MANAGING THE MURRAY-DARLING RIVERS

FOR ENVIRONMENTAL USES

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Executive Summary

Australia is a federation of sovereign states, which under the Constitution of 1901 have full powers over their own water resources. Through representative Councils of Ministers, a national set of guidelines for provision of water for ecosystems has been adopted. Some of the most developed rivers in Australia lie within the Murray-Darling Basin, which includes parts of four States plus the Australian Capital Territory. Some 70 percent of the country's irrigation takes place in the Basin and the need for environmental flows is undisputed. The paper describes the Australian approach to environmental flows in rivers through illustrative case studies within the Basin. It details State environmental flow management processes, and gives examples of principles that have been developed, together with examples of specific environmental allocations. The paper then describes a recent successful inter-state process for balancing environmental water needs, flood mitigation and water supply for irrigation. This community-based process was managed by the Murray-Darling Basin Commission as part of its role in coordinating natural resource management of the Basin States for mutual benefit. The paper draws some conclusions about factors for success, based on the premise that the nature of sustainability is a matter that, among other things, requires community debate and agreement.

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1. Introduction

The very title of this paper may be provocative to some environmental interests, who might well propose that it should properly read, '*Managing the Murray-Darling Rivers to Mitigate the Environmental Impacts of Extractive Uses*'. Without debating the merits of one point of view or another, an important issue that emerges is that rivers should be managed in ways that meet an agreed mix of all interests.

This paper is written from the point of view of a resource manager – one who must strive to find, and then to meet, some agreed mix of the primary competing objectives: Environmental; Economic; and Social. We often use that modern term 'sustainability' to express this mix, but a real world practitioner in resource management quickly finds that sustainability is a loose concept that can mean whatever a community decides that it means. It does not necessarily prescribe high levels of environmental health within the mix.

However, this paper is not about the nature of sustainability. That has been well debated elsewhere, and there are many examples of "Statements" and "Principles" to refer to. What is important here is to realise that in order to manage resources within a basin it is first necessary to have a means of agreeing on what acceptable sustainability looks like for that basin. Natural systems tend to move towards equilibrium, but not always with an end result we find acceptable. (A sewer is a sustainable ecosystem, but you would not choose to live there.)

This paper describes how Australia, and the Murray-Darling Basin in particular, is going about determining the environmental component of the agreed mix when managing rivers. Its primary

conclusion is that, at the end of the day, this determination cannot be separated from the community processes of agreement.

The Commonwealth of Australia is actually a Federation of sovereign States, which under the Constitution of 1901 have retained all rights over their water resources. Whilst it took until 1915 to reach agreement on water sharing of the transboundary Murray River, the States were already seeking economic growth through 'greening the desert', or as some termed it, 'turning water into gold', and an era of irrigation development ensued, reminiscent of that in Western U.S. As elsewhere in the world, this development took place with scant regard to the consequences for river health.

2. The Murray-Darling Basin – An Overview

Australia is an ancient island continent. It is dominated by arid and semi-arid landscapes, but also has narrow tropical bands on its eastern and northern coasts. For tens of thousands of years its population was relatively small, comprising indigenous groups of hunter-gatherers living in harmony with the landscape. In the late 1700's European settlement began, and today it is an industrialised nation of some 19 million people, strongly urbanised, and concentrated on the coastal areas. Its economy was initially built on an agricultural base, but today agriculture generates only some 4 percent of gross domestic product. Gross value of farm production is A$27 billion, of which around 80 percent or A$22 billion represents the value of farm exports.

Around 40 percent of this farm production originates from the Murray-Darling Basin in the eastern half of Australia. The Basin is 1,057,000 square kilometres (sq km) in extent, and takes its name from two dominant rivers, the Murray and the Darling, with a combined length of 3,780 kilometres. See Figure 1 for a map of the basin. The rivers are characterised by very flat gradients (most of the Basin is less than 200 metres above sea level), highly variable flows, and limited runoff. As a result of flat gradients and high evaporation, several of the westward-flowing rivers in the centre of the Basin

Figure 1


MAP OF BASIN
QUEENSLAND
COTTON
BRISBANE
SOUTH AUSTRALIA
HORTICULTURE
NEW SOUTH WALES
SYDNEY
ADELAIDE
RICE
MELBOURNE
VICTORIA
DAIRY
MURRAY DARLING

virtually terminate in deltaic wetlands systems. All of these wetlands are of significant environmental value and are major considerations in environmental management of the rivers.

