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WATER RIGHTS: AN ECOLOGICAL ECONOMICS PERSPECTIVE

by

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“WATER RIGHTS: AN ECOLOGICAL ECONOMICS PERSPECTIVE"

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> *“This ... could have been a consequence of what had gone before. That it derived from perhaps unwarranted assumptions and misguided judgements ... It therefore could have been interpreted as a willingness to think again.”*

H.C. Coombs (1992) “Shame on Us! Essays on a future Australia.”

Abstract

COAG water policy reform agenda is used as a backdrop to illustrate how the ideas, propositions and recommendations being developed by ecological economists differ from those that have been developed by conventional economists.

Ecological economics is a new trans-discipline, characterised by models, that take the laws of nature seriously; a vision that economies are nested within and dependent upon maintenance of a global ecological system; and a concern for the welfare of people in this generation and in future ones.

Ecological economics seeks to understand the underlying and fundamental causes of environmental degradation and the means to redress them. Efficiency is not seen as a sacrosanct objective but maintenance of the integrity of our global ecosystem is. The market is important but not the source of all information. Recognition of uncertainty, a willingness to consult with and use social welfare functions set by communities; and attention to institutional issues are part of the core agenda.

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Introduction

The International Society for Ecological Economics (ISEE) was established in 1988 by a group of ecologists and economists concerned about the failure of economists to understand ecology and ecologists to understand economics. The vision was, and still is, of a trans-disciplinary society whose members develop new means to understand interactions between economies and ecosystems. ISEE’s founders hoped that the Society would act as a catalyst helping people to identify the policy reforms necessary to maintain ecosystem integrity and improve social equity throughout the world for present and future generations. Founding members include people from many disciplines: economists, ecologists, environmental scientists, system modellers, engineers, geographers and philosophers are all represented in the list. Hypothesising that the greatest gains might come from understanding interactions that cross disciplinary boundaries, the society was to be trans-disciplinary.

The Society’s ethic is one that gives priority to sustainability. However, as a young trans-discipline, many definitions of sustainability are tolerated. "Ecological economists share a loose consensus about desirable development objectives and about the importance of government and citizens individually and in groups, as well as the market place" (Duchin, 1996). Those threatened by the emergence of ecological economics use inconsistencies within the emerging literature to criticise its practitioners. Others, mostly those interested in ecological economics, find these inconsistencies a source of inspiration. The culture is one that encourages people to seek out and challenge implicit assumptions. There is an admitted plurality of legitimate perspectives (O'Connor *et al* 1996).

Ecological economists seek methods of analysis and modelling relevant to questions and problems about ecosystem maintenance and attainment of sustainability. They are searching for new institutional arrangements and the policy instruments to implement this vision. ‘**One of the major differences between ecological economics and conventional academic disciplines is that it does not try to differentiate itself from other disciplines in terms of its content or tools.** It is an explicit attempt at pluralistic integration rather than territorial differentiation .... Ecological economics does not aim at analysing or expressing ecological, social, and economic relationships in terms of concepts and principles of any one discipline. It is thus not merely ecology applied to economics nor is it merely economics applied to ecology. It is a trans-disciplinary approach to the problem that addresses the relationships between ecosystems and economic systems in the broadest possible sense in order to

develop a deep understanding of the entire system of humans and nature as the basis for effective policies for sustainability" (Costanza *et al* 1996).

Central Ideas

As stated above, ecological economics is searching for a practical, shared vision of both the way the world works and ways to live sustainably within its physical limits. Daly (1996) argues forcefully that a global economy should be seen as a small subset of the world's ecosystem. Costanza *et al* (1996), using standard neo-classical valuation techniques, are showing that the unpriced value of a lot of the world's ecosystem services and its natural capital is around two times the value of global GNP. Apart from many powerful critiques of the assumptions that underlie neoclassical economics (see for example, Daly and Cobb 1989), ideas central to ecological economics include:

modelling the *interface between the environment and the economy* (Folke and Kaberger 1992; Perrings 1987);

an emphasis on *holistic modelling and systems thinking* that enables ecologists to understand how the systems they study affect the economy and economists to see how economic behaviour feeds back to the environment and natural resources (Costanza *et al* 1996);

