Government of South Australia
Adelaide and Mount Lofty Ranges
Natural Resources Management Board

Climate Change in the Adelaide and Mount Lofty Ranges Region

Impacts on Natural Resource Management

The Greenhouse Effect is vital for life on Earth because it acts to warm the planet by retaining radiated energy. Human actions have resulted in an enhanced Greenhouse Effect, which is projected to significantly alter South Australia's climate.

Climate change could compromise the integrity of multiple use landscapes

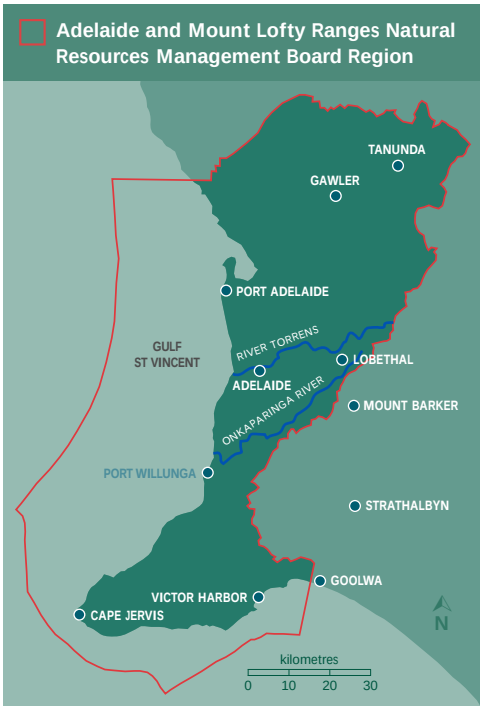
The Department of Water, Land and Biodiversity Conservation (DWLBC) with funding from the Australian Greenhouse Office (AGO), part of the Commonwealth Department of the Environment and Water Resources, is working in partnership with the Adelaide and Mount Lofty Ranges (AMLR) Natural Resources Management (NRM) Board to:

- raise awareness about the importance of climate change for the NRM sector
- help the NRM sector understand the likely impacts of climate change in the AMLR Region
- suggest ways in which government, industry and the NRM community can adapt to climate change, and
- promote the integration of climate change into short and long-term risk management for sustainable NRM.

Within the AMLR Region, climate change has the potential to significantly compromise the sustainability of natural resource management (NRM) for current and future generations.

This brochure has been produced to inform people with considerable awareness of, or professional experience in, NRM within the AMLR Region of the emerging challenges associated with projected climate change. A summary is presented here of projected climate change impacts and adaptation strategies for NRM in the region, as identified in a recent DWLBC report[1].

Since that report was published, CSIRO scientists have updated climate change projections for South Australia[2]. For the AMLR Region, average annual temperatures are projected to increase by 0.4 – 1.2ºC by 2030. Climate change in the AMLR Region could also mean substantial reductions in the amount and reliability of rainfall, with annual reductions from 1 – 10% for the region[2].



For more information go to:
www.dwlbc.sa.gov.au/nrm/projects/climate.html

Australian Government
Department of the Environment and Water Resources
Australian Greenhouse Office

Climate Change – A Challenging Prospect for Our Region

Natural resource managers in the AMLR Region already deal well with climate variability, but climate change will provide new and significant challenges. The projected changes within this diverse area (Table 1) will lead to a suite of secondary environmental impacts, further described under the themes of water, land, biodiversity and coasts in this brochure.

Table 1 Projected climate change in the AMLR by 2030[2,3]

Greenhouse gas emissions

- ▲ Carbon dioxide increase to 420 – 480 ppm (Current = ~ 380 ppm)

Temperature

- ▲ Annual range of warming of 0.4 – 1.2ºC
- ▲ Increase in the annual number of hot days over 35ºC in Adelaide to 15 – 20 days (Current = 14)
- ▲ Increase in the annual number of hot spells (3 – 5 days over 35ºC) in Adelaide to 2 spells (Current = 1 spell)
- ▲ Increase in the annual number of hot days over 40ºC in Adelaide to 2 – 3 days (Current = 1 day)

