Don’t drain the Murray….

PLUG THE PIPE

SUBMISSION TO THE SENATE INQUIRY INTO WATER MANAGEMENT IN THE COORONG AND LOWER LAKES

This scene might be more stark and graphic if it was a bare landscape, cracked and dry – the classic drought photo. In fact it is even more frightening because this arm of Lake Eildon (the reservoir for the Goulburn River and the Goulburn irrigation District) has been without water for so long that grass and trees have reclaimed their previous territory. Cattle have been agisted on the former lake bed as a measure to reduce fire risk. In the background, trees have been free of inundation for years and their tips are just above the old waterline noticeable on the rail trail bridge.

Lake Eildon has not been full since 1996. The landscape tells us that the worse case scenarios posed by the CSIRO are already with us in the Goulburn-Broken Catchment. There is no science, practical experience or common sense to support plans to pipe 75 billion litres of water per year from the Goulburn River to Melbourne.

The Advisory Committee which reviewed the Victorian Governments plan for the North-South Pipeline refused to take on board such evidence relying on their terms of reference.

Photo: Ed Adamson. Taken near Bonnie Doon, Victoria January 2008.

BACKGROUND

In the lead-up to the 2006 Victorian State Election the Labor Government promised that if elected it would not pipe water from the MDB to Melbourne and would not build a desalination plant. Melbourne was on 3a water restrictions at the time.

In June of 2007 it announced a plan for supplying Melbourne with water which involved a desalination plant and a pipeline from the Goulburn River to the Sugarloaf Reservoir where the water would be treated for use in Melbourne.

The pipeline would have an annual capacity of 100 billion litres but would be limited to pumping 75 billion litres. The water for Melbourne would allegedly come from taking one third of ‘new water’ obtained through upgrading irrigation infrastructure.

Packed community meetings howled down the proposal on the grounds that there was already insufficient water in the Goulburn-Broken Catchment to supply irrigation and environmental needs.

Plug The Pipe was formed by affected communities. In the initial period there was some confidence that when the government heard the facts it would see reason and withdraw the proposal. Most of the community could not comprehend how a government could install a pipeline from a dry catchment to a wetter catchment. The message came back that it was a done deal not open to negotiation and we dug in for a long fight.

Also the irrigation communities have been virtually told ‘no Pipeline, no funds for irrigation infrastructure up grades.’

The Brumby Government hopes to finish the Project and be pumping water prior to the 2010 Election.

CONCLUSIONS AND RECOMMENDATIONS

The North-South Pipeline is a water diversion which is the equivalent of putting a new dam or water allocation onto an already overstressed river system. In current circumstances water savings programs while desirable will not compensate for the Goulburn River being treated as a Magic Pudding.

Approval of the Project will set precedents which will merely shift and exacerbate patterns of over-allocation by making it easier to approve more pipelines. In future it would merely be necessary to rely on unverified plans for future water savings to escape the tests of the EPBC Act. These patterns once established will be harder to address as reducing water allocations to large cities will be politically far more difficult than reducing irrigator allocations. Over-allocation could be endemic and unstoppable.

The Senate Inquiry should find that the North-South Pipeline should not be approved until a sustainability audit is done on the Murray-Darling System and an independent Environmental Effects Statement is prepared.

RELEVANT FACTS

Note: The Advisory Committee commissioned by the Victorian Planning Minister to assess the Pipeline Project ruled that most of the evidence in this submission was inadmissible under its Terms Of Reference. This includes evidence on climate change projections for the Goulburn-Broken Catchment.

NO ENVIRONMENTAL ASSESSMENT ON EXTRA WATER DIVERSION

The Victorian Government environmental assessment process accredited by Minister Garrett does not include an environmental assessment of the likely impact on the Murray and lower Goulburn of the diversion of 75 billion litres of water per year from the Goulburn River to Melbourne.

The Environment Protection and Biodiversity Conservation Act requires (Sect 527E) that the Environment Minister must consider likely secondary impacts of projects under assessment.

Therefore any approval of the Pipeline Project by Environment Minister Garrett without environmental studies of the impacts of water extraction on wetlands and migratory species will be in breach of the spirit of the Act and perhaps the letter. Therefore it may be challengeable at law.

WATERY FIGURES

The Victorian State government's case supporting the Pipeline is based on one third of projected 'water savings' from improving irrigation infrastructure being available to pipe to Melbourne. The following are the major flaws in this case.

- Savings projections have been criticized by the Victorian Auditor General on the grounds they are not from an independent source.
- Government water wastage figures have included water lost to evaporation and seepage in wetlands. This is environmental water which cannot be legitimately counted as wasted.
- Only 5% of the total system will be subject to upgrades.

- Errors in measuring devices have been counted as 'new water.'
- Any savings are very likely to be required within the MDB for environmental flows, critical human needs and irrigation. Climate change projections indicate there are no surpluses for distribution.

In other words there is real scope for water savings but that scope has been exaggerated for political purposes.

BORROWING ENVIRONMENTAL WATER

It is anticipated that the pipeline will be finished and pumping prior to water being available through the specific savings programs known as the Food Bowl Infrastructure Renewal Project. Therefore the Victorian Government proposes to pump water from savings from earlier projects which were supposed to supply extra water for the "Living Murray Project." We consider this as robbing environmental water allocations.

The Victorian Government plans to pump 150 billion litres of this critically needed environmental water to Melbourne in 2010/11.

WATER CREDIT CARD 'MAXED OUT'

There has recently been a water pipeline commissioned to supply the rural cities of Bendigo and Ballarat which are both on stage 4 restrictions and have dangerously low reservoir levels due to ongoing low rainfall patterns.[1]

Coliban Water is planning to supplement the Bendigo supply from the Water Quality Reserve held in Lake Eildon.[2] This reserve is supposed to be an emergency supply for flushing Blue-Green Algae or oxygenating the river to prevent fish kills.

There has been no water flowing through the Bendigo "Goldfields Superpipe" for some months and this city remains on stage 4 restrictions. This is simply because there is insufficient water in Lake Eildon to supply all current demands.

There are T-Pieces in the Ballarat Pipeline to provide for possible extension of the supply to the towns of Daylesford and Castlemaine.

A further pipeline is under construction from the Goulburn River to the rural towns of Broadford and Kilmore. Kilmore is a relatively short distance from Melbourne's

[1] Coliban water Web Page (9 Sept 2008) shows water storages at 14.7%. Ballarat storages are 12.5% -source Central Highlands Water Web Page.

[2] Bendigo Advertiser Aug 14, 2008 Pages 1 and 2. Article "All Rain But No Gain" - Coliban Water Services manager Neil Burn is reported as saying that "Coliban Water had scheduled to start pumping its back-up allocation of 5000 megalitres from the water quality reserve at Lake Eildon…"

outer northern suburbs. Its population will expand rapidly and it is possible to imagine the supply from the Goulburn being connected to these suburbs thus providing a capacity to supply Melbourne additional to the 75 billion litres through the North-South Pipeline.

The call on the Goulburn River for the abovementioned requirements is thought to be in the order of 30 billion litres per annum.

To our knowledge none of these water diversions has been accounted for in the environmental assessment process set up between the Commonwealth and the Victorian Government.

No public authority such as the Victorian Department of Sustainability and Environment has made a public submission regarding the capacity of the Goulburn and Murray Rivers to survive climate change and increasing water diversions.

FURTHER DEBITS

In 2003 and 2006/7 millions of hectares of Victorian State Forest and National Park were burned by wildfire. Much of the area burned was in Murray River catchments. Over coming decades, new growth will further reduce runoff into the MDB. Again this reduction in water availability has not been brought to account by the Victorian Government.

TOORALE STATION PURCHASE

While this submission was being written, Senator Wong announced the purchase of Toorale Station. It would be necessary to purchase five such stations to offset the combined diversions we have described and there would still be no net benefit to the Murray River.

NO FEASIBILITY STUDY

The Victorian Government and its departments have not been able to present to the public, or a recently held Upper House Inquiry, a document setting out the business case for the project.

COST BLOWOUTS

The Brumby Government has stated for some time that the cost of the project will be $750 million. We are aware that design work on the project was still incomplete at least until recently. A decision to place a section of the pipe in a tunnel under part of the Great Divide was made many months after the abovementioned cost was announced. Tunnelling would make a substantial addition to costs.

We think that it is most unlikely that an accurate cost could be given prior to the completion of detailed design work and on the basis of expert engineering advice we predict massive cost blowouts.

PROCEDURAL UNFAIRNESS

The public hearings before the Victorian Planning Minister's Sugarloaf Pipeline Project Advisory Committee were held in April 2008 while design work on the project was still under way. We submit that it was procedurally unfair for the public to be required to make submissions on a project which was still being designed.

INTEGRITY OF APPROVAL PROCESS

During the assessment process the Victorian Government has continued to order and purchase equipment for the project costing many millions of dollars. We are aware that sections of the pipeline are being stockpiled. Either the Government is recklessly over confident in a decision from Minister Garrett or they know that a way will be found to circumvent the requirements of the EPBC Act.

HOW MUCH WATER IS NEEDED

The only study we are aware of which begins to estimate the volume of water needed for environmental purposes is that done by the Victorian Environmental Assessment Council which recently studied the Red Gum Forests along the Murray.

Their estimate was that 4000 billion litres was needed for flooding forests over a period of 4 – 5 years.[3] They have been pessimistic regarding the achievability of this figure. Once again we make the point that this was information from a Victorian Government Department that was not brought to account.

[3] Victorian Environment Assessment Council River Redgum Forests Investigation July 2008

More Water for Irrigation and the Environment?
Some Problems and Prospects for Worthwhile Investments

Oliver Gyles

1. INTRODUCTION

Because of a growing concern about the riverine environment, there are calls to increase environmental flows in the Murray-Darling Basin (WWF Australia, 2002). Allocations for consumptive use in the connected Murray River system would fall under a series of proposed scenarios by 350 gigalitres (GL), 750 GL or 1500 GL (MDBC, 2002); and by 750 GL, 1630 GL or 3350 GL (Young *et al*, 2002) as shown in Figure 1.

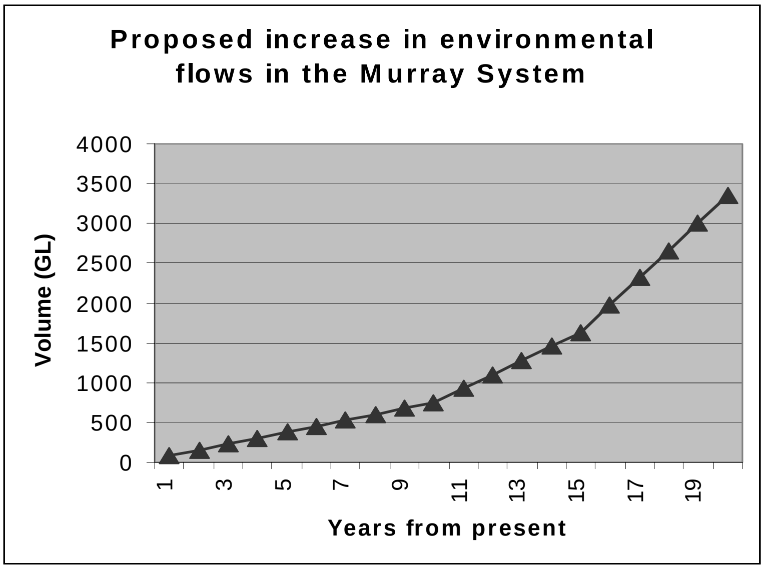

Figure 1: Schedule of increased environmental flows proposed for the Murray System (after Young *et al*, 2002)

Increasing environmental flows on this scale is a big idea. While there may be some complementary outputs in river management, environmental flows and consumption are ultimately competitive uses. On an area basis, the increased environmental flow scenarios contemplated by Young *et al* have the potential to reduce the area of irrigated agriculture[1] by 95,000 hectares, 200,000 hectares or 420,000 hectares. This is equivalent to wiping out irrigation in Northern Victoria.

