REVIEW OF THE MDB GUIDE

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Contents

GENERAL

The Guide was prepared by the Murray Darling Basin Authority (the Authority) within constraints imposed by purpose specific legislation in the Australian Government Water Act of 2007 (Water Act). The scope of the Water Act was determined by jurisdictional issues between the Australian and State Governments and advice provided by scientists. Many of the comments given here arise because of constraints imposed by the scope.

While referred to as a guide the report was prepared as a plan wherein preparation and implementation of the plan is the main function of the Authority under the Water Act. The change in designation from plan to guide was implemented to highlight that targets identified in the Guide could change following community consultation.

Considerable difficulty was encountered in determining the methods used in developing the Guide despite the numerous publications on the methods by and for the Authority. In particular, CSIRO was funded to produce results to an Authority specification through the CSIRO Sustainable Yields Project. However,the Authority identifies:

> However, to adapt for the specific needs of the Basin Plan, the methods and tools underpinning the CSIRO Sustainable Yields Project have been updated by the Authority.

As no changes to methods are given for the updates it is assumed here that that any changes made by the Authority do not alter the basic approach.

The difficulty in determining methods arises even within the CSIRO reports. The indications in the Guide are that the CSIRO catchment modelling was used to determine water yields and distributions. The situation is given in two sentences under River System Modelling in the Summary of Methods.

> The modelled runoff series from SIMHYD are not used directly as subcatchment inflows in these river system models because this would violate the calibrations of the river system models already undertaken by State agencies to different runoff series. Instead, the relative differences between the daily flow duration curves of the historical climate scenario and the remaining scenarios (respectively) are used to modify the existing inflows series in the river system models.

That is, yields determined using catchment modelling differ from the observations so results from catchment modelling were only used to rescale existing observations to different change scenarios.

Objectives of the Guide

The Guide is presented as providing the basis for the management of the entire Murray Darling Basin, as required by the Water Act. However, but it only addresses the partitioning of blue water between agriculture and the environment. The bulk of the water resources of the Basin by way of green water are not addressed. Vegetation is only considered directly for wetlands, and indirectly for crops by way of the value of produce from irrigated lands. Soils are not addressed. The limitation of restricting considerations to a narrow aspect of the Basin is critical if only because soils and vegetation throughout the Basin affect the quality and quantity of water flowing to streams.

Historic basis

The historic basis for the development of the Guide is summarised on the Murray Darling Basin Commission web site (www.mdbc.gov.au) where the MDBC became the MBDA with implementation of the Water Act. Initial concerns were for river navigation but that rapidly turned to concerns by States to obtain their 'rightful' share of the water. The issue has always revolved around South Australia depending on river flows where the water originates in other States when all States have increased irrigation to increase development.

The key change with development of the Water Act relates to identifying amounts of water to be allocated to the environment to maintain or improve the health of the Basin, with environmental flows being given priority over other uses. This change reflects community concern for the environment and assertions by scientists that such allocations are essential. The implicit assumption is that the health of the Basin can be maintained by allocating water flows to particular 'environmental assets'.

The MDBC was established to achieve a coordinated approach that addresses equity between users while maintaining the health of the basin, but the need for coordination appears to have become a desire for consistency. The MDBA has to develop a consistent basin wide framework without any justification for the uniform approach being apparent.

The change from the MDBC to the MDBA reflects the general perception that the health of the Basin has been degrading despite the best efforts of the MDBC and State agencies. All indicators of environmental health have been degrading despite large expenditures by governments on addressing environmental issues. While the changes associated with the Water Act are meant to at least halt the decline there has been no assessment of whether the changes recommended in the Guide will or can meet the basic objective of maintaining the health of the Basin.

Water in rivers derives from the land hence the anthropogenic impacts on water flows arise from land use impacts additional to the construction of water storages and harvesting ('diversions'). The States control all aspects of land and water use within their jurisdiction, Australian Government owned land excepted, but the Australian Government has limited control through cooperation by States and has gradually been asserting limited control through application of international agreements.

The Authority is meant to achieve a coordinated approach to Basin management but where it has no control over land use apart from specifying the amounts of environmental and harvestable blue water. Scientists are implicated in continuing this constraint in identifying that environmental requirements can be met by reducing water harvesting.

The issue of jurisdiction is briefly addressed in section 15.3 of the Guide where the opening paragraph identifies the rigidity of the constraint. The remainder identifies how the issue is being addressed. The issue for the MDBA is the same as with the environmental management of Defence training areas, how to achieve desired environmental outcomes without having control over the land users.

> ## 15.3 Relationship of Basin Plan to natural resource management activities
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> All Basin states have existing mechanisms for integrating natural resource management at the regional level – for example, through the implementation of regional natural resource management plans. To the extent that these regional plans relate to the management of water resources, it will be important that they are consistent with the directions and arrangements proposed under the Basin Plan.

It will be important that the people implementing these regional natural resource management plans – for example, those based at the various catchment management authorities – are engaged in the implementation of relevant parts of the Basin Plan, such as the Environmental Watering Plan and the Water Quality and Salinity Management Plan. The Authority will seek advice from Basin states and the regional natural resource management bodies on how best to engage them in implementing the Basin Plan.