Rainfall

- ▼ Likely decrease in average annual rainfall of 1 – 10%
- ▲ More extreme rainfall events

Environmental Change

Changes in climate could lead to important environmental change for the AMLR Region, such as:

- ▲ More intense storm events
- ◀▶ Changes in the timing of flowering and breeding cycles
- ◀▶ More variable breaks in the winter growing season
- ▲ Sea-level rise
- ▲ Higher coastal storm surges
- ▲ More frequent and intense bushfires
- ▲ More frequent erosive events
- ◀▶ Changes in the impacts of weeds and animal pests
- ▼ Reductions in groundwater recharge
- ▼ Reductions in average stream flows, including down the River Murray.

Climate change could lead to more frequent erosive events

Sea-level rise and coastal storm surges could impact on coastal areas

Agreement on Climate Change

An overwhelming majority of climate change scientists agree that Australia is currently experiencing climate change. However, there are many uncertainties regarding the future rate and extent of climate change, and the form that it will take.

The discussion here is based on current CSIRO projections of projected futures, and attempts are made to incorporate the uncertainty while assessing appropriate NRM responses.

Legend

- ▲ *Possible increase*
- ▼ *Possible decrease*
- ◀▶ *Possible increase or decrease*

What are the Most Vulnerable NRM Sectors?

The most vulnerable sectors to climate change are generally expected to be in those systems that are not intensively managed by people, such as native biodiversity conservation and coastal systems.

Potential Impact

The potential impacts of climate change are due to a combination of:

Exposure
The weather events, weather patterns and background climate conditions that affect the system, and

Sensitivity
The responsiveness of systems to climatic influences and the degree to which changes in climate might affect them.

Adaptive Capacity

The capacity of a system to change in a way that better equips it to deal with external influences.

Vulnerability

The extent to which a human society or system is unable to cope with the negative impacts of climate change, variability and extremes.

Our response to climate change can be guided by a vulnerability index which reflects the potential impacts of projected climate change and our capacity to adapt to change.

A number of NRM sectors are vulnerable to projected climate change in the AMLR Region (Table 2). This severity rating is not designed to undervalue other NRM issues, rather that the issues mentioned could be considered priority areas for investigation and action in the short-term.

Biodiversity conservation, horticultural production and fire, flood and coastal management are predicted to be most vulnerable as a result of high potential impact and medium to limited adaptive capacity.

The adaptive capacity for intensively managed sectors, such as annual cropping, is expected to be considerable. Such an assumption is based on the current wealth of our society and the historical adaptive capacity of agro-ecosystems, which exclude future risk associated with policy changes, globalisation, fuel costs and urban encroachment.

Further specific vulnerability assessments will need to be built into risk assessment for different NRM contexts.

Table 2 **Summary of vulnerability analyses for NRM in the AMLR[1]**

System	Sector	Potential Impact	Adaptive Capacity	Vulnerability
Water	Riparian flood management	Medium	Limited	Medium-High
	Surface water	Medium-High	Significant	Medium
	Groundwater	Medium-High	Significant	Medium
Land	Agriculture: annual crops	Medium-High	Significant	Medium
	Agriculture: horticulture	Medium-High	Medium	Medium-High
	Land management	Medium	Significant	Low-Medium
	Parks and gardens	Low-Medium	Significant	Low
Biodiversity	Terrestrial biodiversity	Medium-High	Medium	Medium-High
	Freshwater biodiversity	High	Limited	High
	Revegetation	Medium	Significant	Medium
	Invasive species	Medium	Medium	Medium
	Bushfires	High	Medium	Medium-High
Coasts	Coastal flooding	High	Medium	High
	Beach management	High	Medium	Medium-High

The vulnerability assessments presented in Table 2 are based on rational analyses of the potential climate change impacts and the adaptive capacities of the NRM systems.

Our Water

Water management systems are generally highly adaptable to climate change due to the range of potential policy and technology responses (Table 3). The likely exception in the AMLR Region is riparian flood risk management, which may be less adaptable to potential climate change impacts such as more extreme weather events.