recognition of the *material dependence* of economies on ecosystems and the limits to human appropriation of environmental processes and resources (Daly 1996);

an interest in *macro-economic policies* such as issues like whether or not savings should be taxed and whether government activity should be financed via a consumption tax or only on taxes on things that diminish environmental values (von Weizsacker and Jesinghaus 1992);[1]

an interest in the definition and distribution of *property rights* as in the most general sense these rights allocate rights to use natural resources and harm the environment (Hanna and Munasinghe 1995);

an aversion to *irreversible actions* and a focus on *precaution* in the face of uncertainty and ignorance about the consequences of proposed actions (Young 1995);

an interest in *envisioning* alternative ways of organising socio-economic activity and a recognition that as the future is shaped by the present we have a responsibility to future generations to keep options open to them;

an interest in *post-normal science* which considers the science of complexity to be inseparable from considerations of ethics and politics (O'Connor *et al* 1996; Funtowicz and Ravel 1993); and

an interest in three types of *failure* - market failures that are the lifeblood of much neoclassical economics, empowerment failures and government failures (Young 1992).

Collectively these ideas have led a significant number of ecological economists to advocate the use of a much fuller set of evaluation criteria than is found in the neo-classical economic literature. One such set is summarised in Box 1. For other lists see Young (1992); Stavins (1990); Common (1990); Bohm and Russell (1985). Economic notions of allocative and productive efficiency remain but, whenever partial models are used, maintenance of efficiency is not seen as an essential criterion for the attainment of improvements in social welfare. **On inter-generational equity grounds, for example, an ecological economist in collaboration with a panel of ecologists might recommend that a species be protected even though the cost of protecting it was more than benefits assessed by a conventional economists contingent valuation study.**

Australian contributions that fall within the rubric of ecological economics include Mick Common's book "Sustainability and policy: Limits to economics" (Common 1995); Clive Hamilton's "The Mystic Economist" (Hamilton 1994); and my own book "Sustainable investment and resource use" (Young 1992). The range of papers by Steve Dovers on Sustainability also deserves mention as do the many papers and books by Clem Tisdell who was writing like an ecological economist well before any one thought of the concept. Australian centres of interest in ecological economics include CRES at ANU; NEEEP at UNE; Green Innovations in Melbourne; and my own group at the CSIRO Division of Wildlife and Ecology.

The impact of Ecological Economics

While any statement made by the inaugural president of ANZSEE and the Secretary/Treasurer of ISEE must be expected to contain some advertising, I think that the evidence presented in Box 2 suggests that the ideas being explored by ecological economists are and should be taken seriously. In 1994, a comparison of journal paper-adjusted citation rates ranked *Ecological Economics* as:

the 16th most cited environmental science journal;
the 22nd most cited ecology journal; and
the 19th most cited economics journal.

As Box 2 indicates, demand for the product is high. The richness of the ideas being explored amongst the ecological economics community can be appreciated by exploring the links to the ANZSEE web site at http://cres.anu.edu.au/~dstern/anzsee/ANZSEE.html.

Box 1

Evaluation criteria used by ecological economists

i) ***Economic efficiency*** - Having regard to implied and actual values, the chosen trade-off between production and conservation is achieved at least cost (*productive efficiency*) and so that no reassignment of property rights would improve production or biodiversity objectives without making some-one worse off (*allocative efficiency*);[2]

ii) ***Dynamic and continuing incentive*** - the mechanism used continues to encourage technical innovation, improvement of biodiversity beyond the official policy target; and automatically adapts to changing technology, prices and climatic conditions;

iii) ***Equity*** - no group of people, including future generations, is unfairly disadvantaged or favoured by the instrument's operation;

iv) ***Dependability or certainty*** - the instrument will deliver the desired biodiversity target, even when knowledge about likely responses is uncertain;

v) ***Precaution*** - the instrument avoids the chance of serious or irreversible consequences especially when there is scientific uncertainty about outcome;

vi) ***Administrative feasibility and cost*** - monitoring and information costs are minimal (*low information cost*),[3] government enforcement is cost effective, can be financed from available revenue and self enforcement is encouraged (*low administrative cost*), the instrument's requirements are simply explained (*communicative simplicity)*,[4] and the decision-making processes associated with the instrument can be understood by all parties (*transparency*); and

vii) ***Community and political acceptability*** - the policy instruments motivate the community to ensure that biodiversity conservation objectives are achieved, are perceived as being legitimately formulated and delivered, adds to social harmony, are consistent with government commitments and attracts bipartisan support.

