

# **Public Funding for Environmental Issues: Where to Now?**

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## **Introduction**

“The momentum behind ever increasing salinity budgets appears to be irresistible. We need to start spending the money sensibly, so that the new money is not spent as unproductively as the old money.” (Pannell, 2000a)

“A large expenditure of public funds for salinity can easily be justified on the basis that, if it is well spent, it will avoid substantially greater public costs in the near and distant future. Unfortunately, it would also be easy to spend the funds in a way that has virtually no sustained benefit. Providing public funds as subsidies to farmers for measures that are not effective will not only be wasteful, but also morale sapping for the farmers. We have also tended to devote too many resources to activities intended to inform and persuade farmers to adopt new farm practices, before we have developed practices that are suitable for them to adopt.” (Pannell, 2000b)

“If we can learn anything from our experiences with the decade of Landcare and the first five years of the Natural Heritage Trust, it is that we must not confuse activity with effectiveness.” (Tom Hatton, CSIRO, quoted by Frost et al., 2001)

“It is clear that the scope for economic instruments to make a positive difference is limited. This is because the on-farm economics of treatments are mostly adverse and the off-farm benefits per hectare of on-farm treatment are mostly small.” (Pannell, 2000c)

“The two most important broad areas of change ... are (a) better targeting and more rigorous analyses of proposed public investments, and (b) a greater emphasis on the development of technologies, both for salinity prevention (e.g. perennial plants, engineering methods) and adaptation to a saline environment (e.g. salt-tolerant plants, engineering, commercial use of saline water resources).” (Pannell, 2001b)

## **Some Givens**

1. Government intervention for environmental issues should target market failure. There are various types of market failure. Market-based economic instruments, regulatory approaches, and persuasive approaches are all, in principle, only justified on efficiency grounds where there is market failure (although they may be motivated/justified by equity issues at times).
2. Values of public and private assets at risk from the consequences of resource degradation are highly variable across locations, and the distribution is very highly skewed with small areas of very highly valued assets.

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3. The types of assets at risk are broadly different in Western Australia and the MDB. Water resources are paramount in the MDB. In WA the biggest issues are land related: loss of biodiversity (Keighery, 2000), loss of agricultural land (Ferdowsian et al., 1996), and damage to built infrastructure (Dames and Moore – NRM, 2001; Short and McConnell, 2001; National Land and Water Resources Audit, 2001). South-West WA has the highest biological diversity in Australia and is one of 25 biodiversity hotspots in the world.
4. Hydrogeological systems are highly variable (local, intermediate and regional and various versions of each of these) (National Land and Water Resources Audit, 2001).
5. Responsiveness of groundwater systems to management is generally much less than previously assumed, particularly for off-site effects. (George et al., 1999a, 1999b; Hatton and Nulsen, 1999; Hatton and Salama, 1999; Walker et al., 1999; Heaney et al., 2000; Stauffacher et al., 2000; National Land and Water Resources Audit, 2001)
6. Off-site benefits from groundwater management can be long delayed. (Hatton and Salama, 1999; National Land and Water Resources Audit, 2001). Major land use changes in the MDB in the next seven years would have no measurable beneficial impact on water quality during that seven year period.
7. In some catchments, particularly high rainfall regions, surface water flows provide fresh water to dilute salinity in waterways (Heaney et al., 2000).
8. Some key salinity treatments have major external costs in some situations. One example is perennial vegetation which reduces flows of fresh surface water. Because this impact is more or less immediate, the external costs of revegetation can be greater than the external benefits in water resource catchments in higher rainfall regions (Heaney et al., 2000). Another example is arterial drainage system, which *may* create a range of problems downstream, including potentially, increased flood risk.
9. “The costs of salinity” (or more generally “the cost of degradation”) is not the relevant issue for management and policy decisions. A more relevant issue is “the net benefits of salinity management” (or “the net benefits of resource protection”). “The costs of salinity” are radically different from “the net benefits of salinity management” because salinity treatments are (a) only partly effective, (b) slow to take effect and (c) expensive.
10. For some key assets at risk, the urgent interventions are local, not catchment wide. For some, all the required interventions are local (e.g. Dames and Moore – NRM, 2001).
11. Voluntary adoption of land-use changes on scales which would prevent downstream impacts of salinity has not happened (Kington and Pannell, 2001; Curtis *et al.*, 2000), and will not happen given currently available technologies and land uses (Pannell, 2001a).
12. Development of profitable technologies and land uses which have salinity prevention as a side benefit is one way to enhance adoption.
13. The value of the salinity-prevention benefits of such technologies are small relative to their direct costs and benefits. (Bathgate and Pannell, 2001; Pannell, 2001b).
14. Some regions have a high proportion of landholders who are “on a trajectory out of agriculture” (Barr et al., 2000) and are likely to be unresponsive even to profitable land use options. For these, the key is probably rural adjustment.