Increasing the efficiency of irrigation water use is seen as a way to offset reduced allocations. Indeed some see increasing water use efficiency as the next quantum leap in water resource development. Options such as reducing water storage and transmission losses, improving irrigation efficiency and improving plant water use efficiency can help maintain production under reduced water availability. And switching from production of "low value" to "high value" commodities can increase gross value of returns. However the costs of implementing these options must constitute a critical economic constraint to the adoption of these solutions.

To provide a basis for analysis, inefficiencies in water use are defined, the illusory nature of some proposed savings is explained and a method for valuation of real savings in comparison

[1] Irrigation intensity of 8 ML/ha

to costs of proposals is described. The simple treatment of these issues here is not complicated by the unique attributes of local situations. This is not a major difficulty if real options are examined in detail using benefit:cost analysis principles before policy changes are made or investment is sunk.

The limited prospect for obtaining a significant volume of real savings is discussed. This highlights the need for a sound policy for achieving the best allocation of limited water resources to competing uses.

2. NATURE OF INEFFICIENCIES

2.1 Technical Inefficiency

2.1.1 Irrigation System Losses

2.1.1.1 Channel Outfalls and Paddock Tail water

Flows exceeding demand spill over the end of the channel or drain off the end of the irrigated paddock. Estimates of combined gross losses range from 25-50% of stream diversions. Figure 2 shows a hypothetical irrigation system where paddock tail water and channel outfalls do not return to the river. Of gross diversions of 100 GL only 60 GL are used for crop production. The remaining 40 GL comprising channel outfalls and paddock tail water is lost from the system. Net diversions are 100 GL

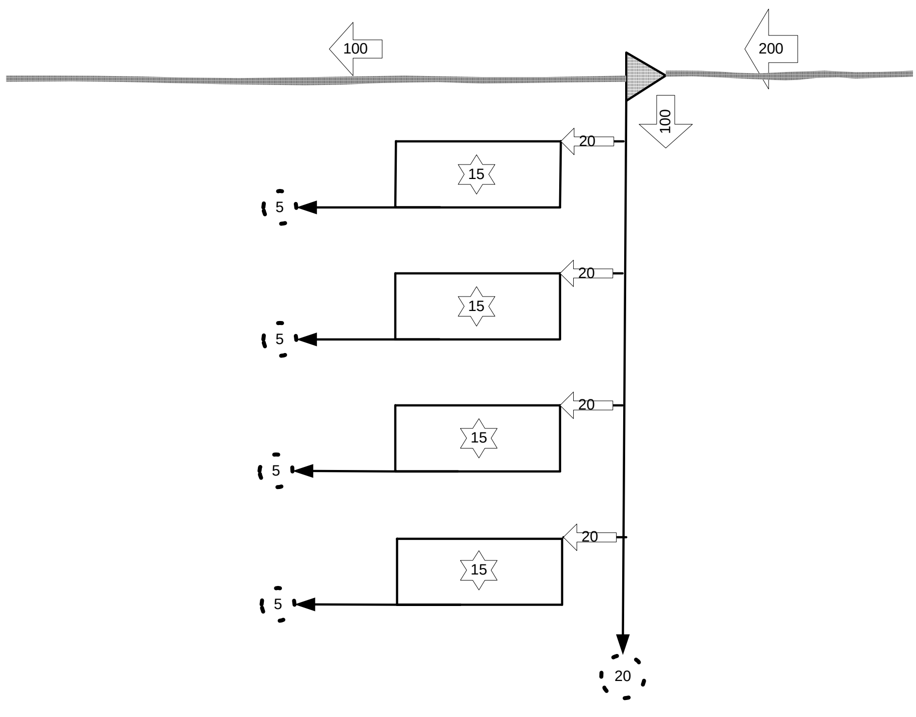

Figure 2: Schematic illustration of water flows for an irrigation system with 40% gross outfall and paddock tail water losses. Arrows show flow volume and direction, star symbols indicate consumptive use and dotted circles show volume of losses

The magnitude of real or net losses depends on the ability to recycle within the irrigation system or return excess flows to the river. Returned flows contribute to environmental flows.

Figure 3 shows the same system where diversions exceeding irrigation demand flow back to the river via the farm and district drainage network. In this example excess flows of 40 GL return to the river. Net diversions are 60 GL

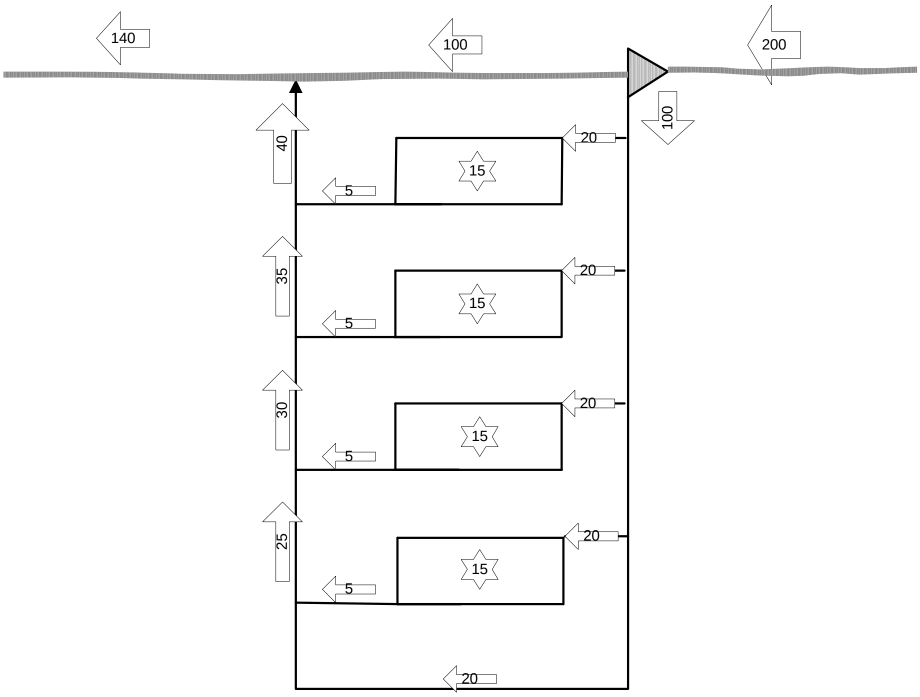

Figure 3: Schematic diagram of water flows for an irrigation system with 40% tailwater and outfall losses returning to the river.

2.1.1.2 Seepage

Water that seeps below the channel bottom or the root-zone in the irrigated paddock supplements existing groundwater resources. Gross surface system losses depend on channel/pipe materials, length of irrigation season, soil type, irrigation technology and management.

Magnitude of real or net losses depends on the proportion of groundwater returning to the river and the ability of sub-surface drainage systems to recycle groundwater accessions.

2.1.1.3 Evaporation

Gross losses are in the order of 15-20 ML/ha of water surface depending on climate. These losses are not recoverable, except that within irrigation areas increased humidity from evaporation may moderate plant water demand.

2.1.2 Plant Water Use Inefficiency

There are diminishing returns to increasing water use intensity (irrigation or rainfall) as other factors of production become limiting.

2.2 Economic Inefficiency

The assumption here is that, given the market for produce, water resources are irrationally allocated to low value enterprises.

3. IDENTIFYING PROSPECTS FOR REAL SAVINGS

3.1.1 Irrigation System Losses

3.1.1.1 Channel Outfalls and Paddock Tail water

Since returned flows already contribute to downstream allocations there are no system savings obtained from reducing return flows. This simple algebraic reality obliterates the major forlorn hope of increasing catchment water resources. Figure 4 shows that eliminating tail water losses and channel outfalls and supplying only crop irrigation demand does not create new water. Net diversions are still 60 GL and downstream flows are not increased above 140 GL.

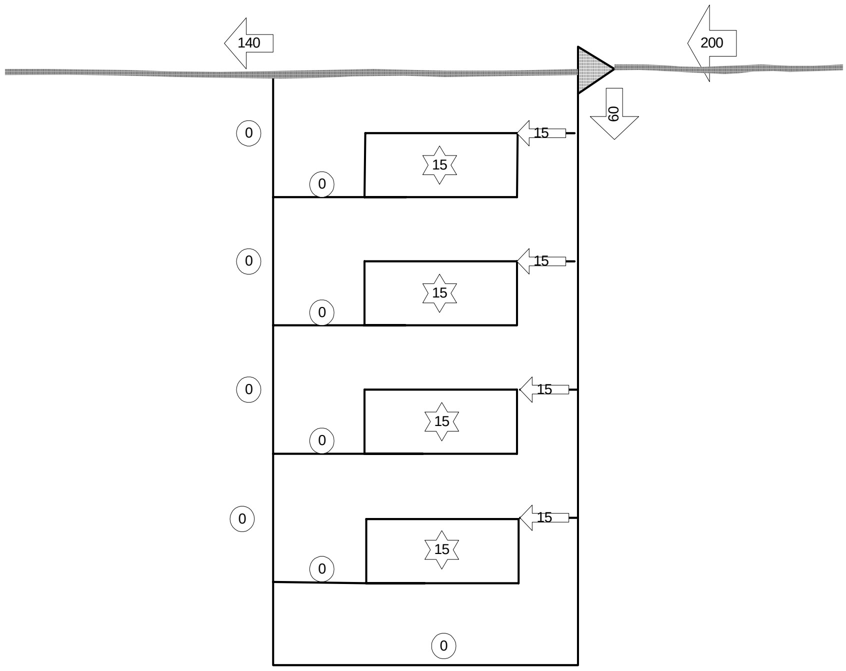

Figure 4: Flows in system when perfect control in water delivery and irrigation water use is attained. No water savings benefit is obtained.

Conceptual difficulties occur when only parts of a system are considered. Outfalls are in fact spillovers. They may be negative spillovers as losses from one part of the system. But they are also positive spillovers providing inflows for the downstream component.

At the basin scale there is basically only one outfall, through the barrages at Goolwa, close to the mouth of the Murray. Calling transfers between jurisdictions "losses" and then aggregating "losses" from each of the *n* jurisdictions introduces an iterative process of nonsensical double counting between jurisdictions all the way down the system.

3.1.1.2 Seepage

Given the interconnectedness of surface and groundwater systems, seepage losses are also spillovers. The prospects for real savings depend on the extent to which seepage is used as a water resource and the time lag between accessions and groundwater pumping.

If seepage is already being recycled by existing groundwater pumps, the only real savings from seepage reduction are reduced operating and maintenance costs for the groundwater pumps.

3.1.1.3 Evaporation

Prospects for real savings depend on opportunities to decrease specific exposure by reducing the surface area exposed to evaporation and/or increasing the water depth of storages. Options include piping open channels and changing system operating rules and decommissioning shallow storages such as Lake Mokoan and Lake Alexandrina (Anon, 2001).

3.1.2 Plant Water Use Efficiency

Given a reasonable standard of management, increased production per unit of water can only be obtained by investing in developing and adopting new production technology. The adoption of higher harvest index semi-dwarf wheats in the 1980s is an outstanding example. Other options include regulated deficit irrigation of peaches and partial root zone drying of winegrapes using drip irrigation technology, amelioration of physical and chemical constraints to soil fertility and development and/or introduction of plant types more suited to the climatic conditions experienced. An example of the latter option would be the replacement of temperate C3 photosynthetic pathway species with more water use efficient sub tropical C4 plants for summer production.

3.2 Economic Efficiency

It is often suggested that because horticulture has high gross margins per megalitre, and modern horticulture can deliver high water use efficiency, that the best policy solution for increasing water use efficiency is to mandate or subsidise horticultural use.

