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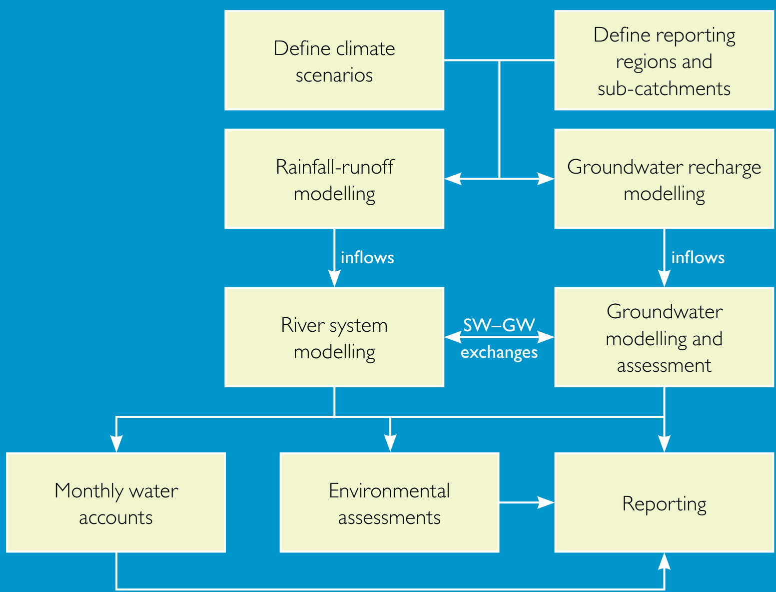
Water Availability in the Ovens

Summary of a report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project

January 2008

Project framework

The project framework begins with definition of sub-catchments for modelling and regions for reporting, and with definition of the climate and development scenarios to be assessed (including generation of the time series of climate data that describe these scenarios). The climate data form inputs to spatio-temporal modelling of the implications of these climate scenarios for catchment runoff and groundwater recharge. The catchment development scenarios (farm dams and forestry) are modifiers of the resulting modelled runoff time series. The runoff implications are then propagated through existing river system models. The recharge implications are propagated through groundwater models – for the major groundwater resources – or considered in simpler assessments for the minor groundwater resources. The connectivity of surface and groundwater is assessed and the actual volumes of surface-groundwater exchange under current and likely future groundwater extraction are quantified. Monthly water balances for the last 10 to 20 years are analysed using all relevant existing data and remotely-sensed measures of irrigation and floodplain evapotranspiration, and are compared to the river modelling results. The implications of the scenarios for water availability and water use under current water sharing arrangements are then assessed and synthesised.



The uncertainty in the assessments is considered from the perspective of "IF this future" (of climate and development) "THEN these hydrologic implications". There is uncertainty in both the IF and the THEN. The uncertainty in the IF is typically large, since the degree of future global warming cannot be accurately predicted. Additionally, there is still considerable uncertainty in predictions of rainfall change resulting from global warming. The uncertainty in the THEN stems from the adequacy of hydrologic and meteorologic data and the imperfect predictions of hydrologic response to climate change given current understanding. The implications of the uncertainty assessments are summarised under *Limitations* (page 5) to advise users of the reliability of the assessments with respect to the terms of reference of the project.

Scenarios assessed

The assessments of current and potential future water availability have been undertaken by considering four scenarios of historical, recent and future climate and current and future development. All scenarios are defined by daily time series of climate variables based on different scalings of the 1895–2006 climate. The first scenario is for **historical climate and current development** and is used as a baseline against which other scenarios are compared. The second scenario is for **recent climate and current development** and is intended as a basis for assessing future water availability should the climate in the future prove to be similar to that of the last ten years. The third scenario is for **future climate and current development** and evaluates three global warming scenarios using 15 global climate models to provide a spectrum of possible climates for 2030. From this spectrum three variants are reported: a median (or best estimate), a wet variant and a dry variant. The fourth scenario is for **future climate and future development** and considers the effects of both a 2030 climate and the expansions in farm dams and commercial plantation forestry expected under current policy, and the changes in groundwater extractions anticipated under existing groundwater plans. All scenarios assume current water sharing arrangements and do not attempt to include possible management responses to changes in climate, water availability or development.

> Lanigans swamp, Vic (North East CMA)

Acknowledgments
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Photos courtesy of the North East Catchment Management Authority, Victoria (North East CMA), Department of Sustainability and Environment, Victoria (DSE).