The Authority recognises the valuable contribution of the range of joint investments in natural resource management programs by Basin states that have occurred in the past, and is keen to build upon those into the future. These joint investments include the Basin Salinity Management Strategy, Sustainable Rivers Audit, The Living Murray, the Native Fish Strategy, the interstate water trade program and other knowledge-generation and investment activities.

Structure of this Review

The sections are:

- **Structure of the Guide**
- **Water Yields**: estimates of blue water availability
- **Environmental Flows**: estimates of blue water needed for the environment to address Basin health
- **Potted Basin History**: anthropogenic changes to the Basin's environment
- **Repairing the Basin**: a rational approach to improving the health of the Basin

Estimates of water use by way of extractions are not addressed as these represent bookkeeping. The estimates contain errors but the sources of error are known and are being progressively addressed.

STRUCTURE OF THE GUIDE

Presentation

The Guide has been designed as a 'coffee table' presentation with city dwellers as the target audience. This is despite its direct impact being on farmers and the glossy form of presentation being an anathema to them, particularly when its recommendations negatively impact on their livelihood. This city focus occurs with the content and wording of the text as well as the extensive use of scenic photographs. The Guide is difficult to read on a computer to the point of being very annoying.

The material is presented as being the best possible that should be regarded as being correct. The information base is presented as being unchallengeable. Comments to this effect include the 'use of best available science', and the 'peer review' of methods used to develop the information.

The use of best available science is addressed throughout, but succinctly can be addressed by identifying that the presentation represents the best interests of those conducting the work. There is no testing and hence no estimates of the reliability of any predictions. The chances of achieving the desired environmental objectives have not been assessed.

Peer review is inferred as ensuring veracity when reviewers typically have the same interests as those conducting the work. It's a case of the preachers assessing their disciples, and vice versa.

Scope

The Guide is identified as relating to the entire Murray Darling Basin and as addressing the requirements of the Water Act. While the Authority was established to address management of the entire Murray Darling Basin its activities are restricted to blue water. Section 15.3 of the guide identifies that issues identified as involving natural resource management (NRM) have been excluded even when intrinsically tied to water.

This tight constraint on the issues addressed is identified in the Guide but the reference is always to improving the health of the Basin. Readers are led to believe that actions identified in the Guide address the health of the entire Basin. They don't, and there is no means for anyone to determine how the proposals relate to the health of the entire Basin. It is an act of blind faith to suggest that the health of the entire Murray Darling Basin can be addressed by considering only those parts that are inundated by water at some time.

From a scientific perspective the constraint of only addressing rivers and inundated lands is limiting to the point of negating the entire Guide. The amount, timing and condition of water accessions to streams is determined by the condition of the surrounding lands. Failure to address the lands of the Basin means that the management actions needed to improve water in the Basin cannot be implemented.

While now called a guide the Guide was prepared as a plan that was meant to be implemented. However, most of the material in the Guide is irrelevant to implementation, and some issues central implementation are scantily addressed. Performance monitoring, which is the means of achieving continuous improvement in performance, is addressed by dot points outlining administrative procedures.

> The Monitoring and Evaluation Program will:
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> - provide the framework for collection and analysis and publication reporting of the critical information needed to determine whether and how the Basin Plan is meeting its purpose, objectives and targets
> - guide and facilitate data and information provision for annual reporting ,and 5-yearly and 10-yearly reviews of the Basin Plan
> - ensure, through reporting of outcomes, that Basin Plan activities meet Australian Government requirements for accountability and transparency, to enable learning and improvement
> - provide the principal mechanism to reinforce, review and refine activities as part of an ongoing adaptive management process.
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> The monitoring and evaluation framework will address six key elements of the Basin Plan:
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> - ecosystem outcomes from the implementation of the Environmental Watering Plan
> - water quality outcomes from implementing the Water Quality and Salinity Management Plan
> - reporting on critical human water needs
> - risks to the condition and availability of Basin water resources
> - water trading and transfer rules effectively implemented
> - socioeconomic impacts minimised.
>
> The Monitoring and Evaluation Program will also establish the information needed to evaluate effectiveness of the Basin Plan, by using the approach of the Australian Government's framework for natural resource monitoring, evaluating, reporting and improvement.

The final sentence in the monitoring section addresses outcomes but only by reference to procedures. No tangible performance measures are identified for either the health of the Basin or economic activity when these are meant to be the focus of the MDB Plan.

Best Available Science

The Guide is said to be based on the best available science, apparently to assert that the information base for water availability, and the conclusions on environmental water requirements, are unchallengeable, at least without the acquisition of new information. As identified below, nothing has been tested, and no testing has been identified to compare predicted and realised outcomes. There is abundant use of technology, and ambit claims based to various extents on information and knowledge, but nothing that could be regarded as science.

The most reliable knowledge arises through trial and error, hence science is not needed for the Guide to be useful. Trial and error involves continuous evaluation, as arises in nature with evolution. However, incremental change in evolution lacks direction when land management incorporates objectives. For trial and error to be useful in land management there must be a well defined program of evaluating realised outcomes against objectives.

The limitation of trial and error relates to an inability to project forward (predict). As the purpose of the Guide is to alter future outcomes its veracity depends strongly on the validity and reliability of the underpinning predictions. The modelling by CSIRO that was meant to address this requirement for water supply but does not. The requirement to assess future outcomes with ‘environmental assets’ is not addressed.

