POWER FOR IRRIGATION WEALTH AND RIVER HEALTH
(Trading Environmental Energy for Environmental Services and Flows)

Michael Longhurst*
Central West Catchment Management Authority, Dubbo, NSW, Australia

ABSTRACT
Providing irrigators with electricity in exchange for reduced water allocations offers a solution to recovering water for environmental flows for the Murray River. All beneficiaries of irrigation water and hydro-electricity should share the cost of managing the impacts of large dams. A community contribution of free or low cost power in exchange for reduced allocation could compensate irrigators for providing environmental services.

600GWh of subsidised electricity per year could encourage conversion from flood irrigation to more water efficient systems. This energy could provide 30 metres of pressure to deliver 6,000GL through spray irrigation. 6,000GL is 80% of the 7,500GL irrigation allocation in the Murray system. 1,500GL has been recommended as the 20% environmental flow needed to improve the health of the river.

A voluntary exchange by irrigators of some water allocation for power could provide a market based instrument to:

- Increase environmental flow allocation for the Murray;
- Compensate irrigators for voluntarily reducing allocation to provide environmental services;
- Encourage shift from flood irrigation to more water efficient systems;
- Reduce irrigation salinity and water logging;
- Expand rural irrigation manufacturing and supply industry; and
- Trade water and power across catchments with varying levels of allocation to maintain rural economies.

KEY WORDS
Environmental energy, environmental flows, flood irrigation, gigalitre (GL), Hydro-electricity, market based incentive, megalitre (ML), pressurized irrigation, river regulation, water allocation.

INTRODUCTION
Don Blackmore, Chief Executive of the Murray Darling Basin Commission concluded that a "mutual obligation" transcending State boundaries was needed to sustain the future of the basin (ABC 2001).

A voluntary instrument is put forward that provides all beneficiaries of water and electricity sourced from large dams in the Murray Darling Basin opportunity to contribute to restoring river health. Increased irrigation demand has extracted too much water from rivers. Governments of the Murray Darling Basin have agreed to increase environmental flows by up to 1,500GL per year (MDBC 2003). Some mechanisms and incentives are suggested for sharing the costs of reduced water allocation to provide several environmental services.

*Correspondence to: Michael Longhurst, Central West Catchment Management Authority, PO Box 2105 Dubbo, NSW, Australia.
E-mail: Michael.longhurst@cmansw.gov.au

About 14% of 7,500GL of bulk delivered water in the Murray Darling Basin is lost in delivery. Recovery of this water could come from engineering solutions to such as installing pipes and lining channels to reduce evaporation and seepage (Whittington & Hillman 1999). The potential recovery of these losses could provide an additional 1,000GL.

Some loss of allocation to irrigators is likely to provide some of the environmental flows. The total annual cost of environmental flows across the Basin of 1500GL is estimated at $74m to $155m and a permanent reduction of allocation measured as lost property rights ranges from $1,040m to $2,186m (MDBC 2003).

A uniform cut of allocation of 1500GL is considered a blunt and uninformed approach to achieving environmental flows. The several regulated rivers that deliver irrigation water have a range of environmental flow needs. Further analysis of a market based approach could inform where to best source and release environmental flows (MDBC 2003).

Simply buying back water may not encourage more water efficient irrigation. Some larger irrigation scheme companies are opposed to the sale of water allocation from their districts. The fear of these irrigators of such a loss of allocation could increase shared infrastructure costs and erodes the local community and economy (MDBC 2003).

A more integrated approach to management of the water and power stored in major dams is suggested to improve river health, compensate irrigators for reduced allocation and encourage water efficient crops and irrigation methods.

Changes to current irrigation methods could save water, but at some expense to irrigators. Pressurised irrigation (spray, drip) uses less water but needs more power than flood systems. A voluntary system to off-set reduced water allocation traded for low cost power is described.

Further economic and social analysis is needed to fully evaluate this incentive scheme. Calculations and quantities are indicative only. The concept suggested of trading water for power as an instrument to provide environmental flows and more efficient irrigation is the focus of this discussion.

BACKGROUND

An estimated environmental flow of 1,500GL annually is needed to provide a moderate chance of improving river health in the Murray River. This 1,500GL is equivalent to 20% of the 7,500GL irrigation water allocation for the Murray system. More water flowing down the Murray is needed to reduce salinity, improve aquatic habitat and keep the Murray open to the sea (Scientific Reference Panel 2003).

