What is 'environmental water'?

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Abstract

As Australian policy makers have sought to make the use of our water resources more sustainable, the concept of 'environmental water' has arisen. Unfortunately, there has never been an agreed definition of the term, so its meaning varies. Some uses of the term environmental water assume it is any water which supports or enhances natural ecological systems. Other uses relate to rights to water that are committed to achieve environmental benefits (but may be sold for economic use when not needed). A common misconception is that water is used for either environmental or economic purposes, when water in rivers is more often than not both at different times. In fact water is commonly used many times before it is finally 'lost' by evaporation or outflow to the sea. Statistics about volumes of water for the environment are misleading and inconsistent, principally because authors of reports attempt to force water volumes into either environmental or consumptive in an ad-hoc way. This paper explores explicit and implicit definitions of environmental water in common use and suggests how greater clarity might better inform policy making.

Keywords

Environmental water, water accounting

Definitions in current use

The national stocktake of water accounting (Sinclair Knight Merz, 2006) reports that across Australia the term 'environmental water' is used by people to mean several different things, such as:

- Water consumed (eg by evaporation, transpiration etc) by ecological processes. For example, in the case of water flowing into a floodplain wetland only the water that does not eventually return to the river is classed as environmental water;
- The residual of water not used for human consumptive purpose, including all losses and evaporation;
- Water that is set aside for environmental purposes, whether it actually achieves ecological benefits or not. (Examples of this are water access entitlements set aside for environmental purposes, and non-entitlement rights such as the Barmah Millewa forest watering rights on the Murray);
- Water that is held in storage and released specifically to achieve environmental outcomes;
- Water allocations that the environment has a right to, either rules based or entitlement based;
- Any water that achieves ecological benefits. For example it is argued by some that any water that flows down a river is ecologically beneficial, even if it is extracted at a point downstream for irrigation.

The consequence of these different meanings is that when different authors use the term 'environmental water' they are implicitly meaning one of these things, while the reader may be thinking another.
The National Water Initiative (NWI) makes several references to environmental water. The closest thing to a definition of environmental water is found in clause 35, which states:
"Water that is provided by the States and Territories to meet agreed environmental and other public benefit outcomes as defined within relevant water plans is to… be defined as the water management arrangements required to meet the outcomes sought, including water provided on a rules basis or held as a water access entitlement"

The language here is less than clear, but taking into account clauses 78, 79 and 85 also, there is an overwhelming sense that the authors of the NWI conceived environmental water (whether defined by *rules* or *water access entitlements*) as rights to extract and/or capture water (e.g. in a dam) so that physical water can be *provided* by an environmental water manager to achieve specified *outcomes*. It implies that the amount that can be drawn on at any time by the manager pursuant to the rights can be quantified, and that the

manager has some discretion in relation to when and how that water is provided so as to maximise achievement of outcomes.

The NSW *Water Management Act 2000* section 8 defines environmental water as the actual water arising from commitments either via rules in plans or from licensed water rights. A range of different types of environmental water commitments (generally called rules) appear in NSW water plans, including annual extraction limits (which commit water not extracted to the environment); discretionary allocations; minimum flows at certain points and certain times; transparent and translucent dam release rules; and (for unregulated rivers) rules which prohibit or limit extraction of water at times of low flow.

The *Victorian Water Act 1989* (as recently amended) provides for an "environmental water reserve", which is water that is set aside for the environment either under legislation, statutory plans or conditions on entitlements. In practice the actual rules used to implement the environmental water reserve are similar in nature to those listed for NSW.

South Australian legislation (*Natural Resources Management Act 2004*) requires that water allocation plans assess the needs of water dependent ecosystems and plan for allocation of water taking that into account. The concept of 'environmental water' is not developed in either legislation or plans. The plans incorporate an assessment of the regime needed to maintain ecological systems, and set out rules for allocation and use of water that are designed to maintain that regime where feasible. The River Murray plan includes a 200GL/yr licensed allocation of water which may be taken from the River Murray to water wetlands, and strategies to lower and surcharge River Murray weir pools at various times

Like South Australia, Queensland water legislation and plans do not develop or use the concept of 'environmental water'. The *Water Act 2000* (section 10) requires planning and allocation of water to be ecologically sustainable. Water resource plans have been prepared on the basis of determining how much disturbance of natural flow regimes (by dams, weirs, extraction of water) can be sustainably allowed. In practice the water resource plans and subordinate river operation plans incorporate a range of strategies similar to those used in other states eg minimum flows at various points, target weir pool levels etc.
These definitions can be categorised into three types of meanings given to the term 'environmental water':

1) Any right to water (i.e. to extract water and/or to water captured in a storage for release when called – also commonly know as water entitlements or allocations) which is designated to be used to promote ecological outcomes;
2) Any water which is provided with the objective of achieving a ecological objectives (whether it comes as a result of the exercise of a water right or an operating rule);
3) Water which achieves ecological objectives regardless of how or where it comes from or what else it is used for.