Recent Initiatives

- The SA Government has implemented stricter controls on water use from ground, surface and mains water supplies in the region.
- The SA Bureau of Meteorology Flood Warning Centre works on research and information provision in relation to local flooding.
- DWLBC, CSIRO and Flinders University are investigating climate change impacts on surface flows within the AMLR Region.
- Many local councils have introduced water conservation strategies.

Table 3 **Potential climate change impacts and adaptive capacity of AMLR water systems**[1]

	Potential Impact	Adaptive Capacity
Riparian flooding	**Medium** More extreme rainfall events will lead to flood thresholds being reached more often Potential of flooding impact is significant on human welfare, infrastructure and economic activity	**Limited** Area is highly developed and space is required for adaptation options Significant investment in infrastructure required to bring about change
Surface water resources	**Medium-High** Direct reduction in rainfall, runoff and infiltration Increasing water demand with warming, drying Ongoing buffering capacity of River Murray water is significant	**Significant** Reduce wasteful use and enhance infrastructure capacity Implement industry water saving and production efficiency measures
Groundwater resources	**Medium-High** Direct reduction in rainfall, runoff and infiltration Increasing water demand with warming, drying Groundwater rights in region are almost allocated	**Significant** Increase groundwater recharge and reuse Water trading to promote efficient water use

Ideas for Future Responses

- Model flood impacts on key catchments within urban, peri-urban and rural areas, and change planning management responses accordingly
- Develop water-sensitive urban designs and flow calming techniques, including the establishment and expansion of wetland areas
- Reduce water use and improve efficiencies across industries and communities, potentially through water trading and other market-based instruments
- Enhance capacity to transport and store water
- Increase reuse of stormwater and wastewater in the region

Future responses include increased stormwater reuse and expansion of wetland areas

Our Land

Land management systems are generally highly adaptable but will come under pressure with more extreme weather conditions (Table 4). The greatest vulnerabilities could lie with those agricultural systems with long investment and management time-frames. Other systems will need be flexible and resilient to respond to change.

Recent Initiatives

- The SA Government, Adelaide University and CSIRO are modelling projected impacts of climate change on cereal and wine production, and are working to examine how land management will be affected by climate change.
- South Australian Research Development Institute's Climate Applications unit is working with primary producers to assist with management of climate variability and change.
- DWLBC is examining methodologies for supporting the management of sustainable landscapes in light of climate change.

Table 4 **Potential climate change impacts and adaptive capacity of AMLR land systems**[1]

	Potential Impact	Adaptive Capacity
Agriculture: annual crops	**Medium-High** Warming and less reliable rainfall will directly affect dryland cropping systems Farming systems are quite resilient to climate variability due to improved agronomic practices	**Significant** Annual cropping systems can be adjusted relatively quickly Crop varietal choice and management techniques offer substantial opportunities
Agriculture: horticulture	**Medium-High** Horticultural systems are buffered by significant external inputs, especially irrigation water, but resources are limited Some systems, including wine grapes, apples, cherries and vegetables, are highly sensitive to temperature extremes	**Medium** Adjust to change, including different species, varieties and water management systems Horticultural systems require significant time to change and adjust
Land management	**Medium** Higher wind speeds and extreme rainfall events could increase erosion risks Reduced groundwater recharge could decrease salinity risk, but poor water use in agricultural fields could exacerbate recharge	**Significant** Changes in land management can reduce exposure of farming systems to soil degradation Broader use of perennials can reduce risk
Parks and gardens	**Low-Medium** Hot spells are likely to increase Many European garden types are sensitive to hot spells or water use restrictions Ovals, golf courses and other lawned spaces are buffered by irrigation	**Significant** Gardeners can carefully manage water, including using tank and recycled water Indigenous and other gardens are adapted to low rainfall availability

Ideas for Future Responses

- Include into crop rotations varieties that are adapted to shorter growing seasons or more variable intra-seasonal conditions
- Explore opportunities for diversifying production systems to reduce risks, including the commercial use of perennial vegetation
- Use reduced tillage systems in areas that are likely to experience more extreme rainfall events but reduced growing season rainfall
- Develop a better understanding of weather patterns and the use of different crop and garden species
- Reduce the use of scarce irrigation water resources for low value crops
- Adopt water conservation and reuse technologies in parks and gardens, such as drip irrigation systems and reclaimed water irrigation systems