> Cover: Lagoon on lower Ovens River, Vic (North East CMA)

Ovens region

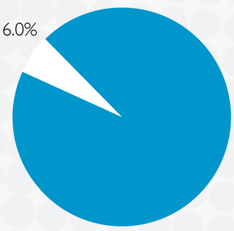
The Ovens region is in north-eastern Victoria and represents 0.7 percent of the total area of the Murray-Darling Basin (MDB). The region is based around the Ovens and King rivers. The population is 46,000 or 2.3 percent of the MDB total concentrated in the centres of Wangaratta, Myrtleford, Beechworth and Bright. The major land use is dryland pasture used for beef and sheep grazing. Over half of the region is covered with native vegetation primarily in the highlands. Approximately 7700 ha were irrigated in 2000 including 2700 ha for vines and 3500 ha for pasture production. The Ovens River channel from downstream of Wangaratta to Lake Mulwala (the impoundment behind Yarrawonga Weir on the Murray River) is an environmental asset of national importance. It was nominated under the Victorian Heritage Rivers Act 1992 in recognition of the significant features of the area. The region generates approximately 6 percent of the runoff within the MDB. The region uses 0.2 percent of the total surface water diverted for irrigation in the MDB and 0.4 percent of the total groundwater used in the MDB. The Ovens River is unregulated upstream of Myrtleford and partly regulated downstream due to the presence of Lake Buffalo and Lake William Hovell on its tributaries.

> Ovens River, Vic (North East CMA)

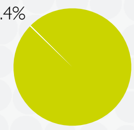
Broad land use in the year 2000

Land use	Area		
	percent		ha
Dryland crops	2.5%		19,300
Dryland pasture	39.4%		307,400
Irrigated crops	1.0%		7,700
Cereals		*1.4%*	*100*
Horticulture		*15.6%*	*1,200*
Orchards		*2.6%*	*200*
Pasture and hay		*47.6%*	*3,700*
Vine fruits		*32.8%*	*2,500*
Native vegetation	53.5%		417,900
Plantation forests	2.8%		21,700
Urban	0.7%		5,500
Water	0.1%		1,100
Total	**100.0%**		**780,600**

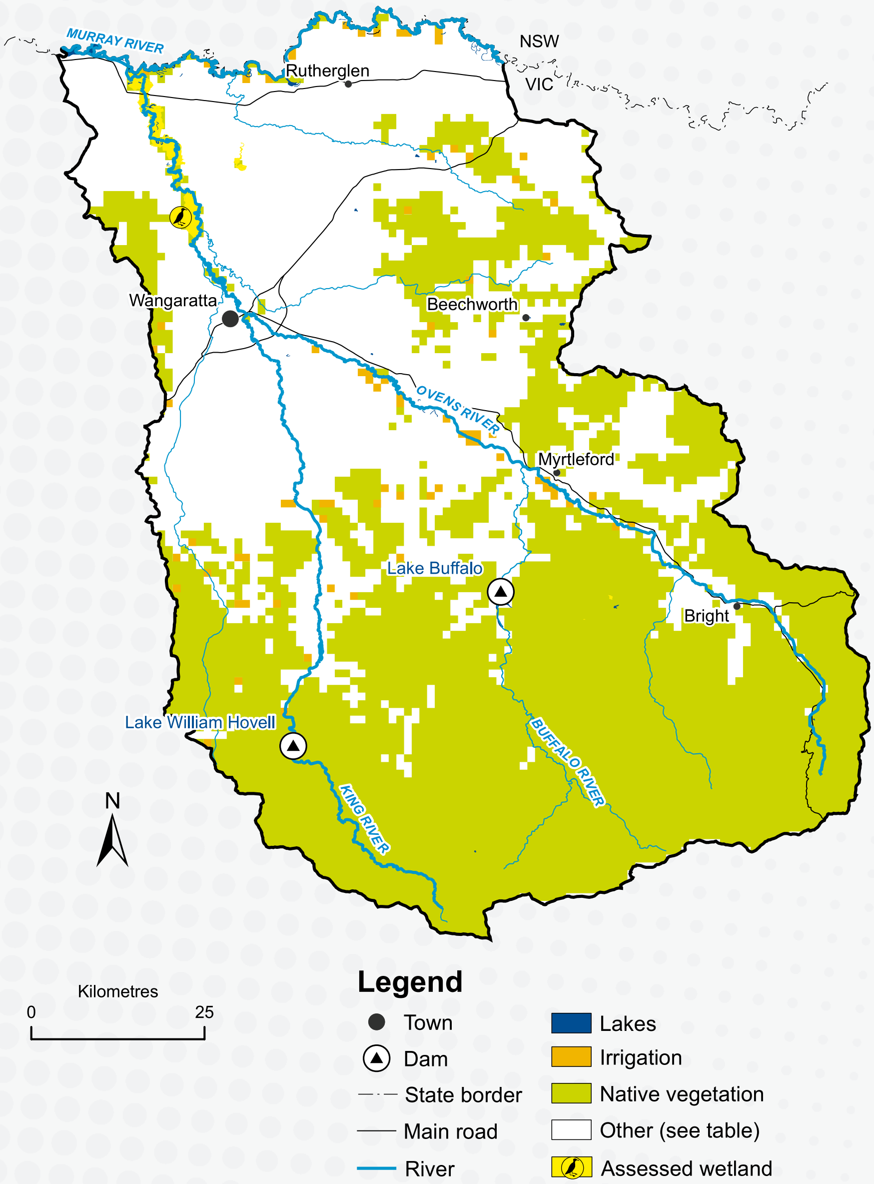
Source: Bureau of Rural Sciences (2000)