It is important to understand which type of meaning an author has in mind in order to properly understand their statements.

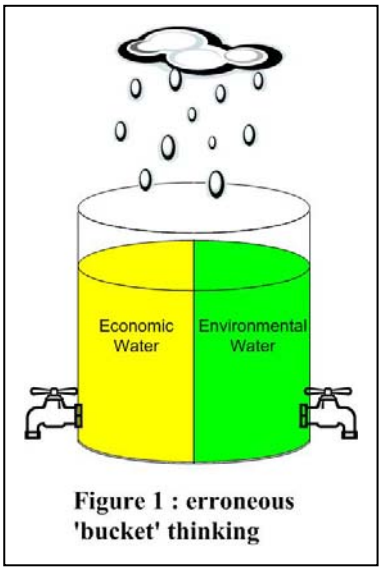


Figure 1 : erroneous 'bucket' thinking

Water is normally used more than once

A common misconception, reflected in diagrams and statistics, is that water is either economic or environmental in terms of its benefits. River and aquifer systems are conceptualised as 'buckets' into which water flows and is neatly divided into environmental and economic (Figure 1). Many presentations show pie charts with the inflows into a system portioned into various uses – the environment being one. This thinking fails to recognise that water is a multi-use resource, achieving a range of benefits as it passes through the landscape before returning to the sea or the sky.

In practice, water planning for ecological sustainability aims to maximise the ecological uses of water as it passes through a river system. To a large extent, ecological benefits are achieved with only partial 'consumption' (ie removal by evaporation, transpiration or locking into bio-matter) of the

water. For example in-river ecosystems remove little water, and a large portion of water which inundates floodplain wetlands returns to the river or recharges aquifers – enabling it to be used again for either ecological or economic purposes.

In a river system water flows in from the catchment, passing down streams into rivers and during floods spreading water onto floodplains. As it moves through the system it supports ecological systems. Where there are no significant dams or weirs, water which is extracted continues to achieve these ecological benefits down to the point of extraction, thus being clearly multi-use.

Where there are significant dams to hold water and release it in a controlled fashion, the flow regime below the dams may be altered so that it no longer supports many aspects of the natural ecosystem. Some environmental rules are designed to make these releases in ways that are more reflective of natural flow patterns so that negative effects are minimised or removed. For example, pulsing of water supply flows has been used in many areas to mimic natural variations. Thus it is possible that water supply releases from dams are still to some extent ecologically beneficial in addition to their being used for economic benefits.

On the other hand, a significant proportion of the water which flows into wetlands and floodplains makes its way back into the river, and so can be extracted downstream for economic production. Thus there is no doubt that water is commonly used many times before it returns to the sea or the atmosphere.

