2 Water use in the Murray-Darling Basin

Key points

- The availability of water throughout the Murray-Darling Basin (the Basin) varies from region to region, reflecting diverse topographic and climatic conditions.
- Rainfall is less variable and, on average, higher in the south and east of the Basin than in the north and west. As a result, the south-east section of the Basin has consistently greater surface water availability than the north-west.
- The growth of storage capacity in the Basin has allowed irrigation to develop, notwithstanding the variability of inflows into Basin rivers. This has altered the natural flow regimes of these rivers.
- Overall, groundwater accounts for a small percentage of water used in the Basin, but is significant in some regions.
- The current level of consumptive water use in the Basin (including recent rises from a growth in floodplain and groundwater harvesting) is putting pressure on water dependent ecosystems, particularly those experiencing extended dry conditions.
- Climate change is expected to reduce the long-term availability of water throughout the Basin, particularly in the south-east.
- At present, available water is allocated to consumptive use in state water plans and must comply with the Cap. Consumptive water in the Basin is mainly used for irrigated agriculture.
- Current water planning arrangements result in proportionally less environmental water in periods of dry conditions.

The terms of reference for this study ask the Commission to examine market mechanisms that might help achieve the Australian Government's objective of reallocating water from consumptive to environmental uses. This chapter provides background information on water availability in the Murray-Darling Basin (the Basin), as well as how the water is allocated to both consumptive and environmental uses.

2.1 Water availability

The Basin covers an area of approximately 1.06 million square kilometres, approximately 14 per cent of Australia. Based on long-term averages, the Basin receives around 530 000 gigalitres (GL) in rainfall each year, of which 94 per cent is evaporated or transpired by plants, 2 per cent is taken up by soils or groundwater, and 4 per cent becomes runoff or stream flow (ABS 2008b). This section explores water availability throughout the Basin, by examining patterns of rainfall, as well as availability of surface water and groundwater.

Rainfall

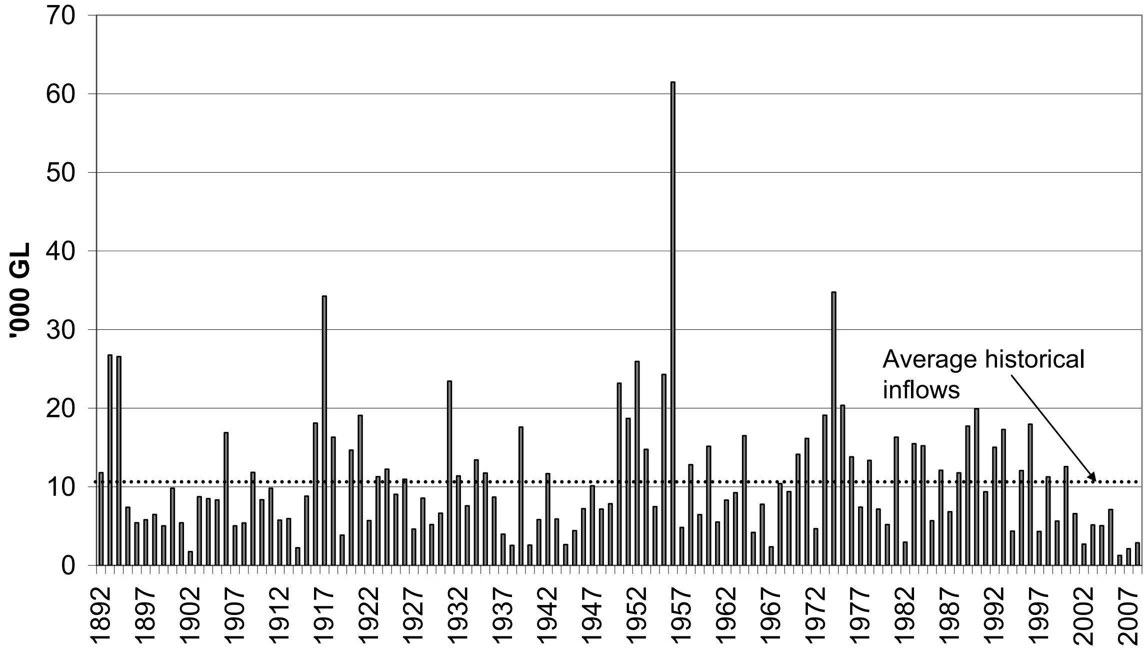
Rainfall in the Basin differs greatly between regions, with the east being significantly wetter (up to 2000 mm per year at the wettest point) than the west (around 200 mm per year) (Kirby et al. 2006). Rainfall in the north is more variable and tends to fall in summer, with large episodic falls of short duration typical. Rainfall in the south occurs mainly in the winter and is less variable. Variance of rainfall over time is a key feature of rainfall patterns in the Basin, with large swings across the seasons, years, and decades. These patterns affect the availability of surface water and groundwater.