Conclusions

Given the constraints associated with its jurisdiction presented in the Guide the Authority has no chance of improving environmental outcomes in the Basin. Given the approach adopted by States this conclusion also applies to them. For example, the objective with salinity management is to retain salt in soils when historically that has caused the demise of most irrigation systems throughout the world.

WATER YIELDS

Basics

The specification given by the Authority for development of the yield estimates by CSIRO is essentially:

- Develop and apply a transparent, consistent and robust methodology to estimate the total water resources of the MDBC disaggregated to large catchments that can encompass surface and ground water interactions and changes in climate.

As presented the approach appears to be:

1. Estimate blue water yields from different Basin catchments using an empirical computer model

2. Identify the amounts of blue water in streams, storages and harvested ('diverted')
3. Estimate the groundwater supply through water balance between rivers and groundwaters with groundwater extraction.
4. Estimate the amount of blue water needed for environmental purposes
5. Define the potentially harvestable blue water as the difference between total water yield and the environmental requirements
6. Assign cuts to current limits to harvestable water

On close examination the approach used was:

1. Estimate blue water yields from different Basin catchments using an empirical model
2. Use existing river models to identify the current blue water availability, harvesting, and surface – ground water interactions
3. Estimate the amount of blue water needed for environmental purposes
4. Define the potentially harvestable blue water as the difference between total water yield and the environmental requirements
5. Use the estimates of catchment yields from the computer model to scale the river observations for climate changes thought possible with global warming.

Surface Water

The information on water yields, storages and extractions derives from existing river models run mainly by the States. These were linked by CSIRO but the current amounts of available blue water by way of river flows, impoundments and 'diversions' are as embodied in existing river models.

Scenarios for changes considered possible with global warming were addressed using catchment modelling to predict current catchment outflows and those expected with change. The ratio of the current to predicted yields is used to rescale the values in river models.

> Future river yield = Observed current river yield * (modelled future catchment yield / modelled current catchment yield)

The steps in the catchment yield modelling were:

- Correlate water outflows with rainfall for around 200 calibration catchments using a numerical implementation of a 6 parameter conceptual model. The calibrations establish values for the parameters.
- Use the calibrations in applying the model to proximal catchments to estimate yields from eastern and southern Basin catchments.
- Use the model with default parameters to estimate yields from the western parts of the Basin (approximately 2/3 of the basin).

Estimates of yields from catchment modelling serves only to identify the change in the amount of river flow predicted to arise with different scenarios for climate change.

In the best form of implementation of the model the catchment outflows are derived by extrapolating results from calibration catchments. However, studies testing the applicability of extrapolating results from calibrated to uncalibrated catchments identify that this approach has high unreliability. This unreliability applies even with 15 adjacent undisturbed catchments 2 to 10ha in size on the same geological formation and with equivalent soils and vegetation[1]. While catchments can perform in a consistent manner each catchment is unique.

The criticality of this limitation is evident in the lack of agreement between catchment yields and observed yields associated with river models identified above. It is also evident in the extrapolation of calibration results being restricted to proximal catchments[2]. This critical constraint had to be known but has not been clearly identified.

This constraint negates the use of the methodology for estimating Basin yields. However, it is unclear as to what impact it has when the predicted catchment outflows are used solely to adjust observed river flows for different climate change scenarios. Logically the situation is that the uncertainty in changes is compounded by the need to apply the model outside the calibrations. The results have no apparent value.

A feature of the method of unknown consequence is the use of gridded surfaces for daily rainfall. Rainfall is recorded at meteorological stations and hence represents point observations. Rainfall data were interpolated to 5km grids using a surface fitting algorithm that establishes a reasonably smooth gradient between adjacent stations.

Spatial gradients in rainfall are smooth when averaged over periods of years but this need not arises with daily observations. Storm fronts and patchy showers result in abrupt spatial changes in rainfall that cannot be addressed using surface fitting to produce grids, particularly at the density of recording stations across the Basin. ‘Results’ derived through spatial interpolations of daily rainfall using surface fitting are discordant with reality. As daily rainfall grids were used in the catchment modelling this smoothing is problematical.

Results from empirical models as used to predict catchment outflows from rainfall are only applicable within the range of observation. They should not be used to predict beyond the range of observations used to establish them, as has been done in using the model calibrations to address climate change. A technical manifestation of this limitation is that the model can become unstable and produce completely unrealistic results, but, even if the model remains stable, the results have high but unknown levels of uncertainty.

In the outline of the method it is stated that uncertainties in predicting future climate produce most error compared to the method used to predict catchment yields but there is no way of knowing. One is as bad as the other in violating a basic constraint with modelling and not incorporating the basic scientific requirement of testing.

Groundwater

Potential groundwater recharge was estimated through computer modelling but not used in addressing yields other than to compare predictions for the current situation with those thought possible with global warming. Groundwater recharge (actually predictions of flow through the soil profile that may contribute to groundwaters[3]) was predicted for 20 ‘representative’ points

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[1] This situation arises because of the marked non-linearity of responses wherein a small difference in catchment characteristics can produce marked differences in outcomes. It is compounded in numerical modelling by the use of arithmetic averages as arises when using grids of daily rainfall. The rainfall data are temporally as well as spatially averaged as daily averages are inapplicable when addressing water processes in soils and vegetation.

