Connections

Farm, Food and Resource Issues

Volume 5

April 2003

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

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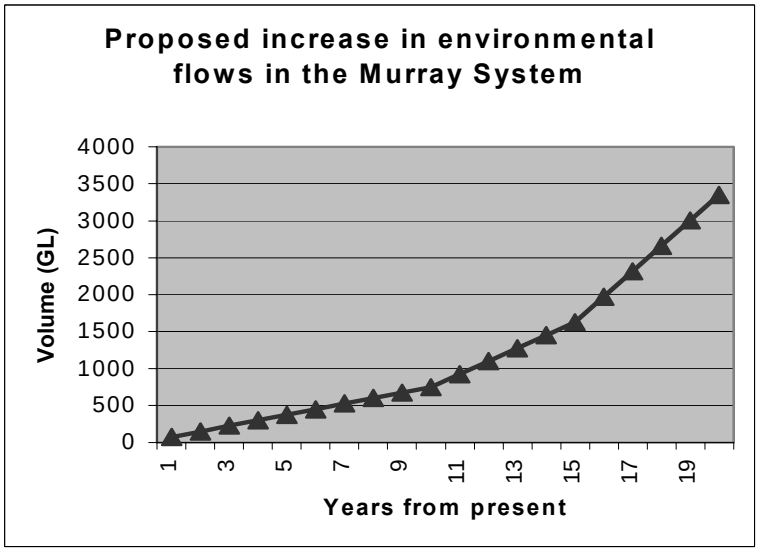
Introduction

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

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



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

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

To provide a basis for analysis, inefficiencies in water use are defined, the illusory nature of some proposed savings is explained and a method for valuation of real savings in comparison to costs of proposals is described. The simple treatment of these issues here is not complicated by the unique attributes of local situations. This is not a major difficulty if real options are examined in detail using benefit : cost analysis principles before policy changes are made or investment is sunk.

[1] Irrigation intensity of 8 ML/ha

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

Nature of Inefficiencies

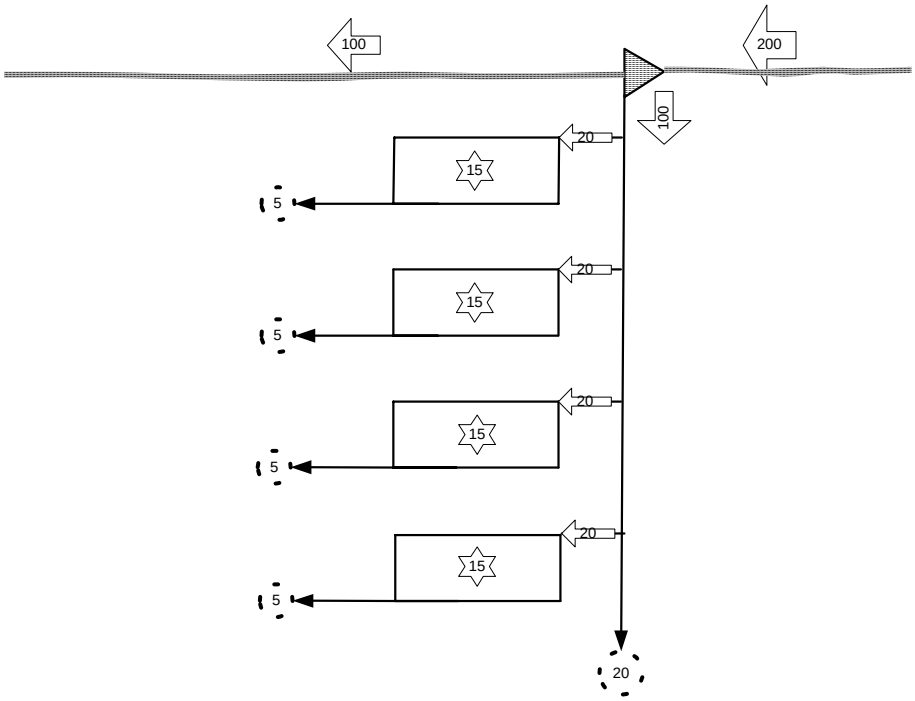
Technical Inefficiency

Irrigation System Losses

Channel Outfalls and Paddock Tail water

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

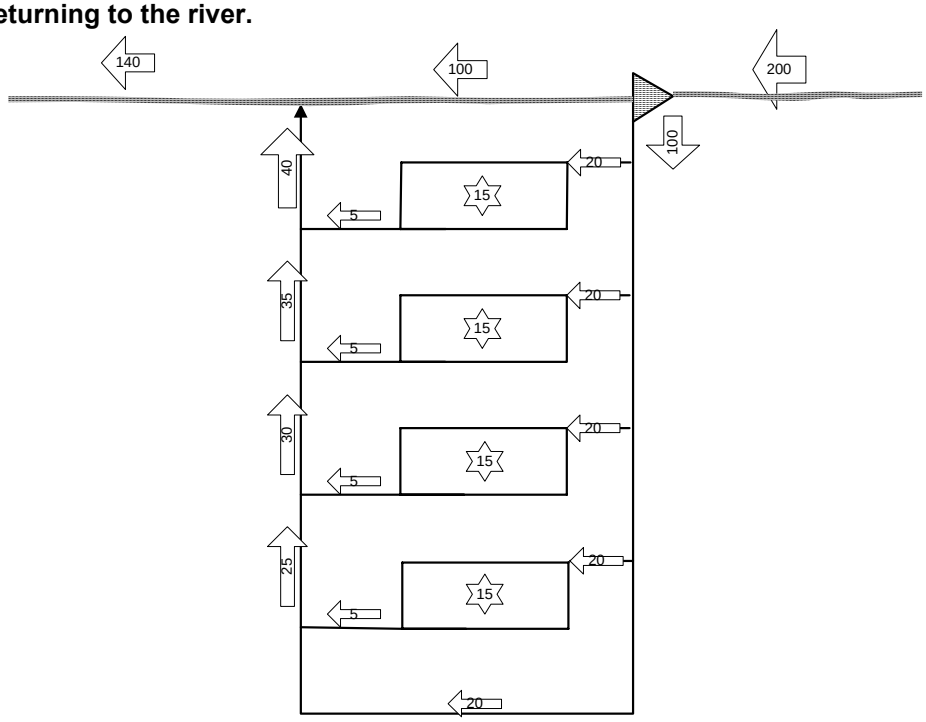
Figure 2: Schematic illustration of water flows for an irrigation system with 40% gross outfall and paddock tail water losses. Arrows show flow volume and direction, star symbols indicate consumptive use and dotted circles show volume of losses