Surface water

At any time, the stock of surface water available throughout the Basin is dependent on the amount held in storage, as well as the recent pattern of inflows into the Basin's river systems, lakes and wetlands. The variable nature of inflows (figure 2.1) is due largely to the variability of rainfall. Currently, the Basin is experiencing a period of very low inflows, with the past ten-year period the lowest on record, and with nine of the last ten years below average (MDBA 2009j). However, there have been other extended periods of dry conditions, notably around 1900 and 1940. These inflows also vary from region to region.

Average temperatures run in a strong gradient, from a high in the north-west, to a low in the south-east. This means that relatively more rainfall in the north-west is evaporated and transpired reducing runoff in this region. The combination of higher rainfall and lower evapotranspiration means most runoff is generated in the upland catchments of the south-east, particularly the headwaters of the Murray, Murrumbidgee and Goulburn rivers (figure 2.2). The Darling and its tributaries account for less than 10 per cent of total flow, even though their catchments extend over approximately twice the area of the Murray and its tributaries (MDBC 2008c).

Figure 2.1 **Murray system inflows (including the Darling), 1892–2008**[a]



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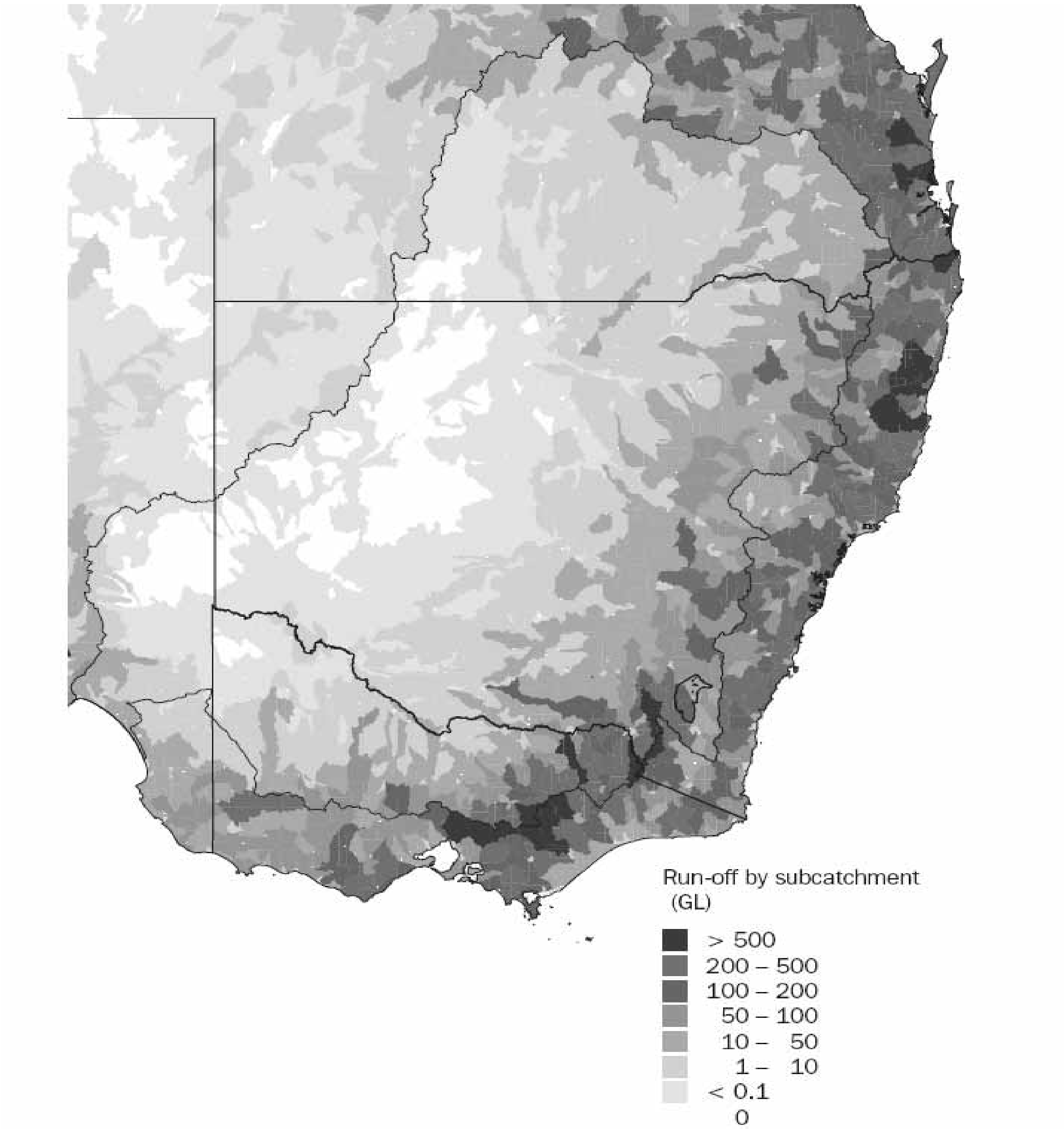
[a] Excludes any Snowy Scheme releases into the Murray. The data are generally sourced from tributary models, based on current conditions and the current level of development. The models are steady state (with no increased regulation or extraction through time). Observed data are used where modelled data are unavailable (post 2000).