Share of MDB runoff



Share of total MDB groundwater use (excluding confined aquifers of the Great Artesian Basin)



Key findings

- **Current** average surface water availability is 1776 GL/year and 25 GL/year (1.4 percent) of this is diverted for use. This is a low level of use. Current groundwater use is about 12 GL/year or 33 percent of total water use.
- If the **recent** climate (1997 to 2006) were to continue for the long-term, both average surface water availability and end-of-system flows to the Murray River would be reduced by 27 percent.
- The best estimate of **climate change by 2030** is less severe than the recent past: average surface water availability and end-of-system flows would reduce by 13 percent.
- **Future development** of commercial plantation forestry and farm dams is expected to be small with minor impacts on runoff. Groundwater extraction is expected to increase by 90 percent by 2030 to become nearly half of average total water use.

For historical climate and current development

The average annual rainfall for the entire region is 1004 mm and modelled average annual runoff is 231 mm. The region generates about 6 percent of the total runoff in the MDB. Current average surface water availability is 1776 GL/year. Currently 25 GL/year (1.4 percent) of this is used – this a low level of use.

The region uses four levels of water restrictions: levels 1 and 2 are mild restrictions; levels 3 and 4 are severe restrictions. For Wangaratta, mild water restrictions are currently activated in less than 5 percent of years as are severe restrictions. For Bright, mild water restrictions are currently activated in 37 percent of years while severe restrictions are activated in 10 percent of years.

Current groundwater extraction in the Ovens region is estimated to be about 12 GL/year including stock and domestic use and use in unincorporated areas. This represents 33 percent of average total annual water use and 45 percent of total water use in years of minimum surface water use. This is a low level of groundwater development as extraction is less than 7 percent of rainfall recharge. Current groundwater use reduces streamflow by about 6 GL/year.

The high winter–spring flows that help sustain the floodplain and associated billabongs of the lower Ovens River have not been affected by water resource development.

For recent climate and current development

The average annual rainfall and runoff over the past ten years (1997 to 2006) are 11 percent and 26 percent lower respectively than the long-term average values.

If the climate of the last ten years were to persist, water availability and end-of-system flows to the Murray River would be reduced by 27 percent but average surface water use would be largely unaffected. However, mild and severe water restrictions would be activated more frequently for both Wangaratta and Bright due to increases in demand that result from lower rainfall and higher evaporation. Rainfall recharge to groundwater would fall, but groundwater use would still be low at less than 9 percent of rainfall recharge.

The average period between winter–spring floods inundating billabongs along the lower Ovens River would increase but would still occur at least once per year. Events would be one-third smaller in volume and the average annual flooding volume would be halved. This would reduce considerably the extent of floodplain inundation.

For future climate and current development

Rainfall-runoff modelling with climate change projections from global climate models indicates that runoff in the region will decrease significantly by 2030. The best estimate 2030 climate is a 13 percent reduction in average annual runoff. The extreme estimates under high global warming range from a 44 percent reduction to a 1 percent increase in average annual runoff. The extreme estimates under low global warming range from a 14 percent reduction to no change in average annual runoff.

Under the best estimate 2030 climate water availability and end-of-system flows to the Murray River would be reduced by 13 percent (231 GL/year) with negligible impact on average surface water use in the region. Water supply to Bright would require mild water restrictions in 41 percent of years and severe restrictions in 14 percent of years. The frequency of water restrictions for Wangaratta would be largely unaffected. The level of groundwater development would remain low.

Under the wet extreme 2030 climate water availability would increase slightly, but reduced demand would mean surface water diversions would be slightly lower. Water restrictions for Bright would be activated less frequently. Under the dry extreme 2030 climate water availability would be reduced by 45 percent and demand would increase due to reduced rainfall and increased evaporation, resulting in a slight increase in average surface water use. End-of-system flows to the Murray River would be reduced by 46 percent. Water supply to Bright would require mild restrictions in 62 percent of years and severe restrictions in 21 percent of years. Water supply to Wangaratta would require mild restrictions in 18 percent of years and severe restrictions in 14 percent of years.

Under the best estimate 2030 climate the periods between high winter–spring floods that inundate billabongs on the lower Ovens River would increase in duration. The average period between floods would increase by 15 percent (about one month)

> Ovens floodplain near Peechelba, Vic (North East CMA)

and the maximum period between events would increase by 29 percent (about ten months). The average flooding volume per event would be reduced by 21 percent and the average annual flooding volume would be reduced by 29 percent. It is likely these changes would have ecological consequences. Under the dry extreme 2030 climate there would be major increases in average and maximum periods between high winter–spring floods and reductions in flood volumes with adverse ecological consequences. Under the wet extreme 2030 climate periods between winter–spring floods and flooding volume would remain similar to the current flow regime.