[2] This does nothing to resolve the issue. For example, the Moonie catchment contains large areas of gilgaied soils that have neither runoff or groundwater accessions but the calibration applied does not address this situation.

[3] The characterisations of groundwater in the Guide relate to the available observations and methods used for modelling. They do not relate well to the sub surface water acquisitions, storages and flow characteristics where this limits considerations.

across the Basin using a ‘mechanistic’ model. At each point predictions were made for combinations of 8 representative soil types and 3 vegetation types. These predictions were extrapolated across the basin using maps of rainfall and soil and vegetation types.

There is no apparent reason why the groundwater change results should be considered useful in addressing changes associated with global warming when they were not considered to be useful in addressing current water yields. There is no reason to believe that the groundwater recharge modelling has any validity or serves any useful purpose.

The method used to address groundwater supplies and surface-ground water interactions represents a juggling act based on the assumptions that:

- groundwater extractions are reflected in river flows but with a time lag
- groundwater recharge is given by groundwater extractions at an equilibrium condition
- groundwater recharge at an equilibrium condition is sustainable

For implementation this requires good knowledge of groundwater acquisitions through surface infiltration that usually are only sufficiently reliable when they are zero.

Issues that arise with this approach are:

- The lateral groundwater flow patterns do not mirror those for the surface. Indeed, there can be multiple flow patterns as groundwater systems can be vertically layered. Catchments for groundwater systems are very different to those for surface water but they are treated as being the same, except for the Great Artesian Basin which has evidently been excluded.
- Not all groundwater accessions contribute to streams.
- Different groundwater systems exhibit different connectivities to rivers and hence exhibit different time lags
- Groundwater exists that does not arise through surface percolation (non meteoric groundwater). Deep groundwater can be magmatic in deriving from water in rocks, and other sources can also contribute.

The approach adopted can be used for some local situations by establishing empirical relationships between observations. However, it cannot be generally applied and can only account for groundwater systems that are harvested. The assumption that groundwater recharge is given by groundwater extractions at an equilibrium condition may sometimes be correct but it only arises under specific conditions, noting that there can be a wide range of equilibrium conditions. The methods used to address groundwater recharge represent a pragmatic approach to obtaining estimates for use in management that may be useful but are never correct.

Summary situation

The estimates of water availability used in the Guide derive from models and plans being used by State agencies to manage the resources. While considerable attention is given to modelling by CSIRO this is of no theoretical or practical consequence.

ENVIRONMENTAL FLOWS

Estimation Methods

The estimates of environmental flows were variously determined. The methodology indicated as being used in the Guide is based on addressing selected indicator sites and attributes where the methods used to derive the estimates vary between sites. There is an approach but no particular methodology where that approach is based on maintaining what is there. The approach represents an attempt to preserve systems that naturally change.

The commonality across the Basin is the objective of maintaining what exists by way of identified water and wetland systems. This extends to rivers that naturally became dry but where flows are now maintained through infrastructure developed for irrigation. The environmental requirement is identified as being a need to maintain flows.

The first site presented illustrates the approach and the outcomes (Lower Balonne River Floodplain System). The objective is to maintain all attributes considered to depend in some way on the accession of surface water flows. This includes grasslands where grasslands in the region can be damaged by flooding and are not dependent on it. Grasslands were included solely because they were identified as becoming flooded in satellite imagery.

It is commented in the assessment for the Lower Balonne River Floodplain System that existing diversion serve to maintain key assets. This is an inevitable outcome of an approach that seeks to maintain what is there. If something exists it does so because existing conditions are suitable.

While conditions are suitable for what exists they are seldom optimal. This situation can arise for many reasons, as with transient conditions producing widespread recruitment of a species. The general conditions need not be optimal for the recruits to survive and develop, but their presence prevents recruitment by others.

The discrimination between suitable and optimal is significant in attempts to manage systems. The interpretation used in developing the Guide is inevitably that the current situation is degraded and that the requirement is for it to be improved. However, the improved state commonly represents a situation considered optimal rather than what normally occurs. As manipulating a system to provide gains to one thing almost invariably produces losses in others, the changes designed to promote something considered desirable can degrade the total system.

The 'methodology' used to assess environmental flow requirements has the political benefit of demonstrating that all aspects considered important by environmentalists have been addressed. It does not, however, have any basis in science as nothing has been tested. There is nothing that provides insights into errors associated with the identified needs let alone any estimates of requisite water supply. At best it represents expert opinion but, given the absence of rigour, this raises questions as to the nature and level of expertise.

Implementation

Following subjective consideration of things considered important, only sometimes associated with a quantitative estimate of the water requirement, the conclusions are expressed by way of percentages of the uninterrupted flow that can be harvested while maintaining the identified environmental assets.

Adequacy of current environmental flows, by region

End-of-system flows are broad-scale measures of flow that reach the end of a catchment or the end of the Basin. As an indicator of the hydrologic and environmental connectivity of the rivers of the Basin, end-of-system flows are used as a measure of the adequacy of the water available to meet the environmental needs of key ecosystem functions and key environmental assets in regions. Using this method, end-of-system flows under current arrangements are compared with modelled end-of-system flows for conditions in a without-development scenario. Current end-of-system flows are expressed as a percentage of a region's long-term, without-development flows. Where the value for current end-of-system flows for a region is <60% of without development flows, the adequacy of environmental flows in that region is considered 'poor'. A value of 60%-80% is considered 'moderate', and a value of >80% is considered 'good'.