Statistics which give the wrong impression

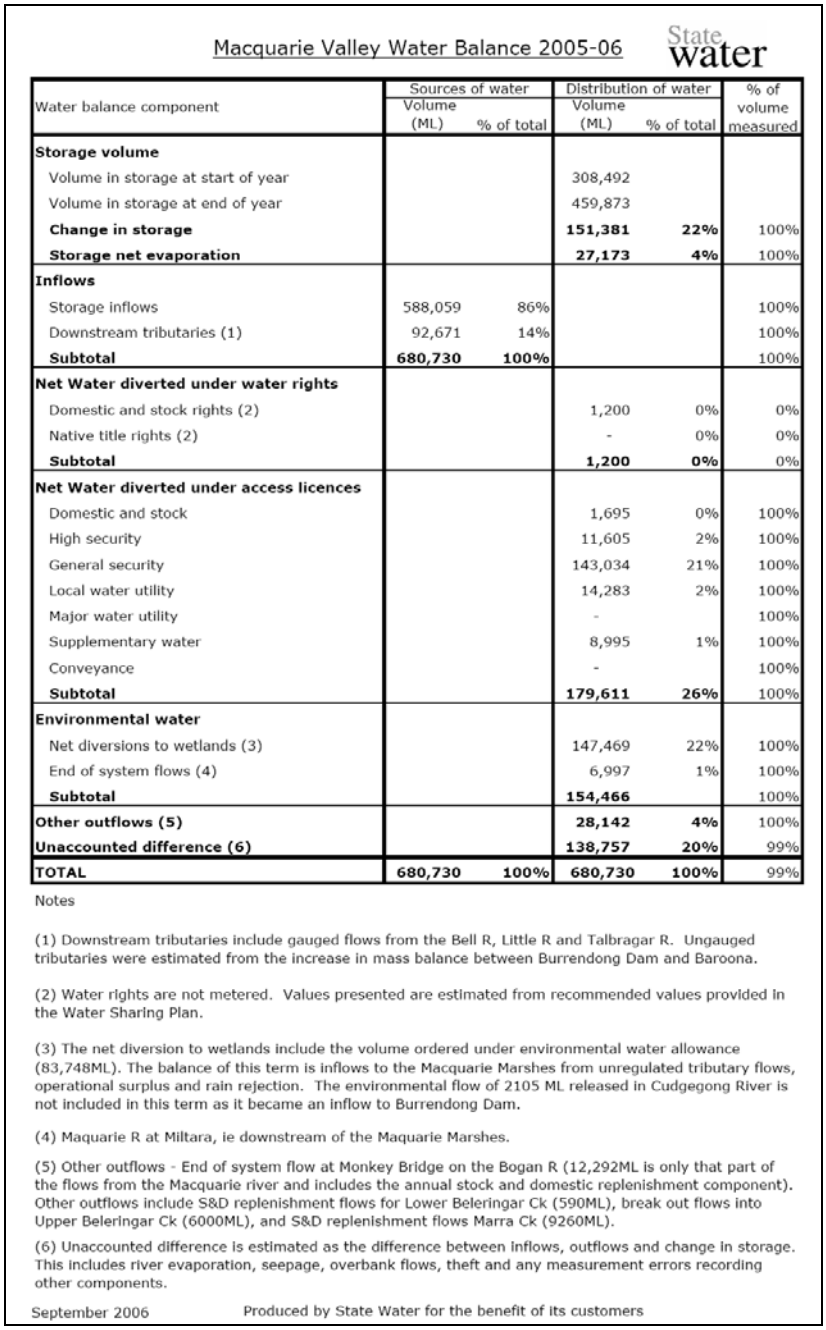
When public authorities report environmental water volumes based on 'rights' or other such meanings, the public often perceive this from a 'benefits' point of view. As shown above, attempts to divide up water into environmental and economic will always give the wrong impression because water is frequently used multiple times.

Example: Macquarie Valley Water Balance Report
The report shown at Figure 2 is published on the website of NSW State Water (http://www.statewater.com.au/watdel/watbalmac.pdf).
This report is a water balance, which aims to show what water has come into the river system and where it has gone to. Reading this as it stands there is an implication to the casual reader that 23% of the inflows is beneficial to the environment, and the rest is not.

The major problem is that a water balance report of this kind is driven by financial accounting thinking which seeks to place volumes of water into one box or another so the totals will balance. Two classes of environmental water are shown. The first is the net water going into the Macquarie Marshes. The second is end of systems flows, part of which would be returns from the Marshes. The report implicitly defines 'environmental water' as water which leaves the system for a purpose deemed to be environmental.
This definition is different to the legal definition of environmental water which applies in NSW, which is that environmental water is any water that arises from environmental commitments either via rules in plans or from licensed water rights.

It is also different to the meaning used in the Macquarie regulated river plan (NSW Government, 2003), which makes provision first for environmental water to be all water in excess of that allowed to be extracted. Using the figures in the water balance report, this amounts to 348,538 ML (inflow taken into storage is discounted as it may be released for extraction or environmental purposes in future years), or 51% of inflow, compared to the 154,466 ML (23%) shown in the report.

In addition, the plan provides for environmental water as releases from dams for instream environmental purposes. The volumes involved here would overlap at least to some extent the environmental water arising from the first rule, making summing the volumes inappropriate. The report refers to some of this in note 3 (2105 ML released into the Cudgegong River), but excludes it from the table because it does not leave the system.