### Some interpretations and observations

1. The idea that public money should only be used to generate “public benefits” is only loosely related to the idea that Government intervention for environmental issues should target market failure. It is largely separate from the issue of “public goods”

(which are related to efficiency, and about which economists do have sensible things to say). The “public benefits” idea may have a basis in efficiency in some cases, but it is more often a question of distribution. Economics has little to say about this in a normative sense. Even if we subscribe to it, defining “public benefits” is highly problematic. For example public benefits are clearly not synonymous with public goods (non-rival goods or non-price excludable goods). Who, then, is included in the “public”. Why in principle are benefits to them preferred over benefits to others? However, given that budgets are tight and demands for expenditure are big, I accept that the “public benefits” criterion does provide a handy means of excluding claims on the public purse; it is a somewhat dodgy but convenient rationing device.

2. Even if one subscribes to the “public benefit” funding criterion, an interpretation that it implies that funds must not also generate private benefits for farmers (or others) is illogical and counterproductive in achieving the objective of maximising public benefits. In many cases, the most cost-effective approach to generating public environmental benefits is to encourage uptake of practices which generate both environmental benefits and some private benefits to farmers (but not sufficient to make them commercially attractive in their own right). For this reason, the Natural Heritage Trust criterion to exclude funding to works which generate even low levels of private benefits results in a loss of public benefits, not a protection of them. Compounding this, the criterion sends a message to farmers that the Natural Heritage Trust is not a partnership. Given that almost all of the existing management strategies needed to address environmental degradation require farmers to sacrifice effort and money (above and beyond the finances provided by Natural Heritage Trust) this interpretation of the “public benefit” criterion is extremely unwise.
3. For most agricultural land in Australia, the off-site salinity-related benefits of planting perennials are smaller than the on-site net costs. The catchments where the net benefits of revegetation would be high will be particular, readily identifiable individual catchments, containing assets of exceptional value. Apart from these catchments, the potential gains to the community as a whole from government intervention to reduce off-site impacts from salinity are not great.
4. In other words, even though much of the agricultural land is a source of salinity-related external costs, these external costs are not sufficient to be a cause of market failure because the on-site net costs (and in some cases the external costs) outweigh the external benefits of intervention. Areas where market failure does occur will be areas with very high value assets at risk combined with sufficiently responsive groundwater flow systems.
5. Given the absence of market failure, and given the first “given” in the previous section, market-based economic instruments, regulatory approaches, and persuasive approaches are all, in principle, not justified for salinity purposes on most of the agricultural land. In most locations across the agricultural regions of Australia, the benefits from perennials due to salinity prevention or delay are small relative to the costs and direct production-related benefits of the perennials. It is therefore unlikely that policy instruments to provide incentives for adoption of perennials, whether economic or regulatory, would be socially desirable except in one of two situations. Either the perennials would need to be almost as economically attractive as existing farm enterprises (which is currently only true in a minority of situations) or they would need to be in locations where they provide protection to assets of outstanding value.

### Distinguishing Between Different Types of Government Action

This section is substantially based on Chapter 2 of the report of the Western Australian Salinity Taskforce (Frost et al., 2001), which was released in September 2001.