Source Young *et al* (1996).

Box 2

The influence of Ecological Economics

Objective assessment of the impact of a discipline is difficult and usually wrapped with highly qualitative and personal assessments backed up only with anecdotes. There are, of course, some indicators we can point to. Regional chapters of ISEE now exist in Canada, Australia/New Zealand, Chile, Europe, and Russia. In the next year or so, new chapters are expected in the United states, South America, South Africa and China. Interest is high and ISEE leaders are encouraging discussion of ecological economics at other meetings. Examples include a session at the Ecological Society of America (ESA) meetings in 1994 which resulted in a special 1996 issue of *Ecological Applications.* An ecological economics session is planned for the January 1997 American Economic Association meetings in New Orleans. So, at least at the academic level, Ecological Economics seems to be having quite an impact. This AAERE meeting demonstrates growing Australian interest. Fifteen months ago, ANZSEE's first conference at Coffs Harbour attracted over 350 participants.

Another way to assess impact is to look at the performance of ISEE's journal - *Ecological Economics* - first published eight years ago in 1989. One statistic used to assess academic impact is the "Impact Factor" of journals listed in the Science Citation Index (SCI) and the Social Science Citation Index (SSCI). This "Impact Factor" (IF) is the total number of citations to a journal divided by the total number of articles in the journal over a given year.

For 1994, *Ecological Economics* had an IF of 1.313 (up from .731 the previous year). This places *Ecological Economics* high up the list in several different groups. It ranks 16th out of 96 Environmental Science journals, just below *Environment* at 15th (IF = 1.386) and above *Ambio* at 20th (IF = 1.232), *Estuaries* at 39th (IF = 0.793), and *Environmental Management* at 59th (IF = 0.477).

When compared with other Ecology journals, *Ecological Economics* ranks 22nd out of 72, just below *Conservation Biology* (IF = 1.643) and *Ecological Applications* (IF = 1.556) and well above *Landscape Ecology* (IF = 0.767), *Ecological Modeling* (IF = 0.683), and *Wetlands* (IF = 0.548).

When compared with other Economics journals, *Ecological Economics* ranks 19th out of 139, not far behind the *American Economic Review* (IF = 1.657) and almost equal to the *Journal of Environmental Economics and Management* (IF = 1.357). It is well above *Land Economics* (IF = 0.744), *Resource and Energy Economics* (IF = 0.476), and the *Journal of Agricultural and Resource Economics* (IF = 0.255). If one put all the journals in all three of these groups together, *Ecological Economics* would rank 54th out of 344 and it would be the only journal included in all three groups.

Subjectively, one could argue that these are quite good impact ratings for such a young journal, especially when one considers that the 1994 IF's are based on 1993 data, so we are talking about the IF of three years ago, when the journal was only in its fifth year. Between 1993 and 1994 (using 1992 and 1993 data, respectively) the IF of Ecological Economics almost doubled. While this would certainly not happen every year, we can expect the current IF of *Ecological Economics* to be higher than it was in 1993.

Ecological Economics is one of the few journals that receives a significant number of citations and ranks well as an environmental science journal, as an ecology journal and as an economics journal, a feat few other journals can claim and one that confirms the trans-disciplinary status we intended for the journal.

Source: Adapted from Costanza (1996).

In the remainder of this paper, I propose to draw attention to a few of the ideas central to ecological economics and to illustrate the difference between recommendations arising from ecological economists and conventional environmental economists. I do this largely by way of illustration by focussing on uses that underlie the Council of Australian Governments (COAG) Water Reform Agenda. I choose this example, partly because it is an issue that I am familiar with and, partly, because it is a current issue that requires simultaneous attention to environmental, equity and efficiency objectives. Physical, economic and social processes need to be understood simultaneously. Key differences are in bold.

Water resource allocation systems throughout Australia where designed to encourage people to use water and, by doing so, increase production. This development era is now, largely, passed. As COAG has recommended, Australia now needs a system that promotes sustainable forms of water use and encourages people to use water in a manner that is not to the detriment of future Australians.