The water resources of the Basin are now highly developed. Annual runoff is some 24,000 million cubic metres (MCM) of which around half is lost to natural processes. Total diversions are around 10,600 MCM of which 95 percent goes to irrigation. Storage dams in the Basin total 30,000 MCM and support some 1,470,000 hectares of irrigation, representing 70 percent of the Australian total.

The Basin is now home to 2 million people and boasts a gross product of over A$20 billion.

However, this intense use of water, coupled with agricultural practices in the dryland areas that reflected a European approach rather than Australian realities, has brought a range of natural resource issues into focus. Irrigation-induced salinity appeared more than thirty years ago, but there is now growing evidence of decline in native fish populations, loss of vegetation, degradation of soils, water quality decline bringing about algal blooms, and most recently, emerging evidence of a widespread issue of dryland salinity resulting from land clearing.

The response has been the Murray-Darling Initiative of the 1980's, which has been described as the world's biggest experiment in integrated catchment management. It involves the cooperation of the State Governments of the Basin, together with the Commonwealth Government, in natural resource management. The Basin ethic is about achieving objectives together that could not be achieved by working alone. The former River Murray Commission, that simply managed the Murray through a system of works to deliver agreed shares of the water resource, was enlarged to the Murray-Darling Basin Commission (MDBC) and a Council of Ministers was created. The objective of the Murray-Darling Basin Ministerial Council is:

> *"To promote and coordinate effective planning and management for equitable, efficient and sustainable use of land, water and other environmental resources"*

3. Approaches to Environmental Flows in Rivers

'Environmental flows', is used in this paper to mean all components of flow management that are aimed at 'river health', and which range from specific environmental allocations, through temperature and other water quality management, to induced patterns of flow variability.

The paper concentrates on this issue of environmental flows. This is however, only one part of managing rivers to maintain environmental health. Water quality in rivers for example, is much more a product of land use management than of water management. Flow management programs for example, need to be complemented by catchment nutrient management programs and by riparian zone management programs. Australia has long recognised the imperative for integrated natural resource management and bases its approach on community-based integrated catchment management.

3.1 The Council of Australian Governments (COAG)

COAG comprises the Premiers of the various sovereign States, together with the Prime Minister of the Commonwealth of Australia. It debates matters of national significance.

In 1994 COAG agreed on the need for a national water reform program and issued a comprehensive statement of principles and processes. Much of the program relates to institutional reform of the water sector to align with the National Competition Policy, such as the separation of water utilities from resource management agencies. COAG also agreed on the need for environmental flows, although this need was expressed within the context of a major review of water allocation policies which sought amongst other things to establish a national framework for implementation of property rights in water to facilitate the growing trade in water rights. The key flow management elements of the COAG decision were:

States are to give priority to formally determining allocations or entitlements to water, including allocations to the environment.

Environmental requirements are to be determined on the best scientific information available and will have regard to the inter-temporal and inter-spatial needs required to maintain the health and viability of river systems.

Whilst many States were already well engaged in this process, the COAG Water Reforms provided the impetus for a national effort. The property rights context caused many in the water industry to see environmental provisions in the simplistic and inadequate light of a volumetric allocation for the environment. It also incidentally caused many irrigators to initially imagine that the property right would be a title to the water itself rather than a usufructuary right. An inter-governmental committee subsequently developed a set of national guidelines for provision of water for ecosystems.

3.2 Nationally Agreed Principles for Provision of Water for Ecosystems

The following 12 principles were issued in 1996 by a council of government Ministers known as the Agriculture and Resource Management Council of Australia and New Zealand.

1. *River regulation and/or consumptive use should be recognised as potentially impacting on ecological values.*
2. *Provision of water for ecosystems should be on the basis of the best scientific information available on the water regimes necessary to sustain the ecological values of water dependent ecosystems.*
3. *Environmental water provision should be legally recognised.*
4. *In systems where there are existing users, provision of water for ecosystems should go as far as possible to meet the water regime necessary to sustain the ecological values of aquatic ecosystems whilst recognising the existing rights of other water users.*

5. *Where environmental water requirements cannot be met due to existing uses, action (including reallocation) should be taken to meet environmental needs.*

6. *Further allocation of water for any use should only be on the basis that natural ecological processes and biodiversity are sustained (i.e. ecological values are sustained).*