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There are three main types of action available to Government:

- Protection of outstanding **public assets** from the consequences of salinity and other forms of resource degradation (e.g. water resource catchments, threatened high-value conservation areas or roads);
- Investment in and support for major actions on **private land** by developing new technologies and new industries (e.g. perennial plants for salinity prevention, salt tolerant plants for productive use of saline land or engineering options); and
- Support and incentives for planning, coordination and implementation of on-ground works on **private land** (e.g. for water management and protection of biodiversity).

It is important to distinguish between these because:

- While all are relevant, not all have been adequately recognised or resourced in Government strategies and programs to date;
- Each action needs to be pursued in different ways, with different roles and emphases by government, community groups and individuals;
- Acceptance of these three distinct actions has important implications for future salinity strategies, such as National Action Plan for Salinity and Water Quality and phase two of the Natural Heritage Trust; and
- The community draws these distinctions and believes that current mechanisms and programs do not appropriately prioritise the three types of action.

These categories do not encompass every aspect of government involvement in salinity (e.g. national or statewide monitoring and evaluation). However, they capture the key roles directly related to achieving change on the ground.

### Targeted intervention to protect particular public assets

Previously, salinity has been seen as a problem that would be addressed by landholders across the entire landscape with the protection of public assets achieved as a result of the voluntary actions of landholders. In Western Australia the need for targeting of priority assets was recognised in the 1996 Salinity Action Plan with the establishment of Water Resource Recovery Catchments, Rural Towns Program and Biodiversity Recovery Catchments.

Further improvement in scientific understanding of salinity has highlighted that:

- Other than in some Recovery Catchments, the level of adoption by landholders of salinity prevention measures is generally only a small proportion of that needed to prevent impacts on public assets and that this is likely to continue to be the case for some time;
- Even if landholders were to dramatically and immediately increase the adoption of salinity management measures there would be continuing damage to key public assets as watertables shift to a new equilibrium over the coming decades; and
- For some key public assets at risk, the priority need is for works within or immediately adjacent to the assets. Often this will require engineering solutions, especially where salinisation is well advanced. Work in the surrounding catchment could provide benefits in the longer term but will be insufficient to protect these public assets in the short to medium term.

These insights indicate the need for a much more targeted and selective approach to protection of public assets from salinity. Public assets must continue to be identified and prioritised for action because of the richness of the biodiversity and the high value of the public infrastructure and public water supplies that are at risk.

The nation's salinity strategy should focus on determining what action is required to protect specific public assets and importantly, whether those actions are justified. In

Western Australia, the Salinity Council has developed a Framework for Investment in Salinity Management which attempts to lay out the basis on which this should be done.

### Development of New Technologies and New Industries

The highly targeted approach to protecting public assets described above implies that only small areas of farm land would qualify for direct public funding for the purposes of implementation of on-ground works to prevent salinity impacting public assets.

For other farmland, salinity management would primarily be the responsibility of farmers with limited direct financial support from Government.

However, farming systems which allow farmers to deal with salinity at a large scale are viable in only a few parts of the country facing serious salinity risks (e.g. the broadscale planting of lucerne in some regions).

Therefore there is a need to better develop new technologies and farming systems in four broad areas:

- various kinds of engineering works;
- profitable perennials for recharge areas (for salinity prevention);
- salt tolerant plants to make use of saline land; and
- methods to utilise saline water economically.

All of these have their place in delivering options and solutions for salinity management.

In Western Australia there is a ground swell of support amongst farmers for the use of engineering solutions to combat salinity, particularly by deep-drainage. While there are some situations in which drainage appears to be having a beneficial impact, it is still unclear in what circumstances drainage will be best applied to be effective and economic. There are conflicting views within the farming and scientific communities about the efficacy of engineering solutions to reduce salinity and the significance of potential down-stream impacts. This conflict and uncertainty reinforces the need for far greater resourcing and effort in this area.

Even with concerted efforts, the realistic prognosis is for a continuing worsening of salinity impacts in future. This highlights the importance of developing improved methods for making productive use of saline land and saline water.