Application to Water Allocation

In 1994, COAG committed itself to the "Implementation of a Strategic Framework for the Efficient and Sustainable Reform of the Australian Water Industry." Under the agreement, states have agreed to try to "implement comprehensive systems of water allocations or entitlements backed by separation of water property rights from land title and clear specification of entitlements in terms of ownership, volume, reliability, transferability, and if appropriate, quality." The $2.4 billion of financial assistance offered to states is conditional on satisfactory progress being made. Properly designed, and in concert with contestable markets and astute institutional arrangements, these reforms have the potential to make water use consistent with community values.

As indicated above, **ecological economists are particularly interested in the specification of property rights. In contrast, conventional environmental economists tend to focus on prices and market valuation and leave discussions about property rights to institutional economists.** Ecological economists see markets as excellent servants but poor masters. Institutional and macro-economic policy reforms are seen as a means to achieve sustainability. Property-right systems are preferred to pricing systems because property-right systems define the ecological limits and then leave the market to work out what prices and charges are necessary to keep use within those limits across space and through time. Property-right systems tend to be ecologically more dependable than pricing systems. While neo-classical economic theory would suggest that there is no difference between price-based and right-based approaches, this is true only if charges are varies to account for differences across space and through time. In practice, governments routinely fail to vary prices in response to changing economic conditions and opportunities (Young 1992). When a property-right is used to define the limit, however, market processes take over. Value is determined by market opportunity

within ecological limits.

Specifying and allocating water rights

The current system of water allocation varies from district to district and state to state. There are no fully specified perpetual rights. Essentially, an entitlement to a fixed quantity of water, say 10 ML, is allocated with an implicit degree of reliability attached to it. Access to 10 ML might be expected 7 years in 10 but that situation might change. Apart from the political process, there is little to protect each user from the issue of further licences or the cancellation of current licences. Often, groundwater rights and rights to harvest water from unregulated streams are vague. The question of how to specify and allocate water rights is one of the most difficult issues raised by the COAG reform agenda. Responding to COAG, ARMCANZ (1995) proposes that "where practical, individual water users - not institutions - should hold the property rights to shares in natural water resources." This is not unlike the share system gradually being introduced for New South Wales fisheries (Young, 1996). Under this system a fishery, or in this paper's case, a sub-catchment is defined and each water user is issued shares in proportion to their current entitlement to use water. Thereafter, changes in this entitlement can be made only through the acquisition or sale of shares.

ARMCANZ has gone on to say "ownership tenure should be perpetual but with conditions of access associated with entitlements that are subject to reviewability within an open planning system." Essentially, the question is one of what to share and how to work out the details necessary to make sharing possible.

Essentially, the challenge is to find a system that will enable rights to an uncertain volume of water to be traded. Many years ago the corporate world faced up to this very problem in relation to uncertainty in revenue streams. Companies form and shareholders, in proportion to the number of shares they hold, receive profits as and when they are made. Entry and exit from the system is possible only by trading shares. This same system is easily adapted to water by giving each water user within a sub-catchment shares in the total amount of water available for consumptive use. In this paper I recommend that shares be used as the mechanism to facilitate trade and prevent new entrants diluting the value of the opportunities available to existing users. Within this framework, I suggest that a document- called a catchment management plan - be used to define the rights and obligations that attach to each share. If this recommendation is accepted then an important institutional innovation occurs. The status of a management plan changes from that of an indicative document to a formal legal instrument with status similar to that of regulations under an act of Parliament. Shareholders would have rights and obligations defined by sentences and statements made in the plan.

Taking a trans-disciplinary approach and well advised by communicators, an ecological economist might also recommend that discussion in the management plan about the relationship between shares and expected allocations be expressed in terms of expected median flows - not mean flows. In one South Australian river system that I have looked at in the Clare Valley, the median flow is 60% of the mean flow. Operationally, this means that either 31% of the mean flow has been allocated for consumptive purposes or, alternatively, 51% of the median flow has been allocated to consumptive purposes. The statement that 49% of the median flow has been set aside for environmental purposes conveys a very different message to a statement that 39% of the mean flow has been allocated to environmental flows. **Generally, ecological economists tend to take a much more pro-active approach to informing people about ecological principles than is common among conventional economists.**

A dual-right system

Drawing upon some of my earlier work, I would also recommend a "dual-rights" system that formally separates entitlements to receive water allocations on a regular basis from volumes of water that have been assigned to people. This mechanism enables a significant reduction in transaction costs and opens the way to make water rights more valuable than they otherwise would be.