Unfortunately the market reality does not support this policy option (if the objective of policy is to increase net social welfare). Commodity composition is in loose equilibrium with capital markets because the mobility of capital in market economies leads to equal rates of adjusted[2] **net** return in all activities. For commodity composition to change dramatically, extensive changes in demand for irrigated produce is necessary. This may be engendered by trends in global demand (Hooke, 1997) and development of new production technology conferring a comparative advantage to local production. Until then, too rapid expansion into horticulture is a recipe for financial ruin.

4. VALUING WATER SAVINGS

4.1 Market prices

Water markets have been operating for more than a decade (Simon and Anderson, 1990). Average prices for permanent transfer of water right in recent years in a number of irrigation areas is shown in Figure 5. The price dispersion can largely be explained by the expected mid to long run average allocation on different systems, by immediate seasonal allocations prevailing and by other factors such as locational variability in terms of institutional arrangements, prices for inputs and commodities and climate (Colby *et al*, 1993). When these factors are taken into account a price of \$500-\$600 per megalitre of permanent entitlement to annual delivery seems a reasonable estimate of the recent market price of water.

[2] Adjusted for market risk, existence of sunk capital, production uncertainty etc..

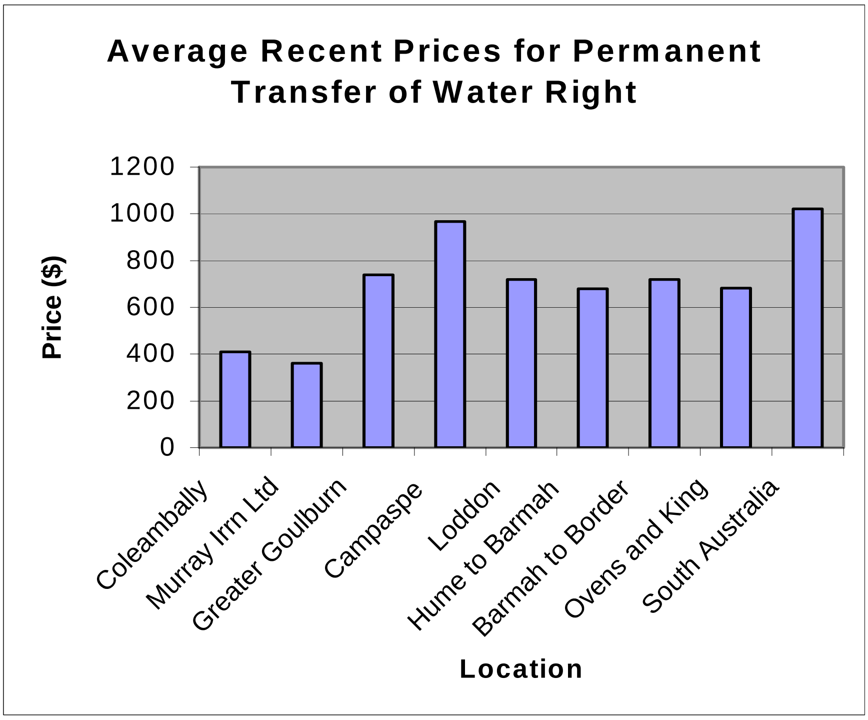

Figure 5: Average recent prices for permanent water right. Because of different allocation policies on different irrigation systems the figure does not indicate the price of permanent entitlement to annual delivery of one megalitre. (Data after Marsden Jacob in ACIL (2002))

4.2 Are Market Prices Appropriate?

Given the existence of contestable water markets, and land and water management plans to manage or tax the external impacts of irrigation, market prices should represent the social value of water at the margin of resources.

Markets facilitate the transfer of rights between willing buyers and willing sellers. Trade occurs when willingness to pay (WTP) at least equals willingness to accept (WTA). Provided buyers and sellers are equally well informed, the equilibrium market price of water will represent the net present value (NPV) of the future stream of benefits flowing from the water entitlement in either use. Buyers and sellers will base their estimate of the value of water on the expected timing and magnitude of the additional production from irrigation using the entitlement, the expected market value of the additional produce, the magnitude and timing of additional costs and the required rate of return on marginal or core capital, whichever is appropriate.

There seems to be some underlying policy apprehension that reluctant sellers are seeking inordinately high rents from speculation. Despite the fact that the use of futures trading to manage risk in agricultural markets relies purely on speculation, some consider it inappropriate to speculate on the value of water. Yet, given the uncertainty inherent in the estimation outlined above, a non-speculative valuation is impossible.

4.3 Reconciling Willingness to Pay and Willingness to Accept

A large part of the commonly perceived gap between the NPV of water in “high” and “low value” uses is due to the inappropriate use of unadjusted gross margins as a means of comparison. The annualised additional capital development costs should first be deducted from the gross margin of the expanding enterprise. This substantially reduces the annual net margin for the “high value” use. The relative present value of the “high value” net margin will be further reduced when discounted at the desired rate of return on marginal capital rather than the low discount rates used for sustainability of core capital advocated by Quiggin (1992).

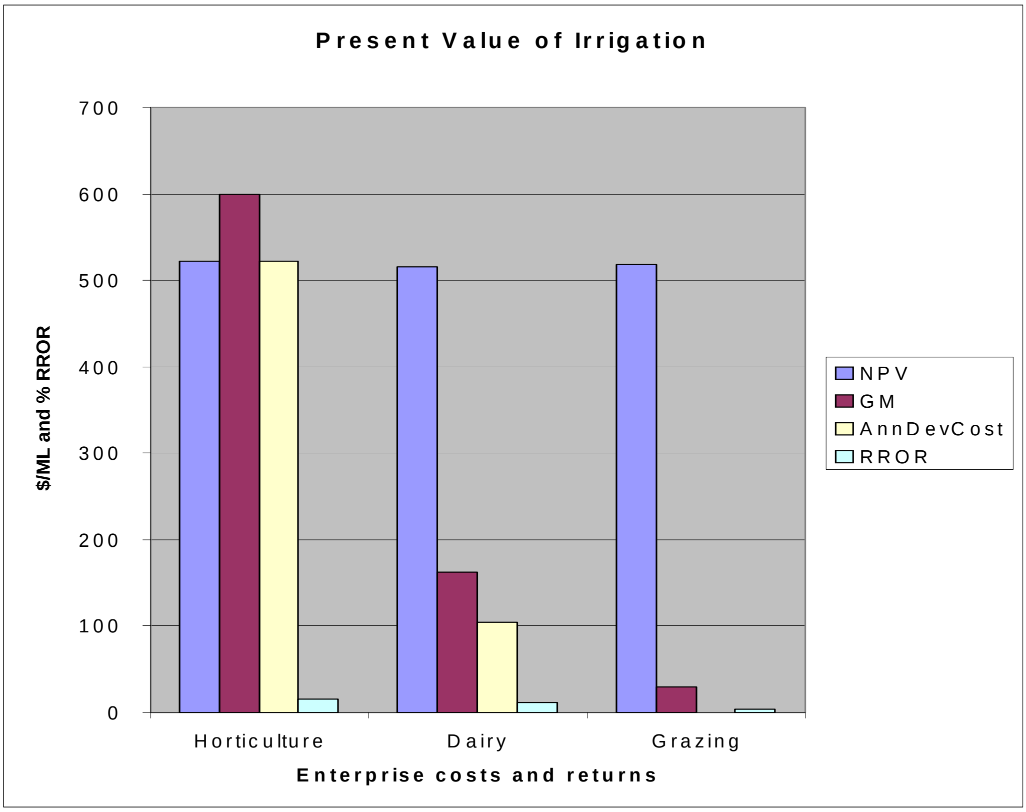

Figure 6: Present value of continuing existing irrigated grazing enterprise or developing new irrigated horticulture or irrigated dairy activities.

Figure 6 shows how inclusion of development costs and risk adjusted discount rates reconciles a large disparity in gross margins between enterprises. In this example, the NPV of irrigated development in horticulture and dairy generating gross margins of $600/ML and $163/ML respectively is much the same as that of an existing irrigated grazing enterprise with a gross margin of $30/ML.

From a regional viewpoint, flow-on economic activity will arise in servicing and processing the additional output of high value commodities. While it is generally accepted (Sinden and Thampapillai, 1995) that these “multiplier” benefits should not be counted from a nation-wide perspective, there may be a case to consider their loss if industry output contracts when water allocations are reduced.

5. ESTIMATING IMPACTS OF REDUCED AGRICULTURAL ALLOCATIONS

As the long run agricultural development costs are already sunk, the present value of the future loss of gross margin should be used to estimate the agricultural opportunity cost of heightened environmental demands. Using recent market prices, the cumulative cost of purchasing water entitlement for the full implementation of the scenarios outlined in Young *et al* (2002) is $1.8 billion. The present value of the cost of the scheduled program of acquisition is $940 million. Given that the market price of water will rise as the supply for consumptive use is restricted, this must be very much an underestimate. Yet this very underestimate is roughly double the estimate made by Young *et al* of $450 million using an economic model for a scenario where there is no adjustment through investment in increased water use efficiency. What is the reason for this extreme discrepancy? Some increases in future environmental flows may be released from storages during seasons of high inflows and low irrigation demand. Depending on inflows and demand in following seasons, this approach may moderate the impact on agricultural output at the margin of regional water resources. The potential for this moderation would tend to disappear at the higher levels of proposed increases in environmental flows. Higher environmental flow regimes may bring some benefits to downstream users through lower salinity levels. But the value of these benefits is relatively minor and comparatively low cost engineering options for salt interception are available. Further, Quiggin (1988) has shown the rational national adjustment to salinity is to move salt sensitive uses upstream.

Surely, if an economic model is to be effective in guiding profitable investment, its structure must entertain all feasible options and its output must reconcile with the reality of market prices.

6. RATIONALE FOR INVESTMENT IN WATER USE EFFICIENCY

Private and public investment should yield increased profit and net social welfare. The corollary of this is that it is foolish to promote a state of higher technical efficiency if the benefits of being there don't exceed the costs of getting there. Thus the appropriate evaluation of proposed intervention should be based on a conventional financial or benefit: cost analysis and its implementation should be driven by cost sharing arrangements recognizing private and public net beneficiaries (Mishan, 1976).

While there is a growing realisation that investment in unprofitable efficiency gains is nonsensical, there is a continued clamour by vested interests for funding of unprofitable projects. In some instances there may be complimentary benefits or other trade-offs to bear in mind which may complicate decision making. These aspects may be made explicit in the benefit:cost analysis but are not central to the issue of identifying real water savings considered here.

The most complicated proposals are for the funding by government of water authorities' projects to reduce outfalls in exchange for increased environmental flows. These arrangements must attenuate the property rights of water entitlement holders. This is so because the net effect on environmental flows is zero as shown in Figure 4. Hence additional water must be released from storage to keep the bargain to increase environmental flows. The additional releases mean allocations to irrigators are reduced. It can be seen as a scheme by water authorities to appropriate and sell part of irrigators' bulk water entitlements. Such schemes promote an opposite view to that of Randall (1981) who advocated that "*The simplest solution, it seems, would be to vest ownership of all tailwaters with the original water title holder*".

Another scheme to reduce water losses is the proposal to improve the accuracy of measurement of water deliveries to farms. The major assumption here is that water deliveries are significantly underestimated. Be that as it may, very little if any real water savings will result from improved measurement of deliveries *per se* because crop water demand will remain unchanged. Given that farm practices and technology remain the same, either the same real volume of water will be delivered to satisfy crop demand or a reduced area of crop will be grown under a limitation imposed by a cap on diversions. In the former case there is no increase in environmental flows and in the latter case increased environmental flows will come at an agricultural opportunity cost in addition to the cost of improved metering.