Large dams provide water to irrigators and hydro-electricity to the general community. River flows are regulated to meet irrigation demand. Hydro-electricity is captured and delivered for use by households and industry across the grid system in south-eastern Australia (Pigrim2000). The cost of improving river health should be shared by all the users of energy and water stored in dams.

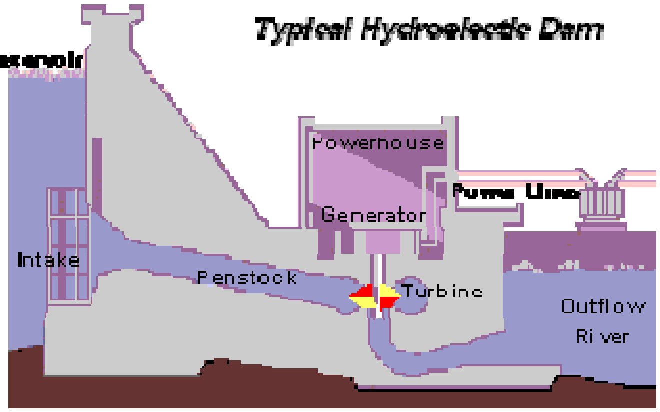


Figure 1 – Stored energy and water (http://www.tva.gov/power/hydroart/loo.htm)

Over 80% of the irrigated area in NSW uses flood or furrow method (NSW Water Resource Council 1991). Flood irrigation uses less energy and more water than pressurised systems. Systems that need more pressure than flood include spray, micro-jet and drip irrigation.

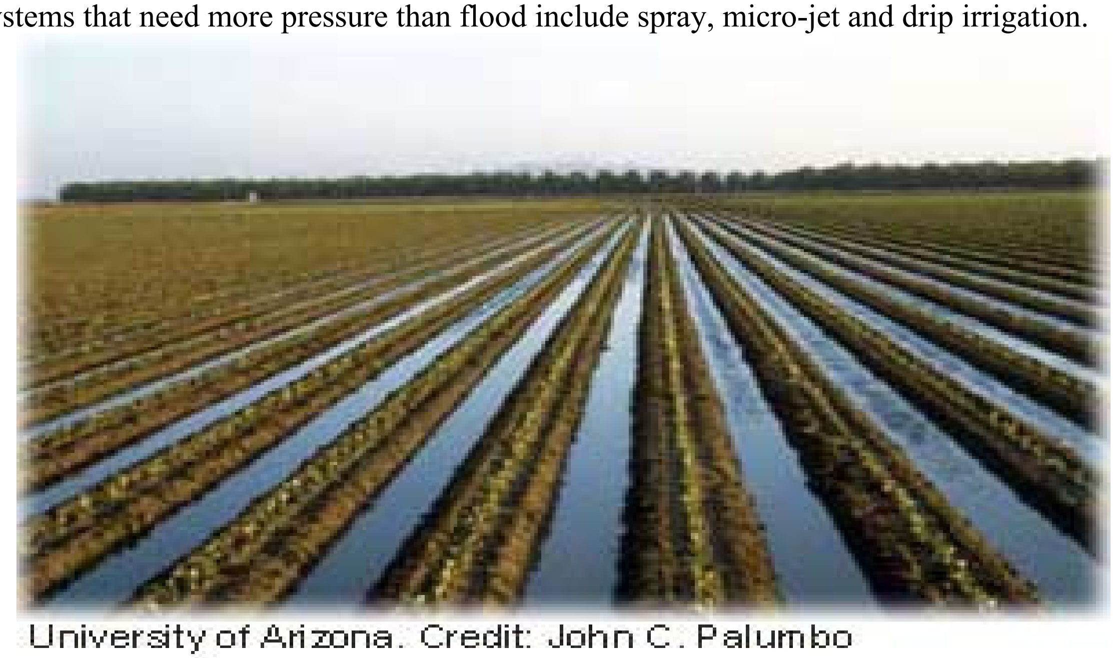


Figure 2 – Furrow flood irrigation

Flood irrigation (Figure 1) applies more water than most crops need by watering the whole area between plants and deeper than the root zone of seedlings and shallow rooted plants. The low energy component of flood irrigation encourages inefficient water use.

The energy cost of pumping a megalitre of pressurized water onto a unit of land using spray or drip (Figures 3 & 4) is about three times or more than using flood irrigation. Most of the energy for flood irrigation is used in pumping water to the top of the bank. Energy for 30 metres of pressure for spray is needed in addition to pumping water up the river bank onto level ground.