Of these four types of technology, the most challenging may be the development of new profitable perennials for recharge areas. Realistically this will be a slow and expensive process with failures as well as successes. In addition, recent predictions of salinity extent suggest that even if perennials are established over large areas, salinity in many catchments will continue to worsen (although at a reduced rate and to a lower final equilibrium level). Therefore we must be clear about the rationale for pursuing this approach. Reasons for advocating it include the following:

- Profitable perennials are the only prospect for prevention (as opposed to remediation) of salinity on most of the threatened agricultural land;
- Substantial improvements in the range and scope of profitable perennials seem achievable;
- Of the four types of technology for salinity management on farms, public off-site benefits would arise primarily from salinity prevention using perennials;

- In situations where subsidies for perennials on farms may be appropriate (i.e. on farms near to the key public assets) the level of subsidy can be reduced if the perennials are made less costly/more profitable. Thereafter public funds can be saved and directed to other priorities;
- More profitable perennials will dramatically reduce the problem of achieving widespread adoption;
- Profitable perennials could also attract private sector finance to meet the establishment costs, which are beyond the means of many farmers;
- New industries based on perennials will generate social benefits to rural regions, resulting from greater wealth and employment. This includes the potential to introduce new industries such as bio-energy, bio-fuels for transport, aquaculture and wood products, as well as maintaining existing industries such as wool and meat production with the introduction of perennial pastures.

In all likelihood, the salinity-related benefits from new industries based on perennials will be small relative to the total of other benefits of such industries, which will include profitability, diversification, regional development and broader environmental benefits. Nevertheless, salinity provides an imperative to pursue this approach, since large-scale salinity prevention on farmland is probably not achievable by any other means. Salinity provides the primary impetus to Australia to review its agricultural landuse.

### Planning, Coordination and Implementation of On-Ground Works

This category represents the dominant approach to natural resource management policy in Australia over the past ten years primarily driven by the Commonwealth Government's National Landcare Program and continued by the Natural Heritage Trust. The approach relies on voluntary actions of catchment groups coupled with partial subsidies for on-ground works. This approach remains dominant in the thinking behind the National Action Plan for Salinity and Water Quality.

This approach will not achieve change on the scale necessary to manage salinity. While a range of important benefits for farmers and the broader community have resulted from the National Landcare Program and the Natural Heritage Trust, including benefits to biodiversity conservation and waterways, in many locations *salinity prevention* benefits are a minor outcome. This is because of the scale of change needed for effective salinity prevention, the great expenses involved in acting at that scale and the ineffectiveness of small-scale changes.

A further important outcome from this category of action has been awareness about salinity and other natural resource management issues. This foundation of knowledge means that Australia is well placed to take the next step in its salinity management strategy. It needs to be a significantly different step than the proposed National Action Plan.

### Some Implications for NAP and NHT2

Government investment contains elements of all three of the actions described above. However, the National Action Plan for Salinity and Water Quality is deficient in its dominant emphasis on funding delivery through regional groups, implying an emphasis on planning, coordination and partial funding for on-ground works (which will achieve relatively little for salinity management).

The National Action Plan is an evolution from Landcare and ICM. The document released to announce the program, “*Our Vital Resources – National Action Plan for Salinity and Water Quality*”, emphasises “Integrated Catchment/Region Management Plans” to be developed “by the community”. The community is to be supported in this by the existing facilitator and coordinator support network, by skills development programs, by extension of technical information, and by a major public communication program “to promote behaviour change and community support”. In all this, the program sounds disappointingly similar to the past programs.

Novel elements of the National Action Plan include the setting of targets for salinity, with funding to achieve these targets being directed to community-based groups in the regions. The setting of targets for each catchment or region raises a number of issues. If they are not based on detailed empirical analyses which account for the hydrological and economic realities of the catchment, targets might easily define outcomes which are inferior to a business as usual approach. If they are based on scientifically credible analyses, targets for the available budget will be very modest, even allowing for unrealistic expectations about the sacrifices to be made by farmers. Likely response times in river salinity to major revegetation activities in the Murray Darling Basin are 100 years or more. This means that achievement of short to medium term water quality targets for the rivers in the Basin will probably depend on the viability of engineering schemes, such as pumping/evaporation to intercept saline groundwaters. The option of desalinating water for domestic consumption in Adelaide may also become attractive.