7. *Accountabilities in all aspects of management of environmental water provisions should be transparent and clearly defined.*

8. *Environmental water provisions should be responsive to monitoring and improvements in understanding of environmental water requirements.*

9. *All water uses should be managed in a manner which recognises ecological values.*

10. *Appropriate demand management and water pricing strategies should be used to assist in sustaining ecological values of water resources.*

11. *Strategic and applied research to improve understanding of environmental water requirements is essential.*

12. *All relevant environmental, social and economic stakeholders will be involved in water allocation planning and decision-making on environmental water provisions.*

3.3 A Basin-wide Baseline – the MDBC 'Cap' on Extractions

In 1996, prompted by the findings of the 1995 Audit of Water Use in the Murray-Darling Basin, the Basin Ministerial Council made an historic decision to end the revealed continuing growth in diversions in order to protect river health. The Council agreed to limit the annual levels of water extraction from the Basin rivers to those applicable to the levels of development that existed in 1993/94. The highly sophisticated management needed to give effect to this seemingly straightforward decision has taken 3 years to develop and is based on modelled, climatically adjusted diversions.

A significant implication of the Cap, as it became known, is that all future growth in water-based economic productivity must come from gains in water use efficiency, or from water trade. As a result, the market value of irrigation water entitlements virtually doubled overnight.

Whilst the Cap decision was largely driven by considerations of end of system flows (eg the median volume of water reaching the Murray mouth had diminished by 79 %) the Cap has provided a baseline of extractions upon which the States could build their environmental flow programs. Descriptions follow of the approaches of the three upstream States of the Murray-Darling Basin.

3.4 Queensland – the 'WAMP' Process

Queensland, in the northern headwaters of the Darling River system, had yet to engage in the intensity of irrigation development that characterises the other Basin States. It therefore argued that it should be permitted to further develop, but only to the extent that river health would not be jeopardised. It further proposed to use its comprehensive Water Allocation and Management Planning (WAMP) process to determine the necessary balance, and thus also determine any allowable additional extractions. After debate, MDBC agreed to allow Queensland to meet its Cap obligations through this WAMP process, but required that it be subject to independent audit. Because of the more variable, even ephemeral, nature of many of Queensland's inland rivers, the Cap in that state is more determined by end-of-system flows than by instream extractions.

The WAMP process sets out to determine the minimum flow characteristics for river health through scientific evaluation. The process is informed by a Technical Advisory Panel and further by a Community Reference Panel. In working through this, Queensland has found two principal difficulties that are common to all such efforts.

Firstly, there is the fact that, as yet, no reliable algorithms exist that link ecosystem response to flow interventions. This is coupled with relatively limited fundamental research to date, and the inherent difficulties of conducting research and monitoring in a semi-arid and variable system. Secondly, there

is the fact that any additional water extractions, at least in theory, result in what many would term as environmental degradation. In at least some river systems, Queensland is finding that current levels of water extraction, contrary to some expectations, may well turn out to be too high – that is, unsustainable in the long term. This has yet to be verified.

Work is continuing, but resolution finally, as elsewhere, is likely to be found in the socio-political sphere, rather than the scientific sphere.

3.5 New South Wales – River Flow Objectives

New South Wales has perhaps the most comprehensive approach to environmental flows. In 1995 it embarked on a process of determining River Flow Objectives, accompanied by a parallel and complementary set of Water Quality Objectives for every river in the State. These objectives are endorsed by Government and, broadly speaking, are set by the environmental regulator (Environment Protection Authority) for the resource manager (Department of Land & Water Conservation) to accomplish. The resource manager achieves this through direct operational management of the dams that it controls on many of the rivers, and through conditioned licensing of the extractions by private diverters and by public utilities.

In this State, all previously government-owned and operated irrigation schemes have been privatised into the ownership of the existing irrigators. These schemes, including Murray Irrigation Limited, the world's largest private irrigation scheme, are all subject to environmentally conditioned water extraction licences.

