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This chapter identifies key threats to water resources, and forecasts their impact on water availability and quality over the next 50 years.



Managing future threats to water resources

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Key points of the chapter

- Surface water is the source of 91 per cent of the water used in the region.
- Irrigation accounts for 89 per cent of water use, while urban use accounts for about four per cent.
- Climate change is likely to be the biggest factor affecting future water availability, resulting in the next 50 years being drier and warmer than the past century. Other threats include climate variability (drought), water regulation and extraction and interception activities.
- It is possible that the low streamflows and inflows experienced since 1997 represent a major and ongoing change in water availability. The Strategy plans for the continuation of this as its most severe water availability scenario.
- If nothing is done, reduced water availability will result in: increased risk of zero allocation years for irrigators; greater frequency, severity and duration of urban water restrictions; and reduced environmental flows.
- Over the past 12 years there has been a disproportionate reduction in water availability for the environment compared with consumptive use. This is because most environmental water is provided by unregulated flows and spills from storages, rather than secure entitlements.

2.1 Sources and values of water

In the Northern Region surface water is the source of the vast majority of water used. On average, 91 per cent of total water use is surface water, five per cent is groundwater and four per cent is alternative sources; including stormwater and recycled water¹. There are about 485 GL of groundwater entitlements, which is 12 per cent of surface water entitlement volume (see Appendix 2 for more information).

The region's total surface water resources are 10,230 GL/year (long-term average), of which environmental flows account for 4,089 GL/year. Only six per cent of this is provided by environmental entitlements (see Appendix 4); the remainder comes from unregulated flows and spills from storage.

Of the surface water resources taken for consumptive use, 89 per cent is used for irrigation and other rural use and four per cent is used in urban areas (see Figure 2.1).

These different uses reflect the many important values supported by the region's water resources, including social, economic and environmental (see Figure 2.2).

Figure 2.1 Surface water use in the Northern Region (GL/year)²

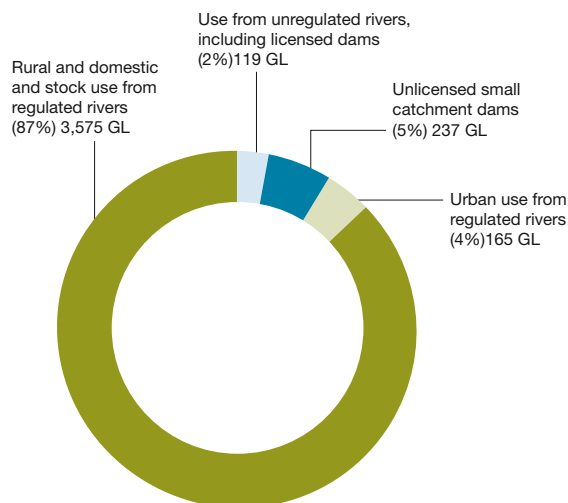


Figure 2.2 The many values supported by water

<p>Agriculture Agricultural production is a key factor in Victoria's ongoing prosperity, with horticulture, dairy and mixed farming enterprises underpinning regional economies.</p>	<p>Towns and cities Households, businesses and urban communities rely on safe, secure supplies for drinking, washing, maintaining sports grounds and open spaces, manufacturing and other industrial uses.</p>	<p>Environment Healthy rivers, wetlands and floodplains are home to important plants and animals such as Murray cod, river red gums and migratory birds.</p>
<p>Recreation and tourism Important recreational activities take place on or near rivers and wetlands, including fishing, water-skiing, boating, camping and picnicking. Resulting tourism supports regional economies.</p>	<p>Indigenous culture The health of waterways and land remains central to Indigenous culture, particularly significant fish and bird species, plant foods and medicines.</p>	

2.2 Threats to water availability

The key risks to water availability include:

- climate change and variability
- water regulation and extraction
- interception activities such as small catchment dams, land use change and forest regeneration after bushfires.

2.2.1 Climate variability and change

Victoria's rainfall has a high level of seasonal and inter-annual variability and there are a range of factors that influence this variability (see Appendix 3). Rural and urban water supply systems have been designed to manage the variability experienced over the historic record. Climate change represents an additional influence and will probably be the biggest factor affecting future water availability. In all likelihood, climate change will result in the next 50 years being drier and warmer than the past century. Droughts are also expected to be more frequent and severe.

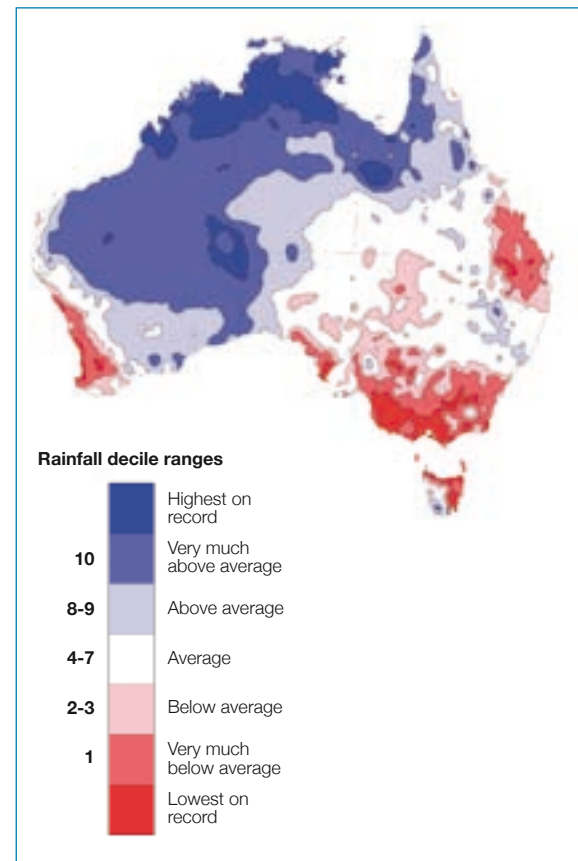
Victoria's rainfall, along with much of eastern Australia, has been experiencing a considerable downward trend since the 1970s. The past 12 years have been particularly dry with most of the Northern Region experiencing well below average rainfall (see Figure 2.3). Victoria's water entitlement framework has been designed to cope with drought, but the duration and severity of the low streamflows and inflows experienced since 1997 has limited the ability of people, industries, the environment and water storages to recover. The effects in the region have included:

- reduced allocations since 2002/03 for irrigation and urban water use, in line with the gradual reduction in storage levels
- significant pressure on the environment from reduced streamflows and allocations, with environmental water being directed towards maintaining drought refuges for plants and animals
- more severe and extended water restrictions for towns, impacting on households, industry and community and recreational activities
- reduced water availability for domestic and stock use, and additional impacts on dryland crops and pastures due to reduced rainfall
- more prolonged restrictions and bans in unregulated river and groundwater systems
- increased use of groundwater as a drought contingency water source and reduced groundwater recharge.

"The last 11 years of dry conditions have reduced the resilience of regional communities and their river systems, and many people are well aware that 'business as usual' is no longer an option."

– Draft Strategy submission DS161

Figure 2.3 Australian rainfall deciles
(1 October 1996 to 31 August 2009)³



The Strategy applies lessons from the past 12 years to be better prepared for future drought or permanent changes to water availability. Irrespective of the cause, there is little prospect of returning to the water availability of the past century and northern Victoria must be in a position to respond to a future with less water.

It is possible that the low streamflows and inflows experienced since 1997 represent a major and ongoing change in storage inflows. A similar change occurred in south-west Western Australia where inflows were reduced by about 50 per cent in 1975 and up to 64 per cent in the past 10 years (see Figure 2.4). Extensive research into the causes of the Western Australian changes in rainfall and inflows has shown that they result from large-scale atmospheric circulation changes which have resulted in an increase in average atmospheric pressures, a southward shift in storm tracks and a reduced potential for the development of storms. In turn, these changes are considered to result primarily from a combination of the enhanced greenhouse effect and natural variability. Ozone depletion may also be playing a role through its influence on the Southern Annular Mode (a mode of climate variability that involves alternating changes in storms and windiness between high and mid-latitudes). Similar factors are influencing Victoria's climate. In both regions, further research is necessary to better quantify the relative contributions of natural variability and the various human-induced forcings to the observed changes in climate (see www.ioci.org.au for more information).

Climate change – how do we know?

Victoria is an active participant in the South Eastern Australian Climate Initiative (SEACI), a research program established in 2006 (see www.seaci.org). This initiative aims to better understand the key climate drivers affecting south-eastern Australia over a range of timescales, and in particular, the causes of the dry conditions that have been experienced since 1997. Research released in 2008 concluded that there are now firm signals linking the current dry conditions to global warming. See Appendix 3 for an explanation of the known drivers of Victoria's climate.

SEACI has found that the key factor influencing the rainfall decline is a rise in atmospheric pressure in southern Australia, associated with an intensification of the sub-tropical ridge (a belt of high pressure located in the mid-latitudes, around 30-35 degrees south). This intensification weakens and shifts south the cold fronts and low-pressure systems that used to bring reliable rainfall to south-eastern Australia and accounts for 70 per cent of the reduced rainfall.

While natural variability will have played a part in the recent changes in climate, the clear link between the dry conditions and global warming identified by SEACI suggests that dry conditions may persist. Through SEACI, the Victorian Government is contributing to further research to better understand the relative roles of natural and human-induced forces in these changes. This work will be important in determining if, and to what extent, current and further rainfall declines can be expected as a result of climate change.