Recent Initiatives

- One of the primary goals of the *State NRM Plan 2006* is "Landscape scale management that maintains healthy natural systems and is adaptive to climate change".
- The SA Government has released *No Species Loss – A biodiversity strategy for South Australia 2006-2016.*
- The Department for Environment and Heritage is undertaking biodiversity vulnerability assessments in some key wetland areas of the AMLR Region. It is also planning for changing climates through the *NatureLinks* program.
- The SA Coast Protection Board has examined mangrove/salt-marsh succession resulting from coastal impacts.
- CSIRO and SA universities are using environmental information to predict future bird and plant distributions.
- DWLBC and the Co-operative Research Centre for Weed Management are examining the risks of current and potential weeds.
- The Bureau of Meteorology, Macquarie University and Monash University are developing a national database on the ecological impacts of climate change.

Our Biodiversity

Native terrestrial and freshwater biodiversity conservation are likely to be highly vulnerable to climate change (Table 5). The risks will be exacerbated by the fact that the AMLR Region forms a relatively isolated cool and humid temperate island within an area experiencing a drier Mediterranean climate.

Table 5 **Potential climate change impacts and adaptive capacity of AMLR biodiversity systems[1]**

	Potential Impact	Adaptive Capacity
Terrestrial biodiversity	**Medium-High** Increase in hot, dry conditions Most local biodiversity is highly adapted to variable, hot, dry conditions but bioclimatic envelopes could change significantly	**Medium** Spatial ecological adjustments are limited by disturbed, fragmented and invaded systems
Freshwater biodiversity	**High** Most catchments are short and highly dependent on regular rainfall Many freshwater ecological systems are already extremely marginal Salinity, pollution and turbidity levels will all increase, with reductions in average flows	**Limited** Ensure environmental flows Lack of excess water available in system
Revegetation	**Medium** Plant establishment, reproduction and productivity depend on species experiencing appropriate environmental conditions	**Significant** Replanting programs can adjust species mixes, but may need to account for changing bioclimatic envelopes
Invasive species	**Medium** More droughts, storms and fire impacts could change disturbance of systems Increased disturbance could enhance opportunities for invasion	**Medium** Invasive species control is already difficult in many cases Largely intact systems are likely to be able to resist further invasion
Bushfires	**High** More extreme weather events and/or prolonged warmer/drier spells are projected Fires are highly sensitive to specific weather conditions such as long, hot spells and strong winds blowing for long periods	**Medium** Opportunities for landscape planning and investment in vegetation management Increase fire-fighting capacities

Ideas for Future Responses

- Examine potential to reduce water harvesting to ensure environmental flows are available
- Identify key biophysical and ecological components of biological communities that are vulnerable to climate change
- Create mosaics, linkages and buffer zones across the landscape
- Support protection of relatively undisturbed and connected ecosystems by extending, redefining and possibly supplementing reserves
- Further develop flexible integrated pest management and risk management approaches to account for climate change

Our Coasts

Coastal systems are likely to be highly vulnerable to sea-level rise and changing disturbance regimes caused by climate change (Table 6). There is significant uncertainty regarding the rates of change, with projections of sea-level rise ranging from 9 cm to 88 cm by 2100.

Recent Initiatives

- The City of Port Adelaide Enfield has studied the impacts of projected climate change on flooding in parts of its council area.
- The National Tidal Centre, Bureau of Meteorology, has established an Australian and Southwest Pacific sea-level monitoring project to improve the knowledge of sea-level rise in the AMLR Region.
- The SA Coast Protection Board maintains coastal dune and barrier systems to reduce the economic impacts of tide and wave action along the metropolitan coastal system.
- The Department for Environment and Heritage has examined the implications of sea-level rise and climate change for the Fleurieu Peninsula, the Coorong and Lakes Alexandrina and Albert Ramsar site.