The much publicised proposals for saving water by piping irrigation delivery systems (West and Walker, 2002) are clearly uneconomic. This is except perhaps for the replacement of open channels in some stock and domestic and some horticultural development schemes where pressurised delivery can reduce pipe costs and assist the adoption of improved irrigation technology. For these schemes the cost of water savings is around $1,300/ML to

$10,000/ML (Marsden Jacob *et al,* 2002) or roughly twice to twenty times the market price. Extensive replacement of open earthen distribution channels with pipelines is even more expensive costing $20,000/ML to $50,000/ML, (Marsden Jacob *et al,* 2002). This is forty to one hundred times more than the market price of water. And, when it is considered that seepage losses are already recovered by groundwater pumps in irrigation areas, the cost of the real physical savings of evaporation is more like eighty to two hundred times more expensive than the market price. On this basis how can the use of government-backed water bonds for superannuation savings to fund pipeline schemes (West and Walker, 2002) possibly be prudent?

6.1 Scope for profitable investment in Water Use Efficiency

As Adam Smith said "*It is the maxim of every prudent master of a family never to attempt to make at home what it will cost him more to make than to buy*." On this basis it would seem difficult to justify investment in water savings projects that cost more than the market price. An estimated supply curve for water savings is shown in Figure 7. A market price of $500/ML is also indicated. The fact that there are no savings identified below the market price and very limited volume is available at the market price indicates the market is well informed and operating efficiently.

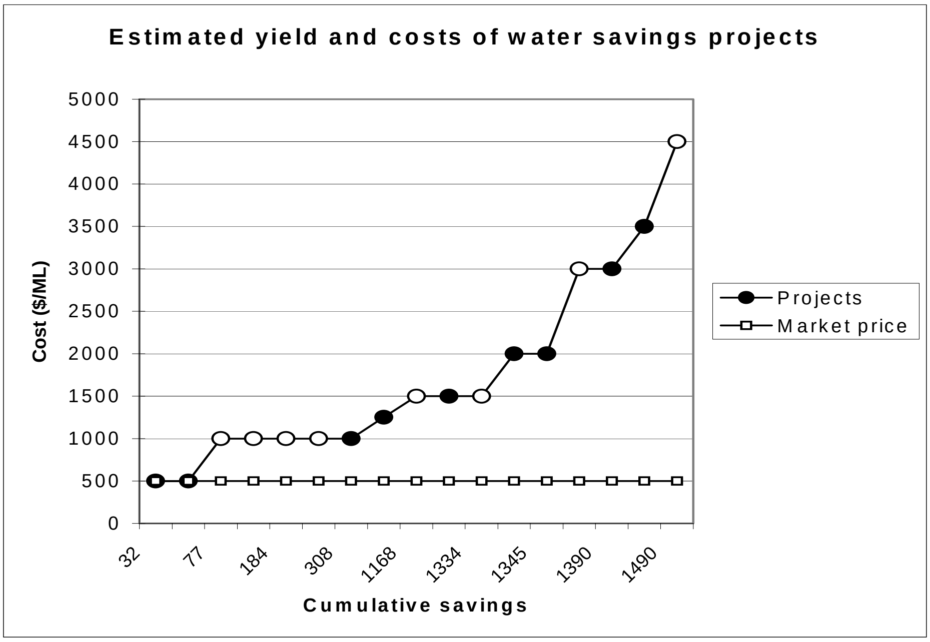

Figure 7: Estimated cost and possible yield of water savings projects. Note that white circles indicate projects where savings are at best dubious, illusory or non-existent. (Data after Marsden Jacob in ACIL (2002) and Anon (2002))

After considering the dubious, illusory or non-existent nature of the water savings claimed for many of the proposed projects (indicated by white circles) Figure 7 shows that the prospects for obtaining high volumes of real water savings at any cost are very limited.

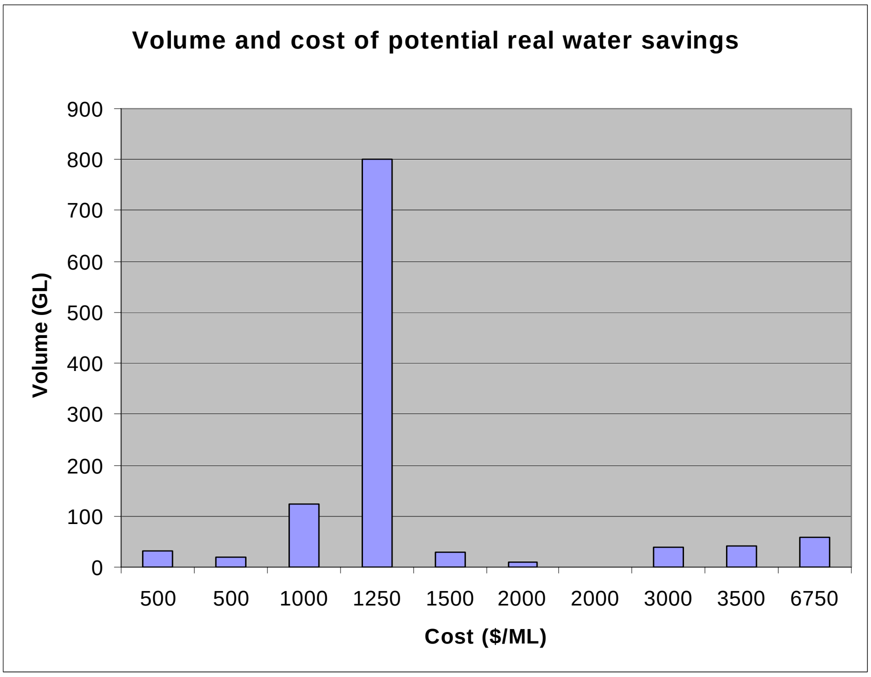

Figure 8: Volume and cost of potential real water savings identified in the connected Murray system

In comparison to the proposed increased volumes for the environment, Figure 8 shows only a couple of projects with significant potential real savings identified in the interconnected Murray system. These are 123 GL for on-farm options and channel sealing in the Murrumbidgee irrigation area (ABARE, 2001) and 800 GL for reduced evaporation losses from Lake Alexandrina and Lake Albert (Anon, 2001). These savings may come at a cost of $1000/ML and $1250/ML respectively.

6.2 Policy Options to Cope with Scarcity

Taking $500/ML as the market price for permanent entitlement to delivery of irrigation water, Figure 7 shows that there are no economical technical solutions to the problem of overuse of water resources by competing uses. Because catchment yield is limited by biophysical factors and the efficiency of use is limited by economic constraints to the adoption of technical solutions, a system of rational allocation is needed if unacceptable levels of degradation are to be avoided (Hardin, 1968). One existing possibility is the water market where "*The economist can imagine circumstances in which, for example, organised groups of recreationists and wildlife enthusiasts would purchase water entitlements and leave them unused to augment, at their own expense, in-stream flows beyond the required minima. Realistically, one would not expect such behaviour to be especially prevalent. But it is hard to conceive of any resource misallocation which would result from its occurrence*" Randall (1981). Indeed, the ACF recently indicated it would not support property rights for water for the environment while it could obtain increased environmental flows more cheaply through the political process (Moss, 2002).

7. DISCUSSION AND CONCLUSION

This examination of the nature of water losses due to inefficiency has outlined basic principles and a detailed analysis should be carried out to evaluate major prospects. But notwithstanding this caveat, the majority of anticipated savings from most projects promoting increased water use efficiency are illusory due to errors in logic and the inability or reluctance of the promoters to view water flows in a systems context.

The indisputable conclusion is that the economical opportunities for real water savings in the connected Murray system can only be measured in hundreds, rather than thousands of gigalitres. Thus increasing environmental flows beyond some hundreds of gigalitres will have nationally significant opportunity costs measured in billions of dollars rather than millions.

To the extent that LWMPs tax and manage the external impacts of irrigation, market prices indicate the social cost of moving water out of agriculture. Little is known of the demand curve for environmental flows but institutional reform properly defining water rights and allowing wider access to the water market would make the derivation of environmental demand an academic exercise.

Market prices indicate the net present value of existing and new irrigated agricultural development opportunities at the margin of regional resources. That governments have indicated willingness to pay double the market price for water savings projects (ACIL, 2002) may indicate either a reluctance to allow an adjustment to policy decisions through the market or an anticipation that market prices will rise dramatically in response to increasing scarcity. This further underscores the prevailing gross underestimation of the agricultural impact of reduced allocations based on some economic modelling.

While there are no currently economical options for greatly increasing water resources in the connected Murray system some may become so as market prices rise in response to reduced allocations for consumptive use. A promising prospect for real increases in effective water resources from reduced evaporation is the decommissioning of Lakes Alexandrina and Albert as irrigation storages (Anon, 2001).

Some very high cost proposals such as pipelining are being promoted on the basis that water savings will be transformed into expertly marketed produce of “high value” far exceeding the cost of water savings. Yet a moment’s reflection will show that, however financially successful such developments may be, the economic value of the water savings can not exceed the least cost alternative source of supply.

Well defined property rights and soundly constructed markets can value and provide that source of supply.

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Don't drain the Murray….

PLUG THE PIPE

LEGAL CHALLENGE CONSIDERED BY ANTI PIPELINE GROUP

The Victorian Government's Controversial North-South Pipeline may yet be subject to further delays as anti pipeline group Plug The Pipe seeks legal advice to stiffen up Environment Minister Garrett's qualifications on his approval of the project.

"We have been vindicated by Minister Garrett's decision to prevent environmental water from projects such as the Living Murray being piped to Melbourne," said Plug The Pipe Spokesperson Jan Beer. "We called the attention of his Department to the fact that Brumby intended to plunder environmental water from water savings intended for the Living Murray Project. This was water intended to prevent the Wetland disasters that are occurring in the Coorong."

"We sent dozens of letters and hundreds of pages of evidence to prevent Garrett ignoring Ramsar Listed Wetlands and Red Gum Forests."

"It is hard to believe but no Victorian Government Environment Department called Peter Garrett's attention to the effects of climate change and the dire state of the Murray. In fact the Victorian Government's Sugarloaf Pipeline Project Advisory Committee said this sort of evidence was irrelevant."

"Now Garrett has left Brumby with a pipeline which will have little or no water in its first years of operation," said Mrs Beer. "Pumping a small amount of water through a billion dollar pipeline will make that water very expensive."

"However we are unhappy that Garret didn't do the commonsense thing and tell Brumby to hold off construction until we see if the Murray-Darling can supply 75 billion litres a year to Melbourne. Instead he has given the go ahead to a project which will either further damage the Murray or leave us with the biggest white elephant in Australia's history."

"Also there are some qualifications such as an audit of water savings which are in his press release but not in his formal decision. The Victorian

Government is unlikely to consider a press release as binding. We have to make Environment Minister Garrett clarify his decision."

"We are exploring all our options including a legal injunction," concluded Mrs Beer.

Contact: Jan Beer 0407 144 777

Water Availability in the Goulburn-Broken

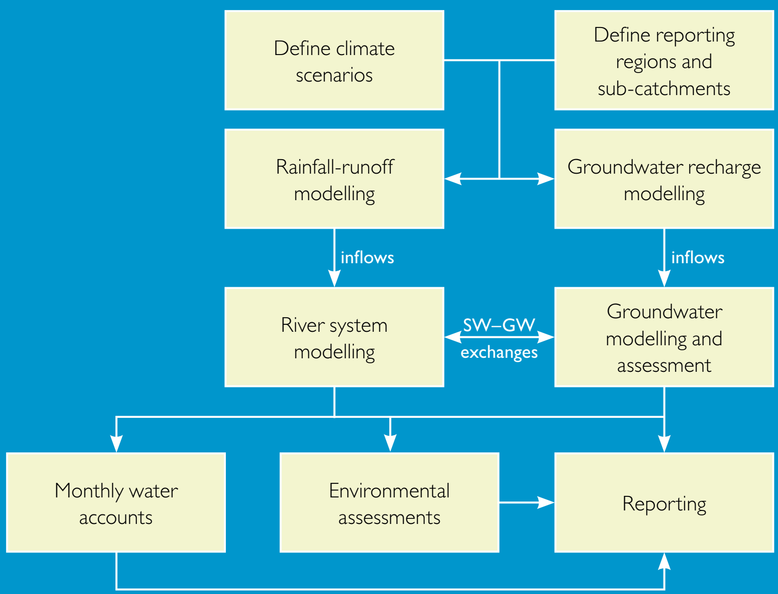
Summary of a report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project

May 2008

www.csiro.au

Project framework

The project framework begins with definition of subcatchments 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 commercial plantation 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 exchange volumes 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.