The Victorian Government is also committed to addressing the drivers of global warming by reducing greenhouse gas emissions and preparing for further changes to our climate. This work is being driven by the Department of Premier and Cabinet (see www.climatechange.vic.gov.au).

Figure 2.4 Annual inflows to Perth storages⁴

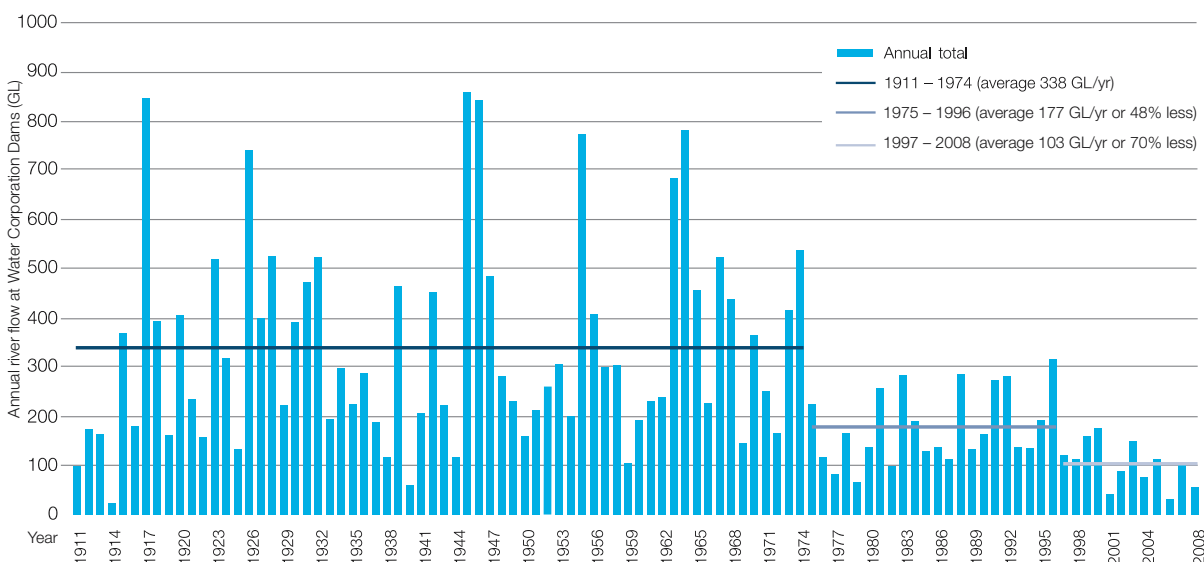


Figure 2.5 shows how climate change could impact on all aspects of the water cycle. Reduced rainfall and hotter temperatures are expected to result in drier soils, less run-off into rivers and storages and more evaporation from rivers, channels and storages.

Changes in rainfall and streamflow across Victoria over the past 12 years have generally been of the order of those expected under medium to high climate change projections by 2055. Across the state, there has already been a reduction in annual rainfall of about 13 per cent.

Reduced rainfall has resulted in a 44 per cent decline in inflows to rivers and storages in the River Murray between July 1997 and June 2007. Inflows in 2006/07 were 1,110 GL; the lowest on record at only 15 per cent of the pre-1997 average (see Figure 2.6). This was followed by another dry year, with inflows in 2007/08 only 2,128 GL. With inflows in 2008/09 also very low, these three years are tracking as the lowest, third lowest and seventh lowest inflows in the historic record across the Murray-Darling Basin⁵.

Victoria has experienced similar periods of reduced water availability in the past; notably in the early 1900s (Federation drought) and the mid-1930/40s (World War II drought). These past periods were not as severe, in terms of streamflow and inflow reductions, as this recent period which has had higher temperatures and potential evapotranspiration⁶. This recent period has also seen a complete absence of high rainfall years (that is, the loss of inter-annual variability) and there has been a disproportionately large decline in autumn and early winter rainfall. This has resulted in low winter-spring run-off and a decline in streamflows and inflows to surface water and groundwater storages.

Figure 2.5 Potential climate change impact on the water cycle by 2050⁷

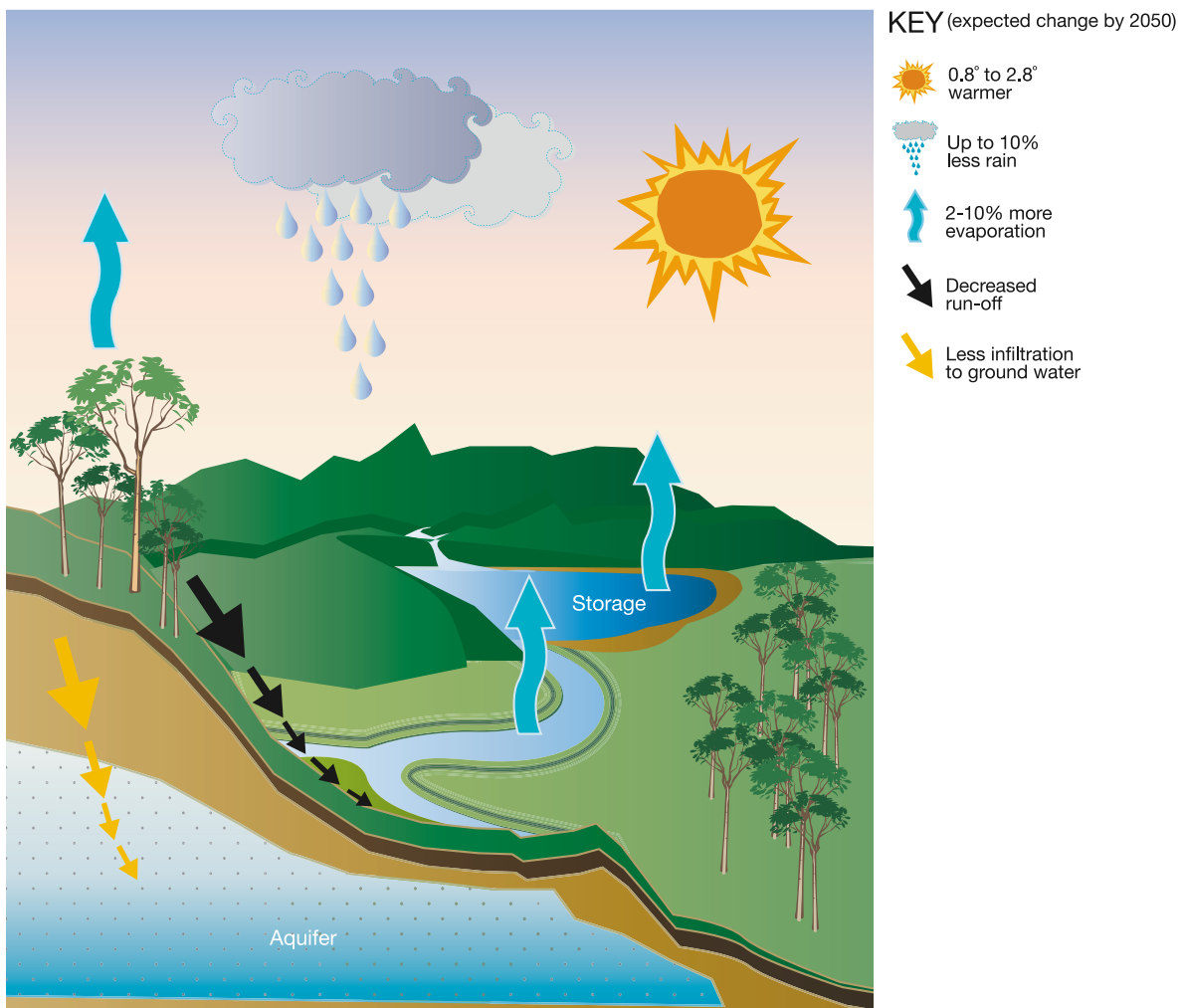
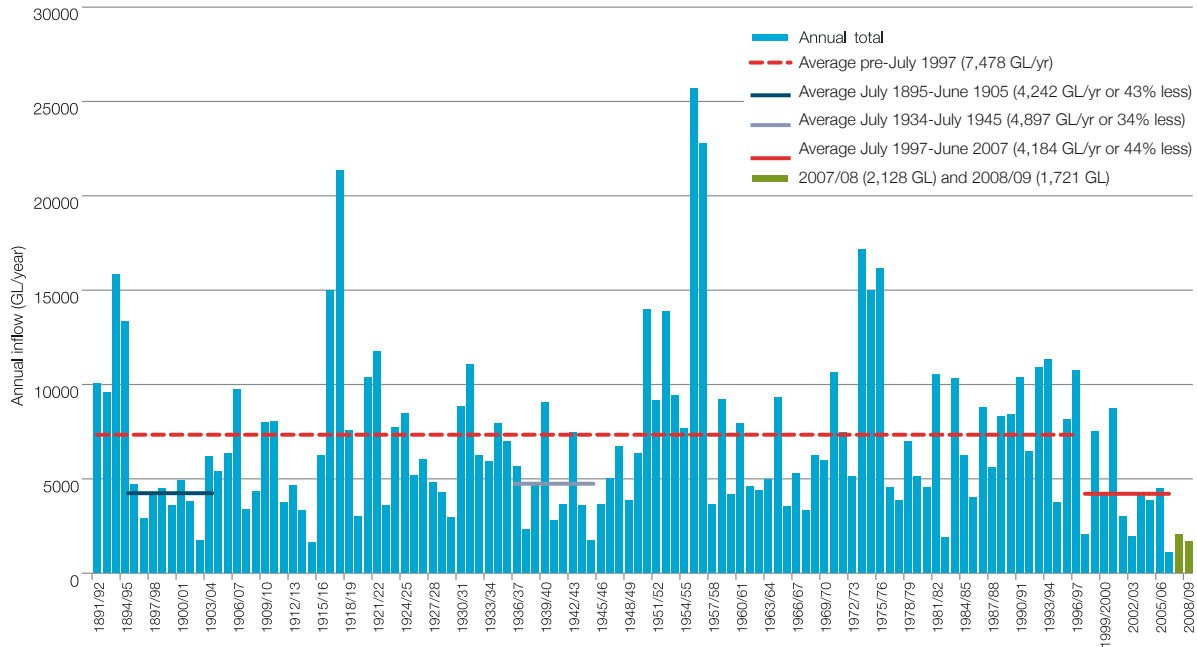