Table 6 Potential climate change impacts and adaptive capacity of AMLR coastal systems[1]

	Potential Impact	Adaptive Capacity
Coastal regions flooding	**High** Increase in height of storm surges associated with sea-level rise and more intensive storm events Increase in occasional high runoff linked to rainfall events Low-lying residential and industrial areas of very high economic, social and ecological value	**Medium** Protection by maintaining natural ecosystems and establishing seawalls, embankments and floodgates Lack of space and expensive infrastructure requirements
Beaches and dune systems	**High** Projected sea-level rise Tidal, estuarine and dune coastal systems are highly dependent on sea-level, tidal range and flooding regime Potential damage to beaches, estuaries, mangroves, salt-marshes, and important recreational, biodiversity and industry assets Previous removal of dune systems undermines resilience	**Medium** Natural systems have ability to adjust depending on sea-level Spatial adjustments limited by development, as well as fragmented and invaded systems Engineering solutions reduce impacts of depleted environmental services

Ideas for Future Responses

- Investigate new flood and stormwater strategies, particularly in low-lying suburbs of Adelaide
- Explore sea defence and drainage solutions to protect the Adelaide coastline from storm surges
- Reduce disturbance to beach and dune systems so that the natural in-built resilience and adaptive responses to change are able to function effectively
- Allow inter-tidal systems, mangroves and salt-marsh to migrate inland wherever possible

The Precautionary Principle: The Example of Managing Flood Risk along the Adelaide Coastline

The Precautionary Principle suggests that where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

The SA Coast Protection Board has applied the Precautionary Principle to inform coastal development by providing planning guidelines which allow for slightly greater than the projected upper estimates for sea-level rise and weather changes to the year 2100[1].

Our coasts and estuaries are likely to be highly vulnerable to sea-level rise and changing disturbance regimes

How Our Region can Begin to Respond

To respond to climate change uncertainty, there should be an emphasis on the need for new discoveries and ideas. As a first step, all natural resource managers and planners will need to own climate change as a reality, even though the specific impacts of that change are uncertain.

We need to begin exploring ways of incorporating responses to climate change into both management and practice. This can be fostered by:

- recognising we are all an integral part of ecologically sustainable management processes
- applying research and adaptive planning techniques that support community ownership of NRM decisions in light of climate change, and
- raising understanding and awareness about climate change impacts to ensure community acceptance of climate change.

We will need to build resilience and flexibility into our NRM systems. From here, a decision-making framework to guide adaptation responses could include:

- the incorporation of climate change into risk management in the short-term
- the application of adaptive management and planning techniques for the longer-term, and
- the application of the Precautionary Principle.

The impacts of climate change will only increase in the future. We have a responsibility to future generations to respond to climate change – now.

Key Publications

[1]Bardsley D. (2006) *There's a change on the way – An initial integrated assessment of projected climate change impacts and adaptation options for Natural Resource Management in the Adelaide and Mt Lofty Ranges Region*. DWLBC Report 2006/06, Government of South Australia, Adelaide. www.dwlbc.sa.gov.au/assets/files/ki_dwlbc_report_2006_06db.pdf

[2]Suppiah R., Preston B., Whetton P.H., McInnes K.L., Jones R.N., Macadam I., Bathols J. & Kirono D. (2006) *Climate change under enhanced greenhouse conditions in South Australia*, CSIRO, Melbourne. www.greenhouse.sa.gov.au/PDFs/SA_CMAR_report_High%20resolution.pdf

[3]McInnes K.L., Suppiah R., Whetton P.H., Hennessy K.J. and Jones R.N. (2003) *Climate change in South Australia*. CSIRO Atmospheric Research, Melbourne. www.environment.sa.gov.au/sustainability/pdfs/csiro_report.pdf

The Sustainability and Climate Change Division (SA) has released: A draft of *Tackling Climate Change Strategy* which can be downloaded at www.climatechange.sa.gov.au/strategy/strategy.htm

The AGO has released: *Stronger Evidence but new Challenges: Climate Change Science 2001-2005*. www.greenhouse.gov.au/science/publications/pubs/science2001-05.pdf

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