Source: MDBC (2008 unpublished).

The Basin also becomes flatter in the west, and some rivers have distributaries (river branches that flow away from the main channel) ending in terminal wetlands. Examples include the Willandra Creek system of distributaries from the Lachlan River and the Narran River distributary of the Culgoa River. Some rivers and streams (such as the Avoca and Wimmera in the south-west and the Paroo in the north-west) also fail to reach the Murray and the Darling respectively, except in periods of exceptionally high rainfall.

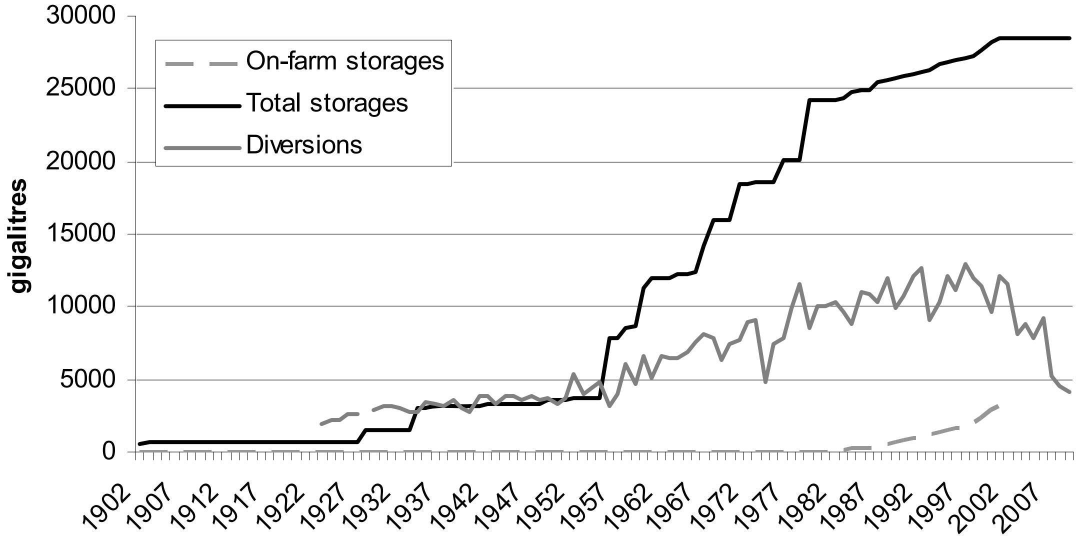
To help manage variability in the availability of water, considerable public and private investment has been made in water storages (figure 2.3). Most storages in the Basin were built from the mid 1950s to 1990, with large storages (over 1000 GL) built at Dartmouth, Hume, Eildon, Burrendong, Blowering, Copeton, Wyangala and Burrinjuck. Public storages in the Basin have a total capacity of 22 611 GL, which accounts for 79 per cent of the total storage capacity throughout the Basin (MDBA 2009g). However, there are also some large on-farm storage facilities, particularly in the Eastern Mount Lofty Ranges of South Australia, and the northern Basin. The growth of storages over time has allowed greater capture and use of inflows for consumptive purposes, as well as intertemporal management of the resource. In Australia intertemporal management is desirable both within a year and between years, owing to the variability of rainfall. The ability to manage flows in this manner has altered natural flow patterns (figure 2.4).

Figure 2.2 **Mean annual runoff in the Murray-Darling Basin, 2008**



Source: ABS (2008b).

Figure 2.3 **Growth in storages and diversions over time**[a]



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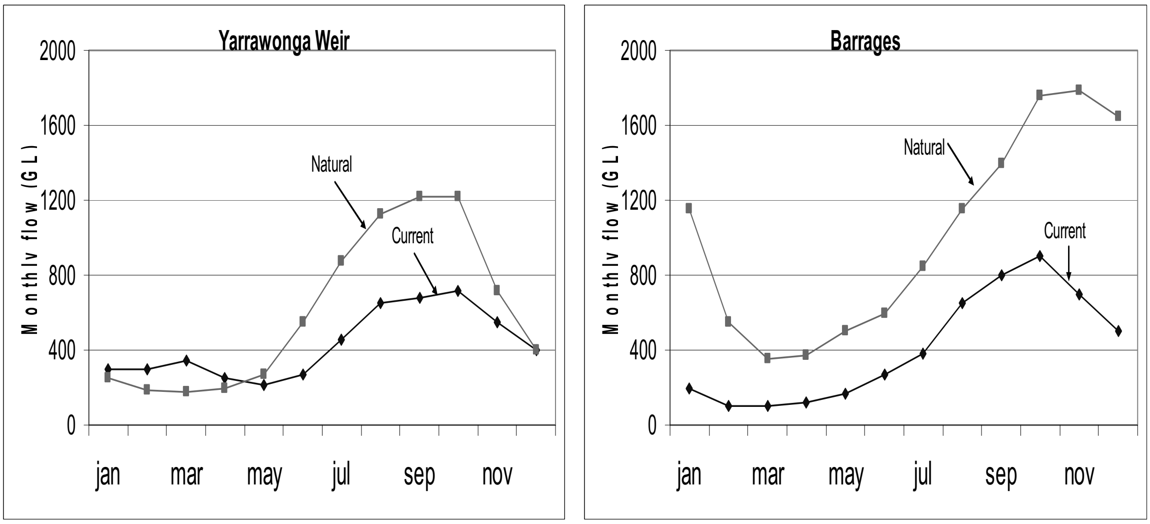
[a] Total storages excluding barrages, weirs and the Snowy Catchment.