The River Flow Objectives process began with a set of principles for the NSW Murray-Darling Basin rivers. These are:

1. *Protect natural water levels in river pools and wetlands during periods of no flow*
2. *Protect flows during natural low-flow periods*

3. *Protect or restore a proportion of freshes and floods and their characteristics (height, duration etc)*

4. *Maintain or restore the natural inundation patterns and distribution supporting natural wetlands and floodplain ecosystems*

5. *Maintain or mimic the natural frequency, duration and seasonality of drying periods in naturally temporary streams*

6. *Maintain or mimic natural flow variability in all streams*

7. *Maintain the rate of rise and fall of river heights within natural bounds*

8. *Maintain groundwaters within levels which are critical for surface flow of ecosystems*

9. *Minimise the impact of instream structures*

10. *Minimise downstream water quality impacts arising from storage releases*

11. *Ensure that the management of river flows provides the necessary means to address contingent environmental and water quality events.*

Reaching agreement on the recommended environmental flow objectives or targets for each river was subject to an initial, wide public consultation process. The negotiation process was then passed to River Management Committees set up for the purpose, and comprising a range of stakeholders, including water users and environmental interests. Government accepted these Committees' recommendations for interim flow objectives, but had previously let it be known that it considered a decrease in water availability for consumptive uses of up to 10 percent to be reasonable. This decrease in water availability occurs through a change in reliability, not a change in the nominal volumetric allocations, so in practice its impact varies with climatic conditions.

Accompanying this was a State-wide consultative process to determine a better defined water access property right to both increase resource security and to assist tradeability of rights. In this latter regard, it should be noted that the existing water rights that are based essentially on a quantified share of flows, but with no guaranteed right of renewal and with no reliability specified, had enjoyed a buoyant transfer trade since 1983 when trading was first introduced.

The adopted packages of interim flow objectives have a heavy emphasis on 'passing flows' for dams, based on principles of so-called 'translucency'. This concept relates to the effect of a dam on flow. If a dam were to pass all inflow, it would be 'transparent'. If a dam were to stop all flow it would be 'opaque'. In between these hypothetical extremes, the flow is 'translucent' to an extent expressed as a percentage of the inflow released - the higher the figure, the more translucent.

Translucent operation of a storage usually occurs in winter and spring months. A proportion of daily inflow is released so that downstream river flows mimic natural variability – but with reduced magnitude. Environmental scientists universally agree on the ecological value of mimicking natural flow variability, particularly for native fish species and macro-invertebrates.

The decision support system for the river flow objectives was a daily time-step, flow simulation model for each river, directly coupled with a regional economic model.

3.6 Victoria's Bulk Entitlement Process

Victoria had begun earlier than most States in working towards better-defined water rights as part of a comprehensive plan to create financial sustainability of its water industry. These included a bulk entitlement process for State-owned irrigation areas, which in the Victorian section of the Murray-Darling Basin were by far the largest water users. Bulk entitlements are also being developed for urban water authorities and other public bodies. The entitlements are granted in perpetuity, with limited ability for government to intervene. Entitlement holders can make trade-offs between yield and reliability.

The bulk entitlement process is putting in place a water allocation framework that:

- maintains the current environmental values of rivers;
- allows for reallocation of water for environmental purposes through market mechanisms; and
- ensures that future water developments will be subject to assessments so that the environmental requirements of river systems are adequately met.

Like New South Wales there is no reduction in water allocations, but potentially a small change in access to water through the application of environmental flows. Victoria has always had conservative approach to allocations which means that 'water rights' are essentially high security – on the Murray River about 96 % reliable in fact, with the greatest shortfall in a simulated 100 years period being 40 % of water right. However, Victorian irrigators have enjoyed significant access to 'surplus' water generally available on most rivers over and above the nominal water rights. It is th extra water, known locally as 'sales water' that is being constrained by environmental requirements.

As elsewhere, environmental flow management is a mixture of low flow rules, wetlands watering requirements, passing flows, flow variability, and some specific bulk environmental entitlements. The emphasis on establishment of a water-trading framework, with effectively perpetual entitlements, and future redistributions to environmental purposes restricted almost entirely to market mechanisms h been controversial. Proponents believe that with an initial relatively conservative allocation of wate to consumptive use, the market is the only means to determine how the community values the environmental health of rivers. Opponents believe that because of the high value of water, acquisition of any significant additional environmental water is now economically out of reach.

4. Examples of Specific Environmental Allocations

These two major examples in the Murray-Darling Basin involved the annexing of significant volum of water from the resources previously available for allocation to irrigation, without compensation to

existing holders of water diversion rights.. Both have been the subject of substantial public debate, but have succeeded because of eventual widespread support in the broader community.

