and Corporate Governance area (see figure). Risk exposure was shown to rise most sharply between 2030 and 2070 in the case of the Community Services and Corporate Governance area.

On 23 February 2010, an adaptation planning workshop was facilitated with relevant BROC staff to review draft actions, evaluate them, add new actions and arrive at a prioritised list of proposed actions, using a tailored Excel based tool to capture and analyse all inputs.

Each proposed action was then evaluated using the following three criteria:

1. 'Win – win' - the extent to which the action will benefit multiple council operations or asset types
2. 'No Regrets' - the extent to which the action would be beneficial regardless of the degree of climate change that ends up occurring
3. 'Cost Effectiveness' - the extent to which the action's costs could be justified considering its benefits.

Consolidation and analysis of the workshop outputs resulted in a total of 63 actions under two broad priority designations - 'Higher Priority' with 34 actions and 'Lower Priority' with 29 actions. Broadly speaking, the proposed actions address the following areas:

- Water and energy efficiency and other sustainable design issues;
- The climate resilience of essential infrastructure;
- The long term protection and enhancement of public open spaces;
- The protection of local properties from sea level rise and bushfire risks;
- Community resilience to increased heat and bushfire risks;
- Staff health and safety;
- The protection of at risk coastal and other habitats;
- Weed and pest control and the protection of biodiversity corridors;
- The financial preparedness of BROC members in the face of climate change risks; and
- The economic development potential of the renewable energy and the aquaculture industries in the region.

Most proposed actions take one of the following forms:

- Providing additional community education (for example regarding the potential impacts of climate change on local biodiversity);
- Providing incentives to encourage climate resilient behaviours in the community (for example to encourage residential and commercial uptake of rainwater tanks);
- Undertaking further studies (for example cost-benefit analyses and risk mapping projects);
- Incorporating or strengthening of resource efficiency and climate resilient principles in councils' existing plans and strategies (for example in the City of Geraldton-Greenough's Bushfire Emergency Response Plan);
- Implementing ongoing monitoring programs (for example regarding infrastructure conditions or patterns in the use of community facilities);
- Providing additional community services (for example targeting vulnerable populations during heat waves); and
- Closer collaboration with relevant regional bodies (for example with the Fire and Emergency Services Authority and the Department of Planning).



The proposed adaptation actions were presented to project stakeholders in a workshop held on 25 February 2010, in order to identify opportunities for cross-agency collaboration in the region. This consultation resulted in several suggestions for collaboration and information sharing, as well as advice on potential funding sources. The agencies and bodies most commonly cited as relevant to the BROCC's climate change adaptation efforts were (in no particular order):

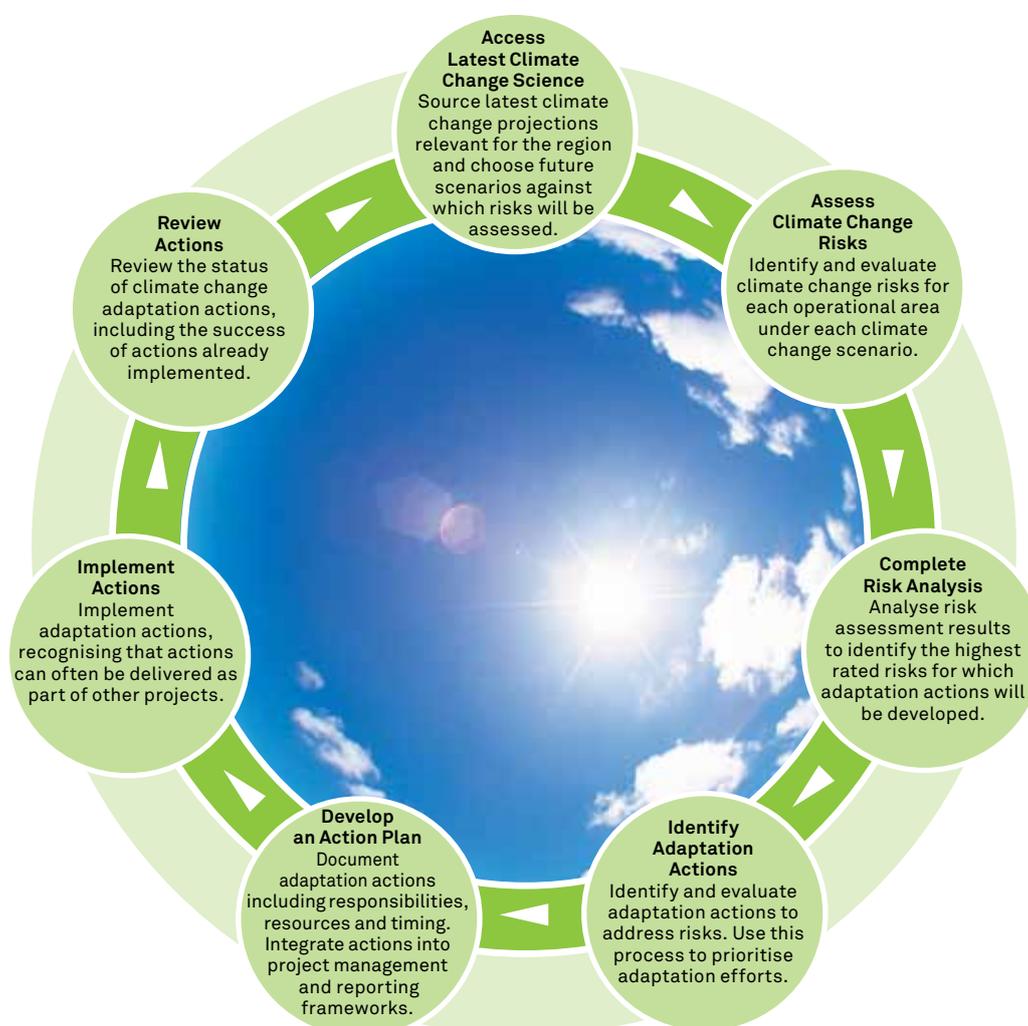
- The Fire and Emergency Services Authority;
- The Department of Planning;
- The Mid West Development Commission;
- The Northern Agricultural Catchments Council;
- The Sustainable Energy Development Office;
- The Office of Climate Change; and
- The Australasian Fire and Emergency Service Authorities Council.

On completion of this Project, implementation of the proposed actions will require the BROCC to undertake the following additional steps:

- Confirm the suitability of the proposed actions;
- Assign specific responsibilities for each action;
- Confirm the prioritisation of actions and a realistic timeline for their implementation;
- Undertake more detailed implementation planning, including resource and budget planning; and
- Consider synergies with other internal action plans and strategies, as well as with programs run by external bodies and agencies, to avoid duplication and take advantage of previous and current work.

While the process of climate change scenario identification, risk assessment and adaptation planning undertaken in this Project has been thorough, the BROC will need to periodically review its climate change risks and responses, as scientific, technological and institutional factors continue to evolve. In doing so, it should ideally follow a process similar to that described in the following diagram.

Climate Change Management Cycle







1.0 Project Introduction and Methodology

1.1 Introduction

The mid west region of Western Australia is likely to face a range of climatic changes in the coming decades. The increased temperatures and reduced rainfall projected for the region threaten to adversely impact the farming, fishing and tourism industries, which are amongst the region's main employment generators. Sea level rise also presents major issues for the region's ports and for its coastal towns, home to the majority of the region's population and its vital infrastructure.

The Batavia Regional Organisation of Councils (BROC), comprising the City of Geraldton-Greenough and the Shires of Irwin, Northampton and Chapman Valley, recognised the need for early climate change adaptation planning and received funding under the Australian Government's Local Adaptation Pathways Program (LAPP) to undertake a climate change risk assessment and develop an adaptation action plan.

AECOM were engaged by the BROC to deliver the BROC Climate Change Adaptation Action Plan project ('the Project') and to assist the BROC to:

- Better understand the potential impacts of climate change in the region;
- Identify the risks posed by climate change to the councils' operations;
- Identify effective adaptation actions to mitigate these risks;
- Encourage a regionally coordinated approach to climate change adaptation; and
- Build capacity within member councils to build resilience to climate change.

This Climate Change Risk Assessment and Adaptation Action Plan ('the Plan') outlines the methodology used in the Project, as well as its key outcomes, and is laid out as follows:

- **Chapter 1.0** provides an introduction to the Project, as well as the methodology employed throughout the risk assessment and adaptation planning phases, including the climate projections the risk identification process was based on.
- **Chapter 2.0** summarises the BROC's climate change risks and opportunities, which have given rise to all proposed adaptation actions.
- **Chapter 3.0** outlines the proposed climate change adaptation actions identified for BROC members under two priority levels, alongside the risks those actions address. Actions are shown under the operational area deemed most appropriate to lead their implementation.
- **Chapter 4.0** outlines opportunities for cross-agency collaboration in climate change adaptation, as identified at the stakeholder collaboration workshop held on 25 February 2010.
- **Chapter 5.0** concludes the Plan and makes some recommendations on implementation for the BROC's consideration.

This Plan consolidates a number of more detailed reports provided to the BROC over the course of the Project. These reports are:

- Issues Paper – submitted to the BROC on 2 December 2009;
- Climate Change Risks and Opportunities report – submitted to the BROC on 2 February 2009;
- Workshop and Stakeholder Engagement report – submitted to the BROC on 19 March 2010; and
- Climate Change Adaptation Action Plan – submitted to the BROC on 23 April 2010.

1.2 Methodology

The first stage of the Project – a stakeholder issues workshop – was undertaken on 10 November 2009, and was summarised in an Issues Paper. This paper highlighted the key, high level climate change issues of most importance to the region as identified by workshop participants, and its findings are summarised in Appendix A.