For future climate and future development

Projected growth in commercial forestry plantations in the region is negligible, and the projected 8 percent increase in farm dams would have only minor impact on future runoff.

Groundwater extraction is projected to increase from about 12 GL/year to nearly 23 GL/year by 2030. Groundwater use would then represent 48 percent of average total annual water use in the region and 60 percent in years of minimum surface water use. Under the best estimate 2030 climate groundwater extraction would represent 13 percent of rainfall recharge. The increase in groundwater use would reduce streamflow by a further 6 GL/year.

The small projected increases in farm dams and groundwater development by 2030 would have almost no impact on the period between and volumes of the high winter–spring flows that inundate billabongs on the lower Ovens River.

> Boggy Creek, Vic (DSE)

Limitations

The runoff estimates for the Ovens region are relatively robust because there are many gauged catchments from which to estimate model parameter values. The largest source of uncertainty for future climate results are the climate change projections (global warming level) and the modelled implications of global warming on regional rainfall. The results from 15 global climate models were used but there are large differences amongst these models in terms of regional rainfall predictions. There are also considerable uncertainties associated with the future projections of farm dams and commercial forestry plantations. Future developments could differ considerably from these projections if governments were to impose different policy controls on these activities.

The model for the Ovens River is appropriate for the purposes of this project – assessing water availability and use. It reproduces observed streamflow patterns very well and produces results that agree well with independent water balance accounts for two reaches. Peak flows are somewhat underestimated by the model. The projected flow regimes for the best estimate 2030 climate and for the dry extreme 2030 climate are significantly different to the current flow regime. Given the model uncertainty, it is difficult to distinguish the projected flow regime for the wet extreme 2030 climate from the current flow regime, or to distinguish the current flow regime from the pre-development flow regime.

The simple groundwater assessments undertaken for the region are commensurate with the low and very low priority rankings of the Groundwater Management Units (GMUs) within the region. However, recharge, extraction, aquifer hydraulic conductivity and surface–groundwater connectivity in the region are poorly quantified, thus the results of simple assessments undertaken are relatively uncertain.

The environmental assessments of this project only consider a subset of the important assets for this region and are based on limited hydrology parameters with no direct quantitative relationships for environmental responses. Considerably more detailed investigation is required to provide the necessary information for informed management of the environmental assets of the region.

Rainfall and runoff

> Lower Ovens River, Vic (North East CMA)

The mean annual rainfall and modelled runoff averaged over the Ovens region are 1004 mm and 231 mm respectively. Rainfall is generally higher in the winter half of the year and most of the runoff occurs in winter and early spring. Rainfall, runoff and the fraction of rainfall that becomes runoff in the region are amongst the highest in the MDB. Although the region is less than 1 percent of the MDB, it contributes about 6 percent of the total runoff in the MDB.

The mean annual rainfall and runoff over the ten-year period 1997 to 2006 are 11 percent and 26 percent lower respectively than the long-term means. However, because of the inter-annual variability and the relatively short ten-year period used as the basis for comparison, the 1997 to 2006 rainfall and runoff are only statistically different to the long-term means at a significance level of 0.2.

Rainfall-runoff modelling with climate change projections from global climate models indicates that future runoff in the region will decrease significantly. Practically all the modelling results with different global climate models show a decrease in runoff. The best or median estimate is a 13 percent reduction in mean annual runoff by 2030. The extreme estimates, which come from the high global warming scenario, range from a 44 percent reduction to a 1 percent increase in mean annual runoff. By comparison, the range from the low global warming scenario is a 14 percent reduction to no change in mean annual runoff.

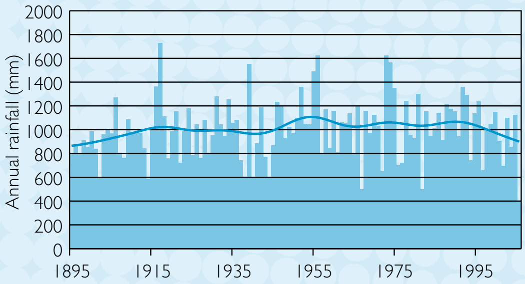
The little to no projected growth in commercial forestry plantations and the projected 8 percent increase in farm dam development would have negligible impact on future runoff in the Ovens.