Under a dual-rights system, allocations of water in November, for example, are registered separately from the entitlement that produces that allocation. A formal share registration system is established for the long-term entitlement to receive allocations. A central share register would be established for each sub-catchment and shares would be mortgageable. As with land, share trades would be possible only with the consent of mortgagees. Using a separate registration system, regular allocations would be made in proportion to shares held. The system used would be similar to that used by banks to track money in savings accounts. New allocations would be credited as and when they become available. Water use would be debited in a similar way. Keeping transaction costs to a minimum, trades could be implemented by writing "cheques".

Facilitating trade

Taking the banking analogy a bit further, periodic allocations would be tradeable within a sub-catchment on a one for one basis. Allocation trades between sub-catchments would be managed via a series of exchange rates set to allow for evaporation, loss to groundwater, effects of the trade on environmental flows, etc. As with money, these exchange rates would vary periodically. As a general rule, the rate for downstream trades would be different to that operating for up-stream trades. Shares would be tradeable in a similar manner.

Environmental flows

At present, statements made about the preferred position for allocations to the environment is unclear. Some statements indicate a preference for environmental shares, others indicate a preference for a separate process to ensure that environmental flows and quality are maintained. COAG's initial document was virtually silent on this issue and it is only recently that the Standing Committee on Land and Water Resources Management (SLWRMC 1996) has issued a document setting out the principles to be followed.

Generally, ecological economists prefer to work with other scientists from a range of disciplines and build models which link that knowledge together. Asked to develop recommendations about the most appropriate way to allocate rights to the environment, **a conventional environmental economist might conduct a contingent valuation or conjoint analysis. Like COAG, however, an ecological economist would argue that environmental water requirements should be determined on the best scientific information available** (ARMCANZ 1996).

Ecological economists also tend to deal with uncertainty in a manner that is quite different from environmental economists. In the face of scientific uncertainty, an ecological economist is likely to advocate a precautionary approach. In contrast, conventional environmental economics texts make virtually no mention of the precautionary principle.

Addressing the question of whether or not to allocate a fixed proportional share to the environment, an ecological economist might recommend a precautionary approach that grants the environment a prior right similar to that given to stock and domestic water users. This would make it possible to change allocations without having to acquire them from consumptive water users. Given the expectation of widespread trade in water rights and the paucity of knowledge about water ecosystems, links from groundwater to surface water systems etc, this approach is more dependable than a system that allocates a fixed share to the environment.[5] It ensures that sufficient water can always be allocated for maintenance of water riverine and wetland ecosystem functions, and biodiversity values associated with these systems.

In summary, the precautionary approach to the question of how to ensure adequate environmental allocations is to set up an institutional process to determine the guidelines necessary to determine how much water should be allocated to the environment at any point in time and then allocate the remainder for consumptive purposes in proportion to pre-defined rights. One consequence of this recommendation, and drawing on the banking model used earlier, is that a complex set of exchange

rates will need to be set up for between catchment trades: 1,000 shares at Griffith may deliver a very different volume of water to 1,000 shares at Albury.

The management plan review

The COAG framework identifies the need for reviews to account for changes in climate, land-use practice, technology etc. An ecological economist, like an institutional economist would see the institutional mechanism for review as a critical part of any resource management strategy. **One of the principles that ecological economists have drawn from the ecological profession is the importance of building-in active adaptive management processes that recognise the presence of uncertainty, ignorance and indeterminacy (see Box 3). In contrast, much environmental economics is conducted in a manner that assumes that information about the environment is constant.** Active adaptive management processes seek to learn from experiments, like the trade of water from one catchment to another. Surprising outcomes are expected and, hence, initial trades should be conducted at a scale and in a precautionary way to minimise the chance of irreversible, adverse outcomes.