The Issues Paper helped set the scene for the subsequent risk assessment workshop, held on 10 December 2009, in which staff from the BROC member councils identified and rated 68 individual climate change risks to their councils' operations, as well as a number of opportunities. All risks and opportunities were identified under one of the following operational areas:

- Land Use Planning;
- Infrastructure;
- Biodiversity and Natural Resource Management;
- Economic Development; and
- Community Services and Corporate Governance.

AECOM's final Climate Change Risks and Opportunities report analysed the distribution of risks across the abovementioned operational areas, and summarised the 68 identified individual risks into 45 more generalised 'summary risks'. Of these 45 summary risks, 38 corresponded to 'higher rated' individual risks, namely individual risks rated 'Extreme' and 'High', as opposed to 'Medium' and 'Low'. The methodology used in the risk assessment process is discussed in Section 1.2.2, while the analysis of risk ratings and a listing of all identified opportunities and higher rated risks is provided in Chapter 2.0.

The project's adaptation planning phase which followed the risk assessment process is documented in detail in the Climate Change Adaptation Action Plan, submitted to the BROC on 23 April 2010. The methodology used in the Project's adaptation planning phase is described in Section 1.2.4.

1.2.1 Climate change projections used in the risk assessment

Participants at the risk assessment workshop evaluated the risks to the operations of the councils based on climate change projections for the years 2030 and 2070.

Climate change projections are generated using climate models and the Intergovernmental Panel on Climate Change's (IPCC's) range of future greenhouse gas emissions scenarios. The projected climatic changes used to assess risks related to higher temperatures, reduced rainfall and sea level rise.

Projections for 2030 show little variation between different emissions scenarios because near-term changes in climate are strongly affected by greenhouse gases that have already been emitted. For this reason, the projections for 2030 are usually based on a mid range emissions scenario and this scenario (A1B) was chosen for the risk assessment.

For 2070, low and high emissions scenarios are often presented. However, the most recent scientific reports are showing that observed emissions of carbon dioxide (the most important greenhouse gas) are exceeding the IPCC's highest emissions scenario (Steffen, 2009). A high emissions scenario (A1FI) was therefore chosen for the risk assessment to ensure that the councils assessed their risks based on the best available information and adopted a precautionary approach.

The climate change projections used in the risk assessment (shown in Table 1) are specific to the mid west region of Western Australia, and are centred on Geraldton.

Table 1 Projections used for the BROCC climate change risk assessment process

Climate Change	Specific Climate Variable	Current Conditions	Projections for 2030	Projections for 2070
Increased Temperatures	Average temperature*	19.8°C	+1.4°C (21.2°C)	+6.4°C (26.2°C)
	Days over 35°C per year*	38 days	+6 days (44 days)	+26 days (64 days)
Reduced Rainfall	Average rainfall*	449 mm	-9.5% (406 mm)	-43.7% (252.8 mm)
	Annual dry days (days with <1 mm rainfall)*	324.1 days	+2.9 days (327 days)	+13.4 days (337.5 days)
Sea Level Rise	Sea level rise^		+0.2 metres	+0.7 metres
	Extreme sea level events (storm surge)~	Factor of four increase in frequency for every 0.10 metre of mean sea level rise		

* CSIRO Marine and Atmospheric Research, 2009

^ Department of Climate Change, 2009

~ Hunter, 2007

1.2.2 Risk assessment workshop

As outlined in the Australian/New Zealand standard for Risk Management AS/NZS4360 (Standards Australia and Standards New Zealand, 2004) assessing a given risk for prioritisation and treatment involves an evaluation of its potential consequences (normally under several consequence categories) as well as assessment of the likelihood of it materialising. Through this process, the combination of consequence and likelihood scores generates a final risk rating such as 'Low', 'Medium', 'High' or 'Extreme' (see Figure 1).

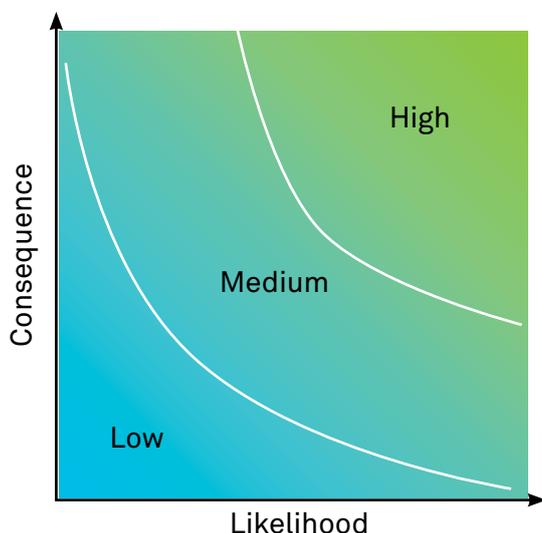


Figure 1 A conceptual risk matrix, demonstrating the relationship between consequence, likelihood and overall risk rating (CSIRO, 2007)

The listing and rating of the BROC's climate change risks was carried out at a risk assessment workshop held on 10 December 2009 and attended by relevant council staff. The process included the following steps:

- Listing climate change related risks by the climatic variable they were most related to. This was done in groups of 3 to 5 people, each addressing risks in the following council operational areas:
 - Land Use Planning;
 - Infrastructure;
 - Biodiversity and Natural Resource Management (NRM);
 - Economic Development; and
 - Community Services and Corporate Governance.

Risks were listed under the climatic variable they were most related to, and were tagged as follows:

- ‘RR’ for reduced rainfall related risks;
 - ‘H’ for increased temperatures (heat) related risks; and
 - ‘SLR’ for sea level rise related risks.
- Listing existing risk controls, namely policies or strategies that already exist within the councils to address the identified risks.
 - Rating all identified risks on their expected consequences as either ‘Insignificant’, ‘Minor’, ‘Moderate’, ‘Major’ or ‘Catastrophic’. This was done for two time horizons – 2030 and 2070.
 - Rating all identified risks on the likelihood of them materializing as either ‘Rare’, ‘Unlikely’, ‘Possible’, ‘Likely’ or ‘Almost Certain’ under the same two time horizons.
 - Deriving risk ratings (‘Low’, ‘Medium’, ‘High’ or ‘Extreme’) from every combination of consequence and likelihood ratings. This was done automatically using a Microsoft Excel formula based on the risk matrix shown in Figure 2.

		Consequences				
		Insignificant	Minor	Moderate	Major	Severe
Likelihood	Almost certain	Medium	Medium	High	Extreme	Extreme
	Likely	Low	Medium	High	High	Extreme
	Possible	Low	Medium	Medium	High	High
	Unlikely	Low	Low	Medium	Medium	Medium
	Rare	Low	Low	Low	Low	Medium

Figure 2 The matrix used to rate the BROCC’s climate change risks from ‘Low’ to ‘Extreme’ (Source: Department of Climate Change and Energy Efficiency, 2006)

1.2.3 Data compilation and analysis

All risk information gathered at the risk assessment workshop was subsequently collated and numerically analysed. Risk information was analysed by operational area, climatic variable, and for each time horizon (refer to Chapter 2.0 for risk data analyses), and a list of summary risks was compiled for each operational area.

The summary risks have been grouped into two rating levels, with those marked 'Lower Rated' summarising the 'Low' and 'Medium' rated individual risks, and those marked 'Higher Rated' summarising 'High' and 'Extreme' rated individual risks. The higher rated summary risks were then used to formulate the BROC's draft adaptation actions.

To enable a numerically valid comparison of risk exposure between operational areas, a Risk Profile Index (RPI) was developed by:

- assigning a relative numerical value to all individual risks according to their ratings in both time horizons ('Low' rating = 1, 'Moderate' rating = 2, 'High' rating = 4, 'Extreme' rating = 6);
- adding up those values within each operational area and time horizon; and
- normalising the resulting sums to a number between 0 and 1, with values of 1 representing the highest risk profile.

The RPI combines both the number and rating of individual risks and in doing so provides a useful comparison of overall climate change risk exposure levels between the five operational areas across the two time horizons. As shown in Section 2.1, the Infrastructure area had the highest RPI in both time horizons, followed by the Community Services and Corporate Governance area.



1.2.4 Adaptation planning workshop

Following the completion of the Climate Change Risks and Opportunities report, AECOM compiled a list of 65 draft actions, which together addressed all of the 38 higher rated summary risks. Where possible, climate change opportunities identified in the BROCC's climate change risk assessment workshop were incorporated into the wording of those draft actions, as were some identified risk controls.

On 23 February 2010, AECOM facilitated an adaptation planning workshop with relevant BROCC staff to review the draft actions, evaluate them, add new actions and arrive at a prioritised list of proposed actions, using a tailored Excel based tool to capture and analyse all inputs.

In the workshop's first part, participants made modifications to some of AECOM's draft actions, removed a number of them and added several new proposed actions to address relevant summary risks. Using a drop down box, participants were also required to designate whether responsibility for each action should sit with one of the four BROCC members, or whether it should be implemented as a regional collaboration. Participants were encouraged to note down any useful comments, particularly in cases where they believed an action would sit better in a different operational area.

In the workshop's second part, each proposed action was evaluated using the following three criteria:

1. 'Win – win' - the extent to which the action will benefit multiple council operations or asset types;
2. 'No Regrets' - the extent to which the action would be beneficial regardless of the degree of climate change that ends up occurring; and
3. 'Cost Effectiveness' - the extent to which the action's costs could be justified considering its benefits.