Source: MDBA, Canberra, pers. comm., 8 Oct 2009.

Figure 2.4 **Natural and current development flows at Yarrawonga Weir and the Barrages**[a]



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[a] Under historic climate.

Source: CSIRO (2008b).

Surface water availability is also influenced by climate change and groundwater use (both discussed here), as well as factors such as afforestation, bushfires, and changes to irrigation management and return flows (PC 2006). Furthermore, inter-catchment transfers occur from the Snowy River to the Murray and Murrumbidgee, and from the Glenelg River to the Wimmera River in Victoria. These transfers average 1200 GL per year (Kirby et al. 2006).

Groundwater

Groundwater is water located beneath the ground surface in underground streams and aquifers. The volume and quality of groundwater in the Basin is variable, reflecting variations in landscape, geology, and recharge conditions.

In 2005-06, 1069 GL of groundwater was extracted, which accounted for 14 per cent of water used for agriculture in the Basin (ABS 2008b). Most of this extraction occurred in New South Wales (71 per cent), with the largest extractions in the Murrumbidgee (218 GL), Namoi (185 GL) and Lachlan (144 GL) catchments. Groundwater use tends to be higher in dry years, as farmers substitute groundwater for surface water.

The use of groundwater has grown substantially in recent years and the CSIRO (2008a) claims that current extraction rates can not be maintained in some catchments, including: the Condamine; Border Rivers; Lower Namoi; parts of the Lower Macquarie; parts of the Lower Lachlan; the Upper Lachlan; and the Mid-Murrumbidgee. It further claims that, without a change in policy, the situation is expected to deteriorate further, since current groundwater management plans forecast groundwater extraction to increase to 3956 GL per year by 2030 (CSIRO 2008a). This represents an approximate doubling of groundwater use across the Basin. At this level of extraction, groundwater use would represent 24 per cent of the total water use in the Basin on average, with a higher fraction in dry periods.

The availability of surface water is affected by the use of groundwater, with around one quarter of current groundwater extraction believed to be reducing surface water availability (CSIRO 2008a). This is equivalent to around 4 per cent of the Basin’s surface water use. This reduction is not uniform and the impact of groundwater extraction on surface water availability in a given area, depends on the nature of connectivity between groundwater and surface water. Some rivers (like the Condamine-Balonne, Namoi and Lachlan) gain water from groundwater, while others (like those in the alluvial valleys of the southern Basin) lose water to groundwater. Future projected growth in extraction of groundwater is expected to occur mainly in aquifers that are connected to rivers, such as the Upper Lachlan and the Mid-Murrumbidgee (CSIRO 2008a). This would exacerbate the effect of climate change by further reducing surface water availability in these regions.

To mitigate these risks, the National Water Commission has recommended that, ‘unless and until it can be demonstrated otherwise, surface water and groundwater resources should be assumed to be connected, and water planning and management of the resources should be conjunctive’ (NWC 2009b, p. 36). This is the opposite of the way in which connectivity has been managed to date. In many areas, the sustainable level of diversions for groundwater systems will be addressed, for the first time, in the forthcoming Basin Plan (box 1.1).