Essentially, the task of each management plan review would be to ask if and how water use rights and obligations should be changed. Considerable change may be necessary. As a means to reduce dryland salinity problems, for example, a review may propose that all irrigators in a groundwater recharge area must replace spray irrigation equipment with drip irrigation equipment.

From an economic viewpoint, the essential issue associated with a review is the question of how best to distribute risks of economic loss and gain. The framework proposed in this paper distributes all the benefits from improvements in consumptive opportunities to shareholders but gives the environment a prior right similar to that presently provided for stock and domestic purposes.

From an operational perspective, attention needs to be given to the frequency of review and the processes by which that review is undertaken. Recognising the benefits of collective decision making, an ecological economist is likely to recommend strong community and resource-user participation in this process. Drawing on fisheries co-management literature, I would recommend that the plan be revised by a committee comprising shareholders, community representatives, environmental representatives and government water-supply managers.[6] **Recommendations for institutional change are common among institutional economists but rarely part of conventional economic analysis - even though policy reforms like the introduction of tradeable water rights requires many institutional reforms.**

Box 3

Different kinds of knowledge

RISK - System behaviour is well known. Range of outcomes and probabilities associated with them can be predicted.

UNCERTAINTY - System parameters are known but don't know the odds.

IGNORANCE - Scientists will be surprised by the outcome. They don't know but in retrospect can usually explain it.

INDETERMINACY - Scientific knowledge is inadequate. Causal chains and networks are open and not understood.

Source: After Wynne (1992).

Another consideration is the frequency of management plan review and the effect of down-side risks that discourage investment. In Figure 1, a five-year review period is proposed[7] and shares are issued for a 10 year period with a guaranteed right of renewal. No matter how imminent the next state or Federal election and how courageous the Minister, this institutional mechanism forces regular review.
Upon completion of the review and release of the new management plan, shareholders are given a

choice between remaining under the rights and conditions that attach to the old plan or dropping through to the new one. If they choose to delay accepting the rights and obligations in the new plan, then they lose 15%[8] of their shares (see Figure 1). This choice bounds the down-side economic risk associated with changes embedded in a management plan. In practice, and faced by such a mechanism, no review committee is likely to force immediate transition to a new set of conditions if that mechanism requires considerable investment or diminishes economic opportunity. The mechanism is designed to force Review Committees to phase-in expensive changes to water rights and obligations. If a Review Committee perceives a need to force all people to move to drip irrigation, for example, this mechanism would give the Committee a strong incentive to give irrigators - at least - 5 years to comply with this requirement. In effect, the right system recommended is one that gives water users a fully tradeable right to use water resources perpetually in a sustainable manner. Elsewhere, I have called this a sustainability guarantee.

Economic uncertainty associated with the review process can be reduced further by rotating catchment reviews so that a few catchments are reviewed each year. This has the added advantage of increasing administrative experience in the review process and reducing monitoring and evaluation costs.