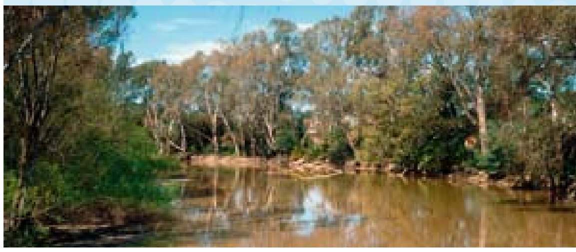


The uncertainty in the assessments is considered from the perspective of 'IF this future' (of climate and development) 'THEN these hydrologic implications'. There is uncertainty in both the 'IF' and the 'THEN'. The uncertainty in the IF is typically large, since the degree of future global warming cannot 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.

> Broken Creek near Nathalia, Vic (CSIRO)



Acknowledgments
Prepared by CSIRO for the Australian Government under the Raising National Water Standards Program of the National Water Commission. Important aspects of the work were undertaken by Sinclair Knight Merz; Resource & Environmental Management Pty Ltd; Department of Water and Energy (New South Wales); Department of Natural Resources and Water (Queensland); Murray-Darling Basin Commission; Department of Water, Land and Biodiversity Conservation (South Australia); Bureau of Rural Sciences; Salient Solutions Australia Pty Ltd; eWater Cooperative Research Centre; University of Melbourne; Webb, McKeown and Associates Pty Ltd; and several individual sub-contractors.

Photos courtesy Goulburn-Broken Catchment Management Authority, Victoria (Goulburn-Broken CMA), CSIRO Land and Water (CSIRO) and the Environment Protection Authority, Victoria (EPA).

> Cover: Dickie Swamp, north of Tungamah, Vic (Goulburn-Broken CMA)

Goulburn-Broken region

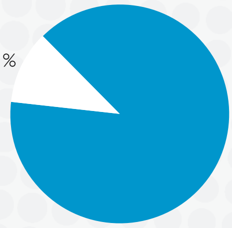
The Goulburn-Broken region is in north-central Victoria and covers 2.1 percent of the total area of the Murray-Darling Basin (MDB). The region is based around the Goulburn and Broken Rivers. The population is 144,000 or 7 percent of the MDB total, concentrated in the centres of Shepparton, Nagambie, Benalla, Kyabram and Tatura. About half the region is devoted to dryland cereal cropping and grazing. Approximately 177,600 ha were irrigated in 2000 including 158,800 ha for pastures and hay and 8,600 ha for orchard production. The lower Goulburn River and floodplain downstream of Loch Garry are listed as nationally important wetlands. The river influences the Ramsar listed Barmah-Millewa Forest and Gunbower Forest wetlands during periods of high flow. The region generates approximately 11 percent of the runoff within the MDB. The region uses around 14 percent of the surface water diverted for irrigation in the MDB and 5.4 percent of the total groundwater used in the MDB.

> Livestock in the region, Vic (Goulburn-Broken CMA)

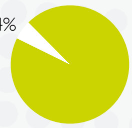
Broad land use in the year 2000

Land use	Area		
	percent		ha
Dryland crops	8.0%		178,000
Dryland pasture	50.2%		1,121,700
Irrigated crops	7.9%		177,600
Cereals		*2.8%*	*4,800*
Cotton		*0.0%*	*-*
Horticulture		*1.8%*	*3,200*
Orchards		*4.8%*	*8,600*
Pasture and hay		*89.4%*	*158,800*
Vine fruits		*1.2%*	*2,200*
Native vegetation	30.7%		685,400
Plantation forests	1.3%		29,600
Urban	0.6%		13,100
Water	1.3%		28,600
Total	**100.0%**		**2,234,000**

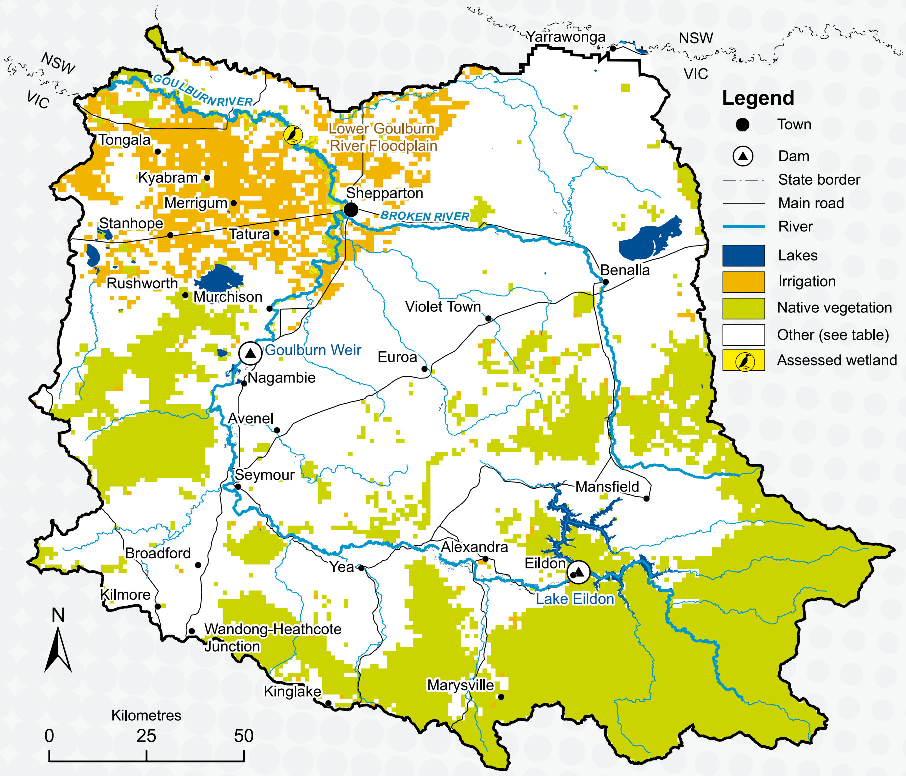
Source: Bureau of Rural Sciences, 2005.



Share of MDB runoff



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



Key findings

- Average surface water availability under the historical climate is 3233 GL/year. At the **current** level of development 1606 GL/year (or 50 percent) of this is diverted for use (including channel and pipe losses and transfers to other regions). This is an extremely high level of use. Groundwater use is 92 GL/year or 10 percent of total water use.
- If the recent (1997 to 2006) climate were to continue, average surface water availability would be reduced by 41 percent and the volume of water diverted for use within the region would be reduced by 25 percent.
- The best estimate **climate change by 2030** would reduce average surface water availability by 14 percent and would reduce the volume of water diverted for use within the region by 6 percent.
- **Future development** of commercial plantation forestry is expected to be negligible. An 8 percent growth in farm dam capacity by 2030 is expected which would have a very minor (less than 1 percent) impact on river inflows. Groundwater extraction is expected to grow by 67 percent by 2030 to become around 16 percent of total water use.

For historical climate and current development

The annual rainfall and runoff averaged over the region is 764 mm and 149 mm, respectively. The current average annual surface water availability for the region is 3233 GL/year. Current average surface water diversions (including water supplied and channel and pipe losses) within the Goulburn-Broken region are 1099 GL/year. A further 507 GL/year is transferred to the Campaspe, Loddon-Avoca and Wimmera regions via the Waranga Western Channel. The relative level of surface water use for the region is defined as the ratio of total surface water diversions (including water transferred to other regions) to water availability. The current relative level of surface water use is extremely high at 50 percent.

Groundwater extraction in the region for 2004/05 is estimated at 92 GL. About 87 percent of this extraction came from the Shepparton Groundwater Management Unit (GMU) (which is a Water Supply Protection Area). Current groundwater extraction is moderate (37 percent of recharge) in the Shepparton and Alexandra GMUs. Much of the pumping from the Shepparton GMU is sourced from reduced groundwater evapotranspiration – a significant fraction of the groundwater is pumped for salinity control and a reduction in evapotranspiration is the intended consequence. Current extraction is low in the other GMUs in the region. Current groundwater use represents 10 percent of total water use on average and 16 percent of total water use in years of lowest surface water diversion. The total average impact of the current level of groundwater use will be an eventual 20 GL/year loss of streamflow to groundwater with most of this occurring by 2010.

Water resources development has increased more than four-fold the average period between large (1000 GL/month) beneficial floods to the lower Goulburn River floodplain. Additionally, undesirably low flows that diminish deep water pools and degrade native fish habitat are now more prevalent – occurring about twice a year on average rather than once every 7 to 8 years under without-development conditions.

For recent climate and current development

The average annual rainfall and runoff over 1997 to 2006 are 15 percent and 41 percent lower respectively than the long-term (1895 to 2006) average values.

If the climate of the last ten years were to continue, average surface water availability would be reduced by 41 percent and end-of-system flow of the Goulburn River downstream of McCoy's Bridge would be reduced by 58 percent. The volume of water diverted for use within the region would be reduced by 25 percent. Transfers to other regions via the Waranga Western Channel would be reduced by 25 percent. The relative level of use for the region would rise to 63 percent.

Under a continuation of the climate of the last ten years, the lower Goulburn River floodplain would cease to receive large flood events leading to serious ecological consequences. This climate would also increase the occurrence of undesirably low flows in the lower Goulburn River which would further degrade the habitat value of the deep pools on the lower Goulburn River, with consequences for endangered fish species.

For future climate and current development

Rainfall-runoff modelling with climate change projections from global climate models indicates that future runoff in the region will decrease significantly. Under the best estimate 2030 climate average annual runoff would be reduced by 13 percent; the extreme estimates range from a 44 to a 2 percent reduction.

Under the best estimate 2030 climate, average surface water availability would be reduced by 14 percent and end-of-system flow downstream of McCoy's Bridge would be reduced by 22 percent. Water diversion for use within the region would decrease by 6 percent. Transfers to regions via the Waranga Western Channel would be reduced by 5 percent. The relative level of use for the region would rise to 54 percent.

Under the wet 2030 climate extreme, average surface water availability would be reduced by 3 percent, water use within the region would be reduced by 1 percent, end-of-system flow of the Goulburn River downstream of McCoy's Bridge would be reduced by 5 percent while the volumes of water transferred out of the region via the Wangara Western Channel would not change. Under the dry 2030 climate extreme, conditions would be slightly more severe than under a continuation of the climate of the last ten years. Water availability would be reduced by 45 percent, water use within the region would be reduced by 29 percent, end-of-system flow of the Goulburn River downstream of McCoy's Bridge would be reduced by 62 percent and the volumes of water transferred out of the region via the Waranga Western Channel would be reduced by 32 percent.

The best estimate 2030 climate would see substantial reductions in the occurrence and volumes of flooding of the lower Goulburn

> Mooroopna Pivot Centre irrigation, Vic (Goulburn-Broken CMA)

River floodplain and the occurrence of undesirably low flows would increase slightly. The dry 2030 climate extreme would lead to similar hydrological changes and ecological consequences as a continuation of the recent climate. The wet 2030 climate extreme would mean little change from current conditions for flooding of the lower Goulburn River floodplain. However, the occurrence of undesirably low flows would increase slightly.