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

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

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



Seepage

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

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

Evaporation

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

Plant Water Use Inefficiency

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

Economic Inefficiency

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

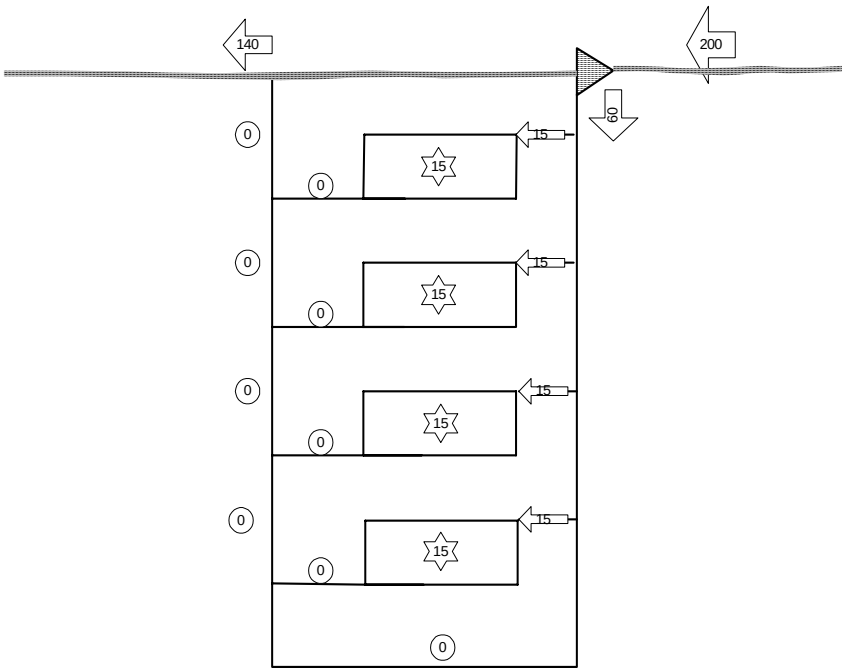
Identifying prospects for real savings

Irrigation System Losses

Channel Outfalls and Paddock Tail water

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

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



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

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

Seepage

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

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

Evaporation

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

Plant Water Use Efficiency

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

Economic Efficiency

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

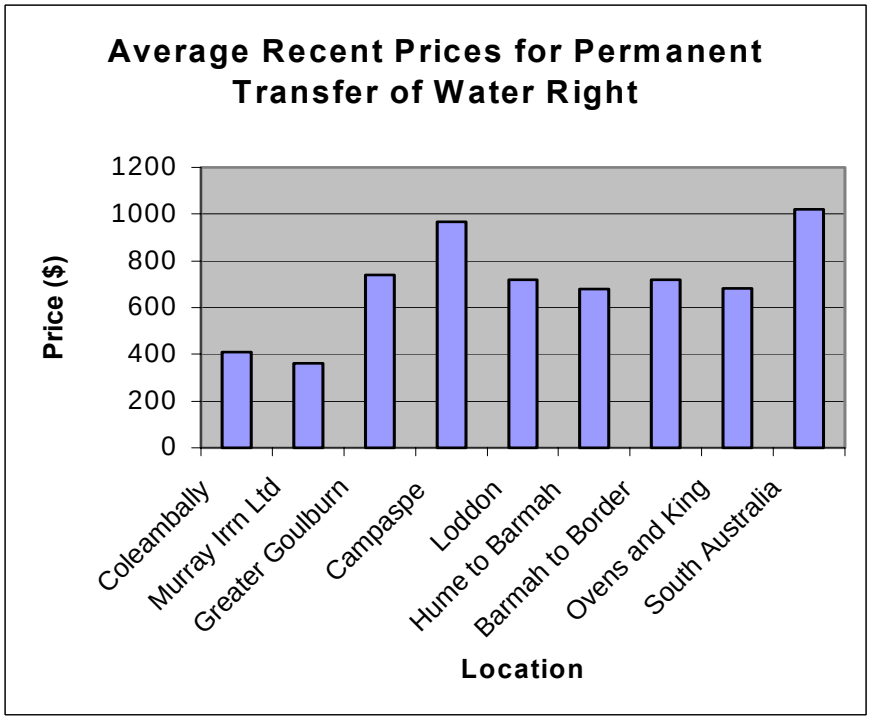
Unfortunately the market reality does not support this policy option (if the objective of policy is to increase net social welfare). Commodity composition is in loose equilibrium with capital markets because the mobility of capital in market economies leads to equal rates of adjusted[2] net return in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

Valuing Water savings

Market prices

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

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



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

Are Market Prices Appropriate?