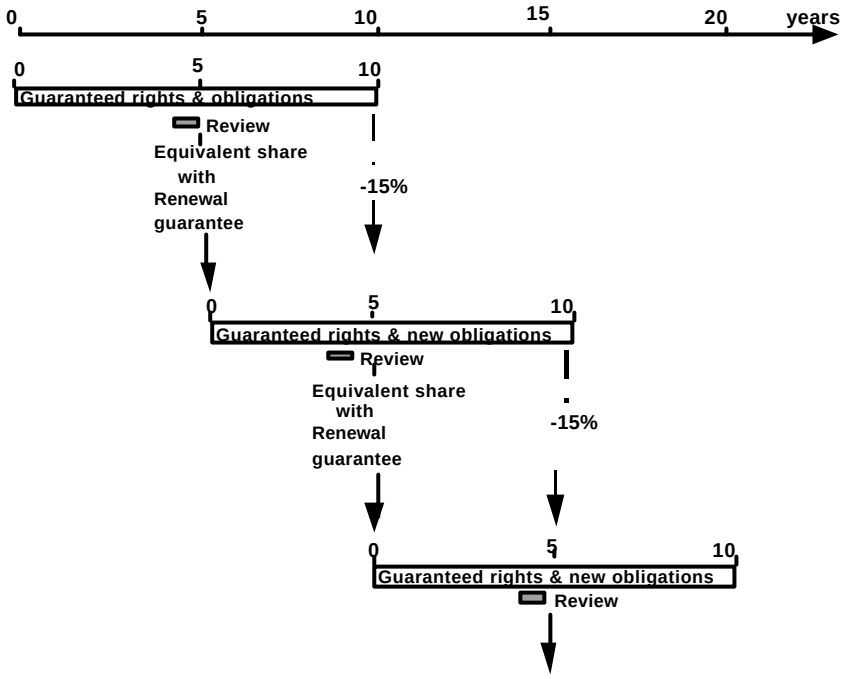

Figure 1 An adaptive share based tradeable rights system that uses periodic reviews to facilitate incorporation of new information while maintaining resource security (after Young 1996).

Stewardship

Stewardship refers to the intentions and behaviour of resource users with respect to maintaining the productivity and ecological characteristics of a resource or ecosystem. Essentially, it is a measure of the degree to which resource users prefer potential long-term benefits to short term, opportunistic gains. It pertains to the willingness of individuals to undertake activities that maintain long-term benefits even when the short term opportunity cost of doing this is high.

In conventional economic theory, which assumes markets reflect social aspirations for a resource, the simplest way to achieve perfect stewardship is to give resource users exclusive rights to use a resource as private property (Andersen and Leal 1991). "Resource security" as Australian industry likes to call it, increases the weight that self interested individuals give to the future relative to the present. **Most ecological economists would agree with this simple theoretical proposition that resource**

security encourages stewardship but then immediately seek to understand the exceptions to this rule and search for ways to ensure that more weight is given to future rather than present considerations.

Considerable resource security is a necessary condition for sustainable resource use and investment but is not a guarantee that this objective will be obtained. As Colin Clark (1973) long ago showed, where the natural rate of productivity is less than the real discount rate, the optimal strategy is to slowly run down the resource. Unfettered privatisation is not a sufficient condition to ensure stewardship in dynamic living systems. Kirby and Blyth (1987), in a highly regarded Australian paper, make a similar point with regard to land degradation. **Conventional economists define soil as just another form of capital, which as it only renews itself slowly, should be eroded at an "optimal" rate. In contrast, ecological economists will argue to the maintenance of natural capital and the introduction of programs to ensure that across the board no net loss occurs (**Janssson 1994; Pearce and Turner 1990**).** Most consider it necessary to address such issues from an inter-generational equity view point and not just argue that some soil erosion must be good because this is "economically efficient."

Under present arrangements, water users rely on political processes to ensure that rights are renewed. Most licences give irrigators little guarantee that they will personally benefit from changes in management arrangements and that a Minister will not dilute the value of their licence by issuing additional ones. The framework outlined above introduces resource security by giving water users a perpetual share of the consumptive potential of a resource and membership of the Committee responsible for revising management plans. Consistent with conventional economics, entry and expansion is only possible through the acquisition of shares or allocations from an existing user.

Apart from increasing resource security, stewardship can be enhanced further by building institutional mechanisms that:

> keep the size of areas over which shares are allocated relatively small so that each shareholder's sense of ownership and control over the system is strong;
>
> make resource security conditional upon compliance with catchment management plans and, in particular, by making loss of shares the main penalty used to enforce compliance. (In practice this means that mortgagees must be informed of all breaches and have an interest in ensuring compliance); and

increase the value of each share by making them mortgageable, by minimising trading costs, and sharing information.

One of the more interesting issues being explored by ecological economists is the relationship between "sense of ownership" and stewardship. Amongst other things this is leading some of them to oppose the globalisation of the world's economy and, at least for natural resources, recommend ownership restrictions. It is arguable that there is a nexus between proximity to a resource and interest in resource stewardship. Applied to water resources, this may mean that stewardship may be greater if ownership is restricted to catchment landholders and independent speculators are allowed to broker but not hold water shares. **A conventional economist might argue that these issues should be left to the Foreign Investment Review Board. An ecological economist would probably not deny a catchment committee the right to restrict share ownership to registered local land holders.** This could be achieved by allowing catchment committees who want to restrict ownership to local people to do so by including such a provision in a catchment management plan.