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To establish the Basin's environmental water requirements, the Authority:

- identified a range of flow regimes required to support key ecosystem functions and key environmental assets at each of the 106 hydrologic indicator sites
- converted flow requirements into catchment-scale volumes of environmental water
- assessed the adequacy of the current distribution of water between consumptive and environmental use in each catchment and across the Basin (see Chapter 5 for detail on current water distribution).

This range of flow regimes required to support key ecosystem functions and environmental assets represents the minimum and maximum boundaries of additional environmental water needed to fulfil the environmental objects of the Water Act, including giving effect to relevant international agreements.

There is considerable discussion about the environmental water needs for key assets at indicator sites, and about the need for different flow regimes to address the requirements of different environmental assets. However, the diverse assessments result in a simple conclusion in identifying a required level of end of system flows. Despite discussion of the differing needs between systems the conclusion is based on the premise that one size fits all.

The effectiveness of the identified acceptable level of harvesting is unknown, and the 'methodology' does not allow identification of the likely effect of increasing or decreasing this level. The assessment of environmental flows is subjective and in no way rigorous.

BASIN HEALTH

Indicators

Health is a concept that relates to general wellbeing. There is therefore no single or simple measure of health. This constraint was previously usually addressed by identifying indicators of health, as with the maintenance of environmental features ('environmental assets') considered sensitive or important.

Wetlands have typically been considered to be useful indicators of environmental health. In Australia this has pronounced limitations due to the ephemeral nature of wetlands. An area may exhibit features of a wetland for a few months in a decade wherein reliable assessment of the condition of such wetlands is essentially intractable for time scales addressed in land management. The term encompassing wetlands in the Guide is water dependent ecosystems where this includes streams as well as intermittently flooded lands.

Gilgaied brigalow lands provide an example of difficulties in using wetlands to indicate the health of the Basin. These have an aquatic flora and fauna that emerges under very wet conditions wherein flooding is essential for the persistence of aquatic plants and invertebrate fauna. The wetland area comprises numerous ephemeral ponds that do not depend on surface water flows or interconnectivities of any form as the ponds are seldom if ever interconnected. Gilgaied brigalow lands are not identified as being environmental assets, possibly because they breach requirements considered essential for water dependent ecosystems to function, namely water supply through surface flows and interconnectivity.

While gilgaied brigalow lands have not been identified as being water dependent ecosystems grasslands on floodplains subject to infrequent flooding have been. This is despite such flooding being detrimental to the grassland, particularly if prolonged.

Concepts

The approach used in the Guide takes indicators a step further, progressing from protecting attributes considered important to addressing ill founded ecological concepts.

Science is directed at understanding nature where nature is tangible. Concepts represent generalisations used in the development of the knowledge and represent abstractions. Concepts are tested through tangible observations.

Land management involves addressing tangible entities such as soils, water and vegetation. Concepts are only of value where the generalisations provide insights as to how the tangible entities could best be managed where what is best depends on the specified objectives. Concepts cannot be used in management, and should not be used to evaluate the success of management. Management involves manipulation of tangible entities and the outcomes of the management must be assessed by way of tangible entities.

Perhaps the most diabolical of the concepts presented as being a prime objective for management is ecosystem services. This concept addresses the benefit of ecosystems to man. It is completely anthropocentric when science is meant to be completely objective and hence divorced from human perceptions. The approach of addressing ecosystem services is antipathetic to science.

The concept of ecosystem services relates to mankind being the center of things with all of the earth's resources being present solely for the benefit of humans. Something only has value when exploited to the benefit of man. It involves beliefs that have a basis in the Christian religion and are the core of the existing capitalist system. Ecosystem services is to ecology what intelligent design is to evolution.

The main concept used as the goal for management in seeking to maintain Basin health is ecosystem functions. For me the meaning of this term is not clear as the same basic physical and biological processes occur in all ecosystems. Where ecosystems differ by way of realised outcomes, as is usual, this primarily arises because of differences in the physical and biological constraints as the underlying processes remain the same.

Definitions of ecosystem function given in a biological dictionary are:

> The collective intraspecific and interspecific interactions of the biota, such as primary and secondary production and mutualistic relationships.

> The interactions between organisms and the physical environment, such as nutrient cycling, soil development, water budgeting, and flammability

These do nothing to clarify the meaning. The first defines ecosystem function as being the collective interactions between organisms without reference to the physical environment when most intraspecific and many interspecific interactions are manifest through changes to the physical environment. The second addresses the physical environment but by way of summary outcomes rather than processes. Aspects such as soil development and flammability can be seen as outcomes of ecosystem processes but it is logically inconceivable for them to be functions.

The illogicality of identifying soil development as an ecosystem function is further illustrated with water budgeting. Humans develop budgets but ecosystems do not. There can be outcomes whereby water is identified as being partitioned between identified components in some way but the functioning of ecosystems does not involve the development of a budget for anything.

This addressing of the meaning of words is not just semantics. The Oxford dictionary has two applicable definitions for function when used as a noun, as arises with the term ecosystem services.