Under each criterion, the Excel based tool enabled a choice between a low score (represented by 1 point) and a high score (represented by 2 points). For each action, the points scored under the three criteria were added up to result in a priority designation as follows:

- Total of 3 points – 'Low' priority
- Total of 4 points – 'Low - Medium' priority
- Total of 5 points – 'Medium - High' priority
- Total of 6 points – 'High' priority.

Following the adaptation planning workshop, all proposed actions were revisited by AECOM in order to present them to representatives of other relevant agencies at the stakeholder collaboration workshop. This consisted of slight rewording for the sake of clarity, the occasional redesignation of actions to more relevant operational areas and the consolidation of very similar actions, resulting in a final list of 63 actions.

Due to the large number of actions which ended up with a 'High' priority ranking, all actions with a priority ranking of 'Low', 'Low - Medium' or 'Medium - High' have been grouped together and are shown as 'lower priority' actions while only actions originally ranked 'High' are shown as 'higher priority'. For reference, specific priority rankings generated at the workshop are shown for all actions listed in Sections 3.1 - 3.5.

1.2.5 Stakeholder collaboration workshop

The 63 adaptation actions were presented to key project stakeholders in a workshop held on 25 February 2010, in order to identify opportunities for cross-agency collaboration in the region. Stakeholders used an Excel based tool to input their ideas against each action under the following headings:

- Opportunities to collaborate/share information
- Potential funding opportunities
- Relevant agency
- Contact names
- Comments/other information.

Inputs received at the workshop are summarised in Chapter 4.0.



2.0 Summary of the BROC’s Climate Change Risks and Opportunities

The Climate Change Risks and Opportunities report summarised the BROC’s 68 identified individual risks into 45 more generalised ‘summary risks’, of which 38 were ‘higher rated’ risks. Along with these risks, the Land Use Planning, Economic Development and Biodiversity and NRM operational areas identified 12 opportunities that climate change may present to the BROC councils. While these opportunities were not rated, and therefore not incorporated into the numerical analyses, they were used to inform the first draft of proposed adaptation actions.

2.1 Analysing overall risk ratings

Figure 3 compares the number of risks between the five operational areas, as well as the rating distributions in 2030 and 2070 within each area. The Infrastructure area had the highest number of risks overall (22), as well as the highest number of ‘High’ rated risks in 2030 (11) and the highest number of ‘Extreme’ rated risks in 2070 (7).

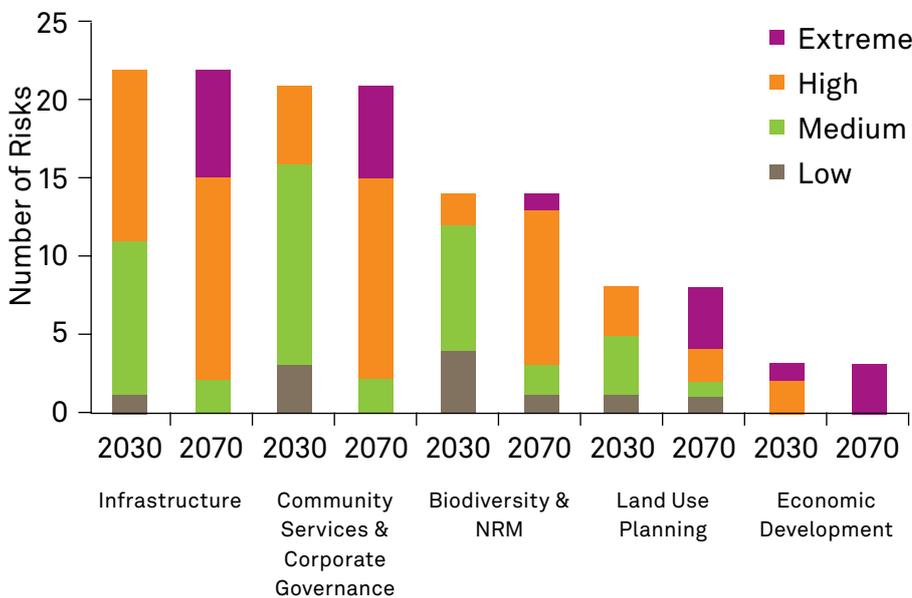


Figure 3 A comparison of risk numbers and rating distributions between 2030 and 2070 for each operational area

As shown in Figure 4, overall risk exposure rose markedly between 2030 and 2070, with ‘High’ and ‘Extreme’ rated risks rising from 23 and 1 to 38 and 21 respectively, and with ‘Low’ and ‘Medium’ rated risks falling from 9 and 35 to 2 and 7 respectively.

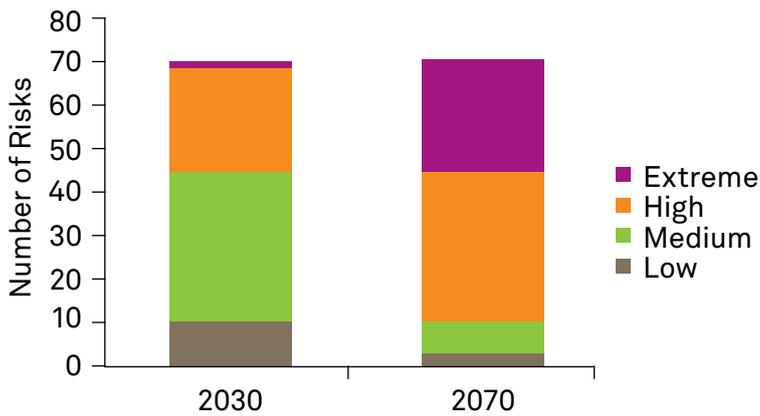


Figure 4 A comparison of risk rating distributions between 2030 and 2070

Using RPIs (as explained in Section 1.2.3), Infrastructure was shown to be the operational area with the highest risk exposure in both the near term and the long term, followed by the Community Services and Corporate Governance area (see Table 2 and Figure 5). Risk exposure rose between 2030 and 2070 for all operational areas, but it did so most sharply in the case of the Community Services and Corporate Governance area.

Table 2 Risk Profile Indices (RPIs) for all operational areas in both time horizons

Operational Area	RPI in 2030	RPI in 2070
Infrastructure	0.66	1.00
Community Services and Corporate Governance	0.50	0.94
Biodiversity & NRM	0.29	0.52
Land Use Planning	0.21	0.36
Economic Development	0.14	0.18

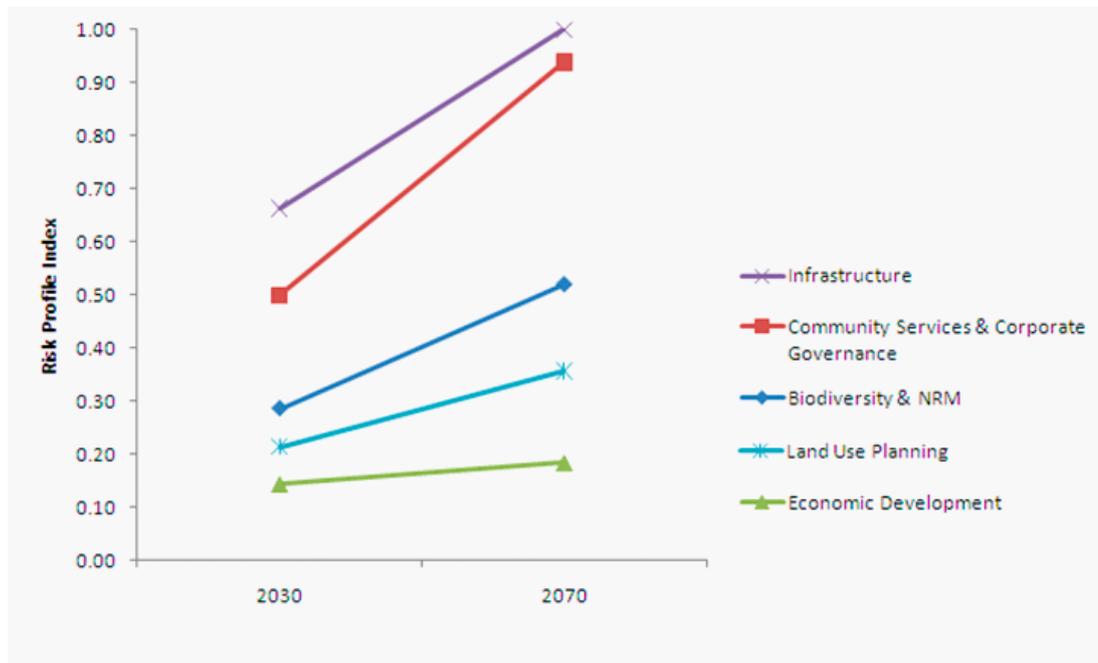


Figure 5 Risk Profile Indices for all operational areas in both time horizons

Figure 6 compares the three climatic variables based on the number of risks they generated, and the distribution of risk ratings between 2030 and 2070 within each variable. Increased Temperatures registered the highest number of risks (29), as well as the highest number of ‘High’ rated risks in 2030 (14) and ‘Extreme’ rated risks in 2070 (9). The overall number of identified risks for Sea Level Rise was low in comparison (19), however all risks identified under this climatic variable were rated ‘High’ or ‘Extreme’ in 2070.

