Potential impacts of Climate Change on the Swan and Canning rivers: **Summary Paper**
Prepared for the Swan River Trust by the Technical Advisory Panel

**Introduction**

Until recently, the earth’s climate has been characterised by a comparatively stable inter-glacial period. This has led to an assumption of climate stability in the decision-making process. This conveniently simple and reassuring assumption is now questionable following global consensus on climate change. This is particularly true where defendable planning policies need to be developed.

Human induced warming of our planet is clearly one of the most pressing environmental concerns of our age. Rising sea levels, shifting patterns of precipitation and altered frequency and size of extreme events will have far reaching global implications [see Box 1].

In Western Australia, human population centres are largely concentrated on estuaries and river systems. In the capital city of Perth, the Swan Canning river system serves as an important focal point with more than 1.5 million people residing within the wider catchment area. The system is showing the same signs of environmental stress as other waterways around the world, with an increase in algal blooms, low oxygen levels and seasonal fish deaths.

Planning, protection and management of the Swan Canning river system is coordinated by the Swan River Trust. The Trust receives advice from a Technical Advisory Panel (TAP) comprised of a group of 15 experts with a diverse range of expertise. The TAP has recognised that the potential impacts of climate change will alter the ecological function of the system and the way that people interact with the rivers as a whole. The existing range of management practices in the Swan Canning Catchment will need to accommodate a new understanding of climate change impacts throughout the region.

In this context, the Trust requested a Technical Report to provide an overview of climate change impacts and potential adaptation strategies for the Swan Canning river system. The report was developed by the TAP to provide a detailed description of global climate change, scenarios for climate change in the Swan and Canning rivers, and impacts and adaptation strategies.

This paper provides a broad overview of the key findings of the Technical Report.

More detailed information in the Technical Report and TAP member information is available from www.swanrivertrust.wa.gov.au or by calling the Trust on 9278 0900.

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**Box 1: Statements on Climate Change**

The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) (IPCC, 2007a) presents the most authoritative statements on climate change to date. It concludes that:

- Warming of the climate system is unequivocal as now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (IPCC 2007a; pg 5).

- Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely (90% probability of occurrence) due to the observed increase in anthropogenic greenhouse gas concentrations (IPCC 2007a; pg 10).

- Continued greenhouse gas emissions at or above current rates would cause further warming and induce many changes in the global climate system during the 21st century that would very likely be larger than those observed during the 20th century (IPCC 2007a; pg 13).
Human induced climate change is largely attributed to the burning of fossil fuels, which has increased the layer of greenhouse gases in the atmosphere and led to elevated atmospheric temperatures. This has subsequent effects on cloud cover, rainfall, wind patterns, ocean currents, and the distribution of plant and animal species. These are problems which have the potential to negatively impact on the lives, livelihoods and aspirations of future generations.

While changes in climate are set to continue through the next 100 years and beyond, impacts are of concern in existing planning time-scales. Identified changes in global environmental conditions include:

- Globally, average surface temperatures have increased by 0.76°C since 1850 (IPCC 2007b) and during the last 50 years, the rate of warming has increased at an average of 0.13°C per decade. Eleven of the past 12 years have been among the 12 warmest on record (IPCC 2007b).

- Total sea level rise during the 20th century was approximately 0.17 m [0.12 m to 0.22 m]. Global average sea level rose at an average rate of 1.8 mm per year from 1961 – 2003 with highest rates observed from 1993 – 2003 (approximately 3.1 mm per year).

- Large-scale changes in sub-tropical atmospheric circulation have been observed. In particular, changes in the southern hemisphere circulation have reduced the likelihood of storm development over south-west Western Australia. This largely explains the observed decreases in south-west winter rainfall. Additional changes include delayed northwards movement in the zone of cyclogenesis. These bring autumn, winter and spring rainfall to south-western Australia and an associated weakening of storm intensity and frequency.

How is our climate changing?

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In general, uncertainty ranges for results in the IPCC (2007b) are 90 per cent uncertainty intervals unless stated otherwise, i.e. there is an estimated 5 per cent likelihood that the value could be above the range given in square brackets and 5 per cent likelihood that the value could be below.
Regional descriptions of climate change in Australia have recently been developed (CSIRO 2007). In predicting local scale (50 km radius) climatic changes, past patterns of change provide a baseline for the development of future scenarios.