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

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

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

Reconciling Willingness to Pay and Willingness to Accept

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

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

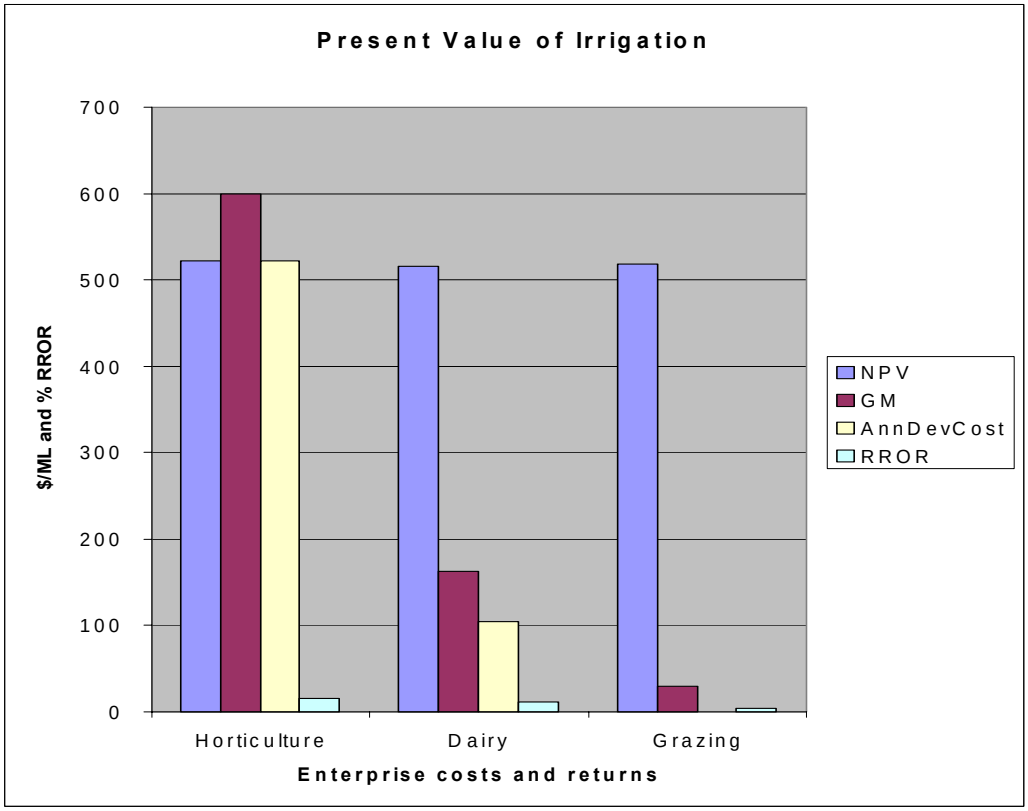


Figure 6 shows how inclusion of development costs and risk adjusted discount rates reconciles a large disparity in gross margins between enterprises. In this example, the NPV of irrigated development in horticulture and dairy generating gross margins of $600/ML and $163/ML respectively is much the same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

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

Estimating impacts of reduced agricultural allocations

As the long run agricultural development costs are already sunk, the present value of the future loss of gross margin should be used to estimate the agricultural opportunity cost of heightened environmental demands. Using recent market prices, the cumulative cost of purchasing water entitlement for the full implementation of the scenarios outlined in Young et al (2002) is $1.8 billion. The present value of the cost of the scheduled program of acquisition is $940 million. Given that the market price of water will rise as the supply for consumptive use is restricted, this must be very much an underestimate. Yet this very underestimate is roughly double the estimate made by Young et al of $450 million using an economic model for a scenario where there is no adjustment through investment in increased water use efficiency.

What is the reason for this extreme discrepancy? Some increases in future environmental flows may be released from storages during seasons of high inflows and low irrigation demand. Depending on inflows and demand in following seasons, this approach may moderate the impact on agricultural output at the margin of regional water resources. The potential for this moderation would tend to disappear at the higher levels of proposed increases in environmental flows. Higher environmental flow regimes may bring some benefits to downstream users through lower salinity levels. But the value of these benefits is relatively minor and comparatively low cost engineering options for salt interception are available. Further Quiggin (1988) has shown the rational national adjustment to salinity is to move salt sensitive uses upstream.

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

Rationale for investment in water use efficiency

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

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

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

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

The much publicised proposals for saving water by piping irrigation delivery systems (West and Walker, 2002) are clearly uneconomic. This is except perhaps for the replacement of open channels in some stock and domestic and some horticultural development schemes where pressurised delivery can reduce pipe costs and assist the adoption of improved irrigation technology. For these schemes the cost of water savings is around $1,300/ML to $10,000/ML (Marsden Jacob et al, 2002) or roughly twice to twenty times the market price. Extensive replacement of open earthen distribution channels with pipelines is even more expensive

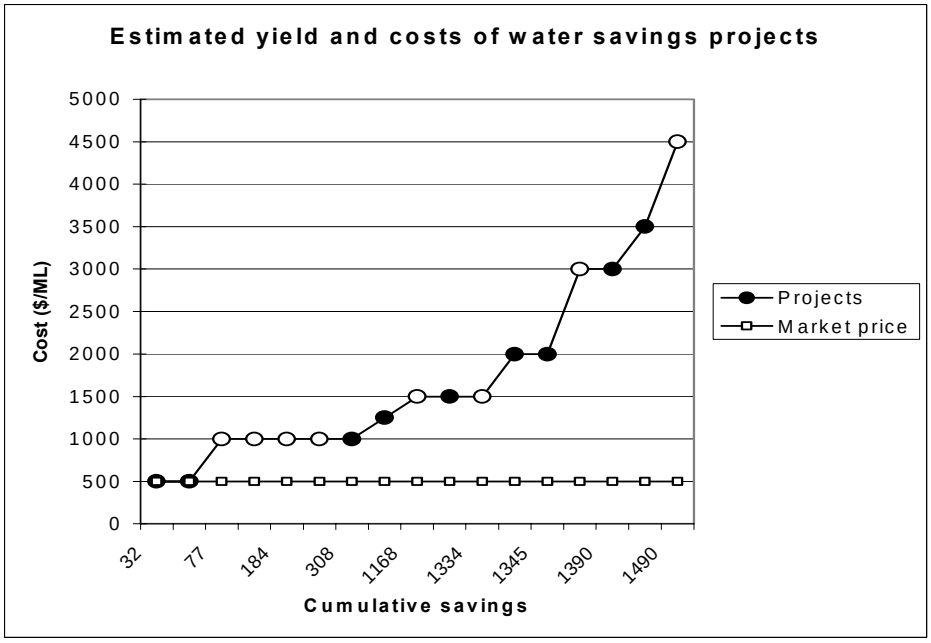
costing $20,000/ML to $50,000/ML, (Marsden Jacob et al, 2002). This is forty to one hundred times more than the market price of water. And, when it is considered that seepage losses are already recovered by groundwater pumps in irrigation areas, the cost of the real physical savings of evaporation is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

Scope for profitable investment in Water Use Efficiency

As Adam Smith said *"It is the maxim of every prudent master of a family never to attempt to make at home what it will cost him more to make than to buy."*