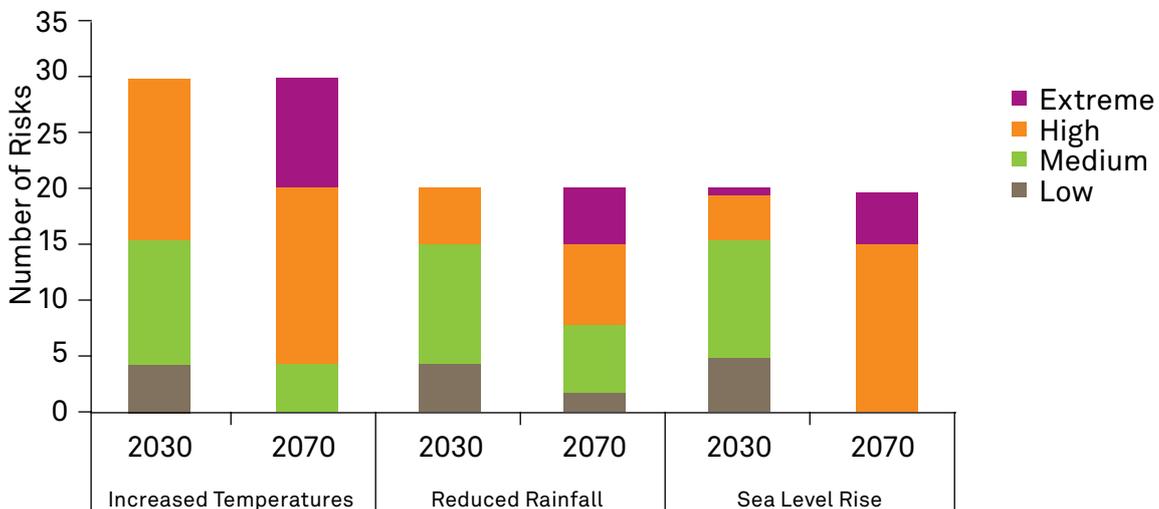


Figure 6 Risk severity for the two time horizons for each climatic variable



2.2 Operational area risk analysis

The following sections summarise the risks and opportunities identified within each operational area.

The summary risks listed under each operational area provide a generalised picture and a succinct description of the individual rated risks identified in the BROC's risk assessment workshop. As explained in Section 1.2.3, summary risks have been grouped into two rating levels for prioritisation purposes.

This Plan shows only the 'Higher Rated' summary risks (namely those summarising 'High' and 'Extreme' rated individual risks), as these were the risks for which adaptation actions were later developed. The risk tags shown in this section are cross referenced in Sections 3.1 – 3.5 to relate adaptation actions to the risks they address.

2.2.1 Biodiversity and Natural Resource Management

Higher rated summary risks identified for the Biodiversity and Natural Resource Management operational area were as follows:

- Diminishing town water supplies due to reduced water availability (r1)
- Damage to, or loss of, endemic species habitat leading to loss of the region's natural heritage (r2)
- Increased prevalence of exotic species due to decline in native species populations, resulting in increased species control costs to councils (r3)
- Damage (e.g. erosion, vegetation removal) to natural coastal assets and habitats (e.g. dune and estuarine systems), resulting in increased revegetation/remediation/maintenance costs to councils (r4)
- Increase in desiccated vegetation due to hotter conditions leading to increased fuel loads and bushfires, resulting in higher fire fighting costs to councils (r5).

Opportunities identified for the Biodiversity and Natural Resource Management operational area were as follows:

- Opportunity to use vegetation instead of hard surfaces in public areas to reduce ambient temperatures
- Loss of vegetation due to increased temperatures and reduced rainfall leading to reduced fuel loads and therefore reduced risk of bushfires
- Opportunities for the local tourism industries to capitalise on migration of tropical fish southward due to increasing temperatures.

2.2.2 Community Services and Corporate Governance

Higher rated summary risks identified for the Community Services and Corporate Governance operational area were as follows:

- Increased need to liaise with community groups to ensure sharing of recreational facilities due to shift away from summer and day time uses of outdoor community facilities (r6)
- Increased cooling requirement in council offices and community buildings resulting in higher capital, electricity and maintenance costs for councils (r7)
- Requirement for councils to provide emergency assistance and shelters in case of climate related natural disasters (e.g. flooding and bushfires), including in council buildings (r8)
- Increasing cost to councils of water capture and storage due to reduced water availability (r9)
- Building repair and insurance related costs to councils due to sea level related flooding damaging council buildings (r10)
- Requirement for additional council monitoring of community outdoor events due to increased risk of heat stress (r11)
- Increased community demand for ‘cooler spaces’ resulting in higher capital, running and maintenance costs for councils due to requirement for more shading structures, landscaped areas, water play facilities and lighting for night time activities (r12)
- Increased occurrence of water borne disease due to hotter conditions (r13)
- Increased council staff wage costs due to requirement for modified work hours to provide staff a break (‘siesta’) in the heat of the day (r14)
- Increased vehicle and communication equipment maintenance and replacement costs to councils due to heat related breakdowns (r15)
- Increased maintenance costs to councils to avoid public injuries due to dried, harder surfaces in outdoor recreation areas (r16)
- Reduced rate revenue to councils due to decline in the viability of the region’s farming land (r17)
- Increased cost to councils due to requirement to relocate coastal community facilities (such as playgrounds and events area) to avoid sea level rise inundation (r18).

No opportunities were identified for this operational area.

2.2.3 Economic development

Higher rated summary risks identified for the Economic Development operational area were as follows:

- Reduced viability of the local tourism industry due to sea level inundation of the Abrolhos Islands (r19)
- Increased costs to councils due to need to protect/regularly service/repair their coastal capital investments (r20)
- Risk that climate change will reduce economic activity and businesses will stop operating in the region (r21).

Opportunities identified for the Economic Development operational area were as follows:

- Opportunity to market floating pontoons and boat accommodation in the Abrolhos Islands due to sea level rise
- Opportunity for marine algae production for the bio fuels industry due to increased evaporation rates
- Opportunity to attract international expertise in growing innovative technological areas such as renewable energy
- Opportunity to convert farming land into other usages as the viability of the region's farming declines, and capture new economic opportunities for the region
- Opportunity to move from traditional fishing to aquaculture and capture new economic opportunities for the region
- Opportunity to use agricultural bi-products as renewable energy sources and capture new economic opportunities for the region.



2.2.4 Infrastructure

Higher rated summary risks identified for the Infrastructure operational area were as follows:

- Increased demand for energy efficient buildings resulting in higher capital costs to build new/ upgrade existing council buildings (r22)
- Higher electricity demand and unit costs resulting in increased running costs for councils (r23)
- Requirement to introduce low water use landscaping practices (including synthetic alternatives) to adapt to the changing climate, resulting in increased capital (and potentially maintenance) costs to councils (r24)
- Higher watering requirements in parks and gardens due to reduced rainfall resulting in higher costs to councils (r25)
- Inadequate drainage infrastructure and lack of sea defences requiring costly upgrades or leading to flooding and inundation related litigation and relocation costs to councils (especially in the Geraldton CBD) (r26)
- Modification of building standards to address extreme events leading to higher community education and retrofitting related costs to councils (r27)
- Faster deterioration of pavements due to increased temperatures resulting in higher maintenance costs and reputation impacts to councils (r28)
- Pedestrian friendly design for urban areas may not achieve its aims due to increased heat, discouraging pedestrians and encouraging car use (r29)
- Damage to roads and bridges due to extreme events resulting in increased repair/relocation costs to councils (r30)
- Increased occurrence of dust storms resulting in higher sweeping and maintenance (open space, road and drainage) costs to councils, as well as more community complaints (r31)
- Increased beach, marina and boat ramp maintenance/repair requirements due to sea level rise and storm surge impacts leading to higher costs to councils (r32).

No opportunities were identified for this operational area.



2.2.5 Land Use Planning

Higher rated summary risks identified for the Land Use Planning operational area were as follows:

- Requirement to modify existing statutory requirements for shading in residential lots and increase compliance monitoring, resulting in higher costs to councils (r33)
- Increased threats to life and property due to influx of residents into vegetated (and therefore more fire prone) areas due to increased temperatures (r34)
- Increased development assessment workload for councils due to increased demand for the subdivision of agricultural lands due to their decreased viability with decreasing rainfall (r35)
- Increased foreshore reserve widths due to sea level rise resulting in higher reserve maintenance costs to councils (r36)
- Loss of public amenity and aesthetic value due to councils' irrigating fewer streetscapes and open spaces as a result of reduced water availability/increased costs (r37)
- Conflict between councils and developers due to a requirement for larger coastal setbacks to protect against long term sea level rise (r38).

Opportunities identified for the Land Use Planning operational area were as follows:

- Opportunity to increase the use of solar passive building design and lot orientation practices through councils' statutory mechanisms
- Opportunity to require less but higher quality public open spaces from developers, as a result of reduced water availability
- Opportunity to increase the capture and reuse of stormwater as a result of reduced water availability and to lessen the burden on reticulated water supplies.



3.0 Proposed Climate Change Adaptation Actions

Participants at the BROC adaptation planning workshop identified and evaluated proposed climate change adaptation actions under five operational areas. The consolidation and analysis of workshop inputs resulted in a total of 63 proposed actions under two broad priority designations – ‘higher priority’ with 34 actions, and ‘lower priority’, with 29 actions. Figure 7 shows the breakdown of proposed actions by operational area and by priority designation.