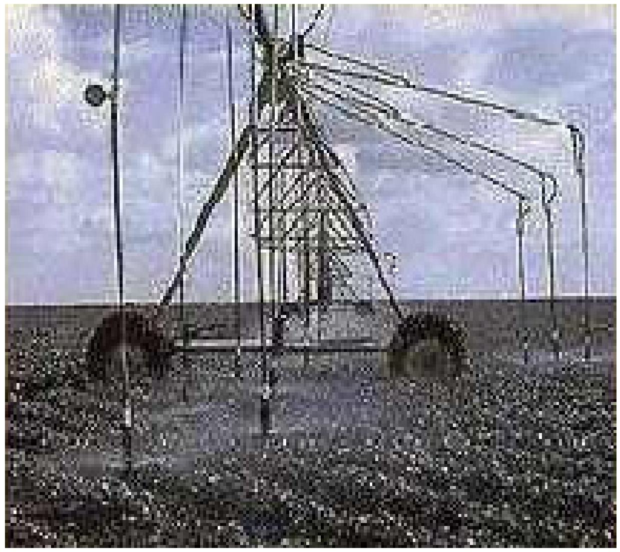


Figure 3 – pressurized spray irrigation

Figure 4 – drip irrigation

Lowering the cost of power for spray irrigation to equal or lower than the energy cost for flood irrigation would encourage more efficient use of water. Exchanging low priced power for voluntary reduction of water allocations could be used to reclaim some of water to be used for environmental flows.