Macquarie Valley Water Balance 2005-06

State water

Water balance component	Sources of water Volume (ML)	% of total	Distribution of water Volume (ML)	% of total	% of volume measured
Storage volume					
Volume in storage at start of year			308,492		
Volume in storage at end of year			459,873		
Change in storage			**151,381**	**22%**	100%
Storage net evaporation			**27,173**	**4%**	100%
Inflows					
Storage inflows	588,059	86%			100%
Downstream tributaries (1)	92,671	14%			100%
Subtotal	**680,730**	**100%**			100%
Net Water diverted under water rights					
Domestic and stock rights (2)			1,200	0%	0%
Native title rights (2)			-	0%	0%
Subtotal			**1,200**	**0%**	0%
Net Water diverted under access licences					
Domestic and stock			1,695	0%	100%
High security			11,605	2%	100%
General security			143,034	21%	100%
Local water utility			14,283	2%	100%
Major water utility			-		100%
Supplementary water			8,995	1%	100%
Conveyance			-		100%
Subtotal			**179,611**	**26%**	100%
Environmental water					
Net diversions to wetlands (3)			147,469	22%	100%
End of system flows (4)			6,997	1%	100%
Subtotal			**154,466**		100%
Other outflows (5)			**28,142**	**4%**	100%
Unaccounted difference (6)			**138,757**	**20%**	99%
TOTAL	**680,730**	**100%**	**680,730**	**100%**	99%

Notes

(1) Downstream tributaries include gauged flows from the Bell R, Little R and Talbragar R. Ungauged tributaries were estimated from the increase in mass balance between Burrendong Dam and Baroona.

(2) Water rights are not metered. Values presented are estimated from recommended values provided in the Water Sharing Plan.

(3) The net diversion to wetlands include the volume ordered under environmental water allowance (83,748ML). The balance of this term is inflows to the Macquarie Marshes from unregulated tributary flows, operational surplus and rain rejection. The environmental flow of 2105 ML released in Cudgegong River is not included in this term as it became an inflow to Burrendong Dam.

(4) Maquarie R at Miltara, ie downstream of the Maquarie Marshes.

(5) Other outflows - End of system flow at Monkey Bridge on the Bogan R (12,292ML is only that part of the flows from the Macquarie river and includes the annual stock and domestic replenishment component). Other outflows include S&D replenishment flows for Lower Beleringar Ck (590ML), break out flows into Upper Beleringar Ck (6000ML), and S&D replenishment flows Marra Ck (9260ML).

(6) Unaccounted difference is estimated as the difference between inflows, outflows and change in storage. This includes river evaporation, seepage, overbank flows, theft and any measurement errors recording other components.

September 2006 Produced by State Water for the benefit of its customers

Figure 2. Water Balance Report prepared by State Water NSW.

Looking at the water in the system from an ecological benefit point of view, it could be the case that water released from the dams for extraction downstream still provides instream ecological benefits en-route to the point of extraction – a typical multiple use scenario. This type of report fails to recognise this whatsoever, just as it excluded the dedicated environmental flows in the Cudgegong River.

Lastly the inconsistency of calling the outflow from the system environmental water when other outflows are not classed as such has to be questioned. The outflow into the Darling is just as likely to be extracted by water users downstream as the replenishment flows listed in note 5 of the report.

Example: Victorian State Water Report 2004/05

Victoria now produces annually a report which shows amongst other things, a water balance table for each river valley. An example is shown in Figure 3. This report has the same fundamental problem as the previous example, in that it forces the volumes of water to be in either one category or another, not recognising that water is multiple use. It thus gives a false impression of the extent to which the river system is being managed to achieve ecological benefits. The end of system outflow for each basin is reported as the environment's share of total flow in the basin. In the example above, this amounts to 449,700 ML out of a total inflow of 2,464,000 ML, or 18%. Readers of the report are given the clear impression that only 18% of the water in the Goulburn produces ecological benefits.

Balance of surface water in the Goulburn basin

Water Account Component	2004/05 (ML)	2003/04 (ML)
Storage Volume		
Volume in storage at start of year [6]	695,500	476,100
Volume in storage at end of year	963,100	859,600
Change in storage	267,600	383,500
Inflows		
Catchment inflow [1]	2,366,600	2,813,300
Inflow from Broken River at Gowangardie	94,900	114,300
Return flow from irrigation [2]	0	0
Treated effluent discharged back to river	2,460	3,150
Sub-total	**2,464,000**	**2,930,800**
Usage		
Urban diversions	27,890	25,550
Irrigation district diversions	1,434,000	1,476,300
Licensed private diversions from regulated streams	25,400	24,800
Licensed private diversions from unregulated streams	8,100	13,700
Silver and Wallaby Creeks to Yarra Basin	9,300	3,000
Environmental water diversions	500	0
Small catchment dams	47,500	47,500
Sub-total	**1,552,700**	**1,590,900**
Losses		
Net evaporation losses from major storages [3]	66,400	119,800
Losses from small catchment dams	9,700	9,700
In-stream infiltration to groundwater, flows to floodplain and evaporation [4]	115,200	293,800
Sub-total	**191,300**	**423,300**
Water Passed at Outlet of Basin		
Goulburn River to Campaspe River via Waranga Western Channel [5]	2,700	0
Goulburn River outflow to River Murray	411,300	494,300
Goulburn River outflow to River Murray via Broken Creek	38,400	38,900
Environment's Share of Total Flow in the Goulburn Basin	**449,700**	**533,200**

Notes:

(1) Inflows have been back-calculated from outflows plus diversions.