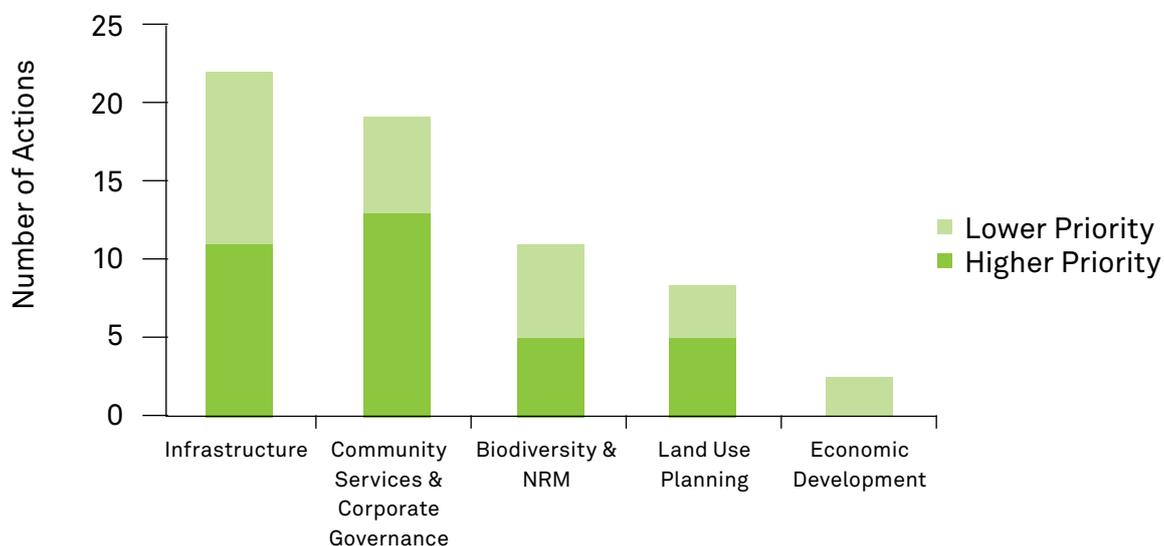


Figure 7 Proposed climate change adaptation actions by operational area and by priority designation

Sections 3.1 – 3.5 list the BROC’s 63 proposed adaptation actions in ‘higher priority’ and ‘lower priority’ tables, alongside the more specific rankings they were originally given at the adaptation planning workshop (e.g. ‘Low - Medium’). Additional details shown for each action are:

- an Action ID reference number;
- the tag/s corresponding to the summary risk/s the action addresses (as listed in Section 2.2); and
- the council responsible for leading its implementation (note that most actions have either been designated as a ‘Regional Collaboration’, or to be led by the City of Geraldton-Greenough).

Note that in each table in Sections 3.1 - 3.5 actions are listed first by specific priority ranking, then by their Action ID. This means that Action ID reference numbers are often not sequential in the tables.

While many proposed actions straddle several operational areas and will require cross-divisional collaboration to be successfully implemented, all actions are shown under the operational area deemed most appropriate to lead their implementation.

Importantly, although this Plan aims to assist the BROC in prioritising its climate change adaptation actions, priority designations shown in this chapter aim to broadly guide rather than specifically dictate the councils’ climate change adaptation agenda. It is understood that into the future, factors outside the scope of this Project’s action evaluation process (for example new funding opportunities) may well affect the way BROC members determine which actions to undertake earlier and which later.

3.1 Infrastructure

Twenty three actions were identified under the infrastructure operational area, of which 12 were given a higher priority ranking. Most actions address issues of water and energy efficiency, the climate resilience of essential infrastructure and the long term protection and enhancement of public open spaces. Table 3 lists the higher priority climate change adaptation actions proposed for the Infrastructure operational area.

Table 3 Higher priority adaptation actions proposed for the Infrastructure operational area

Action ID	Action	Risks Addressed	Action Priority	Council Responsible
Infra 4	Conduct water audits across council facilities (including parks and buildings) to gain a comprehensive understanding of water usage patterns and opportunities for reductions	r1, r9, r24, r25	High	Regional collaboration
Infra 5	Establish water use targets and implement efficiency measures across all existing council operations and incorporate into all new tender documents	r1, r9, r24, r25	High	Regional collaboration
Infra 8	Prioritise drought tolerant species in all council-controlled planting and revegetation projects (e.g. street trees, bush revegetation) and progressively replace species with high watering requirements with more drought resistant ones	r1, r24, r25	High	Regional collaboration
Infra 10	Implement priority recommendations of Towards a Water Sensitive City - Water Planning and Management Strategy currently being developed to increase resilience to future climate change	r1,r9,r24, r25	High	Regional collaboration
Infra 11	Promote the region as a leader in the use of innovative water and energy efficiency technologies	r1, r21, r22, r23	High	City of Geraldton-Greenough
Infra 15	Investigate greywater reuse for all Council owned buildings	r1, r9	High	City of Geraldton-Greenough
Infra 16	Carry out a comprehensive energy audit of all council buildings and develop an energy efficiency strategy to progressively implement audit findings	r7, r22, r23	High	Regional collaboration
Infra 17	Ensure the City Building Energy Use Policy currently being developed includes recognition of potential increases in energy demand due to climate change	r7, r22, r23	High	Regional collaboration

Action ID	Action	Risks Addressed	Action Priority	Council Responsible
Infra 20	Identify and monitor infrastructure assets at risk due to climate change as part of ongoing condition audits, and use the asset management system to produce reports showing assets due for repair, replacement or removal according to both risk and condition factors	r10, r18, r20, r26, r28, r30, r32	High	City of Geraldton-Greenough
Infra 21	Keep up to date with the latest road building and infrastructure design technologies and standards to ensure councils are abreast of advances made, are using the most suitable materials and are designing infrastructure that can cope with future climatic changes	r28, r30	High	Regional collaboration
Infra 23	Ensure new recreational facilities along the coast are designed to be easily relocated	r10, r18	High	Regional



Table 4 lists lower priority climate change adaptation actions proposed for the Infrastructure operational area.

Table 4 Lower priority adaptation actions proposed for the Infrastructure operational area

Action ID	Action	Risks Addressed	Action Priority	Council Responsible
Infra 2	Investigate for each relevant facility increasing mowing heights of lawns to decrease lawn water use and implement where appropriate	r1, r24, r25	Medium-High	Shire of Irwin
Infra 3	Continue the current practice of applying mulch in parks and gardens to reduce evaporation and stabilise topsoil	r1, r24, r25	Medium-High	Regional collaboration
Infra 6	Continue to progressively replace inefficient irrigation systems with more efficient ones	r1, r9, r24, r25	Medium-High	Regional collaboration
Infra 12	Implement a street tree planting strategy as part of the vision for greening Geraldton and to provide additional natural shade	r12, r29	Medium-High	City of Geraldton-Greenough
Infra 13	Work with partners to create demonstration climate-sensitive designs for homes and public open spaces to show leadership and increase community awareness of the benefits	r27, r33	Medium-High	City of Geraldton-Greenough
Infra 1	Continue the existing program to identify and prioritise all viable opportunities for the capture and reuse of stormwater and progressively implement	r1, r9	Low-Medium	Regional collaboration
Infra 7	Revise public open space strategies and service level agreements to facilitate adoption of water wise practices (e.g. mulching) and replacement of grassed landscapes with low water using landscapes (e.g. rock gardens)	r1, r24, r25	Low-Medium	Regional collaboration
Infra 9	Continue current actions to increase the number of drinking fountains and trees/shading structures in recreation areas to ensure user comfort in times of heat and rain, including at beaches to encourage more community use	r12, r29, r37	Low-Medium	Regional collaboration

Action ID	Action	Risks Addressed	Action Priority	Council Responsible
Infra 14	Undertake a cost-benefit analysis to assess the viability of installing rainwater tanks and pumps on council buildings	r1, r9	Low-Medium	Regional collaboration
Infra 18	Investigate the potential for renewable energy technologies to be installed on council owned land or buildings	r7, r22, r23	Low-Medium	Regional collaboration
Infra 19	Develop a simple climate change checklist to be completed for all infrastructure upgrade projects to ensure project managers are aware of the projected climatic conditions and their implications	r10, r20, r26, r28 r30, r32	Low-Medium	Regional collaboration
Infra 22	Undertake a flood study of Geraldton CBD integrating climate change projections (sea level rise and rainfall) to identify areas at greatest risk and the highest priorities for action	r26, r30, r32, r38	Low-Medium	City of Geraldton-Greenough



3.2 Land Use Planning

Eight actions were identified under the Land Use Planning operational area, of which 5 were given a higher priority ranking. Most actions address issues of sustainable house design and the protection of local properties from sea level rise and bushfire risks. Table 5 lists the higher priority climate change adaptation actions proposed for this operational area.

Table 5 Higher priority adaptation actions proposed for the Land Use Planning operational area

Action ID	Action	Risks Addressed	Action Priority	Council Responsible
LUP 1	Provide incentives to encourage residential and commercial uptake of rainwater tanks	r1, r9	High	Regional collaboration
LUP 2	Identify locations most vulnerable to sea level rise and storm surge inundation and develop a long term plan for management that considers avoiding (e.g. set backs from the coast); adapting (e.g. raising building and infrastructure heights); defending (e.g. beach stabilisation, nourishment, restoration, groynes), and retreat (e.g. purchasing land to move development back from the shoreline)	r10, r18, r26, r30, r32, r36, r38	High	Regional collaboration
LUP 3	Ensure the existing moratorium on bulk earthworks (Land Development Specifications) continues to be implemented, and that low water intensity dust suppression methods are used in councils' construction activities	r1, r31	High	Regional collaboration
LUP 4	Investigate and implement ways to increase the use of solar passive building design and smart lot orientation through the statutory planning system	r33	High	Regional collaboration
LUP 8	Consider an urban growth boundary in the Local Planning Strategy and Town Planning Schemes as a high level response to increased fire risk, increased need to conserve remaining vegetation, conservation of water resources and protection of high value agricultural soils	r1, r2, r5, r17, r34	High	City of Geraldton-Greenough

Table 6 lists lower priority climate change adaptation actions proposed for the Land Use Planning operational area.