4.1 Macquarie Marshes

The Macquarie Marshes is a major wetlands system extending over some 1500 sq km near the centre of the Murray-Darling Basin, and is listed under the Ramsar Convention as a wetland of international significance. The Marshes are one of the largest semi-permanent wetlands in south-eastern Australia, and include important waterbird breeding sites. Apart from Ramsar Convention obligations, the Marshes are also highly relevant to the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA).

The deltaic wetlands occur near the end of a river system that is regulated by two reservoirs in its upper reaches. Burrendong Dam has conservation storage of 1189 million cubic metres (MCM) plus a further 489 MCM for flood storage, whilst Windamere Dam has a capacity of 368 MCM. Together they are used principally for the provision of regulated water supplies for irrigation.

Irrigation extractions of some 395 MCM per year had reduced average yearly inflows to the Marshes from 525 MCM under natural conditions to around 350 MCM. As with all variable systems, these averages conceal some of the more extreme changes. Growing evidence of substantial decline in both area and ecological function led in 1986 to an Australian first. After much debate, an allocation to the Marshes of 50 MCM annually of very high security water was set aside under the control of the NSW National Parks & Wildlife Service. This so-called wildlife allocation was the centre-piece of the 1986 Macquarie Marshes Management Plan which included complex rules for delivery of the allocation, provision for monitoring and research, and an irrigation policy which controlled the nature and extent of irrigation near the Marshes.

A major review of the Plan in 1994 revealed that decline in the Marshes was not likely to cease, and that not only was further water required, but that the Plan needed improvement, particularly in the

matter of public auditing and community involvement. A new and more sophisticated Plan was approved in 1996 with a strong emphasis on adaptive management, and provision for a broad-based Advisory and Audit Committee. A key feature for delivery now of the wetlands allocation is to tie it to rainfall events, thus being able to augment water to the Marshes by 'piggy-backing' on natural flow events. The Plan is complemented by a community-based local Land & Water Management Plan.

The most controversial element of the Plan however was provision for a further 75 MCM of environmental allocation, to be supplied at the same reliability as irrigation water in the Macquarie Valley. This new combined allocation to the Marshes reduced average diversions for irrigation from 395 MCM per year to 340 MCM per year, a reduction in excess of 10 %.

Irrigation interests protested that this reduction should be accompanied by compensation. NSW Government response has been to include ongoing socio-economic studies as part of the Plan and to set aside funds for assistance with structural adjustment as part of the State-wide water reform agenda. Interestingly, anecdotal evidence from the valley is showing that the irrigation industry has generally risen to the challenge. With a combination of better risk management made possible by flexible water accounting, and through on-farm efficiencies, overall production has not suffered unduly. Again, of course, averages conceal extremes, and some weaker enterprises are said to be feeling the strain.

4.2 Barmah-Millewa Red Gum Forests

Riverine forests are a feature of the Murray, its tributaries and its many associated waterways and wetlands. The principal tree species is the river red gum (*Eucalyptus camaldulensis*), the most widely distributed of the eucalypts and present in all mainland states. Some trees are up to 500 years old and 40 metres high. The major concentrations of river red gum along the Murray River are in the Barmah-Millewa Forest in the middle reaches of the river between New South Wales and Victoria. Covering some 700 sq km, it is the largest stand of river red gum in the world, with a further 445 sq km on the nearby floodplains of the Murray and Edward rivers.

The Barmah-Millewa Forest is a complex ecosystem, with more than 400 species. In addition to its importance as a forest, it is also among Australia's most important wetlands and is also Ramsar-listed, being a breeding ground for waterbirds, including the sacred and straw-necked ibis.

These wetlands developed in a time of constantly changing river levels with the natural rainfall creating flooding and drying cycles. River regulation, principally for irrigation, has seen the introduction of predictable and stable river levels. The natural cycle has been reversed and moderated, with high flows in summer and autumn regardless of natural rainfall and with less frequent and less severe floods. As a result, significant areas of the forest and associated wetlands are in decline due to too much water at times, and a lack of water at others.

A system of 28 regulators along the natural levees of the Murray have assisted with some restoration of natural drying and wetting cycles, but have not overcome the net reduction in water availability. After many years of study and debate, the Basin Ministerial Council has set aside 100 MCM of high security water supplies for the forest each year.