Figure 2.6 Annual inflows into Victoria’s share of the River Murray system



Notes:

- Inflows include Snowy River transfers.
- Data produced from hydrological models.
- Data prior to 1900 is less robust than remaining dataset.
- Inflows for 2007/08 and 2008/09 are shown here but are not included in subsequent model runs as they were not available at the time. If included the post-1997 average inflow for Victoria’s share of the River Murray would be 3,164 GL/yr or 49% less than the pre-1997 average.
- 2008/09 inflow data is an estimate only, calculated using available operational data.

2.2.3 Water regulation and extraction

It has long been recognised that the construction of large storages and the extraction of water have affected the condition of the region’s rivers, wetlands, floodplains and aquifers. The effects of water regulation and extraction are likely to be exacerbated by the impacts of climate change and in many northern river systems, the water provided for the environment is inadequate to sustain ecological objectives. The Sustainable Rivers Audit undertaken in the Murray-Darling Basin found that the current condition of Victoria’s northern rivers was poor⁸. In addition to a decline in ecological health, towns and industries that depend on reliable, high-quality water are impacted. Victoria and other Basin states have responded by introducing a cap to stop growth in water use and are investing in a range of projects to reallocate water from consumptive use to the environment (see page 130).

The CSIRO Sustainable Yields project (available at www.csiro.au) identified no over-allocated groundwater areas in northern Victoria. However, groundwater levels are declining due to an imbalance between rates of extraction and rates of recharge (see page 28).

In the future it will be necessary to constantly reassess community values to determine the appropriate balance of environmental and consumptive water use. The definitions of ‘over-allocation’ and ‘sustainability’ are a value judgement of the community of the day, and are likely to change over time (see pages 68 and 150 for further discussion).

2.2.2 Interception activities

Interception activities are a risk to water availability because they capture rainfall before it becomes surface runoff or groundwater recharge. These activities include small catchment dams (for farms or domestic and stock use), changes in land use and the impact of forest regeneration due to bushfires. These activities have not historically required a water entitlement (except for small catchment dams for irrigation or commercial purposes which have required a licence since 2002). However, they can reduce the amount of water available to downstream entitlement-holders and the environment.

As water availability decreases, interception activities harvest an increasing proportion of available water as they capture rainfall before it becomes runoff. It is difficult to forecast the full impact of interception activities, as they are variable over time (for example, with bushfires), or localised (for example, with plantations in the Northern Region). However, it is likely that in future, greater emphasis will be placed on accounting for the water use of interception activities (see Chapter 4 for more information).

Small catchment dams

Unlike dams for commercial and irrigation use, dams for domestic and stock use are not licensed and therefore can continue to be built without scrutiny of their impact on downstream users and the environment. Based on current estimates, unlicensed dams capture six per cent of the available surface water in northern Victoria. At a local level, the impact of unlicensed dams can be even greater. For example, with long-term average water availability, small catchment dams in the Campaspe system collectively intercept 11 per cent of streamflow. This increases to 16 per cent under medium climate change, and 29 per cent under a continuation of recent low inflows (see Background Report 1 for more detail and page 21 for water availability scenarios). In sub-catchments with a high density of small catchment dams, natural streamflow can be reduced by up to 77 per cent under a continuation of recent low inflows⁹.

Land use change

Land use change has the potential to impact significantly on water resources in Victoria. For example, a shift from pasture to plantations, or from annual to perennial pasture, can affect the water balance of a catchment by intercepting water that would otherwise become part of the surface or groundwater resource.

The impact of afforestation on water yield in the Northern Region is expected to be relatively low, though local impacts could occur. CSIRO Sustainable Yield Project¹⁰ forecasts an increase of 30,000 hectares in plantations by 2035 in the upper Murray (Victoria and New South Wales). This equates to the interception of 25 to 35 GL per year or 0.9 to 1.3 per cent of average annual yield.

Since the release of *Our Water Our Future* in 2004, progress has been made to quantify the impacts of the various land use changes on water resources across Victoria. Several policy options to account for and manage these changes have been identified and evaluated, including case studies in Gippsland, south-west and north-east Victoria. Drawing on this technical work and research, the State Government is currently determining the most appropriate policy response. The next stage of policy development will be undertaken through the Western Region Sustainable Water Strategy.

Regeneration after bushfires

Fires are a natural occurrence in the Australian landscape, and have a varying impact on water yield depending on the type of vegetation involved, the intensity and spatial extent of the fire, and the proportion of a catchment affected. Quantifying the future impact is limited by the unpredictable nature of bushfires, though the frequency and intensity is likely to increase as our climate becomes warmer and drier.

An increase in rainfall runoff is generally experienced for several years after a fire, due to the reduction in vegetation cover. In the longer term (20 to 80 years), surface and groundwater may be drawn upon as regenerating vegetation enters a phase of rapid growth. As forests mature, water use gradually tails off, eventually returning to pre-bushfire levels.

In 2002/03, fires in north-eastern Victoria burned almost 500,000 hectares of native forest¹¹. In addition, 400,000 hectares in the north-east was burnt in the 2006/07 fire season, including some areas that were previously affected in 2002/03. It is estimated that the maximum combined impacts of the 2002/03 and 2006/07 fires will be a reduction in average annual streamflows from catchments contributing to the River Murray of around 255 GL at around 2025. To put this in context, it represents about three per cent of average annual flows in the River Murray at the confluence with the Ovens River¹². This is a small impact compared to other threats.

The 2008/09 fire season saw the burning of just over 100,000 hectares in the Northern Region, including in part the firestorms that swept across Victoria on Black Saturday (7 February 2009). These fires were unprecedented in their intensity and ferocity. It is not yet known how these fires will impact on the region's water resources. See page 35 for information on the impact of bushfires on water quality.

2.3 Projection of water availability to 2055

The Strategy uses computer models to help project water availability. The models are important in long-term water planning because they provide some insight into what the future may look like, but also indicate of the range of uncertainty that will need to be managed. The following water availability scenarios have been modelled for the major regulated systems in the Northern Region:

- the base case – long-term average, based on the historic record from July 1890 to June 2007
- Scenario A – based on the CSIRO¹³ low climate change predictions
- Scenario B – based on the CSIRO medium climate change predictions
- Scenario C – based on the CSIRO high climate change predictions
- Scenario D – based on a continuation of recent low inflows (July 1997 - June 2007).

The Strategy examines two scenarios in detail – a continuation of recent low inflows (Scenario D) and the medium climate change predictions (Scenario B) and compares these to the base case. Focusing on Scenario D allows planning for a more severe scenario, which is more prudent than assuming inflows will soon return to historical conditions. However, this scenario may not eventuate and therefore it is also important to examine the impacts of the medium climate change projections. Comparing Scenario D and Scenario B with the long-term average (base case) illustrates the range of possible water availability scenarios.

The forecasts in Figure 2.7 highlight the uncertainty in predicting future water availability. It is possible that there may be a slight increase in water availability in the total Murray system in 50 years time (as a result of increased flows in the Darling River), although this is not the case for any other river systems in the Northern Region. Scenarios B and C predict a gradual reduction in water availability, while Scenario D shows the impact of an indefinite continuation of the extreme conditions experienced since 1997.

Modelling our water resources

The Strategy uses the Department of Sustainability and Environment's Resource Allocation Models (REALM) to simulate the operation of the region's water supply systems and show how urban and rural supplies and the environment may be affected by potential reductions in inflows.