Table 6 Lower priority adaptation actions proposed for the Land Use Planning operational area

Action ID	Action	Risks Addressed	Action Priority	Council Responsible
LUP 7	Continue implementation of the Better Urban Water Management Strategy required under State Planning Policy 2.9 Water Resources	r1, r9, r24, r25	Medium-High	Regional collaboration
LUP 5	Develop a region-specific methodology for appropriate coastal setbacks (agreed with developers and government), addressing concerns not currently addressed by the State Coastal Planning Policy	r38	Medium-High	Regional collaboration
LUP 6	Review bushfire management planning mechanisms (e.g. Western Australian Planning Commission 'Planning for Bushfire Protection' tool, City of Geraldton-Greenough Bushfire Emergency Response Plan) to ensure they anticipate changed climatic conditions, for example by revising areas of high bushfire risk in the light of climate change projections	r5, r8, r27, r34	Low-Medium	Regional collaboration

3.3 Community Services and Corporate Governance

Nineteen actions were identified under the Community Services and Corporate Governance operational area, of which 13 were given a higher priority ranking. Most actions address issues of community resilience to increased heat and bushfire risks, the health and safety of council staff and the financial preparedness of the councils in the face of climate change risks. Table 7 lists the higher priority climate change adaptation actions proposed for this operational area.

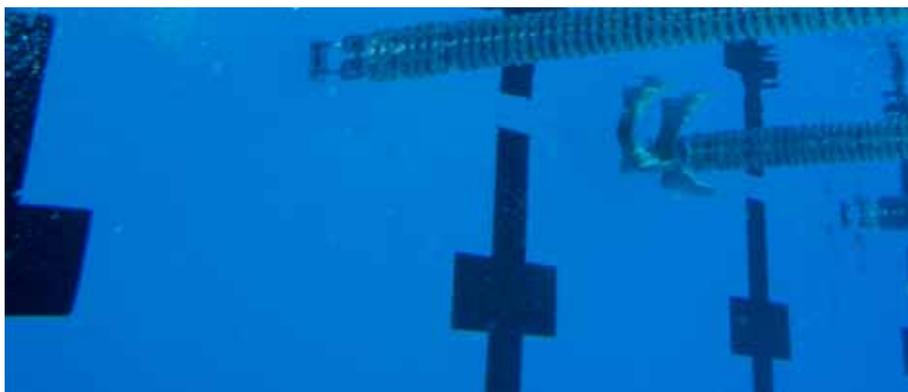


Table 7 Higher priority adaptation actions proposed for the Community Services and Corporate Governance operational area

Action ID	Action	Risks Addressed	Action Priority	Council Responsible
CSCG 1	Monitor usage of councils' public indoor and cooler spaces (e.g. community centres, libraries, swimming pools) during heat waves and respond to any changes required to the design and operation of these facilities, including staffing requirements	r6, r7, r8, r11, r12	High	Regional collaboration
CSCG 2	Identify cool recreation spaces (e.g. community centres, libraries, swimming pools) that have the capacity to expand to cater for increased community use as heat refuges, and put in place a long term expansion plan if required	r6, r8, r12	High	Regional collaboration
CSCG 3	Develop a contingency plan for accessing additional staff (or on-call agency/contractors) to deal with natural disaster clean up requirements	r5, r8	High	Regional collaboration
CSCG 4	Develop a program to identify and provide support to vulnerable (e.g. elderly, chronically ill and very young) residents during heat waves	r8	High	Regional collaboration
CSCG 5	Work with the Fire and Emergency Services Authority (FESA), volunteer fire brigades and other stakeholders to develop a program to educate the community on climate change risks such as bushfires and heat waves and the ways in which individuals can respond to them	r8, r27, r34	High	Regional collaboration
CSCG 6	Continue to implement an early warning system and information distribution systems for times of high fire danger and undertake regular system testing	r5, r8, r34	High	Regional collaboration
CSCG 8	Review outdoor event schedule and strategies, aiming to minimise the number of events occurring in high heat wave risk periods, and to ensure adequate shading and drinking facilities are in place for those events that cannot be rescheduled (e.g. Australia Day)	r6, r11	High	Regional collaboration
CSCG 10	Increase monitoring and treatment for mosquitoes after periods of heavy rain	r13	High	Regional collaboration

Action ID	Action	Risks Addressed	Action Priority	Council Responsible
CSCG 11	Encourage more sporting activities that can be played indoors to reduce irrigation needs, heat exposure and potential for injury due to harder surfaces	r6, r12, r16	High	Regional collaboration
CSCG 12	Ensure councils' financial management and budgeting processes reflect likely increases in water and energy prices into the future (e.g. incorporating a shadow price of carbon into business cases) and conduct an energy-price risk assessment for the coming 5-10 years to inform major investments (e.g. buildings, vehicles)	r7, r22, r23	High	Regional collaboration
CSCG 13	Continue to review recreational facilities to maximise usage wherever possible and ensure new facilities are multi-purpose and multi-functional	r6, r8, r12	High	Regional collaboration
CSCG 14	Assess the availability, accessibility and functionality of councils' public facilities to ensure they are suitable to function as emergency shelters (e.g. making sure air conditioning systems can cope with large numbers of people)	r8	High	Regional collaboration
CSCG 16	Require suppliers of vehicles and communications equipment to demonstrate their products' capacity to cope with extremely hot conditions	r15	High	Regional collaboration



Table 8 lists lower priority adaptation actions proposed for the Community Services and Corporate Governance operational area.

Table 8 Lower priority adaptation actions proposed for the Community Services and Corporate Governance operational area

Action ID	Action	Risks Addressed	Action Priority	Council Responsible
CSCG 15	Monitor incidences of staff health and safety related to extreme weather events (e.g. heat waves), and revise work practices and safety policies in response to any increases	r14	Medium-High	Regional collaboration
CSCG 17	Contribute to the development of the Centre for Regional Climate Change Solutions if it is determined to be feasible (feasibility study currently underway)	R21	Medium-High	Regional collaboration
CSCG 19	Develop governance and management tools to integrate climate risks into decision-making in major projects, e.g. land developments, coastal infrastructure, major purchases	r7, r10,r18, r20, r22, r26, r28, r30	Medium-High	City of Geraldton-Greenough
CSCG 7	Progressively integrate practical climate change advice and information into local emergency management plans to ensure flood prone and storm surge risk areas are identified and managed appropriately (including possible construction of levee banks)	r10, r18, r20, r26, r27, r30, r32, r36, r38	Low-Medium	Regional collaboration
CSCG 18	Schedule annual briefings to council that provide an update on climate change risks and adaptation measures	r21	Low-Medium	City of Geraldton-Greenough
CSCG 9	Discount swimming pool entry fees at the City of Geraldton-Greenough pool during heat waves	r12	Low	City of Geraldton-Greenough

3.4 Economic Development

As shown in Table 9, the two actions identified under the Economic Development operational area (both assigned a lower priority ranking) aim to assess and encourage the economic development potential of the renewable energy and the aquaculture industries in the region.

Table 9 Lower priority adaptation actions proposed for the Economic Development operational area

Action ID	Action	Risks Addressed	Action Priority	Council Responsible
ED1	Work with regional stakeholders (including Northern Agricultural Catchments Council, Department of Environment, Environmental Protection Authority, Department of Agriculture and Department of Indigenous Affairs), to investigate opportunities to use marginal farming lands for renewable energy (e.g. biofuels) and other alternative purposes (e.g. alternative food crops) to create new economic opportunities as the viability of the region's farming declines	r18, r21	Medium-High	Regional collaboration
ED2	Provide incentives (such as fast-tracked approvals) to encourage the development of aquaculture industries to create new economic opportunities for the region	r18, r21	Low	Regional collaboration



3.5 Biodiversity and Natural Resource Management

Eleven actions were identified for the Biodiversity and Natural Resource Management operational area, of which 5 were given a higher priority ranking. Most actions address issues of coastal habitat protection, weed and pest control and the protection of biodiversity corridors. lists the higher priority adaptation actions proposed for this operational area.

Table 10 Higher priority adaptation actions proposed for the Biodiversity and Natural Resource Management operational area

Action ID	Action	Risks Addressed	Action Priority	Council Responsible
BDNRM 4	Increase investment in private land conservation (e.g. targeted incentives for landholders to protect habitat on their properties, targeted acquisition of significant areas)	r2, r3, r4	High	Regional collaboration
BDNRM 8	Continue to monitor changes in water-borne disease rates and adjust existing water testing programs if required	r13	High	Regional collaboration
BDNRM 9	Work with other agencies (e.g. Department of Agriculture and Food, Department of Environment and Conservation) to monitor changes in weeds and pests and adjust control and management approaches in response to climatic changes	r3	High	Regional collaboration
BDNRM 10	Ensure that relevant biodiversity issues are addressed at the Structure Planning stage, anticipating changes to extent, quality and fire risks to vegetation under the changing climate	r2, r3, r4, r5	High	Regional collaboration
BDNRM 11	Ensure biodiversity issues are integrated into Structure Planning, recognising the need for higher priority to be given to protection of existing stands of vegetation and corridors	r2, r3, r4, r5	High	Regional collaboration

Table 11 lists lower priority adaptation actions proposed for the Biodiversity and Natural Resource Management operational area.