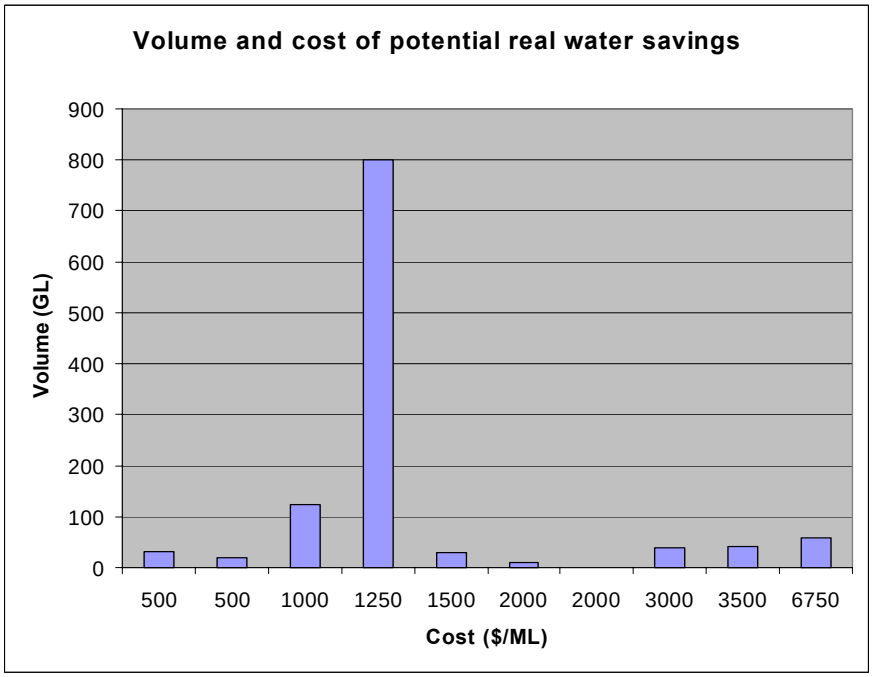
On this basis it would seem difficult to justify investment in water savings projects that cost more than the market price. An estimated supply curve for water savings is shown in Figure 7. A market price of $500/ML is also indicated. The fact that there are no savings identified below the market price and very limited volume is available at the market price indicates the market is well informed and operating efficiently.

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



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

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



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

Policy Options to Cope with Scarcity

Taking $500/ML as the market price for permanent entitlement to delivery of irrigation water, Figure 7 shows that there are no economical technical solutions to the problem of overuse of water resources by competing uses. Because catchment yield is limited by biophysical factors and the efficiency of use is limited by economic constraints to the adoption of technical solutions, a system of rational allocation is needed if unacceptable levels of degradation are to be avoided (Hardin, 1968).

One existing possibility is the water market where

> "The economist can imagine circumstances in which, for example, organised groups of recreationists and wildlife enthusiasts would purchase water entitlements and leave them unused to augment, at their own expense, in-stream flows beyond the required minima. Realistically, one would not expect such behaviour to be especially prevalent. But it is hard to conceive of any resource misallocation which would result from its occurrence" Randall (1981).

Indeed, the ACF recently indicated it would not support property rights for water for the environment while it could obtain increased environmental flows more cheaply through the political process (Moss, 2002).

Discussion and Conclusion

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

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

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

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

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

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

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

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Selfishness or Altruism?
An Historical Perspective of Sustainable Development, Economics and Science

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Introduction

The concept of sustainable development is now pervasive in Australian policy. It is especially prominent in issues that affect Australia's agricultural sector where land and water degradation have become significant threats, not just to Australia's primary production capacity, but to the rural lifestyle and commercial survival of thousands of farming families. Why, with a framework for sustainable development firmly in place, is it so difficult for decision-makers to agree on practicable policy to deal with problems like dryland salinity?

In the Brundtland Report *(Our Common Future)* sustainable development was defined as: 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. (WCED, 1987, p. 43). In Australia the concept became known as 'ecologically sustainable development' (ESD) and was described by the Commonwealth Government as: 'development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends' (Commonwealth of Australia 1994, p. 2). While there are many different definitions of sustainable development, the idea clearly involves present and future economic development, maintenance or *enhancement* of the natural environment, the long-term productivity of living resources and ecosystems, and a measure of social justice. Pearce (1999) concluded that the main problem with sustainable development was to realise it, rather than to define it (p. 69).

While they vary in detail, policies and 'mission statements' on sustainable development tend to embrace a mix of commercial development, conservation and social equity. In addition, all such documents usually claim an ethical, or altruistic, motivation that aims to enhance economic growth and the distribution of wealth, while improving the natural environment. These parallel approaches to development, equity and conservation are not new to social and environmental policy, although claims to be able to achieve all three simultaneously appear to be a recent phenomenon. In the Western Australian draft State Sustainability Strategy, *Focus on the Future,* the goal is to achieve 'simultaneous environmental, social and economic improvement', (DPC, WA, 2002, p. 8).

The complementary objectives of improving commercial outcomes, environmental conditions and social equity have been proposed by scientists, social reformers, philosophers and economists since the eighteenth century. This approach has had significant impacts on society, culture and law in the years subsequent to the nineteenth century Victorian 'intellectual revolution'. However, in nineteenth century political economy there was recognition of the need for priorities and trade-offs between the goals goals of political economy and these placed moral duty first. There were, indeed, many intellectuals who strongly disagreed with the science of political economy. Some, like the poet William Wordsworth and the philosopher Thomas Carlyle, predicted that political economy would turn moral values into a 'cost calculus' (Hodgson, 1997).

Beginnings in the Eighteenth Century

There was a strong reaction against 'mercantilist thought' in the middle of the eighteenth century. Around that time the Italian tradition, founded by the Neapolitan economist Ferdinando Galiani, emerged with, but diverged from, the French Physiocratic and Scottish Schools. All were loosely based upon the concept of a utility-based theory of natural value, and their areas of disagreement were focused on the role of the state as an economic entity. Francois Quesnay (1694-1774), physician to the French king, founded the French physiocratic school of political economy, and in 1758 he published the *Tableau Economique* which was translated into English in 1766 (Quesnay, 1758). Quesnay, as both the physically based doctor and the conceptually based political economist, saw a link between the body politic and the human body, which was reflected in the relationship between the health of nature and the health of society.

[*] My grateful thanks go to Patrick Armstrong and Marion Hercock, both multidisciplinary Bio-Geographers, and Judith Johnston, a 19th Century English Literature expert, who have shared their knowledge, ideas, inspirations, papers and books with me.