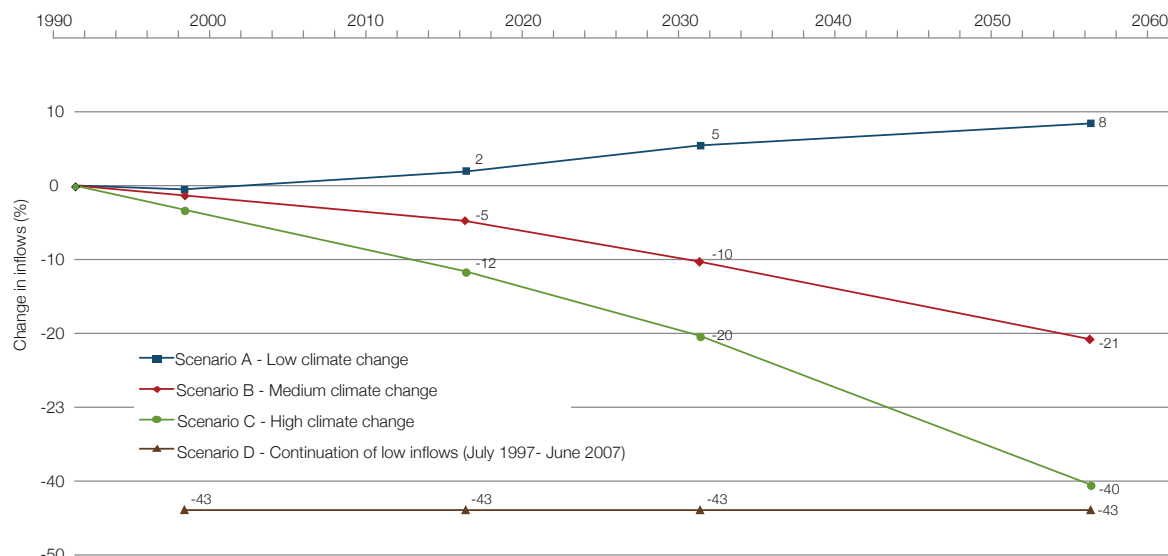
Two types of model runs were undertaken to develop the Strategy:

- 1) Water availability scenarios: these model runs assume the current system operating rules, with inflows affected by climate change. Climate scenarios A-C are formulated by applying a percentage reduction, determined by CSIRO predictions¹⁴, to the entire historic inflow record (July 1890 to June 2007). For Scenario D, the average reduction of July 1997 - June 2007 (from the long-term average) is applied to the entire historic record.
- 2) Option analysis: these model runs assume modified operating rules under base case and scenario inflows to demonstrate how management options would impact on reliability of supply and environmental flows under a range of water availability scenarios.

While Figure 2.6 provides estimates of inflow data for 2007/08 and 2008/09 (Victoria's share of the River Murray), inflows for these years were not included in the water availability scenarios, as the data was not available at the time of the model runs.

The Strategy's forecasts and those formulated through the CSIRO Sustainable Yields Project are very similar. However, the 'dry' and 'wet' scenarios used by CSIRO are more extreme than the 'high' and 'low' scenarios used in this Strategy. The methods used to model the dry inflows of recent years differed between the two projects. Despite this, both the Sustainable Yields Project and this Strategy present a consistent message of future reductions in water availability. Extensive work has been undertaken to ensure the models used are the best available, and they are continuously improved.

Figure 2.7 Forecast availability of inflows for the total Murray system* over 50 years (Scenarios A to D compared with the long-term average)¹⁵



Note: * Refers to total Murray system, not just Victoria's share.

Note that unless otherwise stated the Murray system refers only to Victoria's share of the resource, which comprises 50 per cent of the upper Murray, Kiewa and lower Darling, and all outflows from the other Victorian tributaries.

Table 2.1 shows the potential reduction in total inflows for each of the major river systems in the Northern Region (also see Background Report 2). The western catchments are likely to be more adversely affected than the eastern catchments and the impacts of recent low inflows are similar to or greater than those expected under the high climate change scenarios.

The current extended drought in the Northern Region has been more severe, in terms of streamflows, than any period on record. By applying lessons from the recent drought, Strategy actions will make sure the region is better prepared for similar or more extreme future droughts.

During consultation on the Draft Strategy some community members expressed concern that Scenario D was too extreme. The latest climate research indicates that the climatic conditions of the past 12 years may continue, with a link established between global warming and an intensification of the sub-tropical ridge (see Appendix 3). This possibility is supported by the experience in south-west Western Australia, a location that is affected by some of the same key climate influences as Victoria, where streamflows have been well below average for more than 30 years.

There were comments from some community members that long-term conditions could be more severe. If improved forecasts show a greater likelihood that the ongoing climate will be drier than Scenario D, further actions can be implemented. In the interim, the Strategy improves the region's capacity to manage through drier periods. This approach provides a balance between cost and readiness based on an uncertain future.

Table 2.1 Forecast change in total inflows in the major river systems in the Northern Region (compared with the long-term average)¹⁶

River system	Water availability scenarios at 2055			
	A – Low climate change	B – Medium climate change	C – High climate change	D – Continuation of low inflows (July 1997 - June 2007)
Murray*	+ 8%	-21%	-40%	-43%
Kiewa	-5%	-19%	-32%	-23%
Ovens	-6%	-24%	-41%	-33%
Broken	-7%	-31%	-51%	-53%
Goulburn	-7%	-25%	-43%	-49%
Campaspe	-9%	-31%	-54%	-72%
Loddon	-10%	-34%	-58%	-74%

Note: * Refers to total Murray system, not just Victoria's share.

2.4 How will the available water be shared?

Victoria's entitlement framework determines how available water is shared between various water users and the environment (see page 9). Tables 2.2 and 2.3 summarise how Scenarios B and D will reduce water availability for the major regulated systems in the Northern Region, compared with long-term averages. They show that there is a disproportionate impact on water available for the environment compared with water for consumptive use.

Please note that 'environmental water' refers to the outflows at the end of each system. As such, it includes water that may be used for consumptive purposes further downstream. For example, Goulburn environmental water includes consumptive water being delivered to entitlement-holders in Sunraysia.

Summary of Scenario B – Potential impact of medium climate change in 2055

- Overall water availability (total inflows) could be reduced by 25 per cent in the Goulburn system and 34 per cent in the Loddon.
- Water availability for consumptive use (diversions) could be reduced by three per cent in the Broken and 23 per cent in the Loddon.
- Water availability for the environment (environmental water) could be reduced by 28 per cent in the Murray and 49 per cent in the Campaspe.

Table 2.2 Forecast water availability under medium climate change (impact of Scenario B at 2055 compared with the long-term average)¹⁷

Expected impacts in 2055 - of medium climate change	River system				
	Murray ²	Broken	Goulburn	Campaspe ³	Loddon
Total inflows¹					
Long-term average ⁴	7,596 GL	281 GL	3,287 GL	305 GL	278 GL
Medium climate change	5,621 GL	194 GL	2,458 GL	211 GL	183 GL
<i>Difference (%)</i>	<i>-1,975 GL (-26%)</i>	<i>-87 GL (-31%)</i>	<i>-829 GL (-25%)</i>	<i>-94 GL (-31%)</i>	<i>-95 GL (-34%)</i>
Diversions for consumptive use					
Long-term average ⁴	1,697 GL	31 GL	1,638 GL	110 GL	102 GL
Medium climate change	1,563 GL	30 GL	1,389 GL	99 GL	79 GL
<i>Difference (%)</i>	<i>-134 GL (-8%)</i>	<i>-1 GL (-3%)</i>	<i>-249 GL (-15%)</i>	<i>-11 GL (-10%)</i>	<i>-23 GL (-23%)</i>
Environmental water⁵					
Long-term average ⁴	4,089 GL	184 GL	1,591	162 GL	109 GL
Medium climate change	2,951 GL	99 GL	980 GL	83 GL	58 GL
<i>Difference (%)</i>	<i>-1,138 GL (-28%)</i>	<i>-85 GL (-46%)</i>	<i>-611 GL (-38%)</i>	<i>-79 GL (-49%)</i>	<i>-51 GL (-47%)</i>

Notes:

1. Total inflows include diversions for consumptive use, environmental water, plus systems operating water. Excludes water use in unregulated systems and small catchment dams.

2. Murray diversions and inflows are Victorian shares only. Murray environmental water is Victorian flow at the South Australian border (including Living Murray Initiative commitments).

3. Campaspe diversions include Coliban River diversions for urban and irrigation supplies.

4. Calculated based on historic record July 1890-June 2007.

5. Environmental water is reflected by end of valley flows (ie. flows at the basin outlet).

Table 2.3 Forecast water availability under a continuation of recent low inflows (impact of Scenario D compared with the long-term average)¹⁸

Immediate impacts of a continuation of recent low inflows (July 1997-June 2007)	River system				
	Murray ²	Broken	Goulburn	Campaspe ³	Loddon
Total inflows¹					
Long-term average ⁴	7,596 GL	281 GL	3,287 GL	305 GL	278 GL
Continuation of recent low inflows	4,408 GL	139 GL	1,704 GL	92 GL	77 GL
<i>Difference (%)⁵</i>	<i>-3,188 GL (-42%)</i>	<i>-142 GL (-51%)</i>	<i>-1,583 GL (-48%)</i>	<i>-213 GL (-70%)</i>	<i>-201 GL (-72%)</i>
Diversions for consumptive use					
Long-term average ⁴	1,697 GL	31 GL	1,638 GL	110 GL	102 GL
Continuation of recent low inflows	1,445 GL	28 GL	1,139 GL	56 GL	34 GL
<i>Difference (%)</i>	<i>-252 GL (-15%)</i>	<i>-3 GL (-10%)</i>	<i>-499 GL (-30%)</i>	<i>-54 GL (-49%)</i>	<i>-68 GL (-67%)</i>
Environmental water⁶					
Long-term average ⁴	4,089 GL	184 GL	1,591 GL	162 GL	109 GL
Continuation of recent low inflows	2,005 GL	55 GL	489 GL	23 GL	17 GL
<i>Difference (%)</i>	<i>-2,084 GL (-51%)</i>	<i>-129 GL (-70%)</i>	<i>-1,102 GL (-69%)</i>	<i>-139 GL (-86%)</i>	<i>-92 GL (-84%)</i>

Notes:

1. Total inflows include diversions for consumptive use, environmental water, plus system operating water. Excludes water use in unregulated systems and small catchment dams.