Table 11 Lower priority adaptation actions proposed for the Biodiversity and Natural resource Management operational area

Action ID	Action	Risks Addressed	Action Priority	Council Responsible
BDNRM 1	Ensure all Foreshore Management Plans include specific actions to address long term resilience to future climate change	r2, r4, r18, r20, r26, r30, r32, r36, r38	Medium-High	Regional collaboration
BDNRM 2	Implement a community education program addressing the potential impacts of climate change on local biodiversity, and provide information on ways the community can assist (e.g. by planting regionally native vegetation in gardens)	r2, r3	Medium-High	Regional collaboration
BDNRM 3	Work with appropriate partner agencies to consolidate and extend biodiversity corridors throughout the region, prioritising those corridors that are at high risk from future climate change	r2, r3, r4	Medium-High	Regional collaboration
BDNRM 5	Implement priority recommendations of the Local Biodiversity Strategy currently being developed	r2, r3, r4, r5	Medium - High	Regional collaboration
BDNRM 6	Implement existing biodiversity management plans, and prioritise development of new biodiversity management plans	r2, r3, r4, r5	Medium-High	Regional collaboration
BDNRM 7	Implement priority recommendations of the Coastal Processes Study for high risk coastal areas in Geraldton-Greenough, in partnership with the Department of Transport, the Geraldton Port Authority and other stakeholders	r2, r3, r4, r20, r26	Medium-High	City of Geraldton-Greenough

4.0 Opportunities for Collaboration

The 63 adaptation actions shown in Sections 3.1 - 3.5 were presented to a group of stakeholders in a workshop held on 25 February 2010, in order to identify opportunities for cross-agency collaboration in the region. The following stakeholder organisations were represented in the workshop:

- Department of Planning
- The Water Corporation
- Fire and Emergency Services Authority
- Office of Climate Change (Department of Environment and Conservation)
- Department of Transport
- Mid West Development Commission.

This chapter summarises the most salient stakeholder inputs under each operational area, highlighting in particular identified opportunities for collaboration and information sharing, as well as potential funding opportunities. Participants in the stakeholder collaboration workshop were grouped under the operational area corresponding most closely to their own agency's work, and were asked to first provide inputs into that area. Some participants then contributed inputs into other operational areas.



4.1 Infrastructure

The following opportunities for collaboration and information sharing were identified for actions under this operational area:

- Accessing existing GIS and rainfall data from the West Australian Department of Local Government and Regional Development to assist with assessing the viability of installing rainwater tanks on council buildings (action Infra 14);
- Working with local suppliers and installers to take advantage of incentive schemes and enable greywater reuse in council-owned buildings (action Infra 15);
- Utilising the guidelines for local government carbon neutrality published by the WA Office of Climate Change (action Infra 16);
- Sourcing climate change information from the Western Australian Local Government Association website, and the greenhouse and energy reporting tool (action Infra 16);
- Sourcing information on renewable energy technologies from the Sustainable Energy Development Office (action Infra 18);
- Partnering with Solar Cities to create local renewable energy demonstration projects (action Infra 18);
- Utilising the Green Infrastructure Rating Tool to be published by the Australian Green Infrastructure Council (action Infra 19);
- Sourcing the most up to date approved road design and materials standards from sources such as the Department of Transport and Engineers Australia (action Infra 21);
- Linking with university based research programs (University of Western Australia, Curtin University, Edith Cowan University, Murdoch University) (action Infra 21); and
- Sourcing advice on maritime facilities from the Department of Transport, to assist with the potential need to relocate coastal recreational facilities (action Infra 23).

The following potential funding sources were identified for actions under this operational area:

- The Water Wise scheme;
- The Mid West Regional Grants Scheme, administered by the Mid West Development Commission;
- The Sustainable Energy Development Office;
- West Australian Universities;
- Department of Transport;
- Department of Planning;
- Northern Agricultural Catchments Council;
- Desert Knowledge Australia;
- Regional Development Australia; and
- The Commonwealth Department of Climate Change and Energy Efficiency.

Other relevant stakeholders identified under this operational area include:

- The West Australian Department of Health;
- Electricity retailers, and
- Infrastructure Australia.

4.2 Land Use Planning

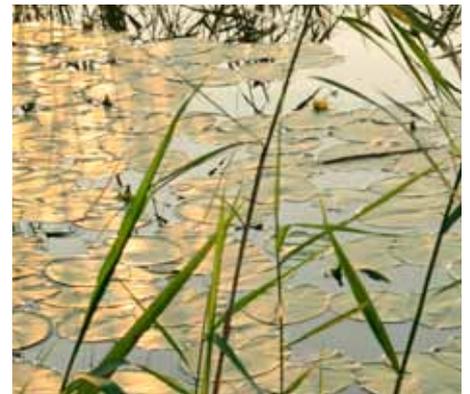
The following opportunities for collaboration and information sharing were identified for actions under this operational area:

- Accessing the Department of Planning’s review of State Planning Policy 2.6 with regards to calculating setbacks (action LUP 2);
- Showcasing innovative solar passive designs to encourage their use (e.g. through a competition), in collaboration with the Master Builders Association of Western Australia or the Urban Development Institute of Australia (action LUP 4);
- Obtaining research previously undertaken by the Northern Agricultural Catchments Council regarding a methodology for the determination of appropriate coastal setbacks (action LUP 6); and
- Liaison with Fire and Emergency Services Authority to help establish the locations of high and low bushfire risk areas, factoring in climate change considerations (action LUP 7).

The following potential funding sources were identified for actions under this operational area:

- Rebates and grants provided by the Western Australian Department of Water and the Water Corporation;
- Grants or contributions from the Department of Planning; and
- Monetary or labour contributions for the rehabilitation and stabilisation of coastal areas from Northern Agricultural Catchments Council.

Another relevant stakeholder identified under this operational area was the Environmental Protection Authority.



4.3 Community Services and Corporate Governance

The following opportunities for collaboration and information sharing were identified for actions under this operational area:

- Closer collaboration with the District Emergency Management Committee and the Local Emergency Management Committee regarding natural disaster cleanup efforts (action CSCG 3);
- Closer collaboration with the Fire and Emergency Services Authority regarding appropriate responses to climate change related natural disasters (action CSCG 5);
- Sharing of information generated through current research being conducted by the District Emergency Management Committee, the Local Emergency Management Committee and the Fire and Emergency Services Authority into cyclone behaviour and resultant impacts (action CSCG 7); and
- Closer collaboration on current processes managed by the Department of Planning in regards to the incorporation of climate change risks into major project decision making processes (action CSCG 19).

The following potential funding sources were identified for actions under this operational area:

- Australasian Fire and Emergency Service Authorities Council;
- Fire and Emergency Services Authority;
- Department of Planning; and
- Attorney General's Department, WA.

Other relevant stakeholders identified under this operational area include the Police and the Department of Agriculture and Food.

4.4 Economic Development

Regarding the possibility of using marginal lands for non-farming purposes such as renewable energy generation (action ED 1), a need to work through the relevant local planning strategies in collaboration with regional stakeholders was identified. Regarding the provision of incentives (such as fast tracking) to encourage aquaculture developments in the region (action ED 2), a comment was made that considering the complex environmental issues related to aquaculture activities, fast tracking may prove difficult, and that it may also be difficult to justify a favourable treatment for aquaculture developments over other viable alternatives.

No potential funding sources were identified for either action under this operational area.

4.5 Biodiversity and Natural Resource Management

The following key opportunities for collaboration and information sharing were identified for actions under this operational area:

- Potential provision of technical support and advice by the Department of Environment and Conservation regarding the long term climate resilience of foreshore areas (action BDNRM 1);
- The provision of support and expertise from the Northern Agricultural Catchments Council, the Water Corporation, the Department of Water, the Department of Planning and the Department of Environment and Conservation to assist with community education activities (action BDNRM 2);
- The identification of priority corridors and sustainable management plans in collaboration with landholders, Landcare agencies and the Department of Planning (action BDNRM 3); and
- Sharing the results of long term research on fire behaviour, conducted by Fire and Emergency Services Authority, Australasian Fire and Emergency Service Authorities Council and the Attorney General's Department (action BDNRM 10).

The following potential funding sources were identified for actions under this operational area:

- Coastcare grants provided by the Department of Planning;
- State and Commonwealth Government grants;
- Fire and Emergency Services Authority;
- Australasian Fire and Emergency Service Authorities Council; and
- Attorney General's Department.

Other relevant stakeholders identified under this operational area include:

- The Western Australian Local Government Association;
- The Department of Agriculture and Food;
- Bushcare;
- Local farming groups;
- Chemical suppliers, and
- Man of the Trees Western Australia.



5.0 Concluding Remarks

This Plan summarises the results of the climate change risk assessment and adaptation planning processes undertaken as part of the BROCClimate Change Adaptation Plan project. It analyses the ratings and distribution of 68 individual risks across five operational areas, highlights the 38 higher rated summary risks for which adaptation actions have been tailored, and lists 12 climate change related opportunities .

Broadly, the BROCC's identified climate change risks related to increased maintenance, running, repair, relocation and resourcing costs, loss of amenity and natural assets, human health and safety hazards, and reduced economic viability. The opportunities identified mostly relate to sustainable urban design practices and to economic possibilities which may present themselves in the region due to the changing climatic conditions

This Plan outlines 63 proposed actions tailored to address the BROCC's higher rated climate change risks. Broadly speaking, the proposed actions address the following areas:

- Water and energy efficiency and other sustainable design issues;
- The climate resilience of essential infrastructure;
- The long term protection and enhancement of public open spaces;
- The protection of local properties from sea level rise and bushfire risks;
- Community resilience to increased heat and bushfire risks;
- Staff health and safety;
- The protection of at risk coastal and other habitats;
- Weed and pest control and the protection of biodiversity corridors;
- The financial preparedness of BROCC members in the face of climate change risks; and
- The economic development potential of the renewable energy and the aquaculture industries in the region.