It is apparently intended that targets should enhance accountability, which has been a serious weakness in previous programs. However, long time lags and scientific uncertainty erode this advantage. Many of the benefits from the policy, if they occur, will be decades in the future. Even a retrospective evaluation of the policy at that time will be difficult because of uncertainty about what would have happened without it.

The regional groups to which funds are to be channeled will find it very difficult not to spread much of the money thinly and non-strategically amongst farmers. The groups will need very high levels of information and leadership if they are not to allocate the money in ways that will be socially and politically attractive but technically and economically inefficient. It may be expecting too much of them to make the difficult but necessary decisions about priorities, especially where it involves fewer funds going directly to farmer members of their communities, many of whom are suffering financial hardship. Provision of high levels of technical information from government and research organisations will be essential for the process to operate effectively.

The plan does allow for technical and economic evaluations to be conducted to back agreements with regional groups (and ABARE has already conducted modelling studies for parts of the Murray Darling Basin, Heaney *et al.* 2000). It remains to be seen how influential these evaluations will be on the contents of the agreed plans.

The other relatively new element in the plan is an improved “governance framework”, including clarification of property rights for water, limits on land clearing and greater use of economic policy instruments (salinity credits, subsidy payments, etc.). These changes seem broadly positive, although I have argued earlier that achievement of benefits from use of economic policy instruments is likely to be highly site-specific.

A high profile component of the plan is airborne geophysics using electro-magnetics and other techniques to identify salt deposits and flows. While information from these

methods no doubt has some value for diagnosis and planning, it does not in itself address the problem in most locations of lack of viable technologies for salinity prevention.

Considerable work in planning and coordination has already been done by many catchment groups and sub-catchments groups during the Decade of Landcare. While planning and coordination for on-ground work remains useful to achieve other natural resource management outcomes (such as on-farm biodiversity protection and reduction of sediment and nutrient flows into waterways) it is less likely to achieve a widespread reduction in salinity. The main salinity-related contribution from this approach is in the management of water flows from engineering works. Overall, planning and coordination for on-ground works should primarily be addressed within the new Natural Heritage Trust Program rather than the National Action Plan for Salinity and Water Quality.

### Some Implications for Other Policy Proposals

Phillip Toyne and Rick Farley claim credit for securing the original funding for the National Landcare Program. More recently they have proposed a 10 point plan “to tackle Australia’s critical land-use crisis” (sic) (Toyne and Farley, 2001, p.62). Point six of their plan states, “A 1% National Landcare Tax should be imposed for the next ten years to raise funds in the order of \$30 billion.”

The determination of this proposed amount was influenced by a study commissioned by the National Farmers Federation and Australian Conservation Foundation (Virtual Consulting Group and Griffin NRM, 2000). That study estimated total costs of a major program of environmental works to be \$65 billion over 10 years, including \$37 billion from the public purse. Most of the expenditure would be targeted against salinity. The study has been repeatedly used as the basis for calls for radically increased funding for the environment, with an implicit or explicit assumption that the \$65 billion would be a good investment. (Incidentally, I am advised that an early draft of the report proposed that the cost of a comprehensive response would be around \$250 billion, but those who commissioned the study considered this to be too large for their strategic purposes).

A sensible response to the Virtual Consulting Group and Griffin NRM (2000) report would have been to realise that the whole notion of buying a comprehensive solution to “Australia’s critical land-use crisis” is ludicrous. If the report were to be acted on (e.g. in the way proposed by Toyne and Farley), the result would be one of the most poorly conceived, unproductive and wasteful programs of public expenditure in Australia’s history.