- an activity that is natural to or the purpose of a person or thing
- practical use or purpose in design

An 'activity that is natural to a thing' could be considered appropriate but it is unclear as to what constitutes an ecosystem activity. This issue is likely best addressed by considering the second option, that of practicality for purpose. This embodies the same anthropocentric precepts as ecosystem services whereby the assessment of the ecosystem is based on its applicability to humans. Addressing ecosystem function is then diametrically opposed to the intent specified in the legislation of addressing requirements for the environment.

The concepts used to establish the environmental requirements reflect beliefs and hence have no basis in science. As with all beliefs they cannot be tested.

The key ecosystem functions used to establish the environmental requirements in the Guide are:

> *Key ecosystem functions*
>
> The Authority has identified four key ecosystem functions considered critical to maintaining the ecological health of the Basin rivers:
>
> - creation and maintenance of habitats for use by plants and animals
> - transportation and dilution of nutrients, organic matter and sediment
> - provision of connections along the river and downstream for migration and recolonisation by plants and animals
> - provision of connections across floodplains, adjacent wetlands and billabongs for foraging, migration and recolonisation by plants and animals.

Points 1, 3 and 4 are outcomes while point 2 addresses process. However, all are irrational.

With point 1 every environment is a habitat for something. With this as a goal nothing need be changed and any change could be considered beneficial.

With Point 2, water flows can transport and dilute soluble salts, including those that serve as nutrients. However, they cannot dilute organic matter, and they typically produce rather than dilute sediments. Sediments are mainly produced by overland surface water flows with dilution only occurring at the confluence of two streams with unequal levels of suspended sediments.

Points 3 and 4 give ecosystem characteristics identified from an anthropomorphic viewpoint. The representation is that of a transport network with the implied assumption that the characteristics are essential for the ecosystem to function. As most species have more than one means of dispersal it is not apparent how connectivity is an ecosystem function. It inverts the conclusion that land use structures such as dams can disrupt the movement of some species to the conclusion that particular movement/ transport networks are needed to maintain an ecosystem. The inversion is without justification.

Conclusions

In addressing anthropocentric concepts the measures identified as addressing the environment address human desires. The water suggested as being taken to address the environment addresses the perceptions of some. Water is being diverted from addressing the needs of one group in society to address the perceived needs of others.

POTTED BASIN HISTORY

Blue Water

Land development initially occurred without irrigation. Irrigation commenced with local extractions but major development was associated with the development of infrastructure. Dams were constructed to provide storages with rivers being used to transport the water to specific regions. The natural drainage system for the land became the water transport system for irrigation.

The Snowy River Scheme was the largest development for irrigation where this provided large water storages in the region having the highest water surplus and turned the coastal flowing Snowy River inland. The Murray River became the main water transport system and major irrigation areas were located along the lower reaches of the river in areas deemed suitable for irrigation farming.

The prime constraint in land selection for farms was terrain as low gradients were needed for the open drains used to distribute water to farms. This requirement for extensive areas of flat land resulted in the major irrigation areas being located in hot regions that were not best suited to crops. Land selection reflected engineering constraints more than the needs of plants.

While irrigated agriculture is the most profitable there have been ongoing reconstructions of irrigation areas involving expenditures of public monies. These were typically associated with a crash in the price of a particular commodity, as arose with loss of privileged access to markets in the UK. The instability was exacerbated by the use of small landholdings to maximise the numbers of people on the land.

While the large irrigation areas were planned there has been considerable opportunistic irrigation and water extraction throughout the Basin. These were initially limited by proximity to suitable rivers but technology has continuously increased the opportunities for irrigation.

Politicians have been highly involved in all aspects and stages of this development. Prior to the 1970s the construction of a new dam was a prime election promise. Government agencies involved in regulation were pressured to provide water licenses even when additional water was considered to be unavailable.

The situation is one of a continuously increasing demand for the extraction of blue water for commercial production where the supply has been considered constant, albeit with high temporal fluctuations. This has increased pressure on the Government regulators wherein farmers now rarely receive the entitlements covered by their licenses. Increasing the number of licenses has decreased the supply to existing license holders.

This deficiency in water availability is an inevitable outcome of the development of the water licenses. Regulators initially pressured farmers to increase their allocations so as to increase the revenue to the States for their management of the resource. This was followed by farmers and politicians pressuring regulators to provide licenses when water was not realistically available.

There are different categories of licenses with different levels of priority in supply. However, with the introduction of titling system all forms of license were given to holders regardless of whether any water had ever been received or not. In an instant the demand on blue water, perceived or otherwise, expanded greatly.

The titling system was meant to resolve issues of water supply. However, the form of implementation exacerbated the situation. Pressure on regulators to constrain water use increased where water use is controlled by identifying the seasonably extractable amounts for different systems.

A water title provides access to an amount of water if it is considered to be available. The water is owned by the Crown (the general public) and the Government represents the Crown in deciding what is available for extraction. However, there is now the absurd situation that the Crown is expected to buy back licenses that it recently gave away to obtain water that the Crown actually owns. The general public is expected to pay for something that they legally own but some think was gifted away with the development of a water titling system.

If the recommendations in the Guide are implemented then the public should be adamant that they should not have to pay anything for the additional environmental water as it is already publicly owned. Governments do not need water titles to obtain water for the environment.

Dryland Agriculture

Agriculture in the Basin commenced with grazing with much conducted by squatters. The land use caused land degradation and land development has involved developing new management procedures to counter the degradation caused by earlier management.