Most proposed actions take one of the following forms:

- Providing additional community education (for example regarding the potential impacts of climate change on local biodiversity);
- Providing incentives to encourage climate resilient behaviours in the community (for example to encourage residential and commercial uptake of rainwater tanks);
- Undertaking further studies (for example cost-benefit analyses and risk mapping projects);
- Incorporating or strengthening of resource efficiency and climate resilient principles in councils' existing plans and strategies (for example in the City of Geraldton Greenough's Bushfire Emergency Response Plan);
- Implementing ongoing monitoring programs (for example regarding infrastructure conditions or patterns in the use of community facilities);
- Providing additional community services (for example targeting vulnerable populations during heat waves);
- Closer collaboration with relevant regional bodies (for example with the Fire and Emergency Services Authority and the Department of Planning).

While several actions listed in this Plan are articulated in some detail, the implementation of all proposed actions will require the BROC to undertake the following additional steps:

- Confirm the suitability of the proposed actions;
- Assign specific responsibilities for each action;
- Confirm the prioritisation of actions and a realistic timeline for their implementation;
- Undertake more detailed implementation planning, including resource and budget planning; and
- Consider synergies with other internal action plans and strategies, as well as with programs run by external bodies and agencies, to avoid duplication and take advantage of previous and current work.

Consultation with relevant stakeholders regarding all proposed actions has resulted in several suggestions for collaboration and information sharing, as well as regarding potential funding sources (as summarised in Chapter 4.0). The agencies and bodies most commonly cited as relevant to the BROC's climate change adaptation efforts were (in no particular order):

- The Fire and Emergency Services Authority;
- The Department of Planning;
- The Mid West Development Commission;
- The Northern Agricultural Catchments Council;
- The Sustainable Energy Development Office ;
- The Office of Climate Change; and
- The Australasian Fire and Emergency Service Authorities Council.



While the Plan provides some insights into potential collaboration opportunities, most agencies identified as relevant were not represented at the stakeholder collaboration workshop, and their willingness and capacity to collaborate and share information with the BROC will therefore have to be confirmed. More relevant stakeholders may also emerge in the near future, as climate change action gathers momentum in the region (e.g. the Climate Change Senior Officers Group to be established by the Western Australian Local Government Association).

Nonetheless, the stakeholder engagement process has revealed many collaboration opportunities, and the breadth of relevant organisations and issues to be addressed calls for a more formalised process of inter-agency collaboration on climate change action in the region. It is clear that the BROC would benefit from a formalised structure through which to incorporate regular stakeholder inputs into its climate change adaptation efforts, be it through the proposed Centre for Regional Climate Change Solutions (mentioned in action CSCG 17), or through other suitable mechanisms.

While the process of climate change scenario identification, risk assessment and adaptation planning undertaken in this Project has been thorough, the BROC will need to periodically review its climate change risks and responses, as scientific, technological and institutional factors continue to evolve. In doing so, should ideally follow a process similar to that described in Figure 8.

Staying abreast of developments in the climate change arena will require regular scientific and other relevant information updates. The information sources listed in Appendix B will assist the BROC in keeping up to date with key developments in this field, in the Western Australian context as well as nationally and internationally.

Climate Change Management Cycle



Figure 8 BROC's ongoing climate change adaptation planning process

6.0 References

CSIRO (2007) Climate Change in Australia. Technical Report, Chapter 6. CSIRO and the Bureau of Meteorology in partnership with the Australian Greenhouse Office, Canberra.

CSIRO Marine and Atmospheric Research (2009) Climate change projections provided to AECOM.

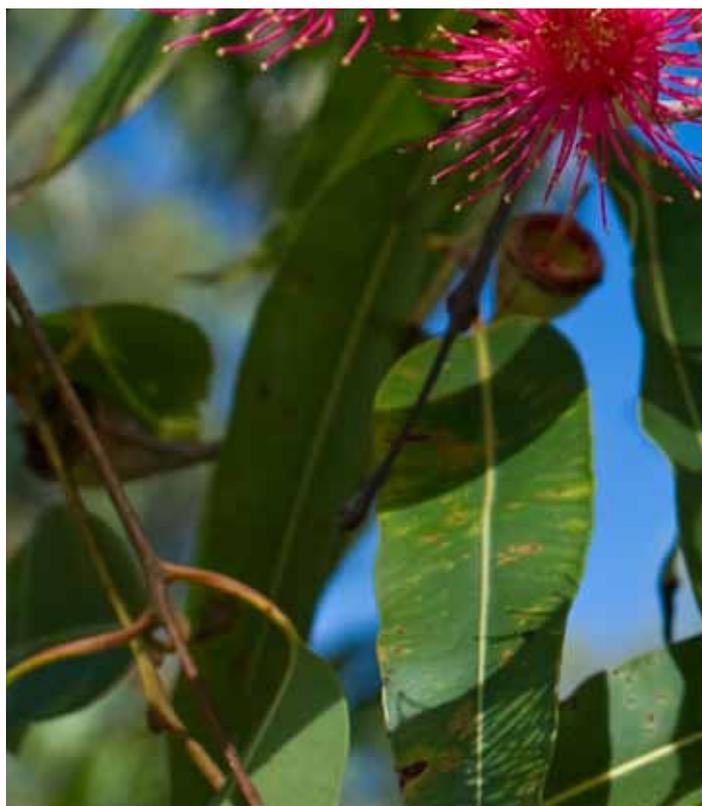
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Hunter, J.R. (2007) Estimating Sea-Level Extremes in a World of Uncertain Sea-Level Rise. Antarctic Climate and Ecosystems Cooperative Research Centre.

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Appendix A Summary of Stakeholder Issues

On 10 November 2009, a workshop was held with 29 stakeholders to identify the range of critical issues they see as being important to the region in regards to climate change.

In addition to representatives from the City of Geraldton-Greenough and the Shires of Northampton and Chapman Valley, the workshop was attended by stakeholders from the Department of Transport, the Northern Agricultural Catchment Council, the Department of Water, the Mid West Development Commission, the Department of Food and Agriculture, the Combined Universities Centre for Rural Health, Telstra, the Department of Environment and Conservation, Ferart Design and the Geraldton Port Authority.

The critical issues of concern identified by attendees are summarised below:

- Agriculture and fishing are critically important to the region and there will be significant flow-on impacts if they decline, including to the region's population and supporting industries.
- Many areas of agricultural land are already degraded or are being poorly managed, increasing vulnerability to climate change.
- Changes in traditional farming practices will be needed in response to climate change and new climatic conditions may present opportunities for farmers.
- The impacts of climate change on fish stocks are largely unknown, however there could be changes in local species and possible migration of northern fish species to the region.
- The Abrolhos Islands may become uninhabitable for seasonal fisherman due to sea level rise.
- Mining uses a significant volume of water and this could be an issue with reduced water availability in future.
- Current infrastructure design standards may not be appropriate for future climatic conditions.
- Increased road maintenance will be required.
- There will be changes in flood risk that will impact on stormwater drainage.
- Ports will be affected by severe storms and sea level rise.
- Climate change may present opportunities for the renewable energy industry in the region.
- Tourism could be affected by inundation of the Abrolhos Islands, coral bleaching, restrictions on recreational fishing and reduced numbers of wildflowers.
- The region has expanding coastal development, combined with low height above sea level and a sandy shoreline that make it more vulnerable to climate change.
- There could be costs and compensation issues for councils in protecting developments from sea level rise.
- Adverse health impacts are likely, including from heat stress, increases in vector-borne diseases and more dust storms.
- More hospitals, doctors and emergency services may be needed, along with more indoor sporting facilities.
- Changes in regional biodiversity could occur, including extinctions of some species and increases in feral animals and weeds.

Appendix B Climate Change Adaptation Reference Sources

- The UK Climate Impacts Programme - <http://www.ukcip.org.uk/>
- Climate Change Impacts and Risk Management: A Guide for Business and Government (Department of Climate Change and Energy Efficiency) - <http://www.climatechange.gov.au/community/~media/publications/local-govt/risk-management.ashx>
- Adapting to Climate Change in Australia: An Australian Government Position Paper - <http://www.climatechange.gov.au/en/publications/adaptation/position-paper.aspx>
- Climate Change Risks to Australia's Coasts - <http://www.climatechange.gov.au/publications/coastline/climate-change-risks-to-australias-coasts.aspx>
- Climate Change Management Toolkit (Western Australian Local Government Association) - <http://www.walgaclimatechange.com.au/>
- Climate Change Science - Faster Change and More Serious Risks - <http://www.climatechange.gov.au/publications/science/faster-change-more-risk.aspx>
- Australian Climate Change Science - A National Framework - <http://www.climatechange.gov.au/publications/science/cc-science-framework.aspx>
- Climate Change in Australia: Technical Report (CSIRO 2007) - <http://www.csiro.au/resources/Climate-Change-Technical-Report-2007.html>
- AdaptNet - <http://www.globalcollab.org/gci/adaptnet>
- Adaptation Links (Office of Climate Change, Western Australia) <http://www.dec.wa.gov.au/content/view/5170/2188/>
- Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Intergovernmental Panel on Climate Change Fourth Assessment Report – Summary for Policymakers (IPCC 2007) – www.ipcc.ch/SPM13apr07.pdf
- State of the Climate (CSIRO/BoM 2010) – <http://www.csiro.gov.au/resources/State-of-the-Climate.html>
- Renewable Energy Atlas of Australia - <http://www.environment.gov.au/sustainability/renewable/atlas/index.html>