			Future climate					
			Current development			Future development		
	Historical 1895–2006	Recent 1997–2006	Dry	Best estimate	Wet	Dry	Best estimate	Wet
	mm		percent change from Historical					
Rainfall	1004	895	-19%	-4%	3%	-19%	-4%	3%
Runoff	231	172	-44%	-13%	1%	-44%	-13%	1%
Evapotranspiration	773	723	-11%	-2%	3%	-11%	-2%	3%

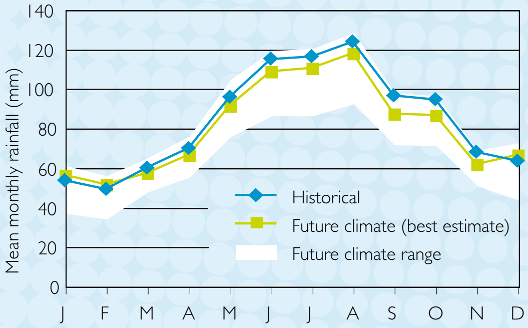
> Ovens River near Peechalba, Vic (North East CMA)

> Fifteen Mile Creek, Vic (DSE)

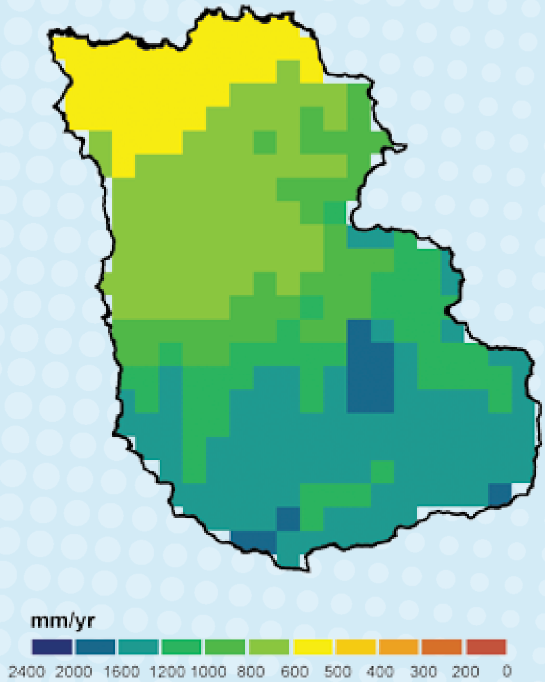
Rainfall



Annual rainfall (1895–2006) spatially averaged across the region (based on SILO data) with low-frequency smoothed line shown to indicate longer-term variations.

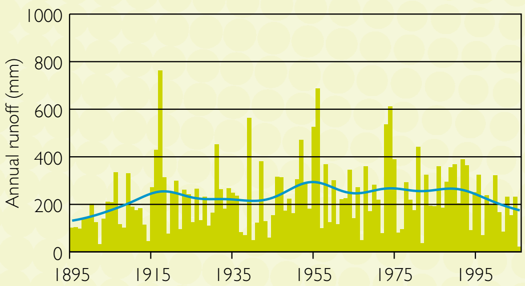


Average (1895–2006) monthly rainfall averaged across the region and range (shaded) of potential changes in mean monthly rainfall due to climate change by 2030.

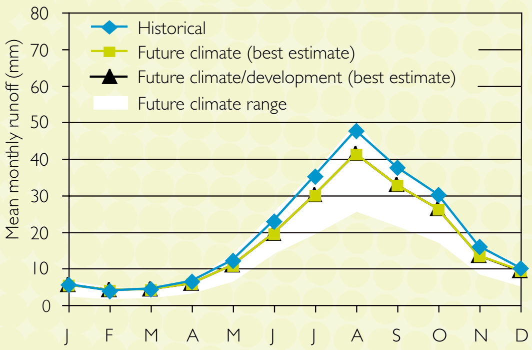


Average (1895–2006) annual rainfall (mm) distribution (based on SILO data).

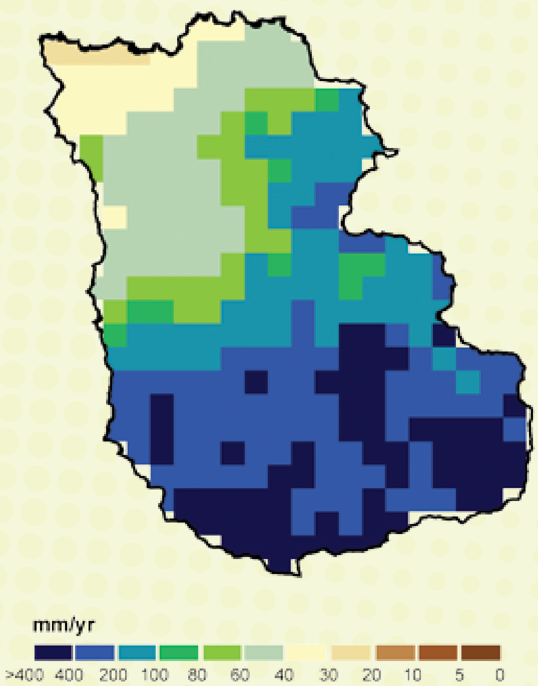
Runoff



Annual runoff (1895–2006) spatially averaged across the region (based on daily runoff modelling) with low-frequency smoothed line shown to indicate longer-term variations.



Average (1895–2006) monthly runoff averaged across the region and range (shaded) of potential changes in mean monthly runoff due to climate change by 2030.



Average (1895–2006) annual runoff (mm) distribution (based on daily runoff modelling).