Adam Smith (1723-1790, founded the Scottish School of political economy and his ideas were later interpreted and adopted across Britain. His was a conceptually based duality since he was both a moral philosopher and a political economist. Thomas Malthus (1766-1834), was much concerned with what would probably now be known as human ecology, and he published his controversial ideas on the economics of population growth in 1798. Historically a number of writers have argued that political economy pre-dated Galiani, Quesnay and Smith. For example Jevons (1881), maintained that the original ideas for eighteenth century political economy, which included theories expounded by both Smith and Malthus, were proposed by Richard Cantillon (1680? - 1734) who developed the 'Land Theory of Value'. Cantillon's work was first published in English in 1759, but was originally published earlier in French, probably in 1725. Smith acknowledges Cantillon in his own work, and Jevons argued that both Hume and Malthus drew on Cantillon. He illustrated this by quoting from Cantillon (chapter XV, p.87, p. 110, in Jevons 1881, p. 7) as follows:

In a word, we can multiply all sorts of animals in such numbers that we could have them even to infinity, if we could find lands to infinity proper to nourish them; and the multiplication of animals has no other bounds than the greater or less means remaining for their subsistence.

Cantillon's ideas cited in the quote above also proposed notions that became embedded in the subsequent work of Paley and Darwin. These scientists were to participate with the political economists and philosophers in the Victorian intellectual revolution that laid the foundations for the concept of sustainable development. The original essence of political economy, and its support of free markets, was strongly allied to notions of truth and liberty. It was driven by the desire to improve the well being of the majority of people by finding a way to redistribute wealth according to the natural laws of production. Contrary to some current interpretations of free-market economics, one policy often proposed by early political economists was to tax wealth by taxing land ownership, and redistributing the revenue to people like landless peasants, whose labour was used to generate wealth from the land, but who owned no capital. Adam Smith wrote in the *Theory of Moral Sentiments* (1759):

And thus, *place …* is the end of half the labours of human life; and is the cause of all the tumult and bustle, all the rapine and injustice, which avarice and ambition have introduced into this world.

Smith examined the reasons for the suffering of the 'greater part' of society, the ethics of human action, and the apparent paradoxes of human altruism and human self-interest in his *Theory of Moral Sentiments.* Smith went on to develop theories about how selfishness might be used, in a constrained manner, for the good of *all* members of society. *An Enquiry into the Nature and Causes of the Wealth of Nations* was published in 1776. *Wealth of Nations* examined the results of economic freedom, including the division of labour, the functioning of markets, and the international implications of a *laissez-faire* economy. Smith appeared to see the lot of the poor and the dispossessed as being linked to mercantalism and the activities of the 'merchant classes' Smith famously wrote (1776):

To found a great empire for the sole purpose of raising up a people of customers, may at first sight appear a project fit only for a nation of shopkeepers. It is, however, a project altogether unfit for a nation of shopkeepers; but extremely fit for a nation that is governed by shopkeepers.

Concern for the plight of women, particularly for the plight of poor women, was one of the moral issues addressed by political economists and social reformers. Adam Smith and Mary Wollstonecraft (1759-1797) focused, to different degrees, on the lot of women. Smith wrote: "it is not uncommon … in the highlands of Scotland for a mother who has borne twenty children not to have two alive" (Smith, 1776, qtd Helibroner, 1972, p.63). Wollstonecraft stated simply "I do not wish them [women] to have power over men; but over themselves" (Wollstonecraft, 1792, ch 2).

Wollstonecraft's writings and protests preceded those of the successful nineteenth century suffrage movement which involved many later social reformers such as Harriet Martineau (1802-1876). Martineau was to be disparagingly identified with Wollstonecraft by reviewers of her own work.

The focus on moral duty, justice and ethics grew as the nineteenth century progressed. Political economists recognised the tradeoffs between wealth generation and justice (ethics). Unlike some of today's sustainability strategies and policies (eg UN, 2002), which aim at the simultaneous realisation of economic efficiency, social justice and ecological conservation, the early political economists almost always put justice before wealth. The current well-intended approach of 'triple bottom line accounting' can rarely be realised because of the inherent tensions between its components. Ultimately, when tensions exist, the traditional bottom line of tangible economics tends to win through.

Ideas of the Nineteenth Century Intellectuals

Many of the nineteenth century thinkers, such as Paley (1743-1803), Carlyle (1795-1881), Martineau (1802-1876), Mill (1806-1873), and Darwin (1809-1882) promoted what would now be considered as

multidisciplinary approaches to scientific, social and other intellectual arguments. Even Church of England clergymen played a role in the scientific debate[1]. Thinkers from the British isles, like those identified above, and others, such as Karl Marx, Auguste Compte and Henry George from Europe and the Americas, made important contributions to scientific, philosophical, political and economic theory. While sometimes considered eccentric or even outrageous, both at home and abroad, such thinkers were often also involved in campaigns for the emancipation of women, the abolition of slavery, and the education of the poor.

Many of the nineteenth century intellectual reformers tended, without any suggestion of a paradox, to couple ethical humanist considerations with respect for nature and utilitarianism. They did this in pursuit of ideas about how to improve human 'development', social justice and man's treatment of the natural environment (Lumley, 2001). Appreciation of the importance and implications of the future seemed common to Victorians. However, intellectual reformers, like Mill, Malthus and Martineau, in addition to expressing explicit concern for the future, coupled this concern with concern for the welfare of humanity, and even of the earth itself. These interconnected concerns appear to form a basis for present ideas about sustainable development. John Stuart Mill (1849) wrote:

If the earth must lose that great portion of its pleasantness which it owes to things that the unlimited increase of wealth and population would extirpate from it, for the mere purpose of enabling it to support a larger, but not a better or a happier population, I sincerely hope, for the sakes of posterity, that they will be content to be stationary[2], long before necessity compels them to it.

In an echo of Cantillon, Malthus had commented, a number of years before Mill addressed this topic, "Population, when unchecked, increases in a geometrical ratio. Subsistence only increases in an arithmetical ratio" (Malthus, 1798). Like Malthus, Harriet Martineau was a well-known political economist. In 1835 George Fletcher Moore, who was an agriculturalist, lawyer, and Acting Colonial Secretary of the Swan River Colony before returning to England in 1852, cited Martineau's work in his journal, in the context of the indigenous Australians:

The poor boy as he sat at the fire, had just been transfixed by Nauderry with a spear, in order, I suppose to adjust the balance of power upon the death of Billy, the son of Midgerooroo. This, of course, will be followed up by a retaliation on the part of the Waylo men; and thus is this country prevented from being overstocked with people by a process which the Political Economist Harriet Martineau would, perhaps, not acknowledge as one of her "mild preventive checks to the super abundance of population".