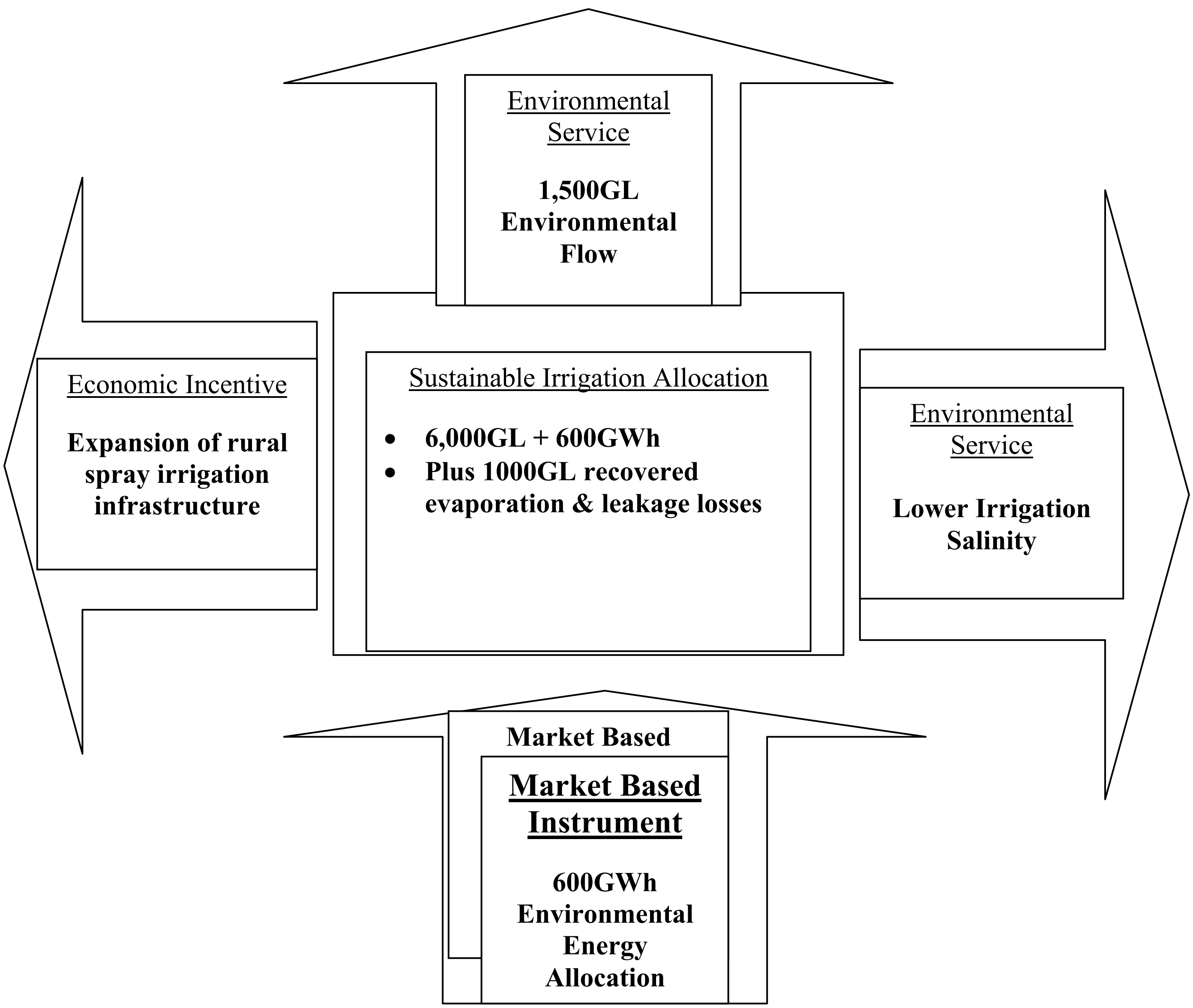
MARKET BASED INSTRUMENT

Incentives are needed for irrigators to adopt more water efficient practices and sustain production with less water. Food and fibre from irrigated agriculture are essential for local consumption and export income for the national economy. A market based instrument to trade power for water could encourage a shift from flood/furrow irrigation (Figure 2). This reduction of applied irrigation water could improve river health (The National Action Plan on Salinity and Water Quality 2002).

The high power cost of pressurised irrigation is a disincentive to water efficient irrigation. A subsidy for several environmental services paid to the primary producer provides more benefits than buying back water (Figure 5). Linking water and power at this primary level encourages investment in water efficient irrigation equipment.

Low margins associated with many winter crops are a disincentive to irrigate. Spray irrigation of winter crops could increase yields in low allocation years when demand and prices are higher. Increased winter crop production could provide valuable food and income in drought years. Climate change and less water could make winter irrigation an attractive option.

Figure 5 - Market Based Instrument & Services to sustain Murray river health and irrigation



Trading water and energy across catchments could be an incentive to moderate investment in allocation and increase investment in spray irrigation equipment. Some catchments have higher levels of over allocation of water than others. Trading power for water provides an incentive mechanism to adjust water allocations from over allocated valleys with catchments with high hydro-electricity capacity.

ENVIRONMENTAL SERVICES

The community as a whole benefits from food and fibre provided by irrigation. The community also uses hydro-electricity from the same dams that store irrigation water, and the community demands environmental services to improve river health.

The term "environmental" is given to flows released from dams to restore river health. *Environmental energy* could similarly describe power allocated to increase irrigation efficiency and improve river flows. A 600GWh annual allocation subsidy from large dams could provide environmental services (Figure 5).

Environmental organisations and agencies are advocating for more environmental flows for the health of river ecosystems (Inland Rivers Network 2003). At the same time the irrigation is an important primary industry producing wealth, food and fibre. It is reasonable to expect the community that benefits and consumes irrigated produce to compensate the reduction of some water allocation for environmental flows.

Relinquishing allocation to be used as environmental flows would be a tangible environmental service at cost of reduced property rights for irrigators. A subsidised power cost to the irrigator by the community could compensate irrigators for providing this service.

The Snowy River will receive 28% of the original flow that had been reduced to 1% by diversion of water for irrigation and hydro-electricity (Craig Ingram 2002). This adjustment to flows to improve the health of the Snowy sets a precedent for the community contributing to reducing impacts of river regulation.

EXCHANGE OF CATCHMENT WATER FOR POWER

Environmental Energy Estimate for Improved Environmental Flows

Paying the full price directly to irrigators in exchange for water rights in a lump sum would be expensive and could shrink a vital rural industry. There are currently physical and institutional constraints on water being fully tradeable across the Basin (MDBC 2003). Trading energy across the Basin is feasible via the electricity grid. A subsidy of low cost power could be considered as an allocation of environmental energy to reduce the impacts of supplying hydro-electricity and irrigation from dams.

A precedent for electricity subsidy in Australia exists for aluminium smelters that pay 2 cents per kilowatt hour, while most households pay 12-20 cents per kilowatt hour (Flannery 2005).

A financial relationship would need to be established to adjust differential increases between energy and water and different water values between catchments. If 10¢/kWh and $1000/ML represented current values, in several years time the relative values are likely to be higher and a different ratio (say 20¢/kWh and $5000/ML). These values would need to be reviewed so the energy subsidy remains fair for both irrigators and the community.

POWER ESTIMATE

How much power is needed to pressurise water for more efficient irrigation?
1,500GL is the 20% recommended to be returned to the Murray for a moderate chance or restoring river health. 100% allocation for the Murray is 7,500GL and 80% is 6,000GL.
A conservative (but hypothetical) quantity of energy to power 6,000GL spray irrigation and encourage most flood irrigation to change to more water efficient methods is used. Many solutions are likely to be developed to recover sufficient flows.