**How has the regional climate changed to date?**

- Average annual surface temperatures in the south-west region have increased approximately 0.6° C from 1900 to 1990.
- Rises in average surface temperatures have occurred in autumn, winter, and spring rather than in summer.
- Indian Ocean average sea surface temperature changes have increased at a similar rate to global sea temperatures - with an almost linear increase of approximately 0.5° C during the past 35 years. However, the ocean waters between Cape Leeuwin and North West Cape adjoining the West Australian coast, indicate an approximately 0.8° C rise in sea surface temperature during the same period (Figure 1).

**Figure 1** Recorded sea surface temperature changes for the global oceans, Indian Ocean and the West Australian continental shelf

- An increase in storm surge activity has been observed since 1990 and is reflected in the elevated maximum water levels recorded in 2003 and 2004 (Figure 2).

**Figure 2** Highest water levels recorded at Fremantle 1897 – 2006 (metres above Australian Height Datum)

- The water level regime in the Swan River river system is influenced by seasonal and inter-annual fluctuations, tides and storm surges (Table 1). Each is of similar scale with height increases between 0.2 to 0.5 m. Fremantle sea level records indicate that the average sea level has risen at a rate of 1.54 mm per annum between 1897 and 2007. This rate of increase is similar to that observed globally (1.1 to 1.8 mm).

**Table 1 Major processes influencing sea level variability at Fremantle**

<table>
<thead>
<tr>
<th>Processes</th>
<th>Time scale</th>
<th>Maximum amplitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Astronomical tide</td>
<td>12–24 hours</td>
<td>0.80 m</td>
</tr>
<tr>
<td>Storm surge</td>
<td>1–10 days</td>
<td>0.80 m</td>
</tr>
<tr>
<td>Leeuwin Current</td>
<td>Seasonal</td>
<td>0.30 m</td>
</tr>
<tr>
<td>ENSO*</td>
<td>Inter-annual</td>
<td>0.30 m</td>
</tr>
<tr>
<td>Global warming</td>
<td>Decadal</td>
<td>0.015 m per decade</td>
</tr>
</tbody>
</table>

* El nino southern oscillation

- There was a steep decrease in autumn and winter rainfall in the early 1970s throughout the region accompanied by a slight increase in spring and summer. Rainfall records indicate that the occurrence of large storms in winter months has significantly decreased as have winter extremes in daily rainfalls.
- Regional river flow has markedly decreased as a result of diminished winter rainfall (Figure 3).
- Marine water is moving further up the river system during summer and autumn resulting in increasingly saline conditions further upstream.
How is the Swan Canning river system predicted to change in the future?

Several potential scenarios have been developed for the Swan River Trust to anticipate future climatic changes. The scenarios are preliminary tools used to imply conditions that will force inevitable change in the regional environment.

The scenarios, derived from recent scientific information on climate observations, predictive modelling and expert opinion, suggest that the Swan Canning river system will experience:

- increases in atmospheric and water temperatures;
- acceleration in sea and estuary water level rise;
- decreases in winter rainfall and streamflow;
- decreases in groundwater levels and consequent flows to drains and streams; and
- increases in warm spells and heat wave frequency.

What impacts will these climatic changes have on our river system?

The intertwined relationship of ecological and social environments sees changes in one bring repercussions in the other. Climate change impacts flowing on to the river system are no exception.

Avon Catchment

Water, sediment, salt loads and nutrients from the Avon Catchment to the Swan River are expected to reduce with widespread drying. The hotter, more arid climate will alter distribution of native vegetation and land use practices. Fuel loads will take longer to accumulate and fire seasons will be extended.

Ecology

The key impacts on the ecology of the Swan Canning river system will be driven by sea level rise and reduced streamflow, increasing the period of salinity stratification and penetration of marine water upstream. Key biological processes will be affected including biological oxygen demand, nutrient cycling and sediment retention. Changes in the distribution and abundance of species are very likely and the seasonal patterns of productivity and food-web dynamics will almost certainly be altered. The upper Swan in particular will experience increased and ongoing problems associated with eutrophication, such as algal blooms and fish kills.