Unlike her male counterparts, Martineau's name is now rarely seen in the lexicon of scientists and economists. Like many women from all walks of intellectual life, her fame is alive in, but frequently confined to, the discipline of English literature. Modern English literature analysts, as well as recognising women forgotten by others, have also made a connection between the fluidity of nineteenth century thought across the disciplines, and the links between evolutionary theory in science and its parallels elsewhere (for example Beer, 1983, 1996).

In her drive to educate the literate masses, Martineau popularised the ideas of Adam Smith, Malthus, and others by publishing her work in the press. Some of Martineau's contemporary reviewers were scathing about what they viewed as her role as a woman wrongfully dabbling in science. Reviewers for both *Fraser's Magazine* and the *Quarterly Review* linked her ideas to those of Mary Wollstonecraft, and they believed her work to challenge the subordinate role of women. As David (1987, p.43) comments, Martineau's interpretations of Malthus' work were said to deal with "unfeminine and mischievous doctrines".

Martineau wrote with a keen knowledge of the works of both Malthus and Mill, and with a passion for morality, the economics of Adam Smith, public education and the welfare of future generations (Martineau, 1877).

Martineau may have found Smith's work appealing because his commitment to social justice, together with a strong moral theme, formed the basis of much of his writing. Like Martineau, he did believe in a vision of limited utilitarianism and economic development that could break the power of the merchants whose social role he so despised. There were also strong theoretical links between the ideas of the political economists and those of the natural scientists. It is not clear how much the economists' ideas influenced the development of Charles Darwin's evolutionary theory (Darwin, 1873). Some scholars argue that Darwin was influenced by reading Thomas Malthus' *Essay on Population* in 1838, others suggest that Darwin had read Adam Smith's work. At the time that Darwin was working on his theory, Harriet Martineau's writing in the popular press was both influential and prominent, and Darwin knew her personally. He is likely to have read her interpretations of Smith's work, and that of the other important political economists. Charles Darwin was certainly influenced by William Paley's *Natural Theology* (1802), which Darwin recognised as being of great importance to him. Paley used the same metaphor of the 'invisible hand' as Adam Smith, but with reference

to animal behaviour in the natural world. Paley, in his turn, was influenced by the writings of Thomas Malthus.

Without doubt, there is a strong degree of isomorphism between Darwin's theory of natural selection, and Adam Smith's theory of economics and the 'invisible hand' which encourages order in the world of *laissez faire* capitalism (Armstrong, 2003).

Concluding Reflections

Although disagreement exists about the proper definition of sustainable development, the concept almost always includes: the conservation of nature, commercial development, altruism and justice, inter- and intra-generational equity and concern for the future. The nineteenth century was indeed an age of utilitarianism and competition. However, the competition was not to be unfettered and utility had limited application. Ideas of altruism were intimately connected with notions of the free market, but ethics, not economics, was to be the 'bottom line'. That era was one of complex ideas, and the seeds of the modern notion of sustainable development could often be detected in scientific, economic, philosophical and literary discourses.

We have much to learn about the motives of the early political economists, and from the historical context in which their intellectual revolution took place. 'Market economics' is sometimes used as a pretext for perpetuating injustices in social and environmental policy. This pretext is often facilitated by a poor understanding of economic theory, and an ignorance of its moral foundations. In addition, an ideological application of the current interpretation of economics frequently drives public policy. If there were better public knowledge of the context in which economics, and parallel notions of moral justice, were developed, the application of practicable and sustainable public policy might progress further and faster. We might then be closer to a solution to the apparently intractable problems of land degradation and salinity, water and air pollution, biodiversity loss, and the ongoing arguments about the efficiency and equity of "who should pay?" whenever a solution to such problems is proposed.

Notes

1. The role of Church of England clergy in the development of natural history and conservation, particularly in the nineteenth century is discussed in Armstrong (2000).

2. My emphasis: this appears to be a call for sustainability with posterity (the future) being Mill's main concern.

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Have the scientists got it right this time?*

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In early November a group of environmental scientists, the Wentworth Group, released a 'Blueprint for a Living Continent'. The blueprint received extensive media coverage and consideration at the highest levels of government. What weight should be given to the Blueprint? Have the scientists got it right? Where is the debate?

Sensibly, the Wentworth Group is building on the back of the drought-induced public awareness of the state of our environment. However, the Blueprint needs to be critically reviewed. It should be the beginning of a public debate, not the end of it.

Scientific reductionism is alive and well

The Wentworth scientists, like moths to a light, promote a fatal reductionism. They advocate a water policy isolated from considerations of the economic, social, spiritual and biophysical realities of our ecosystems. The lessons of history – even our recent history- are forgotten, not learnt. We struggle with the narrowly conceived national program on salinity. We forget the lack of impact of the equally narrowly conceived tree programs of the 1980's. Most astoundingly, we forget that we are now wrestling with the aftermath of the father of all reductionist programs, the Snowy scheme.

Surely the lesson is that there are grave risks in dealing in isolation with one part of the ecosystem. There is no recovery from such a reductionist position. The total ecological jigsaw is greater than the sum of the bits. Once the elements become packaged separately-into their own administrative and policy boxes as is proposed-wild horses will not pull them back together.

Property rights

The Wentworth Group puts its considerable weight behind the runaway train that is the alleged need to better define property rights. Although the Group sensibly defines the water right in terms of it being 'a right to use a proportion of available water for a finite time' just how this removes the uncertainty allegedly limiting investment, development and environmental flows is far from clear. And in any event, has the certainty of land rights prevented land degradation? Quite the contrary one might attest.

The reality is that water rights are vested in the State. What we are looking at here is a claim on public resources reminiscent of the squatter claims on land. We need to examine the basis for these claims and what might be the national benefit from meeting those claims. As the Group says there is only one cake and for every allocated litre there is one not available for an alternative allocation.

In a novel yet bizarre twist the Group suggests that uncertainty about water property rights flows through to uncertainty about the obligations associated with water use. One might have thought that the water user plagued by any such uncertainty might take surety from a clearly regulated need not to pollute.