The following calculation is based on the question “What is the cost of power needed to pressurise 6,000GL for delivery through water efficient systems such as spray irrigation?”

Hydraulic pressure for irrigation is measured in metres and commonly described as a number of “metres head”. In many instances an additional 30 metres head is needed to force water though pipes and drive irrigation sprinklers on level ground.

The formula for water power, referred to as water kilowatts (WkW) is:
WkW = (Litres per second x metres head)/102.04 (Southern Cross Machinery).

For calculating power, the units of ML/hour are converted to litres per second (L/s). One ML/h equals 278L/s.

For 1ML/h and 30m head WkW = (278L/s x 30m)/102.04 = 82 WkW.

Allowing a margin of 20%, about 100kW of power is estimated to pressurise 1ML of water with 30m head for one hour. Therefore, the power to pressurise 6,000GL with 30m of pressure is:
100kWh/ML x 6,000,000ML = 600,000,000kWh (600GWh).

At 10¢ per kWh the cost of 600GWh of power is $60 million per year. The cost of the incentive is likely to be significantly less if a lower bulk energy price was applied. This annual investment could be a continual incentive for water efficient irrigation with more benefits than a simple buy back of allocation.

As an example, an irrigator that has a annual 1,000 ML allocation could exchange 200 ML for 10 cent per kilowatt subsidy to pressurise irrigation of the remaining 800 ML calculated as:
800ML/year x 100kWh/ML x 10 cents/kWh = $8,000 per year subsidy.

Different valleys and authorities charge different amounts for delivered irrigation water. If the annual charge for a ML is $5 then an additional reduction of used water cost of for the 200ML forgone is $1,000. This $9,000 per year incentive can then offset capital and running costs for pressurized irrigation that also gives more irrigation options when allocations are low.

In 2002-03 Snowy Hydro Limited generated 4,750GWh and released 2,220GL of water for irrigation (Snowy Hydro Limited). There are hydro-electricity generators installed on several other storages in the Murray Darling Basin apart from the Snowy. This concept would support more generators on existing dams to increase the quantity of environmental energy for river restoration.

EXCHANGE METHOD

Direct subsidy of electricity to irrigators at primary production level would be easily administered. In many cases the water supply and electricity authorities could collaborate to account for the electricity and water used by the same pump and adjusted concurrently. Irrigators that don't use electricity for pumping could receive a credit for electricity used elsewhere.

The incentive should be voluntary for irrigators holding water allocations on regulated streams on the condition of converting from flood irrigation to a more water efficient system and in exchange for reduced allocation. Existing non-flood irrigators on regulated streams should also receive a subsidy if they volunteer to reduce their water allocation.

Irrigators using non-electric pumps could receive a power credit. Where the irrigation pump is not driven by electricity (eg. diesel engine) the value electric power exchanged for water allocation could be used for another location, purpose, sold or traded by the recipient.

CONCLUSION

Exploration of practical incentives to compensate irrigators and change practices is needed. Close links exist between the energy and water that once flowed freely and now provides produce for the whole community needs to be re-examined. The Murray River needs an allocation of environmental energy similar to environmental flows to restore river health.

The decision to return some water (28% of original flow) and energy for restoration of the Snowy River has set a precedent for community investment in innovative mechanisms for restoring river health.

A voluntary "power for water" exchange scheme would allow a gradual adjustment towards water efficiency. A redistribution of as environmental energy allocation offers a mechanism to reduce many negative environmental impacts and spreads the burden to all beneficiaries of irrigated agriculture and hydro-electricity.

The preceding arguments to redistribute some hydro-electric power to change irrigation practices needs discussion and trial. Recommendations include:

- Survey the irrigation industry for interest in reduction of regulated irrigation allocation in exchange for subsidised electricity;

- Survey community attitudes to sharing the cost of restoring river health by subsidising environmental energy to improve river health;
- Analyse costs of converting from flood to spray irrigation using water allocation for power incentive; and
- Recruit some current flood irrigators to a change to more water efficient irrigation by exchange of water allocation for subsidised power.

Pre-irrigation rivers were shaped by water and energy. These two resources need to be jointly managed to improve management of our highly regulated rivers. The concept that users of hydroelectricity have a similar obligation to offset environmental effects as the irrigation industry recognizes and acknowledges some mutual obligation.

A component of hydroelectricity could be used to as an environmental trade for irrigation allocation. This concept is put forward as a potential voluntary market based incentive to reallocate energy for environmental flows and contribute to meeting mutual obligation.

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