Climate change

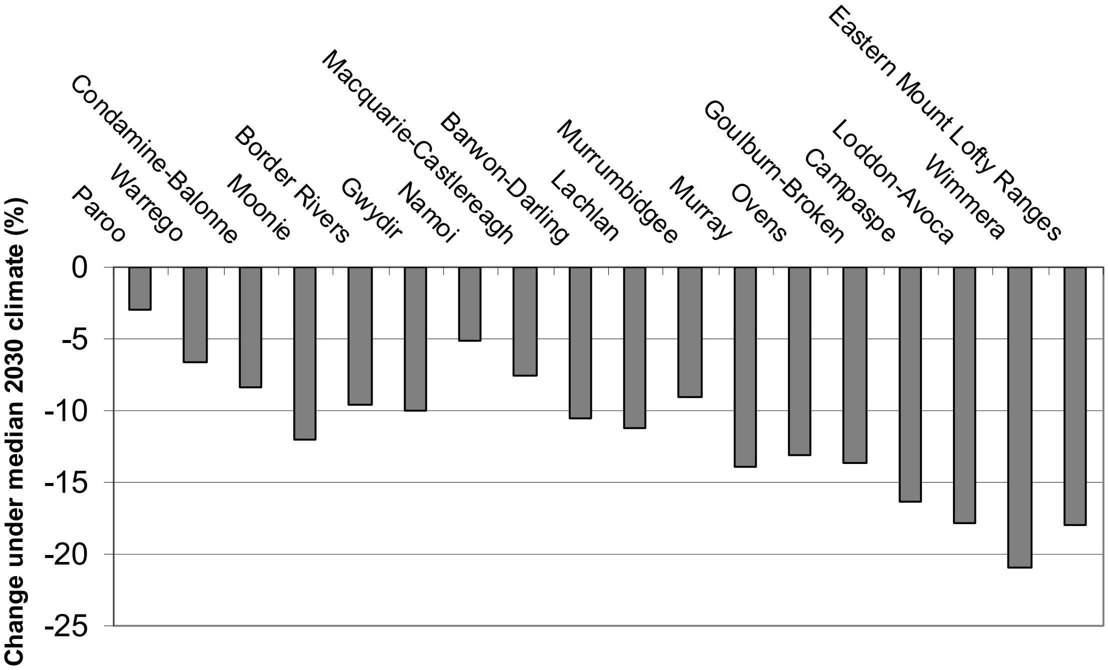
Future availability of surface water and to a lesser extent, groundwater, may be reduced due to climate change. If average temperature increases, as is forecast, evaporation and transpiration will increase and runoff will decrease. There is greater uncertainty about future rainfall patterns, but most climate models project decreases across the Basin. Furthermore, changes in these variables are likely to affect the frequency of bushfires, which will in turn alter water availability. Bushfires have the effect of increasing runoff at first (since there is no interception by vegetation), but runoff decreases as new vegetation grows and uses more water than mature vegetation.

CSIRO (2008a) projections indicate that winter rainfall is likely to be lower across the entire Basin in the future, and summer rainfall may increase, particularly in the north. Uncertainty about the magnitude of these effects results in more uncertain rainfall effects in the northern Basin under climate change. For the northern Basin, around half of the scenarios modelled indicate a decrease in rainfall in the future. For the southern Basin, and particularly in the southernmost parts, practically all scenarios indicate that rainfall will decrease in the future.

The way in which these changes to rainfall will translate to changes in surface water availability is uncertain, and the uncertainty increases the further out the projection. Projections for the median climate change scenario suggest an 11 per cent decline across the Basin — 9 per cent in the north and 13 percent in the south — by 2030 (catchment level declines are detailed in figure 2.5).

Figure 2.5 **Change in average surface water availability by region**

Projections for median 2030 climate



Source: CSIRO (2008).

Changes in recharge to groundwater due to climate change will largely mimic the expected geographical pattern of changes in rainfall, with larger declines in the south-east than in the north (CSIRO 2008a).

2.2 Allocations for consumptive use

The amount of water assigned to consumptive use throughout the Basin is determined by rules set in state water plans. These plans are required to be consistent with the Murray-Darling Basin Cap (box 2.1), which since the mid 1990s has set a cap on surface water diversions for consumptive use. The water available under each plan is assigned to holders of water entitlements, including bulk-level water authorities, irrigation companies or trusts, and some individual irrigators. Most of this water is used for irrigation, with a small share going to households, mining and other industries.

Box 2.1 **The Cap**

In June 1995, the Murray-Darling Basin Ministerial Council (the Council) completed an audit of water use in the Murray-Darling Basin (the Basin), demonstrating that increased diversions of water for consumptive purposes had significantly exacerbated river health problems, including:

- reduced flows at the bottom end of the Murray
- a contraction in the area of healthy wetlands
- declines in native fish species
- increased salinity levels and outbreaks of algal blooms.

The audit found that if diversions continued to grow, further deterioration would have been likely, along with reduced reliability of water supply for irrigators (particularly during drought).

To mitigate this, the Council agreed to impose a limit or Cap on water diversions within the Basin. An interim Cap was imposed in June 1995, and following an independent review of equity issues (Setting the Cap: Report of the Independent Audit Group), a permanent cap for New South Wales, Victoria and South Australia was implemented from 1 July 1997. The Council formalised the operating rules for the Cap under Schedule F of the *Murray Darling Basin Agreement 2000*. Following the Intergovernmental Agreement reached in July 2008, the Murray-Darling Basin Agreement was amended and incorporated into the amended *Water Act 2007* (Cwlth).

For New South Wales and Victoria, the Cap restricts diversions to the volume that would have been diverted under 1993-94 levels of development. For South Australia, diversions are capped at 440.6 GL, and Queensland and the ACT must cap at a modelled level based on historic conditions. Under these operating rules, the cap volume for all states varies year to year, based on conditions at the time.