2. Murray diversions and inflows are Victorian shares only. Murray environmental water is Victorian flow at the South Australian border (including Living Murray Initiative commitments).

3. Campaspe diversions include Coliban River diversions for urban and irrigation supplies.

4. Calculated based on historic record July 1890-June 2007.

5. These percentages may vary from Table 2.1 which outlines the change from the pre-July 1997 long-term average (while this table outlines the change from the long-term average over the full historic record, including July 1997-June 2007).

6. Environmental water is reflected by end of valley flows (ie. flows at the basin outlet).

Summary of Scenario D – continuation of recent low inflows

- Overall water availability (total inflows) could be reduced by 42 per cent in the Murray system and 72 per cent in the Loddon.
- Water availability for consumptive use (diversions) could be reduced by 10 per cent in the Broken and 67 per cent in the Loddon.
- Water availability for the environment (environmental water) could be reduced by 51 per cent in the Murray and 86 per cent in the Campaspe.

Why is there a disproportionate impact on water availability for the environment compared with consumptive use?

Climate change means environmental flows will be reduced significantly more than water for users. This is because the majority of environmental flows are not provided by entitlements; they come from unregulated flows or 'above cap' water that cannot be harvested or spills from storages. Spills from storages are particularly reduced under climate change because storages on average hold less water in them and can therefore capture a greater proportion of inflows.

The environment does have some entitlements (see Appendix 4). While these are less impacted by climate change (see Tables 2.4 and 2.5), they represent less than six per cent of the total water available for the environment.

2.5 Water availability for entitlement-holders

2.5.1 Water share-holders

A water share is a legally recognised, secure share of the water available to be taken from a water system, (see page 10) and may be high-reliability or low-reliability. Reduced inflows mean less water available for seasonal allocations to water shares, expressed as a percentage of the entitlement volume.

High-reliability water shares total 2,288 GL in northern Victoria¹⁹. Table 2.4 outlines the change in allocations for high-reliability water shares under Scenarios B and D compared to the base case assuming no action is taken.

In the Murray system, full allocations for high-reliability water shares are expected in 68 years out of 100 under Scenario D, compared to the base case of 98 years out of 100. The number of years with zero allocations could increase from none to five out of 100. In the Goulburn system full allocations of high-reliability water shares would decrease from 96 to 28 years out of 100 under Scenario D and zero allocations could be experienced one year in every hundred.

More detailed modelling results can be found in Background Report 2.

Table 2.4 Forecast reliability of high-reliability water shares in the major regulated systems of the Northern Region²⁰

Indicator		Scenarios		
		BASE CASE: Long-term average	SCENARIO B: Medium climate change at 2055	SCENARIO D: Continuation of low inflows (July 1997 - June 2007)
Murray	No. of years with 100% allocations	98 out of 100	89 out of 100	68 out of 100
	Lowest allocation	71%	0%	0%
	No. of years with 0% allocations	0 out of 100	2 out of 100	5 out of 100
Broken ¹	No. of years with 100% allocations	89 out of 100	79 out of 100	58 out of 100
	Lowest allocation	0%	0%	0%
	No. of years with 0% allocations	1 out of 100	1 out of 100	5 out of 100
Goulburn	No. of years with 100% allocations	96 out of 100	79 out of 100	28 out of 100
	Lowest allocation	27%	0%	0%
	No. of years with 0% allocations	0 out of 100	1 out of 100	1 out of 100
Campaspe ²	No. of years with 100% allocations	97 out of 100	89 out of 100	34 out of 100
	Lowest allocation	0%	0%	0%
	No. of years with 0% allocations	1 out of 100	1 out of 100	5 out of 100
Loddon ²	No. of years with 100% allocations	94 out of 100	79 out of 100	26 out of 100
	Lowest allocation	0%	0%	0%
	No. of years with 0% allocations	1 out of 100	3 out of 100	11 out of 100

Notes:

1. The base case estimate of 89 years out of 100 is less than that used to calculate the Mokoan decommissioning (91 years out of 100) as this model includes the 2005/06 and 2006/07 water years which occurred after the decision to decommission Mokoan.

2. These numbers differ from those presented in the Draft Strategy as the models were recalibrated to improve estimates of system operating water requirements.

Table 2.5 outlines the change in allocations for low-reliability water shares under Scenarios B and D (assuming no action is taken) compared to the base case.

Low-reliability water shares in northern Victoria total 772 GL²¹. With reduced water availability, low-reliability water shares will be more affected than high-reliability water shares.

In the Murray system, the number of years with full allocations for low-reliability water shares would not change but the number of years with zero allocations would increase from 14 out of 100 under the base case to 72 years out of 100 under Scenario D.

In the Goulburn system, full allocations for low-reliability water shares would never occur under Scenario D, compared to the base case of nine years out of 100. The number of years with zero allocations would increase from 23 years to 96 years out of 100 under Scenario D.

More detailed modelling results can be found in Background Report 2.

Table 2.5 Forecast reliability of low-reliability water shares in the major regulated systems of the Northern Region²²

Indicator		Scenarios		
		BASE CASE: Long-term average	SCENARIO B: Medium climate change at 2055	SCENARIO D: Continuation of recent low inflows (July 1997- June 2007)
Murray	No. of years with 100% allocations ³	<10 out of 100	<10 out of 100	<10 out of 100
	Lowest allocation	0%	0%	0%
	No. of years with 0% allocations	14 out of 100	45 out of 100	72 out of 100
Broken	No. of years with 100% allocations	85 out of 100	70 out of 100	49 out of 100
	Lowest allocation	0%	0%	0%
	No. of years with 0% allocations	10 out of 100	20 out of 100	41 out of 100
Goulburn	No. of years with 100% allocations	8 out of 100	1 out of 100	0 out of 100
	Lowest allocation	0%	0%	0%
	No. of years with 0% allocations	23 out of 100	70 out of 100	96 out of 100
Campaspe ¹	No. of years with 100% allocations	78 out of 100	61 out of 100	3 out of 100
	Lowest allocation	0%	0%	0%
	No. of years with 0% allocations	8 out of 100	20 out of 100	89 out of 100
Loddon ¹	No. of years with 100% allocations	9 out of 100	1 out of 100	0 out of 100
	Lowest allocation	0%	0%	0%
	No. of years with 0% allocations	24 out of 100	70 out of 100	96 out of 100

Notes:

1. These numbers differ from those presented in the Draft Strategy as the models were recalibrated to improve estimates of system operating water requirements.

2.5.2 Licence-holders on unregulated rivers

Unregulated river systems do not have large dams or weirs to regulate flow. While unregulated rivers represent 90 per cent of river length in northern Victoria, they account for less than 10 per cent of its surface water use.

It is difficult to quantify the impact of climate change on unregulated users as effects are system-specific or localised. However in general, impacts could include an increase in the proportion of time licence-holders spend on restrictions or bans and therefore a reduction in reliability.

To better understand the impact of climate change on unregulated systems, modelling has been undertaken for a number of systems including the upper Ovens River. The Ovens system is the largest unregulated system in northern Victoria. Below Myrtleford, the system becomes part-regulated as the reliability of supply is also influenced by regulated tributaries. Climate change could reduce inflows in the Ovens system by between six and 33 per cent (refer to Table 2.1).

Generally, each unregulated river system is managed to a set of rules or a management plan where restrictions and bans on extractions are put in place to protect minimum flows. Projections indicate that for the upper Ovens River, the total time spent on Level 1, 2 and 3 restrictions increases from six per cent under the base case up to nine per cent under Scenario D. The time spent on bans is doubled from 0.3 to 0.6 per cent of weeks, assuming current levels of use. The increase occurs mainly during summer, with little change in winter restrictions (see Background Report 4).

Initial modelling for the Buffalo River (Ovens system) and the Big River (Goulburn system)²³ has been undertaken to better understand the magnitude of impacts for these two unregulated systems. It shows that under Scenario D, licence-holders within the Big River system would be expected to receive their total winter-fill licence volume 64 per cent of the time, compared to 80 per cent under base case. Overall, mean annual diversions could be reduced by around five per cent (see Table 2.6).

Table 2.6 Forecast reduction in mean annual diversions in the Big River and Buffalo River systems due to climate change²⁴

System		Base case	Scenario B	Scenario D
		BASE CASE: Long-term average	SCENARIO B: Medium climate change at 2055	SCENARIO D: Continuation of low inflows (July 1997 - June 2007)
Big River	Mean winter-fill streamflow volume (GL) ¹	129.1	104.9	102.2
	Mean volume diverted (GL)	18.6	17.7 (-5.1%)	17.6 (-5.5%)
	Reliability ²	80%	68%	64%
Buffalo River	Mean winter-fill streamflow volume (GL) ¹	112.3	85.7	73.2
	Mean volume diverted (GL)	20.8	19.8 (-7.7%)	19.5 (-9.1%)
	Reliability ²	77%	72%	70%

Notes:

1. Only winter-fill volume is shown as unregulated diversions are limited to the winter months in most cases.

2. Reliability of supply is the percentage of years consumptive users are expected to receive their Section 51 licence volume having complied with the winter-fill period described by the SDL.