The degradation has been most apparent and best documented for the Western Lands Division of NSW. The Western Lands Act (1901, No. 70) was introduced following an inquiry by a Royal Commission into the "Condition of the Crown Tenants" in the Western Division. The Act was official recognition of the special problems surrounding land settlement in the dry western-fringe country. The Commission inquiry had been prompted by a profound depression in the pastoral industry and its terms of reference required that the causes of this depression and universal despondency in the western grazing industry be investigated[4].

The land degradation has been masked by land developments such as clearing for pasture development and cropping, particularly in wetter areas. While cropping in particular allowed recovery from the depths of depression it has been unreliable in dryer areas. The yields from crops from dryland farming vary considerably between years across the Basin with failure rates exceeding 50% in some regions. As in the past, recent failures have been blamed on drought,

[4] The paragraph is a summarised extract.

however, there has been no assessment of the degree to which the land use has contributed to the droughts.

Hydrologic Changes with Land Use

The hydrologic regime prior to the introduction of livestock and the subsequent clearing of woody vegetation, much of it regrowth or invasive, cannot be definitively known. However, the condition of the systems provides an indication. While the pre 1770 vegetation was not completely natural through being modified by the use of fire by Aboriginal people, it was very different to the existing expressions. Grasslands were extensive, dense and well foliated. The soils were much more friable and permeable to water, and stream lines were much less incised.

The initial and rapid changes produced by grazing were as described in Robertson's letter. Vegetation was denuded, soils eroded, and gullies became steeply incised and often saline. These changes arise through soil structure degradation due to exposure of the soil and reduced plant growth. The associated increase in surface runoff produces soil erosion and streams erode to produce deeply incised gullies. It also produces dryland salinity through surficial lateral seepage of water through the soil leaching soluble salts with the salts accumulating where flows seep to the surface. In parts of the Basin soil erosion has been massive, mainly occurring within short periods and associated with extreme events.

The sequence of change in the Western Division was denudation of grasslands, extensive erosion, and colonisation by native plants which usually had low palatability and became too tall to be grazed by livestock. The woody regrowth was sometimes extremely dense, as can occur with Cyprus pine, but was generally patchy with large areas of bare ground between copses of woody vegetation.

The preferred solution to the woody plant encroachments is to clear, plough, and either crop or plant to perennial pasture. This inevitably provides immediate large gains in production, but it also inevitably represents the commencement of a new degradation cycle. Baring the soil through cropping and/or grazing degrades the soil thereby promoting erosion etc. The resource base of the system declines with each cycle of development and degradation thereby producing a downward slide to the base level of bare ground (desert).

While this pattern of degradation associated with land use is most apparent in the Western Division it is general throughout the Basin. Land use has denuded the vegetation and compacted the soils. This has increased the surface runoff of water where this has caused extensive soil erosion and produced incised channels: the channel incisions serve to accelerate drainage of surface water flows. Land use has therefore greatly increased the surface flow of water to streams but decreased the period of flow. Post 1770 stream flows due to rainfall were larger, briefer, and contained more sediment than the pre 1770 condition.

Land development increased the frequency and extent of flooding. The development of river red gums is almost certainly much greater than pre 1770 condition due to recruitment being promoted by the increased flooding and grazing reducing competition by grasses. Extensive dense stands of river red gum are an example of 'bush thickening', or woody plant invasion, caused by grazing by livestock. The river red gum forests considered to be natural are largely anthropogenic.

The changes in rainfall- runoff characteristics have degraded the biology of rivers and streams. Increased flow rates have scoured channels thereby removing aquatic plants. Aquatic plants have been further suppressed by the high turbidity of flows. However, swamps that depend on intermittent flooding would have expanded with the increased amount and frequency of floods.

The increase in water extractions appears now to have countered the increase in stream flows arising from cropping and grazing. Systems that developed or expanded as a consequence of the increased runoff are now in decline. The issue in preparing the Basin Plan is whether there should be a requirement to maintain systems (‘key environmental assets’) that are artifacts of land use. The current approach is to say yes to all but, as that decision is based on the conclusion that the systems are natural, it is irrational. The use of infrastructure developed for irrigation to maintain something that arose through land degradation caused by grazing does not benefit either the environment or society.

Non-rainfall water accessions

Non-rainfall water accessions derive through indensation[5] whereby plants draw water from the atmosphere using energy derived from the perfield. Given the recent discovery of the process there is as yet no quantitative information of the water accessions to vegetation through indensation, but particular situations provide insights. Once established cacti can obtain all water needed for growth through indensation. Arid vegetation likely obtains most of its water through indensation, and that applies in Australia as elsewhere.

The relative contribution of rainfall to plant growth compared to indensation increases as rainfall increases. However, the total amount of water acquired through indensation will generally increase as rainfall increases for several reasons. One is the greater development of vegetation, another is the occurrence of more humid conditions.

Indensation requires live vegetation to occur, and leaves must be in good condition and not damaged. It is promoted by high concentrations of atmospheric water and so is generally enhanced at night compared to the day, and in winter compared to summer. However, energy from the perfield is continuously available hence indensation can occur whenever the atmospheric conditions are suitable. While the rate of indensation varies with environmental conditions, the supply of water to plants through indensation is much more regular and reliable than through rainfall.