Market mechanisms

For over two centuries Australian agriculture has operated within institutional arrangements that have defined land rights and enabled market- based transfer of those rights. Over the same period we have extensively degraded our land resource. However, this has not deterred the Wentworth Group and others from the notion that applying similar arrangements to water will markedly improve the environmental impact of how we use water.

The Group acknowledges the self-interest of large water businesses ("the history of water development in Australia is a history of articulate interest groups seeking to have water used for their advantage") yet it promotes the establishment of a market mechanism to give expression to those interests.

Curiously, the Group advocates that 'from 2006, water trading could be limited to those with water'.

The point to be made here is that although the market can be a useful tool to give expression to the values of a community, the market does not establish those values.

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* This article was first published in 'Online Opinion' – thanks to 'Online Opinion'.

[1] Tony Gleeson is a contract researcher and farmer with extensive experience in rural policy and research.

Furthermore, there are values that lie beyond commodification, beyond the ability of markets to sensibly price resources for exchange. Environmental flows fall into this category, as do many landscape attributes.

Best practice

The Wentworth Group, like many technically deterministic groups and individuals before it, is apparently sufficiently confident in our understanding of the biophysical features of our landscapes to enable it to assert that there are best practices that should be applied universally within and across catchments. Land managers applying these best practices would be exempt from economic costs. Such approaches do not account for the heterogeneity that exists in our landscapes, they constrain creativity and cycles of continuous learning and they stifle innovation.

The Group proposes that farmers (and others?) ought to be paid for eco-services and the example they list is the provision of clean water. Does that mean that farmers should be paid for not polluting water? Nice work if you can get it!

Tax policy

The quicksand foundation for the Wentworth blueprint is perhaps most evident (and unsurprisingly so) when they enter the field of tax policy. These leading environmental scientists are 'not advocating another new tax' but rather merely that 'a major investment of public capital is needed', that 'we can't expect farmers to pay the full cost of repairing past mistakes', that we 'might add a one cent levy onto income tax', that ' taxpayers should not be expected to support bad land management policies (sic)', 'we need to ensure that our tax systems support sustainability'. Elsewhere they suggest that the needed capital investment might come from:

- consolidated revenue (tax!);
- the full sale of Telstra (direct transfer of public assets to private interests);
- an environmental levy (new tax); and
- incorporating environmental costs into the cost of producing food and fibre (so the higher the pollution cost the greater the price!).

The efficiency and equity implications of these various proposals are not detailed. Perhaps it might be better on both counts if we took stock of what responsibilities farmers should have. If individuals can't meet these responsibilities then they should be encouraged and helped into another occupation.

National Commission

The Group proposes the establishment of a National Commission to set priorities and national targets, accredit institutions and plans and to recommend the funding of investment priorities—a Commission to be managed by an independent board of experts in salinity, biodiversity and community capacity building.

We need to look closely at this proposition for it is the forerunners of these experts who have given us the agricultural practices we have today.

A way forward

The first step is to accept that water rights don't equate to environmental policy and water rights don't equate to an ecologically sustainable development policy.

The second step is to recognise that market based mechanisms are only as effective as the regulation that governs the operation of the market—and this regulation needs to be based on sound ecological and equity foundations.

We need in fact a broadly based consideration of what Australians want from their rural landscapes. We need to be informed by independent analyses on the role of agriculture in the Australian economy. How is it that the non-corporate agricultural farm sector pays no net income tax? How is it that there is no economic growth in the agricultural sector notwithstanding enormous increases in the volume of production (achieved at what environmental and social costs)? How is it that we do not have a public debate in Australia on the multiple functions of agricultureand of farming more broadly?

The answers are simple. It is not in the interests of captured agricultural support agencies and politicians to lead such a debate. And farm organisations mistakenly believe it is not in their interests to lead such a debate.

The problem is that we have outdated institutional arrangements. They lock us into our past, and they deny opportunities for change. We need more diverse, contestable and open innovation systems. We need policies that build on the responsibility of consumers and managers – including land managers – not to pollute.

Managing Climate Risk in Agriculture

Hon. Kim Chance,
Minister for Agriculture, Forestry and Fisheries, Western Australia

Introduction

I am delighted to be here today to officially open the managing climate risk in agriculture workshop. I would like to thank Dr Greg Hurtzler of the university of western Australia and the organisers of today's event for their hard work in putting together the program. I believe this workshop will provide a valuable insight into climate risk and the exciting new methods that are emerging for managing those risks. I would also like to welcome to western Australia our national and international delegates and speakers.

As we all know, many farmers and rural communities are hurting because of adverse seasonal conditions. The disastrous 2002 growing season illustrates that climate variability has a very large influence on crop production and farming systems across Australia. Agricultural production in the grain belt of western Australia is primarily limited by the amount of rainfall and its distribution through the growing season. As a result, western Australian farming systems have some of the highest yield variability in the world.

Western Australian research has shown that to farm successfully, climate risks need to be appreciated and managed well. With farm sizes increasing and farm costs continuing to rise, the importance of tools to assist farmers in better preparing for climate risk is now greater than ever. Information is critical for better preparedness and the themes covered today outline "a positive way for the future".

The four main themes of today's workshop are:

1) Better long-range seasonal forecasts that can prepare farmers for extreme seasons;

2) Management tools that can convert seasonal outlooks and soil moisture reserves into crop yield forecasts;

3) New initiatives for crop and weather insurance, and

4) Farmer adaptation to climate risk.

The state government is committed to assisting farmers to manage climate risk. One of the mechanisms by which the commonwealth and state governments handle seasonal risk is through exceptional circumstances programs.

The exceptional circumstances program provides welfare assistance and business support through the provision of interest rate subsidies for affected farmers. The debate about exceptional circumstances efficiency and effectiveness, and suggestions for improvement, has been on going. The key issue for the program is to continue to move towards progress that will enable producers to self manage risk.

In august 2001, as part of our program of activities to assist farmers in developing risk management tools, the state government established a task force to investigate the feasibility of establishing a commercially viable multi-peril crop insurance product in western Australia. The taskforce, made up of industry, government and independent research personnel, has conducted a thorough investigation of multi-peril crop insurance.

Multi-Peril Crop Insurance (MCPI)

The task force was mindful of the realities of trying to establish a crop insurance scheme here in western Australia, balancing the needs of farmers with the commercial situation faced by the insurance industry. The taskforce has recently provided me with a report, which has a range of recommendations for government to consider.