2.5.3 Groundwater licence-holders

Future groundwater availability is dependent on both the existing stores within aquifers and the level of recharge resulting from rainfall infiltration. The CSIRO Sustainable Yields Project²⁵ concludes that groundwater recharge rates could decline by as much as 30 per cent in the southern Murray-Darling Basin. The report states that “the impact of 2030 climate conditions on rainfall recharge and groundwater levels would be minor compared to the impacts resulting from current and additional future extraction²⁶.” This is because many aquifers have considerable storage volumes and therefore a reduction in recharge will not dry up the resource in the short term. However, to protect the resource over time, the impacts of reduced recharge and ongoing extraction on groundwater levels needs to be managed (see page 69).

It has been predicted that climate change will have little impact on the rate of surface and groundwater interaction and there will be no net impact across the Basin²⁷.

Ongoing depletion of existing groundwater supplies as a result of current and future extraction could reduce groundwater access and potentially quality. In turn, this may result in increased costs for infrastructure, including pump replacement, bore deepening or replacement and groundwater desalination.

Further information regarding the impact of climate change on groundwater systems in northern Victoria can be found at www.csiro.au/partnerships/MDBSY.html.

2.5.4 Urban entitlements

With reduced water availability, urban water corporations’ surface and groundwater entitlements are less reliable. Under climate change scenarios, urban water users could expect to experience more frequent, extended and severe water restrictions. There is also the potential for increased demand due to population growth, which could place additional pressure on water for households and industry in the future. *Victoria in Future 2008* forecasts that the Northern Region’s current population of 529,000 will increase to about 781,000 by 2056²⁸. Average annual population increases to 2031 will chiefly be due to growth in larger urban centres, such as Bendigo, Wodonga, Echuca, Yarrawonga, Cobram, Wangaratta, Shepparton and Mildura.

The potential impact of climate change on urban systems was modelled through urban water corporations’ water supply demand strategies in 2007 and is summarised in Appendix 7. Actions are now being implemented to address long-term urban water supply deficits. As a result, Northern Region water corporations are well placed to manage the impact of climate change on towns and to secure water for future growth. See Chapter 8 for further information.



Bush shower, Ovens River

Photographer: Bruce Cumming

2.6 Water availability for the environment

The changing climate means there will be more frequent and extended droughts, with longer dry spells and less frequent floods. The result will be less water for rivers and wetlands (see pages 23 and 24). If not addressed, the ecological impacts of a significant reduction in environmental flows could include:

- the disappearance of most areas of river red gum forest, including the River Murray icon sites
- a likely end to colonial bird breeding, such as egrets
- a significant decline in populations of golden perch, Murray cod and other native fish
- the degradation and potential loss of internationally recognised Ramsar-listed wetlands, such as the Kerang Lakes.

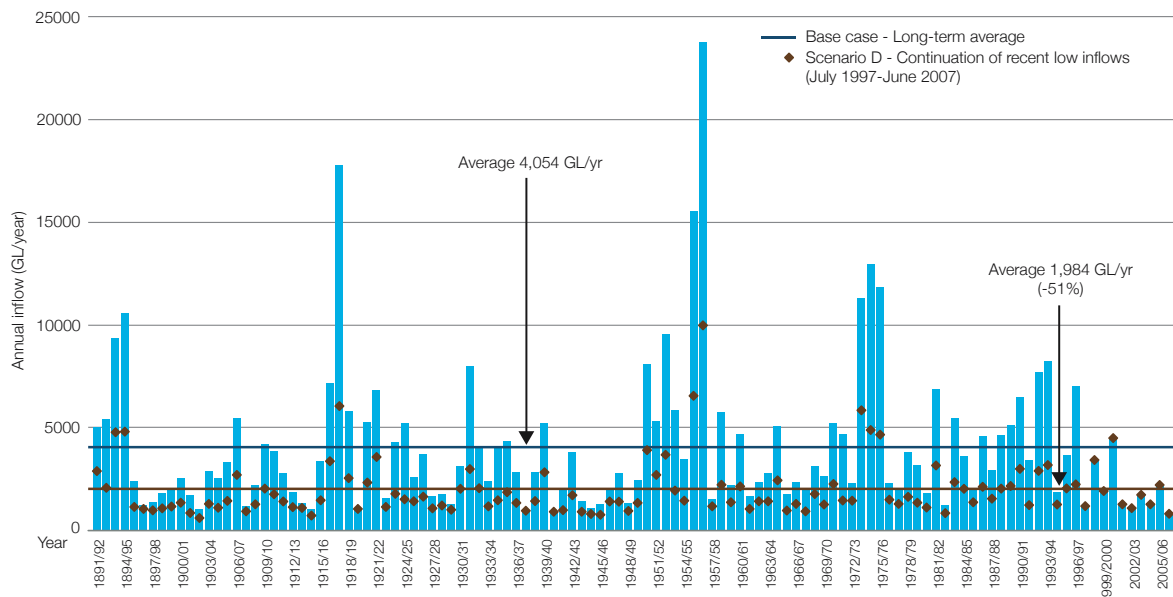
2.6.1 Regulated river systems

Currently, six per cent of the environmental water reserve (EWR) is made up of entitlements with similar characteristics to those held by irrigators (that is, tradeable and a mix of high and low-reliability). Over time, the environment is expected to hold a larger proportion of entitlements (see page 45). These entitlements will experience the same impacts as those of water share-holders that were noted previously in Tables 2.4 and 2.5 (see page 25 and 26). The remaining environmental water is provided as passing flows and above cap water and is more susceptible to the impact of climate change due to a reduced frequency and magnitude of spills from storages, and reduced flows from unregulated rivers.

Tables 2.2 and 2.3 (see page 23 and 24) show that environmental water in the Murray system would be reduced by 28 per cent under Scenario B (medium climate change) and by 51 per cent under Scenario D (a continuation of recent low inflows). Figure 2.8 illustrates the annual change in environmental water in the Murray system under the more severe scenario.

See Background Report 3 for information on the future availability of environmental water in the region’s other regulated river systems.

Figure 2.8 Forecast annual availability of environmental water in the Murray system (Scenario D average compared with the long-term average)²⁹



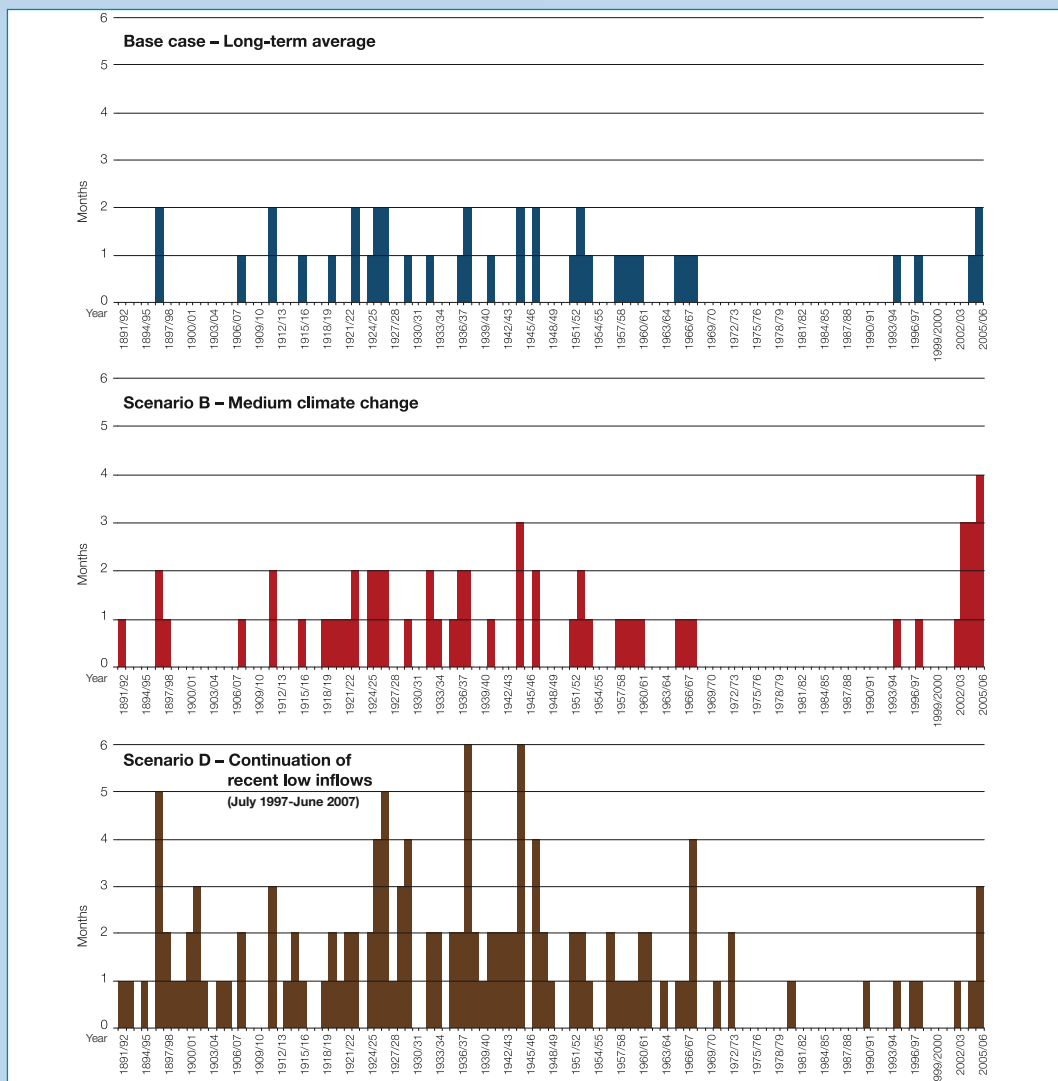
Case study: Campaspe River environmental flows

Environmental flows in the Campaspe River help to maintain water quality, support flora and fauna and protect public health and safety. The community values the river for its healthy native vegetation and wildlife, scenic qualities and as a place of recreation. A scientific environmental flow study in the river established the various flow components required to protect its key environmental values³⁰.