(2) Assumed to be zero as Goulburn-Murray Water was unable to readily separate return flows by basin in 2004/05.

(3) 2003/04 erroneously included evaporation from the off-stream storage of Waranga Basin.

(4) Losses estimated using loss functions from the Goulburn Simulation Model (REALM). The volume of estimated losses decreased from the previous year due to an improvement of the calculation method.

(5) Value omitted in 2003/04.

(6) Start storage of current year and end storage of previous year do not match because the off-stream storages of Waranga Basin and Greens Lake are no longer included in the storage calculation in 2004/05.

Figure 3. Water Balance Report from Victorian State Water Report 2004/05.

The reason for defining the outflow as the environment's share is not made clear. It does not relate to any other definition of environmental water. For example, Victoria's Environmental Water Reserve is to be established in each basin by putting in place a limit on consumptive use of water. This is, initially at least, the value set under the Murray-Darling Basin Cap (Victorian Government, 2004, p44.). Water not extracted is thus implicitly environmental water. Using the figures above, this would amount to 911,300 ML, more than twice the value shown in the report.The system outflow definition implies that only that part of the water which makes it all the way through the river system achieves ecological benefits, which is hardly the case. For example the report shows separately a figure of 115,200 ML for in-stream infiltration to groundwater, flows to floodplain and evaporation. This would be highly likely to be achieving ecological benefits. In addition the much larger river flows between Eildon and the major offtake points may also be achieving significant non-consumptive in-stream benefits (although this depends on whether the negative effects of counter seasonal flows with reduced variability exceed the positive benefits).

In summary then, the reporting of the environments share of water in the Victorian *State Water Report* lacks credibility and leaves readers with a totally wrong impression about the health of the river system.

Conclusion

There is no common understanding of what environmental water is. Meanings in use include environmental water being:

1) Rights to water (ie to extract water and/or to water captured in a storage for release when called – also commonly know as water entitlements or allocations) which are designated to be used to promote ecological outcomes;
2) Water which is provided with the objective of achieving ecological objectives (whether it comes as a result of the exercise of a water right or an operating rule);
3) Water which achieves ecological objectives regardless of how or where it comes from or what else it is used for; and
4) Volumes leaving river systems which are designated (for reasons which are not always clear) to be 'environmental'.

The consequence of these different definitions is that when different authors use the term 'environmental water' they are implicitly meaning one of these things, while the reader may be thinking another. This inevitably leads to misunderstanding and incorrect interpretation of information. In particular the public tend to incorrectly read reports purporting to split volumes in rivers (or aquifers) into environmental and economic as a measure of how well the environment is being supported.

Water as it passes through a river system is likely to be used many times, not just once. Even releases from dams for water supply purposes can be beneficial if they are done in a way which mimics natural variability. Attempts to apportion water volumes as either environmental or not are thus bound to be misleading. Sustainability in river systems relies on having flow regimes which in terms of variability, seasonality and volume support valued ecological systems. Environmental water rules are designed to protect or restore aspects of the flow regime which are considered to be most important. Some rules relate to water allocations similar in nature to water allocations held for economic benefit. These lend themselves to volumetric reporting. Many rules, however, are not able to be specified volumetrically. Regardless of which type of rule, effectiveness cannot be represented meaningfully on any sort of water balance sheet. It can only be demonstrated by whether the targeted flow regime parameters are achieved, and beyond that whether these parameters deliver on the desired ecological outcomes.

With this in mind, it would be more accurate if legislation and policy avoided the assumption that water is either environmental or economic. Sustainability should be the foremost concept, with environment water rules being recognised as strategies to achieve flow regime characteristics identified as being most important for ecological sustainability. Volumetric allocations of water can and should be used to contribute to achievement of these characteristics also. Environmental sustainability reporting should focus on achievement of targeted flow characteristics and/or direct measures of ecological health. Any report which attempts to apportion water in rivers or aquifers into environmental and economic should be avoided.

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