I will not be commenting on the recommendations at this stage because I want the key stakeholders to have some time to consider the complex range of issues that are involved before they are able to advise me of their views.

The report indicates that while a sustainable MCPI scheme may be possible on the actuarial data alone, the combination of September 11 (2001), the HIH collapse and other factors leading to the present turmoil in the insurance industry, as well as the current severe drought nation-wide which is not part of the actuaries we have, mean that such a scheme cannot be underwritten by the insurance industry at this time.

I have looked carefully at the potential for government support (as a subsidy) to improve the viability of the scheme and this is not beyond reasonable realms of possibility; indeed the report indicates that the level of subsidy required could be less than is currently committed to the EC scheme. But even with the matter of

subsidy resolved, the fundamental stumbling block of a complete absence of an underwriting capacity still remains. This issue, while hopefully a temporary matter, is so serious that I am informed that insurers had difficulty obtaining re-insurance for fire and hail insurance last year.

I believe the report provides reason for hope that in the future, when a level of confidence is restored in the insurance industry, a form of MCPI may be possible. While it is disappointing that a MCPI scheme is not possible at present, the work that the taskforce has done in alternative risk management areas, including mutual funds and weather derivatives, open some interesting opportunities that go to the core of today's seminar.

WA farmers have for generations been effectively managing climate risk through a variety of strategies such as diversification in farm and off farm enterprises. Today, with increasing climate volatility, new and innovative products are being developed to assist farmers.

Farm Management Deposit (FMD) Scheme

The farm management deposit (FMD) scheme is designed to assist eligible primary producers with their year-to-year cash flow management. It is delivered commercially through authorised financial institutions such as banks, credit unions and building societies. An FMD allows pre-tax income from profitable years to be set aside to help balance short falls incurred in poorer years. Interest on FMD's is earned at market rates, and tax is paid at the rate relating to the year in which the money is withdrawn.

Tax benefits associated with the FMD scheme require that an FMD be held for a minimum of twelve months in order for it to be eligible. It is worth noting that in response to the 2002 drought, the federal government has announced the introduction of amendments to tax legislation to allow farmers in exceptional circumstances areas to access FMD's that are less than 12 months old and keep the tax benefits. The partial withdrawal of FMD monies will also be permitted without affecting the benefits that accrue to the remaining money.

Farmers in western Australia are taking advantage of the risk management opportunity offered by FMD's with $212.3 million held in FMD's in western Australia as at the 30th June 2002, of which around $150 million was held by grain or grain / livestock enterprises. The FMD works effectively when farmers have had good years to make substantial deposits to see them through the poorer seasons. Without those good seasons to make deposits or with an extended run of bad seasons the FMD no longer acts as a buffer.

Weather Derivatives

Weather derivatives are products based on indexes that closely monitor the incidence of 'normal' weather patterns over a period of time. Once long-term data has been studied, a payment schedule is set, based on the purchaser's anticipated revenues during the option period.

Payments are triggered if there is a sufficient diversion from the norm that exceeds an agreed trigger. For example, farmers could take out protection against a weather event occurring at a designated recording station, such as receiving less that 300 mm of growing season rainfall. They would receive a payout for each millimetre of rainfall below this, usually up to a capped amount. The idea is that in the event of a drought, a farmer could receive a payment to at least partially compensate for loss in yield.

One of the key advantages of weather derivatives is that they can be used to cover low-risk, high probability events as opposed to most insurance products which cover high-risk, low probability events such a floods or fire. Weather derivative markets have grown rapidly, particularly in the United States, since their introduction in 1997. The energy generation industry has been the main user.

Weather derivatives in agriculture offer the farmer the chance to hedge against the major factors influencing crop yields - rainfall, particularly growing season rainfall, and temperature, to hedge against frost. The demand for weather derivatives will depend on the correlation between climatic events such as rainfall or temperature and yield and hence income.

A number of companies such as Macquarie Bank, AXA and SG are offering weather derivatives or are looking to investigate this market. The potential problem with weather derivatives is that at times there can be a poor correlation between rainfall and yield. To circumvent this problem, researchers and the insurance industry are investigating index-based contracts and the development of models that link rainfall to yield. Such models would offer farmers greater surety as they would know the effect of a weather event and would be able to insure effectively.

Crop coverage index based contracts are largely free of adverse selection and moral hazard problems, and have relatively low start-up and administration costs. For the risks facing cropping, two simple index contracts are area-yield and rainfall contracts.

The problem with existing index contracts is that an individual can experience a loss in crop yield, but the index contract is not triggered hence a payment is not made. This is known as basis risk. It may be possible to narrow this basis risk through the use of technology and modelling.

The western Australian government could have a key role in the future in the development of a suitable index model for farmers, sufficient infrastructure to accurately measure the data needed for the index, and monitoring the information to add to its credibility.

Farmer Mutual Funds

An alternative to the finance industry providing risk management products is the concept of farmer mutual funds. Mutual funds usually operate within specific industries. Claims are usually limited by some ceiling or maximum distribution of the available pool.

To insure against an event requires broad participation, either voluntarily through levies or some other rating basis to pool income to protect those included in the mutual fund. Mutual funds work similarly to insurance but generally without reinsurance for disastrous events or catastrophes. The mutual funds usually do not cover events other than along specifically targeted defined circumstances.

Some of you will remember the banana growers in Carnarvon (WA) had such a scheme in place up until three years ago to assist the re-establishment of banana plantations following cyclone damage.

There are a couple of drawbacks in mutual funds: firstly, the need for the fund to cross subsidise high-risk areas. Unless a weighted pooling levy arrangement, similar to that which would be established in the general insurance market prevailed, it would be difficult to attract the broad cross section of primary producers to ensure a viable and stable fund.

Furthermore, systemic risk is also an issue. If all the growers in the same area were subject to the same catastrophic event the pooled income would be drawn on in one major event. Reinsurance, if available, could help overcome this problem. These drawbacks aside, farmer mutual funds could offer growers the opportunity to develop a suite of risk management options.

Conclusion

In conclusion, there is a clear need for further, more detailed, studies on the management of climate risk. I see this workshop as a good forum to enable us to think about other useful strategies.

I wish to congratulate all of those working in this field for the advances they have made and for sharing this work with us in this workshop.