For future climate and future development

Projected growth in commercial forestry plantations is negligible. Farm dam capacity is projected to increase by 8 percent by 2030 leading to a small (less than 1 percent) reduction in runoff over and above the effects of climate change. This minor change would have very little impact on surface water diversions within the region or other components of the regional water balance.

Projected average groundwater extraction by 2030 is 154 GL/year – an increase of 67 percent over current levels. . However, most of this increase is in the Shepparton GMU where much of the extraction is for salinity control and thus may not eventuate, especially if proposed future reductions in irrigation leakage are achieved. Increases in extraction would raise the level of development from low to moderate in the Nagambie and Kinglake GMUs and from moderate to high in the Alexandra GMU. The total eventual impact of groundwater extraction at projected 2030 levels would be an average streamflow reduction of 37 GL/year, and 12 GL/year of this would be due to increases in groundwater extraction outside of the Southern Riverine Plains area.

The projected increase in farm dam capacity and in groundwater extraction would have negligible impact on the environmentally important flooding and low flow regime of the lower Goulburn River.

Limitations

The runoff estimates for the region are relatively accurate because there are many gauged catchments from which to estimate the model parameter values. The largest sources 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.

The river model for the Goulburn-Broken reproduces observed streamflow patterns very well and estimates water balance terms that are similar to the water accounts. The model provides moderately to very strong evidence of changes in flow pattern related to the dry 2030 climate extreme and the best estimate 2030 climate. Evidence for change under the wet 2030 climate extreme is weak to modest. The model provides reasonable to strong evidence of changes in flow pattern related to development in the Goulburn River but not in the Broken River. The changes due to projected development are less than 2 percent of predicted climate changes.

Overall the model is well suited for the purpose of this project. Predictions of changes in low flow patterns are assigned a low level of confidence.

The Southern Riverine Plain groundwater model, developed for this project, was run in a without-development calibration and used to assess the higher priority GMUs. It has been peer-reviewed but has not received widespread scrutiny. Lateral flows from outside the modelled area are small. The grid size is 1000 m, coarser than other groundwater models. The model is assessed as thorough and is adequate for providing information on water availability in the context of this project. It is less reliable for local management requirements. The model reached a dynamic equilibrium under all scenarios.

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.

> Nine Mile Creek at Wunghu, Vic (EPA)

Rainfall and runoff

> Broken Creek at Carlands Bridge, Vic (EPA)

The annual rainfall and modelled runoff averaged over the region are 764 mm and 149 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, particularly in the southern parts, are amongst the highest in the MDB. The region covers 2.1 percent of the MDB area and contributes about 11 percent of the total runoff in the MDB.

The average annual rainfall and runoff over the ten-year period 1997 to 2006 are 15 percent and 41 percent lower respectively than the long-term (1895 to 2006) average values. The recent values are statistically different to the long-term averages.

Rainfall-runoff modelling with climate change projections from global climate models (GCMs) indicates that future runoff in the region will decrease significantly. All the modelling results using climate projections from different GCMs show a decrease in runoff. Under the best estimate 2030 climate average annual runoff would be reduced by 13 percent. The extreme estimates range from a 44 to a 2 percent reduction in average annual runoff.

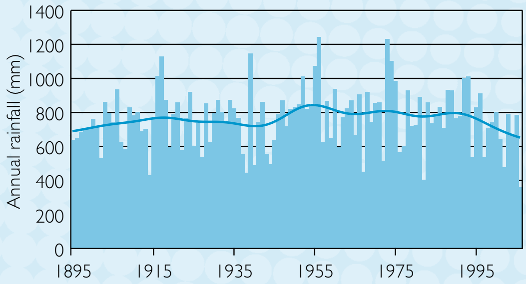
Projected growth in commercial forestry plantations is negligible. The total farm dam storage volume is projected to increase by 8740 ML or 8 percent by 2030. This would reduce average annual runoff by about 0.5 percent. The best estimate of the combined impact of climate change and farm dam development is a 14 percent reduction in average annual runoff. Extreme estimates range from a 44 to a 3 percent reduction.

			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	764	649	-19%	-4%	0%	-19%	-4%	0%
Runoff	149	89	-44%	-13%	-2%	-44%	-14%	-3%
Evapotranspiration	614	561	-12%	-2%	0%	-12%	-1%	1%

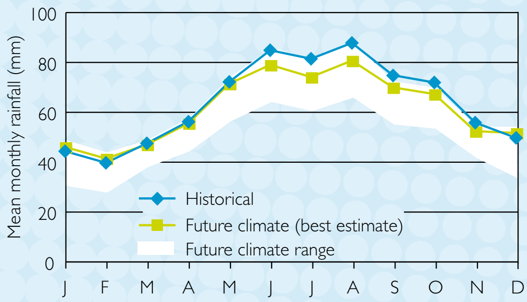
> On Barmah Wetlands, Vic (Goulburn-Broken CMA)

> Black Charlie Creek at Jaes Reserve, Vic (EPA)

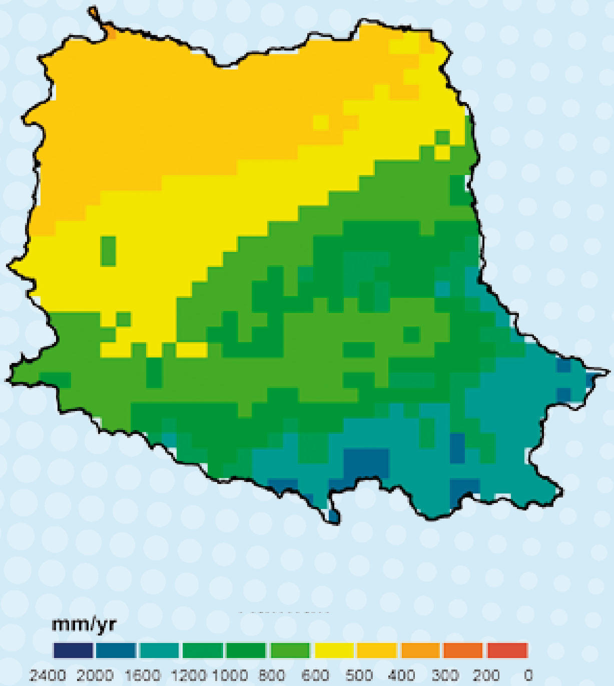
Rainfall



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

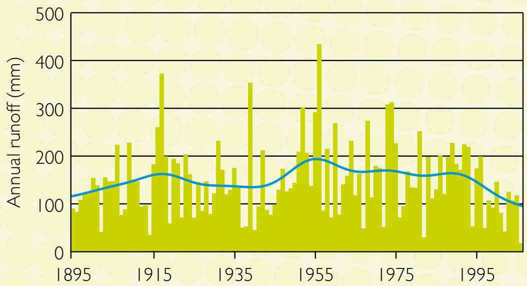


Average (1895–2006) monthly rainfall averaged across the region and range (shaded) of potential changes in mean monthly rainfall due to climate change by 2030.

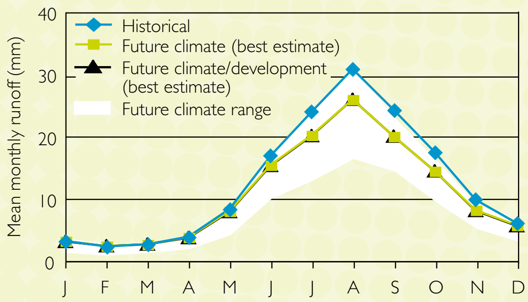


Average (1895–2006) annual rainfall (mm) distribution (based on SILO data).

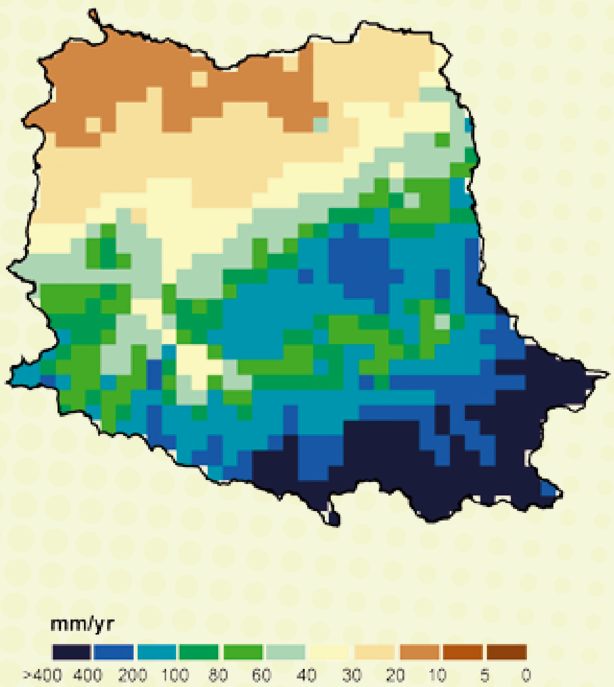
Runoff



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.



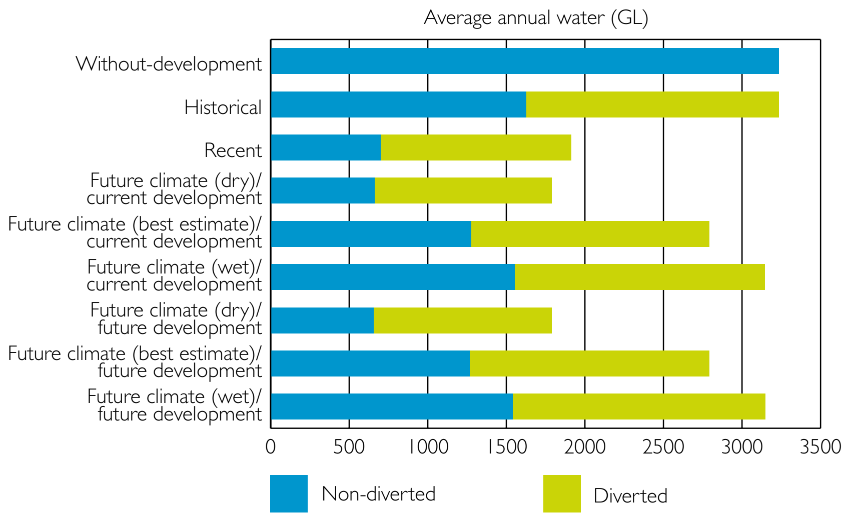
Average (1895–2006) annual runoff (mm) distribution (based on daily runoff modelling).

Surface water

The current average annual surface water availability for the region is 3233 GL/year. Current average surface water diversions (including water supplied and channel and pipe losses) within the Goulburn-Broken region are 1099 GL/year. A further 507 GL/year is transferred to the Campaspe, Loddon-Avoca and Wimmera regions via the Waranga Western Channel. The relative level of surface water use for the region is defined as the ratio of total surface water diversions (including water transferred to other regions) to water availability. The current relative level of surface water use is extremely high at 50 percent.

Reliability of supply is determined separately for high reliability water shares (HRWS) and low reliability water shares (LRWS) and is reported for allocations in February. In the regulated Goulburn system, a 100 percent HRWS allocation occurs in 97 percent of years and the minimum HRWS allocation is 73 percent. A 100 percent LRWS allocation occurs in 42 percent of years and a zero LRWS allocation occurs in 24 percent of years. In the regulated Broken system, a 100 percent HRWS allocation occurs in 88 percent of years and the minimum HRWS allocation is 1 percent. A 100 percent LRWS allocation occurs in 84 percent of years and a zero LRWS allocation occurs in 11 percent of years.