Equity Issues

Another issue that differentiates ecological economics from conventional economics is a much greater concern and interest in equity issues. **In particular, ecological economists are less inclined than conventional economists to assume either that the benefits from structural adjustment will trickle down or that it is most efficient to deal with equity issues via independent policy processes.**

Ecological economists might be expected to argue that compensation must always be paid. They recognise that one of the major criticisms of tradeable property-right systems is that they appear to involve privatisation of economic opportunities previously distributed throughout a community. From an equity position, it can be argued that at least some of the economic rent embodied in water rights should return to the community that created it (Young and McCay 1995; Young 1996).

In the case of water allocation, the issues that require careful consideration are:

the interests of third parties like those who own businesses that supply irrigators; and

the allocation of water to people who hold partly or totally unused licences (sleepers and dozers).

Mechanisms likely to be considered by an ecological economist would be based on ideas and propositions arising from the post-normal science doctrine. These are likely to include

recommendations for:

allocation of 80% of rights in proportion to the highest three of the last 5 years consumption; and allocation of the other 20% in proportion to official entitlement;

a maximum limit on the ratio of shares to land owned in a sub-catchment;

a "return to the community" achieved by the periodic surrender of part, say 2.5%, of each share holding to a tender pool with the revenue realised being returned to the local community; and hypothecation of revenue to a local council or catchment management committee.

An interesting feature of the 'return to the community' option mentioned above is that this mechanism is particularly effective in deepening shallow markets and breaking up monopoly positions. In the United States a variant of this mechanism - known as a zero-revenue auction - is used to deepen air pollution markets. Under this mechanism, every year, each right holder sets a reserve price for a proportion of their share holding and submits that portion to a tender pool. If the price realised is higher than the reserve, then a owner of the shares receives a cheque. It is called a zero-revenue auction because the process yields no money to the government (Young and McCay 1995). Both zero-revenue auctions and community return mechanisms have the additional advantage that they quickly establish a mature market where all people are accustomed to trading water rights on a regular basis.

Concluding comments

This paper is different to most because it uses the issue of water allocation as a backdrop to illustrate differences between propositions arising from conventional environmental economists and ecological economists. As I have defined ecological economics, the main differences that emerge are that ecological economics tends to take a much more trans-disciplinary approach and uses a much wider set of evaluation criteria. Much of what is recommended by conventional economists is advocated by many other ecological economists. The qualifications, however, tend to be different and give much greater weight to the importance of encouraging the maintenance of environmental integrity and institutional processes.

Finally, I think it important to emphasise that I see merit in dialogue and debate about the assumptions and doctrines that surround conventional economics. In an ideal world there would just be economics. That economics would know no boundaries to analysis; would only make assumptions that respect the laws of nature; would see efficiency as one means to achieving superior social objectives such as the benefits of living in a society that emphasises happiness and security through time, values, unexploited

options, and which, does not push everything to the limit. I urge conventional economists to think openly about the advantages of trans-disciplinary approaches that recognise that virtually all economic activity depends upon the maintenance of ecosystems processes.

Notes

[1] Virtually all macro-economic text books contain no discussion of the environment.

[2] This is a Pareto definition of allocative efficiency. The alternative, less restrictive definition of allocative efficiency is the Kaldor-Hicks version - Hypothetically, if those who gain from a proposal could fully compensate those who lose and still be better off, then the proposed change is efficient. In this framework we regard this less restrictive definition as a trade-off between equity and efficiency.

[3] Complex highly technical schemes that require large amounts of information, complex monitoring or many minor decisions are to be avoided.

[4] Stakeholders can obtain information about the instrument easily and find the instruments effects easy to explain to others.

[5] An alternative approach is to give the environment a very large share so that in most years the "environment sector" sells water for consumptive use. To do this without compromising existing standards, all existing use rights would have to be reduced substantially in most catchments. Moreover, some trade between sub-catchments would need to be taxed so that passive environmental values, like the provision of a medium for fish to swim in could be maintained. This would be particularly important for up-stream trades.

[6] Arrangements for interaction among sub-catchments and catchment could be organised and managed according to similar principles.

[7] The five-year frequency of review is arbitrary and is a recommendation that would benefit from empirical modelling. My intuitive judgement is that the optimal period is somewhere between 5 and 7 years. The precautionary approach is to start with a short period and extend once experience has been obtained.

[8] Other penalties for failure to adopt a new management plan immediately are possible.

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