Implementation of the Cap is the responsibility of each state and the ACT. However, an Independent Audit Group conducts an annual audit of the diversions in every designated Cap valley of the Basin, comparing observed diversion against annual targets determined by valley Cap models. There are no explicit penalties in the case of a breach of the Cap in any Cap valley. However, should such a breach occur the relevant minister of the state government concerned is required to report to the Council, on the reasons why the breach occurred, and the actions taken to ensure that diversions are brought back in line with the Cap. Despite this, the Cap has been breached in various Cap valleys on numerous occasions (MDBC 2001 to 2005; 2006b; 2007c; 2008d; MDBA 2009n).

The Cap was designed to halt the growth in diversions, but does not aim to achieve sustainability. New limits on diversions using sustainability as a guiding principle, are being set as part of the Basin Plan (chapter 4).

Irrigation

The Basin is Australia's most significant agricultural region. In 2005-06, it accounted for 39 per cent of farms and more than 39 per cent of the gross value of Australia's agricultural production (ABS 2008b). In the same year, the Basin's irrigated agricultural sector accounted for 44 per cent of Australia's gross value of irrigated agricultural production, and around 12 percent of the gross value of all agricultural production.

Irrigated agriculture is the dominant user of water in the Basin, accounting for 83 per cent of total water used in 2004-05, with a further 13 per cent consumed in conveyance losses (ABS 2008b). Most of this water is used in four types of agricultural activities:

- irrigated pasture (including dairy), mainly situated in the southern Basin. Pastures are often flood irrigated for much of the year, with an average of 3.5 megalitres (ML) per hectare applied in 2005-06
- rice, grown primarily in the Murray and Murrumbidgee catchments. Rice is usually flooded for about three months in summer, with an average of 12.3 ML per hectare applied in 2005-06
- perennial horticulture and grapes, grown throughout the Basin but mainly in the Lower Murray, Mallee and Murrumbidgee. Sprinkler or micro-systems, such as drip or mist irrigation, are used with an average of 4.7–5.5 ML per hectare applied in 2005-06
- cotton, predominantly grown in northern catchments, used an average of 6.4 ML per hectare in 2005-06 (ABS 2008b).

The volume of water used for each of these activities varies from year to year (table 2.1). This variance is larger for annual crops, such as cotton and rice, where the area planted expands opportunistically when water is available.

To a large extent, the geographical location of these agricultural activities reflects the pattern of surface water availability, climatic conditions and storage capabilities. For example, where the water needed to crop is variable, opportunistic production of rice, cotton and other annual crops is common.

The nature of water licences in each area is also linked to water availability, climatic conditions and available storages. The way in which licences are specified also affects the geographical spread of different agricultural activities (chapter 3).

Table 2.1 **Water consumption by agricultural product**

Murray-Darling Basin, 2004-05 and 2005-06

	2004-05		*2005-06*	
	Consumption	*Share of agricultural water use*	*Consumption*	*Share of agricultural water use*
	GL	%	GL	%
Irrigated Pasture	2 371	33	2 571	34
Rice	619	9	1 252	16
Cereals (excl. Rice)	844	12	782	10
Cotton	1 753	24	1 574	20
Grapes	510	7	515	7
Fruit (excl. Grapes)	399	6	413	5
Vegetables	152	2	152	2
Other Agriculture	546	8	461	6
Total	7 204	100	7 720	100

Source: ABS (2008b).

Households, mining and other industries

Water consumption for households, mining and other industries is relatively small in the Basin, with households accounting for 2 per cent, mining 0.2 per cent, and other industries 1.6 per cent, of the use in 2004-05. The allocation of water for households is a high priority throughout the Basin. The use of Murray water for Adelaide is a particularly prominent example, and a five-year non tradeable rolling allocation of 650 GL over a five year period (notionally 130 GL per year) is set aside for this purpose under the Cap.

2.3 Allocations for the environment

The distinction between allocations for the environment and allocations for consumption is problematic. In many water sharing plans water that is not used for consumptive purposes is said to be environmental water. However, 'non-consumptive use' water covers evaporation and other system losses (including some of those incurred specifically in meeting consumptive use requirements, such as conveyance), and hence it would be misleading to regard it as all being environmental water. Conversely, water that is being stored for consumptive purposes, or that is being used as conveyance water, can provide some environmental benefits. The distinction is made more difficult given that irrigators may choose to use some of the consumptive water allocated to them to water private wetlands and return flows can be used downstream by environmental users.

Currently, there are two main types of allocations for the environment in the Basin:

- rules-based environmental water, generally set out in water resource plans
- environmental water entitlements, generally set out in water resource plans, or acquired from irrigators or irrigation infrastructure operators, through purchase or investment in water savings.