Identifying levels of indensation throughout the Basin is highly speculative but some situations are known. Indensation is zero with bare ground, as with crop fallows and overgrazed lands. Indensation occurs during the growth of a crop but would cease when leaves senesce. The period of indensation is short and, due to the limited development of vegetation, high rates of indensation can only arise for short periods leading up to full crop development.

Currently the only means of obtaining an indication of the contribution of indensation to vegetation development is analogous to that used to identify groundwater – stream interactions in the Guide. The required measurements cannot be obtained so observations are juggled for specific circumstances in an attempt to obtain a balance.

Existing methods used to estimate water use by plants do not address indensation but indensation contributes to plant growth. It therefore affects estimates of water use efficiency. Based on water use efficiencies observed in the laboratory, vegetation development in the field is much greater than could arise solely through rainfall. The question is, how much additional water over rainfall is needed to produce the observed vegetation?

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[5] See papers on www.eric.com.au under water. The heavy ‘dews’ that occur following periods of rain represent indensation and not condensation. Storage of Indensed Water in Soils

While extremely loathe to provide a figure one is needed for others to gain an appreciation of the importance of indensation. For intact vegetation in parts of the Basin of consequence to the production of blue water a range between 50 and 100% of the rainfall appears to be realistic.

The estimate of the contribution of indensation will always be a range, even for a particular stand of vegetation. Indensation increases as the vegetation develops. The more vegetation the greater the indensation. However, vegetation development is also controlled by plant life cycles wherein very high levels of vegetation development cannot be maintained[6]. The relationship between the contributions of rainfall and indensation to plant growth is dynamic.

With the pre 1770 vegetation grasses were dominant throughout the basin. With grazing these were degraded to the point of many becoming annihilated. This would have reduced water accessions through indensation to very low levels. The shrub encroachments / woody plant invasions countered the losses from grasses, but the woody vegetation took time to develop, partly due to the erosion but also because of the efforts of landholders to prevent it. Highlands that were little impacted, and hills in eastern parts of the Basin that became densely vegetated by trees, are likely the only areas where levels of indensation are similar to the pre 1770 situation.

The issue for the development of the MDB Plan is the extent to which the change in indensation has affected streams and wetlands by way of flows and condition. The general occurrence of chains of ponds in temperate parts of the Basin at least indicates that indensation provided reliable accessions to streams. From consideration of the process and very limited observations[7], flows would have been low. However, the reliability and quality of the water makes it important for aquatic biota.

The vegetative and soil conditions that produce indensation minimise surface runoff. They also promote the infiltration of rainfall into the soil, its storage in the soil, and its percolation through the soil along preferred pathways such as old root channels. The net effect is reduced flooding compared to the current situation and increased and more persistent stream flows of higher water quality. Total outflows are likely lower than with land degradation but the characteristics of the flows are environmentally much better.

Cumulative effects

Global features strongly influence climate but regional features also have an effect. The cycle relevant to land use is water transpired by vegetation condensing in the atmosphere and falling as rain. It appears that bacteria that move with the transpired water promote the condensation of water and thereby facilitate this process. Water transpired by vegetation increases rainfall.

There is currently no apparent means of determining whether indensation has a direct effect on rainfall. However, there will be an indirect effect through indensation increasing the development of vegetation. The current situation is the reverse whereby the clearing and grazing of vegetation reduce rainfall wherein positive feedbacks produce an ongoing decline.

The reduction in groundwater recharge with loss of indensation will be much greater than the reduction in rainfall due to the degradation of soil structure and the greatly reduced indensation.

The conclusions are that in the pre 1770 situation:

[6] Addressed in a series of papers in the vegetation section of www.eric.com.au

[7] Localised occurrences exist but have been interpreted as being springs arising through rainfall.

- Much more water percolated into groundwater systems
- Flows in streams were much more persistent, of higher quality, but possibly lower in quantity
- Peak flows were considerably lower and of much higher quality

While the yields in streams may currently be greater than pre 1770 that situation will not continue. The inevitable decline in rainfall will reduce water yields as will the loss of groundwater accessions deriving from indensation.

REPAIRING THE BASIN

The solution proposed in the Guide is to reduce water harvesting for agriculture wherein the redirection of water to key environmental assets is identified as maintaining the health of the Basin. Given just a glance at the degradation of the basin, and its causes, this suggestion does not even have the status of wishful thinking. Indeed, redirecting water away from irrigation has the potential to exacerbate the rate of degradation of the Basin by increasing pressure on dryland agriculture.

Maintaining the current condition of the Basin is not an option given the level of degradation and its ongoing and compounding nature. To prevent a total collapse of the productive systems the condition of the Basin must be improved. To be effective as well as practical, the changes must use the natural positive feedbacks to produce ongoing improvements. The changes must reverse the ongoing degradation.

The adverse changes have mainly arisen through dryland agriculture but irrigated lands now contribute significantly given their expansion. The changes needed for the basin to be viable revolve around agriculture.

The key requirement is to maintain a cover of green vegetation where this vegetation development is linked with the development of soils. The soil profile must remain intact with continuous and undisturbed development of plant roots. Solutions developed by farmers in productive systems are summarised in papers on www.eric.com.au.

If the objective of the Basin Plan is to maintain its health while taking account of socio economic considerations, as is the stated intent, then the solution lies in supporting farmers in transitioning into sustainable farming practices. The objective cannot be achieved by taking water from farmers regardless of what it is used for.