One of these flow components is a minimum river flow of 10 ML/day for six months in summer/autumn to provide adequate habitat for fish. Flows below this mean that native fish will continually be in contact with very high salinity levels in the lower Campaspe. One or more months in contact with highly saline water is likely to mean native fish will not survive.

Modelling has been undertaken to determine the ability to provide this flow, assuming no intervention, with long-term average climate conditions (base case), medium climate change (Scenario B) and a continuation of recent low inflows (Scenario D). Figure 2.9 shows that in all scenarios there are many occasions where the flows are less than the required minimum for more than one month. This means that native fish objectives are not likely to be met. Neither do other flow components, such as low flow freshes and low flows in winter for fish passage, meet the recommendations under the climate change scenarios. The ecological impact of this could be declining water quality, pools silting up and loss of native vegetation. Under these conditions, it is highly unlikely the river will support natural populations of native fish such as Murray cod.

Figure 2.9 Forecast number of months where recommended flows of 10 ML/day are not met in the Campaspe River - base case (blue), Scenario B (red) and Scenario D (brown)



Associated floodplains and wetlands

There are more than 400 high-value wetlands in 30 wetland systems in the Northern Region (see Appendix 6). These range from large areas of floodplain, such as the Barmah and Gunbower Forests, to small wetlands on farms and public land. They include floodplain wetlands on the River Murray (including the Living Murray icon sites) and Victoria's tributaries, and those associated with irrigation distribution systems.

Wetlands will be affected by reduced water availability in three ways:

1. Reduced allocations to environmental entitlements will mean there is less water available for watering events, such as for the Barmah Forest.
2. Less water will be supplied to the irrigation distribution system, resulting in less water delivered to and via irrigation system wetlands.
3. The frequency and magnitude of unregulated flows and spills from storages are likely to be reduced as a greater proportion of flows are captured in storage. This will reduce the frequency and duration of overbank flows during natural flooding events.

The expected reductions in water availability mean that wetlands will be watered less frequently. If watering events are too far apart the plants and animals associated with these floodplains may not be able to survive. These plants and animals have various ways of surviving dry periods (such as dormant seeds or eggs and in the case of some frogs, burrowing below the surface), but the time period that they can survive is limited. This is known as a 'dry spell tolerance'.

A reduction in flooding events will mean a loss of connectivity between rivers and their floodplains, with reduced carbon and nutrient exchange. Failure to support adequate flooding regimes could result in:

- the loss of endemic floodplain vegetation, particularly flood-dependant species such as river red gums
- a significant reduction in the biodiversity of river valleys, notably birds, bats, frogs and insects
- reduced productivity in river ecosystems, particularly in food resources for immature and adult native fish.

Many wetlands are dependent on irrigation distribution systems for the delivery of water from an environmental entitlement. Water requirements for these ecosystems will be met in 80 years out of 100 under the base case, decreasing to 38 years out of 100 under Scenario D (see Background Report 8). The impact on ecosystem values in these wetlands will depend on how water distribution is prioritised between different wetlands.

There are many other wetlands associated with the irrigation distribution system that currently cannot receive water from this environmental entitlement due to a lack of delivery infrastructure. Without intervention, the condition of these wetlands will continue to decline. See page 147 to see how environmental priorities will be set to maximise the benefits of the available water, and page 133 for how targets will be set to recover water for these wetlands.



Swans, Lindsay Island

Photographer: Mallee Catchment Management Authority

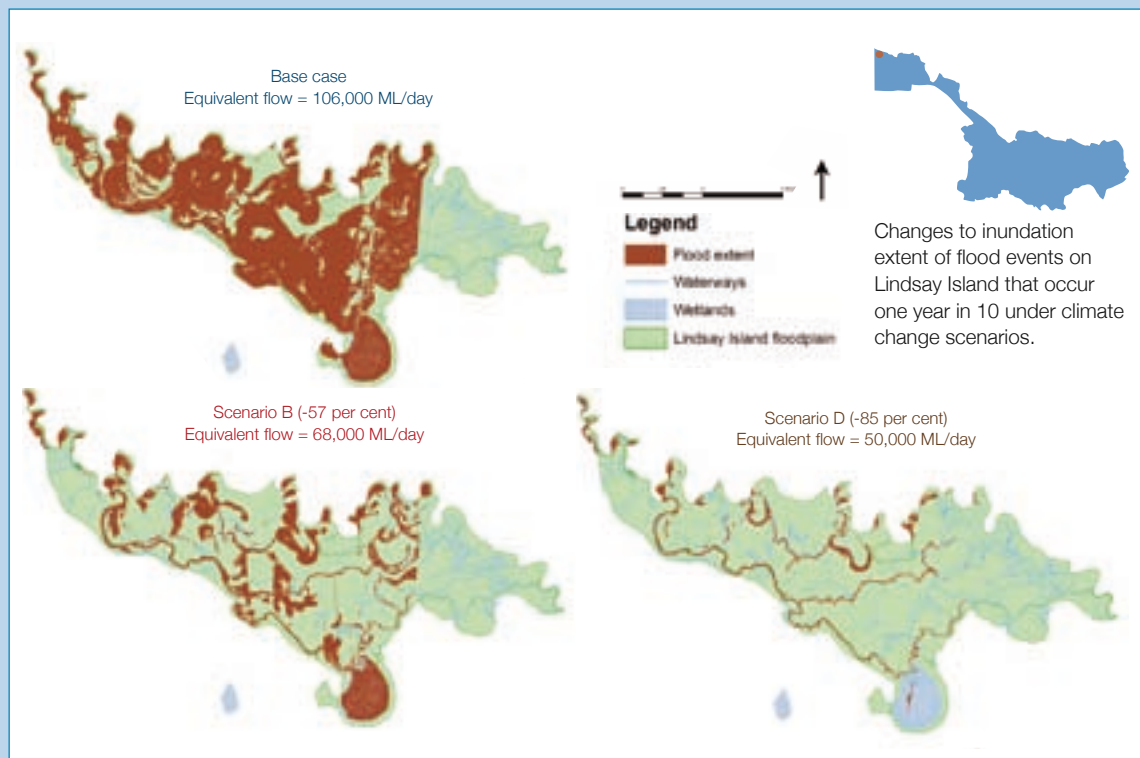
Case study: Change in viable floodplain at Lindsay Island

Lindsay Island is a 17,000-hectare floodplain on the River Murray, just before the South Australian border. Much of the floodplain vegetation is already stressed because of less flooding caused by river regulation and ongoing dry conditions. Only 20 per cent of river red gums were considered to be in good condition when assessed in 2006. Without intervention, the area that receives sufficient flooding to support viable floodplain communities will be further reduced with climate change.

The area flooded every five years (frequently enough to support river red gums and wetlands) will drop by 72 per cent, from 6,000 hectares under the base case to 1,700 hectares under Scenario D. This will greatly reduce the habitat available for native fish, frogs, tortoises and birds as well as river red gums and other flood-dependent vegetation. Several threatened species in this area of the River Murray may not survive this additional pressure, including the nationally-threatened growling grass frog, painted snipe and regent parrot (which nests in large river red gums).

Without intervention the area flooded every 10 years (frequently enough to sustain blackbox and lignum) would drop by 85 per cent, from 14,000 hectares under the base case to 2,210 hectares under Scenario D (see Figure 2.10). A reduction in the area of lignum would impact on breeding and feeding opportunities for waterfowl including threatened freckled, blue billed and pink-eared ducks. Any future breeding events would be much smaller and less frequent, putting these threatened species at increased risk. Figure 2.10 demonstrates the dramatic reduction in floodplain under medium climate change (Scenario B) or a continuation of the recent low inflows (Scenario D).

Figure 2.10 Forecast change to area of floodplain at Lindsay Island for a one-in-10 year flood event (Scenarios B and D compared with the long-term average)³¹



2.6.2 Unregulated river systems

Under climate change, there will be a greater number of years where flows are insufficient to maintain key environmental values. Under Scenario D, average summer flows in the Ovens system will be reduced by 29 per cent and average winter flows by 27 per cent (see Table 2.7). Increased periods of low flows may result in:

- disconnected pools of water, affecting movement of fish and macroinvertebrates
- reduced water quality as a result of increased water temperatures, fewer flushing flows and loss of connectivity
- reduced diversity of in-stream habitat.

2.6.3 Groundwater-dependent ecosystems

Groundwater-dependent ecosystems are those that rely on groundwater for all or part of their overall water needs. These are generally located where groundwater discharges to the surface, including rivers, wetlands and in some instances terrestrial vegetation. Currently, little is known about the extent and distribution of groundwater-dependent ecosystems across northern Victoria.

When groundwater and surface water interaction is high, rivers or river reaches in the Northern Region may rely on groundwater discharge to maintain baseflows. However, the extent of this contribution is highly variable and dependent on local hydrogeological conditions. Floods provide overbank flows and also replenish groundwater reserves. Often groundwater is very important to maintain floodplain vegetation between floods.