The Basin community is now in discussion about how best to deliver this water. The answer is not clear. Irrigation interests are concerned to minimise impacts on their supplies, but the situation is made complex by river channel capacity restraints, and by near universal agreement that a volume greater than 100 MCM is required to halt forest decline. It is generally agreed that as for the Macquarie Marshes, a system of 'piggy-backing' on natural events is desirable, but may cause unwanted flooding elsewhere due to the channel capacity problems. Victoria has made a comprehensive proposal as part of its bulk entitlement processes, but New South Wales has yet to accept this, being concerned to ensure that no advantage to Victoria accrues from the plan. Consistent with Basin approaches to integrated catchment management, the discussions are in the hands of a broad-based Barmah-Millewa Forest Forum, with a mix of community and government agency representation.

5. The Hume and Dartmouth Dams Operations Review

This Review, concluded in June, 1999, has been the most comprehensive exercise in the Basin to date in seeking broad-based community agreement to a revised mix of operational policies for major reservoirs. It involved representation from three States.

5.1 Background

The upper Murray River system is regulated by two primary reservoirs – Hume Dam of 3038 MCM capacity near the towns of Albury Wodonga some 2250 kilometres from the Murray mouth, and Dartmouth Dam within the Hume catchment and of capacity 4000 MCM. The dams are operated principally for water conservation and supply for irrigation - some 3500 MCM annually to New South Wales and Victoria. They also provide flood mitigation, hydro-electricity, salinity reduction, and recreation benefits. Reservoir inflows are strongly cyclic with typically high flows in winter and spring, and low flows in summer and autumn. The release of water from the reservoirs is usually just the opposite, with the result that the natural hydrologic regime of the rivers downstream of the dams is effectively reversed in seasonality. Both dams have alluvial floodplains downstream that support valuable wetlands and anabranches (billabongs) plus significant livestock enterprises.

The scope for conflicting objectives is clear. In 1997, following major flooding the previous spring, the Murray-Darling Basin Commission began a comprehensive review of current operating procedures and policies, which address the competing objectives of water supply, environmental enhancement and flood mitigation.

5.2 Methodology

Whilst a project manager had been appointed to manage the process, and particularly the technical inputs, the review was driven, shaped, and effectively 'owned' by a community-based Reference

Panel. The Panel of 16 members was fully independent and was not influenced or directed by the Commission. It had an independent chair and a representative from each of the 3 state operating authorities, with the remaining 12 members drawn from the community of stakeholders, including external environmental interests. Meetings were also attended by an observer from each state's principal environmental or natural resources agency, and who could assist with technical advice.

The methodology was centred on *Information* and *Inclusion*.

Information – The Panel attempted wherever possible to describe situations by means of factual and, preferably quantified information. This required the time-consuming and expensive creation of a daily time-step river flows simulation model, the quantification of economic outcomes for all sectors, and the development of indicators to attempt to predict the environmental outcomes. The largely successful aim was to minimise arguments about how 'good' or 'bad' a particular scenario was, by having numerical measures of the outcomes. More than 40 operating scenarios were developed, modelled (100 years simulation), and the outcomes analysed.

Attempts to use multi-criteria analysis methodologies, such as analytical hierarchy processes, were abandoned as being insensitive to the many subtleties of an extraordinarily complex system. Instead, the Panel favoured continuing development of information, coupled with debate facilitated towards consensus.

Inclusion – Whilst the Panel contained most of the principal interests, it worked hard to include the whole valley in its deliberations. This began with employing the Australian Research Centre for Water in Society to identify issues that people along the river saw as important. A series of background papers was produced and distributed. The Panel listened to all views and spent time visiting areas of concern, with itineraries and presentations arranged entirely by the local interests. This enabled the compilation of a register of interested stakeholders (around 1800 people and organisations finally) to whom backgrounders and other information was distributed.

When the Panel's views began to emerge, an Options Paper was developed, distributed and discussed at community workshops. When the Final Report and recommendations to the Commission was produced in May 1999, to keep faith with the community every response to the Options paper was identified and summarised.

5.3 Environmental Evaluation of Operational Scenarios

Whilst the models generated comprehensive hydrologic and dollar value outputs for irrigation, hydro-electricity, salinity, flooding, and recreation, there was no available methodology for generating environmental outcomes. As noted previously, fundamental research is in its early days, and there are no reliable algorithms that quantify aquatic ecosystem responses to specific flow interventions.

It was therefore necessary to develop an agreed and comprehensive set of flow parameters that could be viewed as surrogates for environmental outcomes. This was a complex and time-consuming process, but was needed to overcome environmentalist's concerns that any generalised river health indices would mask important details.