If the climate of the last ten years were to continue, average surface water availability would be reduced by 41 percent and end-of-system flow of the Goulburn River downstream of McCoy's Bridge would be reduced by 58 percent. The volume of water diverted for use within the region would be reduced by 25 percent. In the regulated Goulburn system, a 100 percent HRWS allocation would occur in 49 percent of years and the minimum HRWS allocation would be 8 percent. A 100 percent LRWS allocation would occur in 2 percent of years and a zero LRWS allocation would occur in 88 percent of years. In the regulated Broken system, a 100 percent HRWS allocation would occur in 52 percent of years and the minimum HRWS allocation would be 1 percent. A 100 percent LRWS allocation would occur in 48 percent of years and a zero LRWS allocation would occur in 47 percent of years. Transfers to other regions via the Waranga Western Channel would be reduced by 25 percent. The



> Lower Goulburn River at Toolamba, Vic (EPA)

relative level of use for the region would rise to 63 percent.

Under the best estimate 2030 climate, average surface water availability would be reduced by 14 percent and end-of-system flow of the Goulburn River downstream of McCoy's Bridge would be reduced by 22 percent. Water diversion for use within the region would decrease by 5 percent. In the regulated Goulburn system, a 100 percent HRWS allocation would occur in 87 percent of years and the minimum HRWS allocation would be 29 percent. A 100 percent LRWS allocation would occur in 21 percent of years and a zero LRWS allocation would occur in 36 percent of years. In the regulated Broken system, a 100 percent HRWS allocation would occur in 83 percent of years and the minimum HRWS allocation would be 1 percent. A 100 percent LRWS allocation would occur in 79 percent of years and a zero LRWS allocation would occur in 17 percent of years. Transfers to regions via the Waranga Western Channel would be reduced by 5 percent. The relative level of use for the region would rise to 54 percent.

Under the wet 2030 climate extreme, average surface water availability would be reduced by 3 percent. Overall, there would be little impact on the volume of water diverted for use or on the reliability of supply. However, Goulburn River outflows downstream of McCoy's Bridge would be reduced by 5 percent. Under the dry extreme 2030 climate, conditions would be slightly more severe than under a continuation of the climate of the last ten years. Water availability would be reduced by 45 percent, water use within the region would be reduced by 29 percent, end-of-system flow of the Goulburn River downstream of McCoy's Bridge would be reduced by 62 percent and the volumes of water transferred out of the region via the Waranga Western Channel would be reduced by 32 percent. Reliability of supply would be similar to a continuation of the recent climate for the Broken system but would be substantially worse for the Goulburn system. For example, in the Goulburn system a 100 percent HRWS allocation would occur in 33 percent of years and the minimum HRWS allocation would be 5 percent.

Projected future development of small farm dams and increases in groundwater extraction would have minor impacts on streamflow and surface water use.

> Fruit trees in the region (Goulburn-Broken CMA)

> Winton Swamp, Vic (Goulburn-Broken CMA)

	Historical	Recent	Future climate					
			Current development			Future development		
	1895–2006	1997–2006	Dry	Best estimate	Wet	Dry	Best estimate	Wet
Water availability	GL/y	percent change from Historical						
Total inflows	–	-40%	-44%	-13%	-3%	-45%	-14%	-3%
Total surface water availability	3233.1	-41%	-45%	-14%	-3%	-45%	-14%	-3%
End-of-system flow downstream of McCoy's Bridge	1585.2	-58%	-62%	-22%	-5%	-62%	-23%	-6%
Water use								
Lowest 1-year period	496.6	-84%	-89%	-54%	-22%	-88%	-56%	-24%
Lowest 3-year period	601.8	-52%	-60%	-19%	-6%	-60%	-19%	-6%
Lowest 5-year period	622.5	-48%	-56%	-17%	-3%	-56%	-18%	-4%
Average	790.5	-28%	-34%	-6%	-1%	-34%	-7%	-1%
Non-diverted water								
	percent							
Non-diverted water as a percentage of total available water	50%	37%	37%	46%	49%	37%	45%	49%
Non-diverted share relative to historical non-diverted share	100%	43%	41%	78%	95%	40%	78%	95%

Groundwater

Groundwater extraction in the Goulburn-Broken region for 2004/05 is estimated to be 92 GL. This represents 5.4 percent of groundwater use in the MDB. About 87 percent of this extraction came from the Shepparton GMU (which is a Water Supply Protection Area). This level of use represents 10 percent of current total water use on average and 16 percent in years of lowest surface water use.

Surface–groundwater connectivity mapping indicates that the Goulburn River is gaining along most of its length, but losing over two small sections – upstream of the Goulburn Weir and downstream of Loch Garry. Broken Creek is losing at a moderate rate over most of its length. The Broken River is considered to be gaining at a high rate downstream of Orrvale.

Current groundwater extraction is at a moderate (37 percent of recharge) level of development in the modelled Shepparton GMU and in the unmodelled Alexandra GMU. Current extraction is low in the modelled Kialla, Nagambie and Goorambat GMUs and in the unmodelled Kinglake GMU. Much of the pumping from the Shepparton GMU is sourced from reduced groundwater evapotranspiration – a significant fraction of the groundwater is pumped for salinity control and a reduction in evapotranspiration is the intended consequence.

Historical groundwater extraction has and will continue to impact on streamflow in the rivers of the region. The total average impact will be an eventual loss of streamflow to groundwater of 20 GL/year with most of this occurring by 2010. Nearly 15 GL/year of this impact is associated with extraction from the modelled Southern Riverine Plains area, and the remainder is associated with extraction from unmodelled GMUs.

The projected average groundwater extraction by 2030 is 154 GL/year. This is an increase of 67 percent over current levels. Most of the increase in groundwater extraction is expected to occur in the Shepparton GMU where extraction (under the best estimate 2030 climate) would then be 64 percent of recharge.

Projected average groundwater extraction by 2030 would raise the level of development in the modelled Nagambie GMU and in the unmodelled Kinglake GMU from low to moderate. Extraction from the modelled Kialla and Goorambat GMUs would remain at low levels, while extraction from the unmodelled Alexandra GMU would increase to a high level.

The total eventual impact of groundwater extraction at projected 2030 levels would be an average streamflow reduction of 37 GL/year and 12 GL/year of this would be due to groundwater extraction outside of the modelled Southern Riverine Plains area.

Code	Name	Priority	Total entitlement	Current extraction(1) (2004/05)	Permissible consumptive volume	Estimated use (2030)
			GL/y			
V11	Alexandra GMU	low	1.71	0.7	0.9	1.52
V12	Kinglake GMU(2)	very low	1.49	1.05	3.8	1.74
V38	Goorambat GMU	very low	1.54	0.48	4.9	0.852
V40	Kialla GMU	low	2.33	0.86	4.8	0.854
V41	Nagambie GMU	low	6.65	4.55	5.7	4.55
V43	Shepparton GMU(3)	medium	203.6	80.65	none set	136.6
-	Unincorporated areas(4)	-	7.87	3.9	none set	8.23

(1) Current extraction volumes have been supplied by the Victorian Department of Sustainability and Environment, and include estimates of stock and domestic use of 0.10 GL/year for Alexandra, 0.53 GL/year for Kinglake, 0.03 GL/year for Goorambat, 0.05 GL/year for Kialla, 0.14 GL/year Nagambie, and 0.83 GL/year for Shepparton GMUs and 0.36 GL/year for unincorporated areas.
(2) Approximately 78% of the Kinglake GMU falls within the Goulburn Basin. Groundwater entitlements and use are for this portion of the GMU only as the remainder lies outside the MDB.
(3) Approximately 80% of the Shepparton WSPA is contained within the Goulburn-Broken reporting region. Entitlement and Extraction values are reported for the whole GMU.
(4) Unincorporated areas are those areas not covered by GMUs. These figures relate to those areas in the upper part of the catchment with fair groundwater quality (<1500 mg/L total dissolved solids).

Water resources development has increased more than four-fold the average period between large (1000 GL/month) beneficial floods to the lower Goulburn River floodplain. Additionally, undesirably low flows that diminish deep water pools and degrade native fish habitat are now more prevalent – occurring about twice a year on average rather than once every 7 to 8 years.

A continuation of the recent climate (1997 to 2006) would mean that large flood events for the lower Goulburn River floodplain would cease with serious ecological consequences. This climate would also increase the occurrence of undesirably low flows, which would further degrade the habitat value of the deep pools on the lower Goulburn River, with likely consequences for endangered fish species.

The best estimate 2030 climate would see substantial reductions in the occurrence and volumes of high flows to the lower Goulburn River floodplain. The occurrence of undesirably low flows would increase slightly.

The dry 2030 climate extreme would lead to similar hydrological changes and ecological consequences as a continuation of the recent climate.

The wet 2030 climate extreme would not lead to much change from current conditions for flooding of the lower Goulburn River floodplain. However, the occurrence of undesirably low flows would increase slightly compared to current conditions.

Additional catchment development (farm dams and groundwater extraction) would have minimal impact over and above the impacts of climate change described above.

Lower Goulburn River Floodplain

Parts of the lower Goulburn River floodplain are listed as a nationally important wetland (VIC052) with the nominated area covering some 13,000 ha downstream of Goulburn Weir to the Murray River junction.

The wetland consists of a large number of billabongs, anabranches and marginal swamps and includes Gemmill's Swamp, Reedy Swamp State Wildlife Refuges and Loch Garry Wildlife Management Cooperative Area. The floodplain receives water from the Goulburn River via diversions from Goulburn Weir and from a number of effluent channels.

The wetland vegetation is dominated by River Red Gum forest and woodland and more limited areas of Grey Box, Yellow Box, White Box and Black Box. Other flora includes a range of threatened species. A large number of faunal species are recorded, including 34 waterbird species recorded in Gemmill's Swamp. Over 1000 Ibis are recorded regularly at Reedy Swamp. Threatened species that are recorded include Magpie Geese, Bush Thick-knee and Superb Parrot. The floodplain is used extensively for recreation due to the public land areas. Land tenure is mostly State Forest but also the Wildlife Refuges and Management Cooperative Area listed above.

Lower Goulburn River

This area extends from Loch Garry to the confluence with the Murray River and, as indicated above, is a wetland of national importance. It has a range of environmental values including providing habitat for eleven species of native fish: Silver Perch, River Blackfish, Flat-headed Galaxias, Western Carp Gudgeon, Trout Cod, Murray Cod, Golden Perch, Murray Rainbowfish, Flat-headed Gudgeon, Australian Smelt and Freshwater Catfish. Introduced species such as Carp are also found in the area.

	Without development	Historical 1895–2006	Recent 1997–2006	Future climate					
				Current development			Future development		
				Dry	Best estimate	Wet	Dry	Best estimate	Wet
	years		percent change from Historical						
Lower Goulburn River floodplain									
Average period between flooding(2)	2.5	10.7	(1)ne	ne	82%	0%	ne	82%	0%
Maximum period between flooding(3)	11	37	ne	ne	4%	0%	ne	4%	0%
	GL								
Average period between flood events(4)	2056	2950	ne	ne	-32%	-17%	ne	-32%	-17%
Average flooding volume per year(5)	722	239	ne	ne	-62%	-17%	ne	-62%	-17%
Lower Goulburn River									
Average period between low flows(6)	7.6	0.47	-36%	-39%	-13%	-3%	-39%	-13%	-2%
Maximum period between low flows(7)	37.7	1.67	-40%	-20%	-20%	-15%	-20%	-20%	-15%

(1) ne – no events
(2) Average period (years) between flows greater than 1000 GL/month June to November at McCoy's Bridge gauge
(3) Maximum period (years) between flows greater than 1000 GL/month June to November at McCoy's Bridge gauge
(4) Average flow volume per event above 1000 GL/month June to November at McCoy's Bridge gauge
(5) Average flow volume per year above 1000 GL/month June to November at McCoy's Bridge gauge
(6) Average period (years) for which flow is continuously above 18.3 GL/month at Goulburn Weir
(7) Maximum period (years) for which flow is continuously above 18.3 GL/month at Goulburn Weir

About the project

The CSIRO Murray-Darling Basin Sustainable Yields Project resulted from the Summit on the Southern Murray-Darling Basin, 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 Murray-Darling Basin (MDB) on an individual catchment and aquifer basis taking into account climate change and other risks. The project will report progressively to mid-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 are being 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 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 Basincan 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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Sustainable Rivers Audit

MURRAY-DARLING BASIN COMMISSION

FACT SHEET:

SUSTAINABLE RIVERS AUDIT - REPORT 1, MAY 2008

The Sustainable Rivers Audit (SRA) is an initiative of the Murray–Darling Basin Commission, supported by the governments of the five Basin states and territory and the Australian Government.