Surface water

Current average water availability is 1776 GL/year. The current level of use is very low: 25 GL/year (1.4 percent) is diverted for use including 19 GL/year (1.1 percent) for irrigation.

The main storages in the region are lakes William Hovell and Buffalo. Regulated supply provides for 58 percent of the total bulk entitlement and licensed volume.

The region uses four levels of water restrictions: levels 1 and 2 are mild restrictions; levels 3 and 4 are severe restrictions. For Wangaratta, mild water restrictions are currently activated in less than 5 percent of years as are severe restrictions. For Bright, mild water restrictions are currently activated in 37 percent of years while severe restrictions are activated in 10 percent of years.

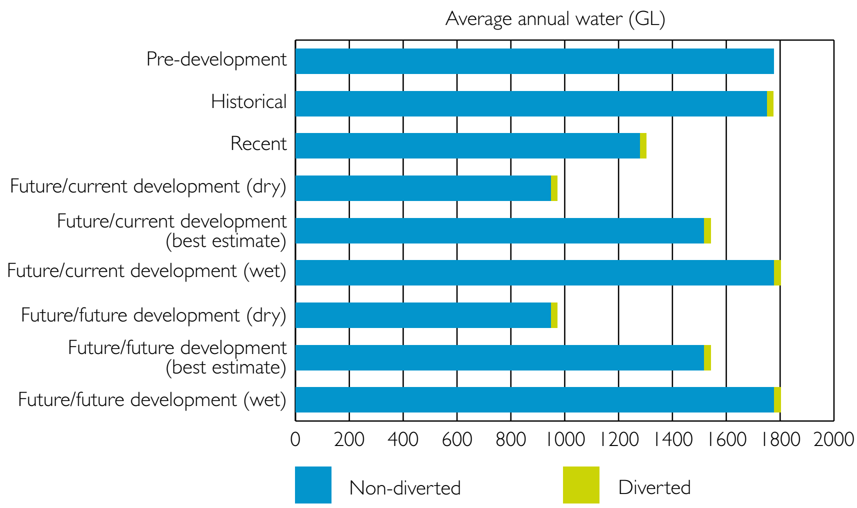
If the climate of the last ten years were to persist, water availability and end-of-system flows to the Murray River would be reduced by 27 percent but average surface water use would be largely unaffected. However, mild and severe water restrictions would be activated more frequently for both Wangaratta and Bright due to increases in demand that result from lower rainfall and higher evaporation.

Under the best estimate 2030 climate water availability would be reduced by 13 percent (231GL/year) with negligible impact on average surface water use. Water supply to Bright would require mild water restrictions in 41 percent of years and severe restrictions in 14 percent of years. The frequency of water restrictions for Wangaratta would be largely unaffected.

Under the wet extreme 2030 climate water availability would increase slightly, but reduced demand would mean surface water diversions would be slightly lower. Water restrictions for Bright would be activated less frequently. Under the dry extreme 2030 climate water availability would be reduced by 45 percent and demand would increase due to reduced rainfall and increased evaporation, resulting in a slight increase in average surface water use. End-of-system flows to the Murray River would be reduced by 46 percent. Water supply to Bright would require mild restrictions in 62 percent of years and severe restrictions in 21 percent of years. Water supply to Wangaratta would require mild restrictions in 18 percent of years and severe restrictions in 14 percent of years.

Projected growth in commercial forestry plantations in the region is negligible, and the projected 8 percent increase in farm dams would have only minor impact on future runoff.

> Buffalo River, Vic (DSE)



Water availability	Historical	Recent	Current development			Future development		
			Dry	Best estimate	Wet	Dry	Best estimate	Wet
	GL/y	percent change from Historical						
Total inflows	–	-26%	-44%	-13%	1%	-45%	-13%	1%
Total surface water availability	1775.5	-27%	-45%	-13%	1%	-45%	-13%	1%
Total end-of-system flow	1751.6	-27%	-46%	-13%	2%	-47%	-14%	1%
Diversions								
Lowest 1-year period	15.3	4%	-12%	0%	-2%	-15%	0%	-2%
Lowest 3-year period	18.8	3%	3%	0%	-1%	2%	0%	-1%
Lowest 5-year period	19.5	3%	6%	0%	-1%	6%	0%	-1%
Average	25.4	1%	2%	0%	-1%	1%	0%	-1%

Groundwater

Current groundwater extraction in the Ovens region is estimated to be 12.3 GL/year including stock and domestic use and use in unincorporated areas. About 54 percent of this extraction occurs from the Murmungee GMU, 44 percent from unincorporated areas, and 2 percent from the Barnawartha GMU. Around 33 percent of the total use is from stock and domestic bores.

Groundwater development in the Ovens region is low: current extraction is only 7 percent of rainfall recharge. Current extraction represents 33 percent of average total annual water use and 45 percent of total water use in years of minimum surface water use. Current groundwater extraction reduces streamflow by about 6 GL/year.