Rules-based environmental water

Rules that provide for environmental water are included in the documentation of the Cap, and in state and catchment level water plans. While the Cap is not set to achieve any specific environmental objectives, it does limit extractions, leaving any residual water for non-consumptive purposes, including environmental purposes.

State and catchment level water resource plans for surface water usually include rules that result in some base environmental flows. The types of rules that are used include minimum flow and water level rules. In regulated systems, these rules are often met through releases from storages. In unregulated systems, ‘cease to pump’ conditions and limits on extraction rates are used. Rules to achieve consistency with the Cap requirements are also commonly included in state and catchment level water plans (box 2.2). In groundwater plans, rules relating to water levels and salinity thresholds are commonly in place.

The specific rules relating to matters like minimum flows and the Cap rules are not additive. In some cases, it is the Cap that determines the amount of non-consumptive use water in a catchment, and the specific rules determine how a proportion of that water is used. In other cases, the specific rules go beyond what is required by the Cap (that is, the Cap is not binding).

While rules-based water currently provides most of the environmental flows throughout the Basin, the practice of assigning specific entitlements of water to the environment, is becoming increasingly important.

Environmental water entitlements

State and catchment level water plans for surface water may also include the provision of entitlements for environmental use. These may be held and used where and when required. For example, the rules in the Murrumbidgee Regulated River Water Source provide for three types of Environmental Water Allowances (allocations) based on certain inflow and use conditions, that can be used for environmental purposes, at the discretion of an Environmental Water Allowance

Reference Group. Alternatively, they may be assigned for use on a specific water dependent ecosystem. For example, entitlements of 100 GL per year (50 GL from both Victoria and New South Wales) are set aside in water sharing plans, for use in the Barmah-Millewa Forest.

Box 2.2 **Rules-based environmental water in the regulated Murrumbidgee**

The Murrumbidgee River is one of the main tributaries to the Murray River, draining an area of 84 000 square kilometres in the south-west of New South Wales. From its source in the Snowy Mountains to its junction with the Murray it is 1600 kilometres long, with 1200 kilometres of that regulated by storages.

The water sharing plan for the regulated parts of the Murrumbidgee commenced on 1 July 2004 and runs for 10 years. This plan, like all water sharing plans in New South Wales, must be consistent with the overarching state water sharing plan set out in the *Water Management Act 2000* (NSW).

The plan sets out four main rules that return water to the environment:

- a long term extraction limit (that ensures compliance with the Cap) set at 44 per cent of yearly flows
- the release of up to 560 ML per day from Blowering Dam, and between 300 and 615 ML per day from Burrinjuck Dam, depending on inflow to the storages
- the additional release of a percentage (dependent on climatic conditions and storage levels) of Burrinjuck Dam’s inflows between 22 April and 21 October
- a minimum flow of at least 300 ML per day to be maintained downstream of Balranald Weir.

Source: DIPNR (2004).

Commonwealth, State and Territory Governments have in recent years also introduced a range of measures designed to recover entitlements for environmental purposes. These programs usually recover water through either the purchasing of entitlements, as is occurring under the Restoring the Balance program, or the funding of infrastructure projects that produce water savings, as is occurring under the Sustainable Rural Water Use and Infrastructure program (both programs are discussed in chapter 1). Other government programs (some discussed more fully in appendix B) that have recovered water in this manner include:

- the Living Murray Initiative, which aimed to recover 500 GL (long-term cap equivalent (LTCE)), by 30 June 2009. The program was funded by both the Australian Government ($400 million) and the Basin states (excluding Queensland) ($300 million). The program recovered water through the purchase of entitlements, 99-year leases, and water savings from infrastructure upgrades (both on and off farm)

- Water for Rivers, which aims to recover 282 GL (LTCE) (70 GL for the Murray River and 212 GL for the Snowy River), by 30 June 2012. The program is funded by the Commonwealth ($75 million), New South Wales ($150 million), and Victorian ($150 million) Governments. The program recovers water through the purchase of entitlements, and water savings from infrastructure upgrades (both on and off farm)
- the Rivers Environment Restoration Program, incorporating New South Wales Riverbank, which aims to improve the condition of specific rivers in New South Wales. The program is funded by the Commonwealth ($72 million) and New South Wales ($102 million) Governments, of which $147 million is available for water purchases
- the Northern Victorian Irrigation Renewal Project which, among other things, aims to recover 175 GL (LTCE) for the environment, by 2012. Stage one of the project is funded by the Victorian Government ($600 million), Melbourne Water ($300 million) and Goulburn-Murray Water ($100 million), with stage two funding of up to a further $1 billion to be provided by the Australian Government, subject to due diligence assessments. The program recovers water through water savings from infrastructure upgrades in the Goulburn-Murray Irrigation District.

The entitlements that are recovered represent environmental water that is additional to that which is implicit in the Cap requirements. For example, if the Cap limited diversions in a catchment to 100 units and then 2 units of water were purchased for the environment, the new limit would be 98 units.