The selection of flow parameters was assisted by the previous work of an 'expert panel'. This technique has been used on other rivers where a quick picture was needed of environmental health, without the time and resources that full scientific investigations would require. It consists of assembling a small team of perhaps 5 or 6 the best available scientists covering disciplines such as geomorphology, limnology, wetlands ecology, hydrology, fish biology and so forth. The team then travels the river together, making joint observations and drawing conclusions based on these plus accumulated experience and knowledge. In a matter of weeks the resource managers have an overall view of the key river health issues of the particular river.

The New South Wales river flow objectives h: d used cumulative flow-duration curves to measure the degree of return to natural conditions, but on the Murray these were found to be too insensitive and did not describe well the critical element of flow variability. With several reaches of river, including

the Barmah-Millewa Forests being considered, each with its own environmental characteristics, up to 150 elements of flow data for environmental flow evaluation were generated for each operational scenario being modelled. The data included seasonal temporal elements, for example stage height-duration bar graphs for natural, current operations, and modelled scenario, for spring months.

A significant by-product of this painstaking detail and discussion was that water users, and irrigators in particular, became aware of the scope and nature of change that regulated flows had produced. As a group of people whose livelihood derived from the river, their natural instincts to want a healthy river now became well informed, and they could understand and debate both the ecological changes and the practicalities and limits to improved flow management.

5.4 Outcomes

The Panel achieved consensus on how to manage what many people believed at the outset were irreconcilable objectives for the management of this precious resource. This was made possible by a consistent and meaningful depth of understanding, patiently acquired by all Panel members. In turn, this created an atmosphere of mutual respect for each party's views and opinions. Debate remained vigorous throughout, but well informed. Rhetoric (a natural tendency for community leaders) was accompanied by requests from the rest of the Panel for facts and evidence. No difference of opinion was allowed to remain unresolved, and the technical people were frequently called upon to do more work to facilitate this resolution.

As a result, the Panel's recommendations were non-trivial. A few examples are:

- For Hume Dam, a managed form of translucency of around 30% was supported, compared to a scientific panel's judgement that 10% was about as much as could be realistically hoped for;

- Irrigators were amenable to contributing to the cost of acquisition of easements to flood (estimated at A$1 million) where high regulated flows close to river channel capacity had impacted on private riparian lands;
- Floodplain land-holders relinquished their long-held desire for flood mitigation through provision of 'air-space' in the reservoirs set aside for flood storage, in favour of environmental flow rules that gave them marginally lesser benefits, but significantly reduced what was otherwise a major impact on water supply; and
- A proposal was agreed to in principle that further riparian flood easements above existing river channel capacity should be considered, in order to permit an increase in allowable environmental and pre-release rates from Hume Dam for instream, forest watering, or flood mitigation benefits, whilst minimising impacts on water supply.

6. Conclusions – Factors for Success

The following are observations of the author, made during 25 years of water resources management in the Murray-Darling Basin and elsewhere. They are not official views of the Commission nor particularly unique, but reflect the strong total catchment management (TCM) ethic that has grown in Australia during that time. It is captured succinctly in the New South Wales TCM slogan of "*...Governments and Communities Working Together*".

- Any process of natural resource management that involves tradeoffs will never succeed properly unless governments and bureaucrats recognise and support the need for community ownership of the process.
- 'Support' in this context includes adequate technical resources for data gathering, scientific investigations, simulation modelling, and socio-economic analysis.

- 'Support' also includes allowing the community to proceed at the pace that it feels comfortable with. Any attempt to push the process too hard to meet purely political timeframes will result in the community losing faith in the process, or even abandoning it.
- 'Community' in this context means the broad community, not just the community of a particular valley or catchment, although they are obviously the key group.
- Broad consultation is vital. This works best, and has most credibility, when it is seen to be led by informed community people, rather than by bureaucrats or experts. These latter are needed of course, but experts should generally be on tap, not on top. The community will however always respect and value the views of genuinely independent experts.
- The process of implementation of a flow management plan is just as important as the process of plan development. All observations about community ownership apply equally to this phase.
- The community will best accept a flow management plan that is built around pragmatic notions of adaptive management. This requires experts to admit that their knowledge is limited. It also requires highly public auditing and monitoring, and a commitment to research.
- Finally, experience in the Murray-Darling Basin shows that when all of these principles are in action, a community will do tougher things to themselves in order to ensure sustainability of the natural resources of their neighbourhood than they would ever permit governments and bureaucrats to do to them.