The upper Ovens is naturally a gaining river and groundwater contributes approximately 5 GL/year of streamflow at Myrtleford (mid-catchment). This is approximately 6 percent of the median annual streamflow.

Groundwater extraction is expected to increase by 90 percent by 2030 to 22.9 GL/year. At this level and under the best estimate 2030 climate, groundwater use would represent nearly half of average total water use in the region, and 60 percent of total water use in years of minimum surface water use.

In spite of the increase, the level of groundwater development in the region would remain low. Combined with the reductions in rainfall recharge expected under future climate, extraction by 2030 would represent at most 16 percent of rainfall recharge. Under the best estimate 2030 climate future extraction would be 13 percent of rainfall recharge.

The increase in groundwater extraction would reduce streamflow by a further 6 GL/year, such that the total impact of groundwater use would be 12 GL/year. While this is less than 1 percent of the mean annual end-of-system flow, it represents 22 percent of the 95th percentile (low) flow.

> Lower Ovens River, Vic (North East CMA)

Code	Name	Priority ranking	Extraction 2004/05*	Total entitlement*	Permissible consumptive volume	Rainfall recharge
			GL/y			
V36	Barnawartha GMU	very low	0.2	0.5	2.1	2.4
V37	Murmungee GMU	low	6.7	11.8	16.7	68.7
–	Unincorporated areas	na	5.4	8.8	na	113.0

* Current extraction and entitlement data is sourced from DSE. 2004/05 extraction data includes an estimated 4.0 GL/year of stock and domestic use made up of 2.57 GL/year from the Murmungee GMU, 0.06 GL/year from the Barnawartha GMU and 1.37 GL/year from unincorporated areas (estimated using information from the Victorian Groundwater Management System and DSE)
na: not applicable

Environment

The high winter–spring flows that help sustain the floodplain and associated billabongs of the lower Ovens River have not been affected by water resource development.

A long-term continuation of the 1997 to 2006 climate would increase the average period between high winter–spring flow events. These events would still occur at least once per year on average. However, on average, events would be one-third smaller in volume so that the average annual volume of winter–spring floods would be halved. This would reduce considerably the extent of floodplain inundation.

Under the best estimate 2030 climate the changes would be smaller than under a long-term continuation of the recent climate. There would be a 15 percent (about 1 month) increase in the average period between high winter–spring flow events and a 29 percent increase (about 10 months) in the maximum period between events. The average flooding volume of these events would be reduced by 21 percent meaning the average annual volume of winter–spring floods would be reduced by 29 percent. It is likely these changes would have ecological consequences.

The dry extreme 2030 climate would result in major increases in average and maximum periods between high winter–spring flow events and reductions in flood volumes with adverse ecological consequences. The wet extreme 2030 climate would mean periods between high winter–spring flow events and flooding volume would remain essentially unchanged from the current flow regime.

The small projected increases in farm dams and groundwater development by 2030 would have almost no impact on the periods between and flooding volumes of high winter–spring flows.

The Ovens River is one of the last largely unregulated rivers in the MDB. It has:

- a largely natural flow regime
- diverse aquatic habitats, including riffles, pools, woody debris, flood runners, anabranches, billabongs and floodplains
- a range of threatened species including up to ten fish species of state and national conservation significance including Murray Cod
- intact riparian vegetation along substantial lengths of the river.

The Ovens River is significant for its large number of 'representative' river sites – noted for their aquatic features – for which specific environmental flow requirements have been recommended. In particular 'Reach 5', which extends from the King River confluence to Lake Mulwala, is a wetland of national importance.

The river corridor covers some 3750 ha along a 52 km stretch of river downstream of Wangaratta to Lake Mulwala. The corridor is a floodplain 2 km wide in parts and contains important native fish habitat and an Ibis rookery (breeding site) near where the Murray Valley Highway crosses the river. Some of the area is a flora reserve and the Lower Ovens Regional Park. Private land is mostly used for grazing.