In the Goulburn Broken system, increased use of groundwater due to lower surface water availability is expected to reduce streamflows by 20 GL per year by 2010. This represents about 0.6 per cent of the average surface water availability under historical climate patterns. By 2030, groundwater use is expected to reduce streamflows by 37 GL per year or 1.3 per cent of average availability³². The significance of these reductions is magnified in the summer and autumn, when groundwater baseflows may make up a greater proportion of the total flow in a river or river reach.

Wetlands that depend on water from local run-off after rain or from groundwater often experience periodic drying under natural conditions and when flooded, provide breeding and feeding habitat for birds including broilgas, Latham’s snipe, craiks and rails and a large range of frogs. Many of these wetlands are on private land and can be damaged by grazing and cropping. Damage to these wetlands reduces habitat for waterbird breeding, especially broilgas.

While some wetlands are entirely dependent on groundwater, others are only partially dependent, usually during droughts. In some cases, groundwater may no longer be available to these ecosystems. The protection of these environmental assets needs an integrated approach that incorporates watering regimes and land management activities.

Table 2.7 Forecast availability of annual, summer and winter streamflow in the Ovens system (Scenario B and D averages compared with the long-term average)³³

Location	Period	Base case - long-term average	Scenario B - medium climate change at 2055		Scenario D - continuation of recent low inflows (July 1997-June 2007)	
		Mean flow (GL)	Mean flow (GL)	Change from base case (GL, %)	Mean flow (GL)	Change from base case (GL, %)
Ovens River at Bright	Annual	202	153	- 50 (-24%)	146	-56 (-28%)
	Summer (Nov-Apr)	37	28	-9 (-25%)	27	-22 (-29%)
	Winter (May-Oct)	165	125	-40 (-24%)	120	-45 (-27%)

2.7 Threats to water quality

Water quality is as important as quantity. Poor water quality has major consequences for the health of people, livestock, rivers, wetlands and aquifers. This includes rising salinity, increasing sediment and nutrient loads, changing pH and temperature level and reduced dissolved oxygen. Water quality issues (for example, blue green algal blooms) may cause short-term water shortages.

Water quality issues are typically caused by run-off from farmland and groundwater discharged from salt-affected areas. Management of these land-based water quality issues requires long-term improvements of land management practices.

New issues are emerging due to ongoing dry conditions, such as the exposure of acid sulphate sediments. Water quality issues are variable over time and space. For example, drought or climate change reduces discharge to streams, but increases the likelihood of other water quality problems stemming from acid sulphate soils and bushfires. Victoria will continue to take a proactive approach to the management of water quality issues, and there will be continuous improvement as new threats to water quality arise.



Salinity

Photographer: Arthur Mostead, MDBA

2.7.1 Salinity

Salinity is the most prevalent water quality problem in the Northern Region.

Substantial reserves of salt are stored in the soils of northern Victoria. As groundwater levels have risen over time (due to clearing of native vegetation and irrigation), saline groundwater discharges to streams have increased and salt that has accumulated on the surface through evaporation is washed into streams.

Salt has serious implications for water quality, plant growth, biodiversity, land productivity and infrastructure. It affects farmlands, floodplains and river water quality, which in turn affects consumptive use downstream. About 260,000 hectares of Victoria's farmland is suffering significant damage from soil salting. Of this, 140,000 hectares or 54 per cent is located in Victoria's northern irrigation districts. 120,000 hectares of non-irrigated (dryland) grazing and cropping land throughout the state is also affected³⁴.

There are two main strategies to manage salinity levels:

1. Limiting the mobilisation of salts stored in the soil profile by controlling the rise in groundwater levels. Groundwater levels can be controlled by reducing recharge (for example, by establishing deep-rooted vegetation, improved surface drainage and more efficient irrigation). Alternatively groundwater pumping or tile drains that remove groundwater can be used to lower groundwater levels.
2. Limiting the impact of salinity, for example, by using salt interception schemes that capture saline water before it runs into streams and then disposing of the salt in evaporation basins.

As the climate becomes drier, salt will be stored more frequently within the landscape or floodplain, rather than mobilised within waterways. This salt may be remobilised into the river system if watering occurs. Improved management of salinity is discussed further on page 124.

2.7.2 Pollution events

Pollution events can often occur in periods of high temperature and low flows (for example, during droughts). Examples include:

- blue-green algal blooms (as occurred in the River Murray in April 2009)
- fish kills resulting from reduced dissolved oxygen levels (referred to as ‘blackwater events’)
- salt slugs resulting from increased run-off from saline soils in a small reach of river (this is typical in some areas after thunderstorms)
- sediment slugs following run-off in bushfire-affected areas.

See page 143 for more information on management of these events.

2.7.3 Acid sulphate soils

Acid sulphate soils are soils that contain sulphuric acid or have the potential to form sulphuric acid when exposed to oxygen (for example, through drying or disturbance)³⁵.

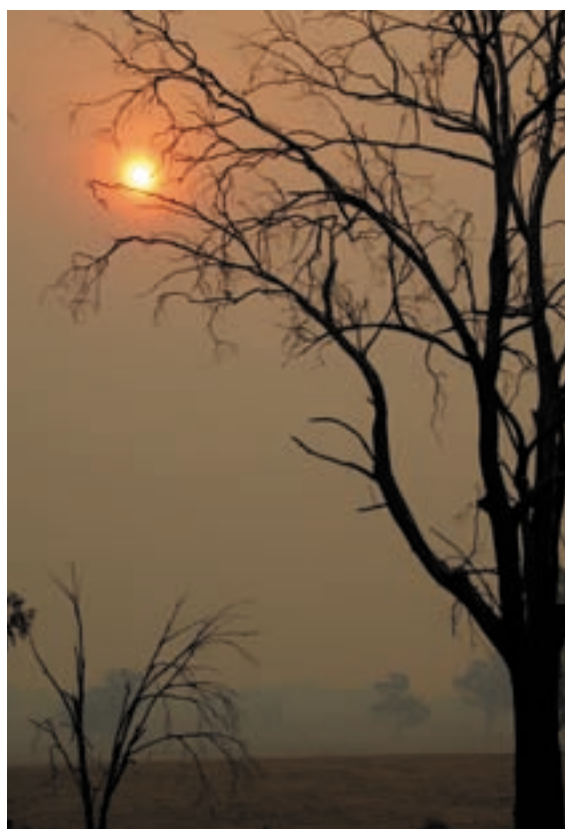
Record low inflows and river levels in recent years have led to the drying of many wetlands in south-east Australia, resulting in the exposure of acid sulphate soils. Acidification of several wetlands has been reported in the last 12 months. Sites at high risk are those that have been permanently inundated and have a strong connection to highly saline groundwater.

Rewetting from rising river levels or rainfall may lead to acidification of wetlands and creeks, with pH dropping as low as one. Other risks associated with acid sulphate soils include mobilisation of metals, deoxygenation of the water column and production of toxic gases. These risks can lead to irreversible damage to the environment and impacts on water supplies. See page 144 for information about how these risks are being addressed.

2.7.4 Bushfire

Bushfires can have a direct impact on water quality. Quality is often threatened immediately after a fire as rain washes ash, charcoal, nutrients and other materials into rivers and wetlands, causing increased turbidity and changes to local stream ecology. The impacts on water quality are often difficult to predict and may be locally variable, as they will depend on the severity of the bushfire and the degree of vegetation recovery, terrain and type of rainfall event. As such, water corporations and catchment management authorities manage water quality risks on a case-by-case basis.

Following the 2003 bushfires, which burnt more than 500,000 hectares of forest and grazing land in the Northern Region, a major study was commissioned to assess the likely impacts of the fires on water quality and quantity. As part of this study, an extensive network of short-term water quality monitoring sites was set up to assess impacts and any possible recovery. A number of detailed reports were produced, and are available from www.mdbc.gov.au. The results and methods will be used to inform further investigations undertaken by the Murray-Darling Basin Risks to Shared Water Resources Program³⁶.



Smoke haze

Photographer: Bruce Cumming

2.8 Where to from here?

There are many factors that will influence future water availability and quality in the Northern Region, including climate change and variability, water extraction and interception activities. Regardless of the scenario that occurs, in the future there is likely to be less water of acceptable quality available for human consumption and the environment. Users on regulated systems will be faced with lower allocations, while unregulated systems will experience bans and restrictions more often. There may be less recharge to groundwater systems and increased demands. Environmental flows will be impacted to an even greater extent. It is clear that our current water use practices are no longer sustainable and will have to change.

With the Murray-Darling Basin Cap in place, Victoria is not permitted to divert more water in the region and analysis shows that new or enlarged storages are not an effective solution (see Appendix 5 and Background Report 10). A large-scale desalination plant is not an option, due to its significant cost and a lack of sufficient seawater. Water savings from modernisation projects provide a critical source of water that can go to consumptive use or the environment, but they may be insufficient to completely address the reduction caused by climate change. As a result, the remaining chapters of this Strategy focus on improving the way existing water resources are managed and used. They aim to maintain key agricultural, environmental and urban values in a future of reduced water availability.

In addition, Victoria (through the South Eastern Australian Climate Initiative and other projects) is investing in improving climate and streamflow forecasts that look forward three to 12 months. This has the potential to improve the management of rural and urban supplies to cope with short to medium-term variability in resource availability.



Chinaman's Bridge, Goulburn River

Photographer: Bruce Cumming