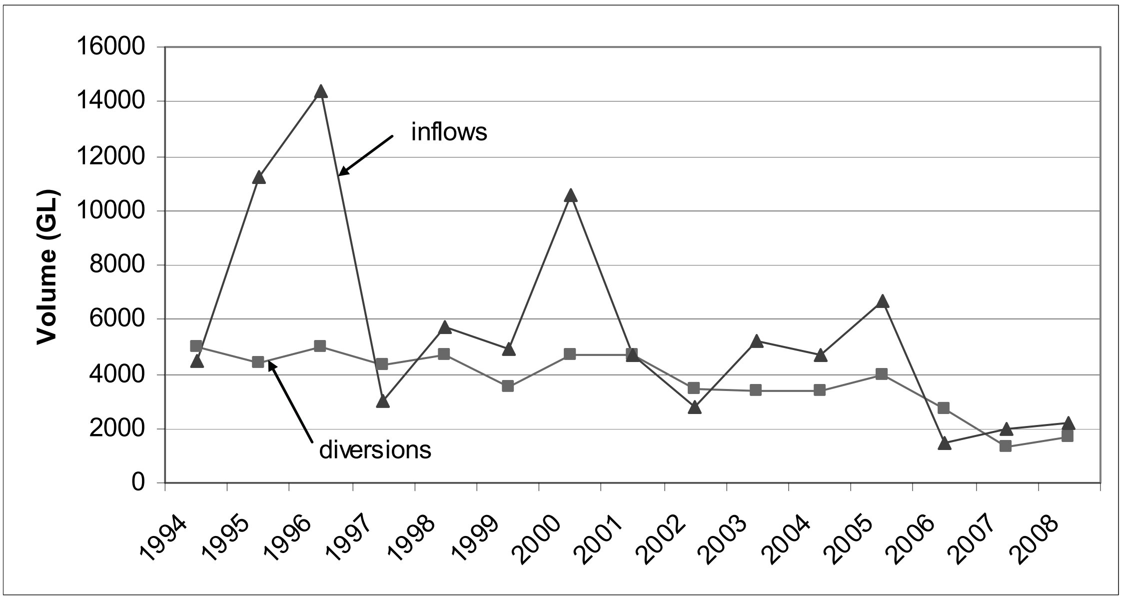
Where water is recovered through entitlements, environmental water managers must manage the seasonal allocations that arise from the entitlements in each year. These may be local organisations such as the aforementioned Water Allowance Reference Group in the Murrumbidgee, or Commonwealth and State government agencies. The Australian Government's environmental water manager, known as the Commonwealth Environmental Water Holder, is located within the Department of the Environment, Water, Heritage and the Arts.

Variation of environmental water

Given that environmental allocations have generally been the residual after consumptive needs have been met, water for the environment has generally declined as irrigated agriculture has expanded in the Basin. The Cap effectively brought an end to this dynamic (except for groundwater, as discussed below). However, it happened to be introduced close to the start of a long dry period that has continued through much of the Basin, to the present time.

This has dramatically reduced the environmental benefits that would otherwise have resulted from the Cap (and from subsequent water recovery efforts), in part because the existing arrangements generally give a more than proportional cut to environmental water during dry periods (figure 2.6).

Figure 2.6 **Murray River inflows and total diversions for NSW, Victoria and SA**[a]



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[a] Data is for the Murray system only and does not include other systems.

Source: Imputed from Grafton (sub. DR81).

The National Water Commission (NWC 2009b) points out that current water plans do not adequately address water sharing arrangements in very dry conditions. The situation has been exacerbated by recent state government suspensions of water plans, and by borrowing from environmental allocations, so that consumptive needs can be met (NWC 2009b). Furthermore, the volume of water for the environment also declined following the introduction of the Cap, due to an increase in groundwater extraction and floodplain harvesting (MDBC 2000). To the extent that groundwater is connected to surface water, and that floodplain harvesting reduces flow in waterways, growth in the use of these forms of water decreases the amount available for the environment.

Climate change is expected to increase the frequency of dry periods in the future, which makes the tendency for the current arrangements to allocate a greater than proportional cut to environmental water in such periods more significant. The CSIRO (2008a) estimated that under current water sharing arrangements, the projected median 2030 decline of 11 per cent in surface water availability (Basin-wide), would result in a 4 per cent reduction of surface water use. This modest decline in use would be made possible by a steep decline in environmental water.

These arrangements are set to change once the Basin Plan establishes new sustainable diversion limits that will replace the Cap (chapters 4 and 6). These will be based on analysis of what is sustainable rather than the level of historic use, and will also cover the use of groundwater.

FINDING 2.1

Current planning arrangements tend to assign a more than proportional cut to environmental water during dry periods. With climate change expected to increase the prevalence of dry conditions (particularly in the southern parts of the Basin), the environmental consequences of this could become increasingly significant. Accordingly, the prospect of climate change adds to the imperative to adjust the balance between environmental and consumptive uses of water in the Basin.