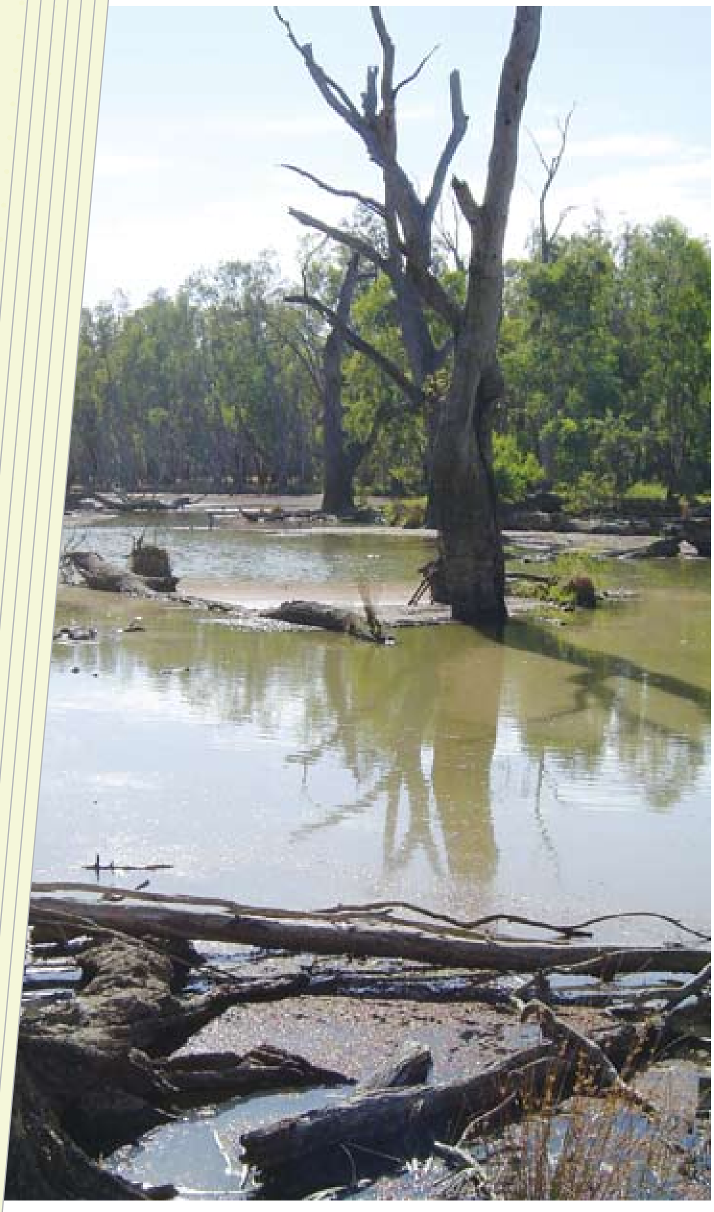
> Catherine River, Vic (DSE)

Winter–spring flow indicators	Pre-development	Historical	Recent	Future climate					
				Current development			Future development		
				Dry	Best estimate	Wet	Dry	Best estimate	Wet
	years		percent change from Historical						
Average period between flows exceeding 100 GL/week between 1 June and 30 November at the Mulwala gauge	0.49	0.50	48%	176%	15%	10%	184%	15%	9%
Maximum period between flows exceeding 100 GL/week between 1 June and 30 November at the Mulwala gauge	2.94	2.94	41%	131%	29%	1%	131%	29%	1%
	GL								
Average flow volume per year above 100 GL/week between 1 June and 30 November at the Mulwala gauge	688	681	-53%	-81%	-29%	-6%	-82%	-30%	-6%
Average flow volume per event above 100 GL/week between 1 June and 30 November at the Mulwala gauge	371	374	-33%	-50%	-21%	3%	-49%	-21%	2%

> Fifteen Mile Creek, Vic (DSE)

> King River Anabranch, Vic (DSE)

> Ovens River, Vic (DSE)



> Lower Ovens River, Vic (North East CMA)

About the project

The CSIRO Murray-Darling Basin Sustainable Yields Project resulted from the Summit on the Southern Murray-Darling Basin (MDB), convened by the then Prime Minister on 7 November 2006. The project is providing governments with a robust estimate of water availability for the entire MDB on an individual catchment and aquifer basis taking into account climate change and other risks. The project will report progressively to early 2008. The project will be the most comprehensive assessment of water availability for the MDB undertaken to-date. For the first time:

- daily rainfall-runoff modelling has been undertaken at high spatial resolution for a range of climate change and development scenarios in a consistent manner for the entire MDB
- the hydrologic subcatchments required for detailed modelling have been precisely defined across the entire MDB
- the hydrologic implications for water users and the environment by 2030 of the latest Intergovernmental Panel on Climate Change climate projections, the likely increases in farm dams and commercial forestry plantations and the expected increases in groundwater extraction have been assessed in detail
- the assessments have employed all existing river system and groundwater models as well as new models developed within the project
- the modelling has included full consideration of the downstream implications of upstream changes between multiple models and between different states, and quantification of the volumes of surface–groundwater exchange
- detailed analyses of monthly water balances for the last 10 to 20 years have been undertaken using available streamflow and diversion data together with additional modelling including estimates of wetland evapotranspiration and irrigation water use based on remote sensing imagery. These analyses provide an independent cross-check on the performance of river system models.

The assessments reported here have been reviewed by a project Steering Committee and a Technical Reference Panel both with representation from Commonwealth and State governments and the Murray-Darling Basin Commission.

Information on how these results may be used in the development of a new sustainable diversion limit for the Murray-Darling Basin can be found at www.environment.gov.au/water/mdb/yields.html.

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Enquiries

More information about the project can be found at www.csiro.au/mdbsy. This information includes the full terms of reference for the project, an overview of the project methods and the project reports that have been released to-date, including the full report for this region.

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