Social Values

The community’s use and perception of the rivers, alongside the social values of the system are likely to change. This is due to a reduction in passive recreational facilities (through loss of beaches, wetlands and associated vegetation); a change from the existing aesthetic value (due to a greater frequency of algal blooms and fish kills that can lead to public perception of an unhealthy environment); and increased development of infrastructure (to mitigate sea level rise).

It will be important for the Trust to maintain good communications with river users, residents, visitors and leaders of the international environmental management community. Gaining their consensus on adaptation concepts, conservation practices and ways to increase system resilience will be valuable.
**Economics**

The main economic impacts of climate change relate to the increasing costs of water quality management. Reduced water quality has already necessitated considerable investment in a range of remedial projects in the system. Climate change is likely to exacerbate eutrophication and fish deaths in the upper Swan. Increased river and land values may require corresponding increased costs associated with monitoring and intervention programs such as oxygenation.

The increased fish deaths and algal blooms may reduce community recreational benefits which may impact on local business in the region.

Economic loss will result from a need to protect, retrofit, repair or replace infrastructure due to increased sea levels and storm surges. Mitigation or modification measures may be required to protect people’s homes and riverside suburbs in the future.

**How can we manage these impacts?**

Adaptation requires commitment of human and technical resources and refers to reducing or accommodating the adverse impacts of climate change. As critical thresholds are likely to be exceeded, strategies to increase system resilience will be essential. The ability to adapt to climate change will be aided by the use of appropriate and robust information on key variables that may be used to develop strategies for protection, accommodation, avoidance or retreat. This will aid community understanding in the processes and role their activities play in the health of the Swan Canning river system.

The collection and analysis of high quality long-term data on key climate change variables is a priority for management of the Swan Canning river system. Furthermore, any new data should be incorporated into predictive models so that the uncertainty of climate change risks can be assessed and improved in the future. Action towards improving understanding of the system’s response to climate change provides a basis to move to cost effective management measures in the future.

Detailed adaptation and mitigation strategies for climate change impacts are presented in Box 2.

**Summary**

Climate change is occurring and will continue to influence our social and ecological environments for future generations throughout the coming centuries.

Adaptive management is increasingly recognised as a tool to ensure successful adaptation to the impacts of climate change. Adaptive management is a systematic process for continually improving management policies and existing practices by learning from the outcomes of strategies in place.

In future years, as adaptation priorities are addressed (Box 2) and climate change science is updated, river managers will need to reassess management position, and update research and adaptation priorities.

This adaptive management approach will ensure river managers are in the best possible position to address impacts of climate change, to maintain the valuable ecosystem integrity of the Swan and Canning river system for all to enjoy.
Box 2: Key adaptation strategies

1. Assessing foreshore vulnerability

Assess the vulnerability of the river foreshore to the major impacts of climate change.
Based on the assessment, develop in partnership with local government setback guidelines, foreshore revegetation strategies and erosion control measures.

2. Improving water quality through oxygenating water, trapping nutrients and ensuring adequate river flow

Develop and adopt innovative technologies to deal with future water quality issues, such as mobile oxygenation units and nutrient trapping products.
Investigate options to ensure adequate river flows.
Continue long-term catchment management to reduce nutrient loads.
Using monitoring and modelling to predict future changes

Expand the water quality monitoring program to include upstream areas, where climate change impacts are most likely to occur.
Continue to refine river and catchment computer models to increase our ability to predict future changes.

Managing biodiversity

Improve our understanding of fisheries and supporting ecosystems response to change, and how these changes will impact biodiversity, recreational and commercial values.
Develop predictive models to determine how changes in water quality in the upper Swan will impact species distribution and biodiversity.
As sea level rises, seek opportunities to establish new bird foraging, breeding and roosting habitat.

Protecting infrastructure

Incorporate sea level rises of 0.1 to 0.3 m in the design, maintenance or replacement of roads, river jetties, boat pens and ramps, sea walls and groynes.
Reference


Swan River Trust

Level 1
20 Terrace Road
East Perth WA 6004
PO Box 6740
Hay Street
East Perth WA 6892
Phone: (08) 9278 0900
Fax: (08) 9325 7149
Email: info@swanrivertrust.wa.gov.au
Web: www.swanrivertrust.wa.gov.au

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