Its first report, released in June 2008, presents "report cards" on river ecosystem health for each of the 23 valleys in the Basin. The reports are based on observations of fish, macroinvertebrates and hydrology from 2004 to 2007.

The audit is overseen and the report written by an independent group of river ecologists, the Independent Sustainable Rivers Audit Group (ISRAG). The group comprises Dr Peter Davies (Chairman), Dr John Harris, Dr Terry Hillman, Associate Professor Keith Walker.

This fact sheet presents the main findings from SRA Report 1: A Report on the Ecological Health of Rivers in the Murray–Darling Basin, 2004–2007. It also outlines the nature of the Audit and the ways that environmental data is used to assess ecosystem health.

How the audit works

The audit gathers quantitative information on environmental indicators in valleys throughout the Basin. The indicators provide 'windows' on particular components of the river ecosystems, and are grouped in the following themes:

- fish;
- macroinvertebrates; and
- hydrology.

Two more themes, vegetation and physical form, will be added to the next report, due in 2011.

Future reports will also describe trends, showing how river ecosystem health changes from one Audit to the next, and over longer periods of time.

The data is gathered systematically using agreed protocols, with quality assurance.

Within each Valley there are one to four zones, defined in most cases by altitude. Sampling sites are located randomly within zones, to enable unbiased statistical analyses and representative reporting.

The indicators are combined to form quantitative measures of 'condition' for each theme, and theme condition ratings are combined to assess ecosystem health.

Condition assessments for each valley are related to a benchmark called 'reference condition'. This estimates the status of a component (for example, the fish community) as it would be if there had not been any significant human intervention in the landscape.

Reference condition is a benchmark representing the river ecosystem in good health, but is not a target for management.

Condition is rated on a five-point scale from good to moderate, poor, very poor to extremely poor, depending on how different the theme components are from their respective benchmarks. The same scale is applied to ecosystem health.

MAIN FINDINGS OF THE AUDIT

While the continuing record drought limited the availability of sampling sites in some valleys, it is too soon to say how much the drought has affected fish and macroinvertebrate communities.

Assessments of condition and ecosystem health for each of the 23 Valleys in the Basin are shown in the table below.

Rank	Valley	Ecosystem	Fish	Macro-invertebrates	Hydrology
1	Paroo	Good	Moderate	Moderate	Good
2	Border Rivers	Moderate	Moderate	Moderate	Moderate to Good
2	Condamine	Moderate	Moderate	Poor	Moderate to Good
3	Namoi	Poor	Poor	Poor	Good
3	Ovens	Poor	Poor	Poor	Good
3	Warrego	Poor	Poor	Poor	Good
4	Gwydir	Poor	Poor	Poor	Moderate to Good
5	Darling	Poor	Poor	Poor	Poor
5	Murray, Lower	Poor	Poor	Poor	Poor
5	Murray, Central	Poor	Poor	Poor	Moderate
6	Murray, Upper	Very Poor	Extremely Poor	Moderate	Moderate to Good
6	Wimmera	Very Poor	Poor	Very Poor	Poor
7	Avoca	Very Poor	Poor	Very Poor	Moderate to Good
7	Broken	Very Poor	Very Poor	Poor	Moderate to Good
7	Macquarie	Very Poor	Very Poor	Poor	Moderate to Good
8	Campaspe	Very Poor	Extremely Poor	Poor	Moderate
8	Castlereagh	Very Poor	Extremely Poor	Poor	Good
8	Kiewa	Very Poor	Very Poor	Poor	Good
8	Lachlan	Very Poor	Extremely Poor	Poor	Moderate to Good
8	Loddon	Very Poor	Extremely Poor	Poor	Moderate
8	Mitta Mitta	Very Poor	Extremely Poor	Poor	Good
9	Goulburn	Very Poor	Extremely Poor	Poor	Poor
9	Murrumbidgee	Very Poor	Extremely Poor	Poor	Poor to Moderate

CONDITION OF FISH

Fish sampling at 487 sites yielded more than 60,600 individuals in 38 species, weighing more than 4 tonnes.

Twenty eight of these were native, many of them small species, contributing 57% of individuals but only 32% of biomass. All fish were returned to the water after measurement (except for pest species in some States).

Fish communities in the Paroo, Condamine and Border Rivers Valleys were in moderate condition, those in eight other Valleys were in extremely poor condition.

Those in the remaining Valleys were in poor or very poor condition. Communities in the northern Basin generally were in better condition than those in the southern Basin.

Native fish numbers dominated in the Lower and Central Murray, Paroo and Warrego Valleys, and by biomass in the Paroo (78%), Darling (62%) and Borders River Valleys (60%).

Golden perch were recorded in 21 of 23 Valleys, and murray cod, freshwater catfish and silver perch were in 16, 7 and 5 valleys, respectively.

Alien species rivalled or outnumbered native fish in nine of the 23 valleys, especially the Campaspe, Gwydir, Macquarie and Murrumbidgee valleys. Three alien species, carp, eastern gambusia and goldfish, were present in all rivers, and redfin perch, brown trout and rainbow trout were also widespread.

Carp were overwhelmingly dominant, being 87% of alien fish biomass and 58% of total fish biomass. In other words, carp accounted for nearly six of every 10 kilograms of fish in the Basin.

Native species were found in only 43% of valley zones where they were predicted to occur under benchmark conditions.

The Darling Valley had the highest biomass of alien and native fish (16.8 kg/site), and the highest biomass of native species (10 kg/site). The Central Murray Valley was next most productive. The Paroo Valley was least productive, yielding 0.75 kg/site of alien and native biomass, although 78% of this was native fish.

MACROINVERTEBRATES

Macroinvertebrate samples taken from 773 sites included more than 209,100 specimens of macroinvertebrates (invertebrates visible to the naked eye) in 124 families.

They include leeches and worms, shrimps, snails, beetles, bugs and the young stages of dragonflies, midges and other insects.

Two indicators based on the presence of families and the composition of communities (but not on estimates of abundance), were combined as the Sustainable Rivers Macroinvertebrate Index.

Macroinvertebrate communities in the Border Rivers, Upper Murray and Paroo Valleys were in moderate condition, and those in the Avoca and Wimmera Valleys were in very poor condition. The remaining valleys were in poor condition.

Twenty three families were recorded in all 23 valleys. A number of families were rare, including 14 that were recorded at only one site each. The common families include many species tolerant to pollution and other human disturbances, and the rare ones contain sensitive species.

In general, the communities of valleys in the northern Basin were in better condition than those in the southern Basin. In addition, upland zone communities generally were in better condition than those in lowland Zones

HYDROLOGICAL CONDITION OF VALLEYS

Data was collected and analysed for 468 sites. For each site, five indicator values were calculated, representing changes in the flow regime due to human intervention.

One third of all Valleys were rated to be in good hydrological condition, and another third were in moderate to good condition. Many of the sites in poor condition were in the lowland zones of the major rivers.

The reference condition for hydrology (the benchmark) was designed to include wet and dry periods.   Condition assessments therefore, reflect the overall effects of the current level of development and water use within the Basin on the historical flow regime rather than that of the recent drought.

ECOSYSTEM HEALTH

Of the 23 valley studied, only the Paroo Valley was rated to be in good health.

The Border Rivers and Condamine Valleys were rated in moderate health. Seven other valleys were in poor health and 13 were in very poor health. No valley was rated in extremely poor health.

Of 62 zones in 23 valleys, two are in good health, eleven are in moderate health and the remaining 46 are in either poor health (19 zones) or very poor health (27 zones). Nine of 13 upland zones were in very poor or extremely poor health.

Valleys in the northern Basin generally were in better health than those in the south.

Two of nine northern valleys were rated in very poor health, compared to nine of 14 southern Valleys. The three valleys rated in moderate or good health were in the northern Basin.

PROGRESS AND PROSPECTS

The Sustainable Rivers Audit is developing into an effective tool for surveillance of the Basin's river ecosystems. Existing indicators and reference condition will be refined and future reports will describe trends in condition and health.

Sampling procedures in the fish and macroinvertebrate themes will be refined to improve consistency between agencies. Methods used for the hydrology theme will also be streamlined.

The scope of the audit will be expanded by the addition of themes for vegetation and physical form, including floodplain environments. Both are at an advanced stage of development and will be included in the next report.

The audit could also be expanded to include floodplain and terminal wetlands, including those declared as Wetlands of International Importance under the Ramsar Convention and icon sites in The Living Murray initiative.

FURTHER INFORMATION

A copy of the SRA Report 1: A Report on the Ecological Health of Rivers in the Murray–Darling Basin, 2004–2007 is available on ther MDBC website: www.mdbc.gov.au

First published - June 2008

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Allocations - Goulburn-Murray Water

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How do seasonal allocations work?

Allocations Remain at 0% Across Northern Victoria

Announcement Date:1 Sep 2008
Next Announcement Due:15 Sep 2008

Allocation Data

The seasonal allocations for Goulburn-Murray Water customers on 1 Sep 2008 are

	High Availability Water Share	Change to High Availability Water Share	Comments
Murray	0%	0%	-
Broken	0%	0%	-
Goulburn	0%	0%	-
Campaspe	0%	0%	-
Loddon	0%	0%	-
Bullarook Creek	0%	0%	-

Further Information

All of the regulated water systems in northern Victoria remained at 0% allocation today as Goulburn-Murray Water (G-MW) released its latest allocation announcement.

"The shortfalls to meeting our operating requirements are reducing, although inflow rates have slowed with the lack of consistent rain since our 15 August announcement," said G-MW Managing Director David Stewart.

Mr Stewart noted that the shortfalls to irrigation allocations in the Murray and Goulburn systems have reduced to 31 gigalitres (GL) and 29 GL respectively. "The two larger systems often receive some useful inflow even under conditions such as those currently occurring in our catchments," said Mr Stewart. "However, inflows in the smaller Broken, Campaspe, Loddon and Bullarook Creek systems tend to drop away quickly without good rains."

G-MW has secured qualified essential needs and carryover in each of its regulated water systems. Delivery of domestic and stock water and some carryover is available in the Murray and Goulburn systems throughout the year. However, significant inflows are needed for the Broken, Campaspe, Loddon and Bullarook Creek systems to resume normal system operations.

Access to Carryover

"G-MW will be working very hard to deliver carryover water where this can be done without incurring excessively high water losses," said Mr Stewart. "Not all channels will be operating all of the time, and those that are will be operating at lower levels than usual. This means that it will not be possible to meet every order on demand."

Customer access to carryover water will be dependent on timing, location and the volume ordered. Orders in the channel systems may have to be grouped to maximise the water available and to minimise operating losses. Access to carryover

delivery will improve as the resource position improves.
River diversion customers in the regulated Murray and Goulburn systems can place orders for delivery of carryover at any time. Limited access to carryover is available to customers in the pumped districts of the Murray system in accordance with the operating schedules prepared by the water corporations. Customers in the other river delivery systems need to discuss their delivery requirements with their Diversion Inspector.
Seasonal allocation outlooks were not updated with this allocation announcement and will next be issued on 15 September 2008. The current inflow trend across all systems is ‘dry', with significant rainfall and inflows needed to improve the outlook for the rest of the season.

Qualification of Rights

The Minister for Water has qualified rights to water to allow supplies for essential needs under the extreme conditions currently affecting northern Victorian water systems. Further details of the qualifications are available from G-MW's website, newsletters and advertisements in local media.