### Where should we go from here?

In summary, the necessary changes to the national policy approach for us to move towards a sound approach to public investment in environmental issues include the following:

1. Treat salinity differently from other NRM issues. The technical characteristics of salinity mean that a different policy approach is needed.
2. Take the science and the economics seriously when designing the broad policy approach. The implications of relatively new research findings are profound, but have not been factored into national policy approaches.
3. Move away from a catchment management focus. Instead, focus on protection of specific assets and determine what works are needed to achieve that protection.



- They often will not be works at the whole catchment scale, although they sometimes might be.
4. Undertake more strategic, targeted and selective investment in on-ground works. Broad brush expenditures are most unlikely to be sound investments for salinity.
  5. Don't rush into spending the money. Undertake serious evaluations of proposed expenditures, including at least hydrogeological and economic aspects. The amounts of money being invested are too large, and the risks of waste too high, to allow less rigorous decisions to continue.
  6. Focus on the technologies for land use and environmental protection. In particular, invest in development of new land use options and improvements in existing ones. Accept that the prime motivation for land use changes on a large scale will be economics. Salinity prevention, if it occurs, will be a spin off from changes made for other reasons.
  7. Get over the Landcare approach. It was an interesting experiment. It is now time to move on, especially with regard to salinity.
  8. Get over the cargo cult mentality about economic market based policy instruments. Similarly, do not expect regulatory or "duty of care" approaches to be "the solution".
  9. Include "living with salinity" as a prominent option in any analysis of options.
  10. Be more honest in communication to landholders and to organisations in the private sector which are being encouraged to contribute funds. There also needs to be a commitment to full and honest disclosure to farmers about the problem and the results of high quality evaluations of the treatments. Honesty needs to temper the spirit of forced optimism which has fueled the Landcare program to date.
  11. Recognise the need for expenditures of different types. Funding to community groups or Regional NRM groups is not the only need and, in the case of salinity, it is of relatively low priority.

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## References

- Barr, N., Ridges, S., Anderson, N., Gray, I., Crockett, J., Watson, B., and Hall, N. 2000, 'Adjusting for Catchment Management: Structural Adjustment and its Implications for Catchment Management in the Murray Darling Basin', Murray Darling Basin Commission, Canberra.
- Bathgate, A. and Pannell, D.J. 2001, Economics of deep-rooted perennials in southern Australia. *Agricultural Water Management* (in press).
- Curtis, A., MacKay, J., Van Nouhuys, M., Lockwood, M., Byron, I. and Graham, M. 2000, *Exploring Landholder Willingness and Capacity to Manage Dryland Salinity: The Goulburn Broken Catchment*, Johnstone Centre Report No. 138, Charles Sturt University, Albury, NSW.
- Dames and Moore – NRM 2001, *The Economics of Predicted Rising Groundwater and Salinity in Rural Towns*, Final Report, June 2001, for Rural Towns Steering Committee and Agriculture Western Australia, Dames and Moore – NRM (a division of URS), East Perth.
- Ferdowsian, R., George, R., Lewis, F., McFarlane, D., Short, R. and Speed, R. 1996, 'The extent of dryland salinity in Western Australia', *Proceedings, 4th National Conference and Workshop on the Productive Use and Rehabilitation of Saline Lands*, Albany, Western Australia, 25-30 March 1996, Promaco Conventions: Perth, Western Australia, pp. 89-97.

- Frost, F.M., Hamilton, B., Lloyd, M. and Pannell, D.J. 2001, *Salinity: A New Balance, The report of the Salinity Taskforce established to review salinity management in Western Australia*, Perth. Report can be downloaded from <http://www.ministers.wa.gov.au/edwards/Features/salinity.htm>
- George, R.J., Nulsen, R.A., Ferdowsian, R. and Raper, G.P. 1999a, 'Interactions between trees and groundwaters in recharge and discharge areas - a survey of Western Australian sites', *Agricultural Water Management*, vol. 39, pp. 91-113.
- George, R., Clarke, C., Hatton, T., Reggiani, P., Herbert, A., Ruprecht, J., Bowman, S. and Keighery, G. 1999b, The effect of recharge management on the extent of dryland salinity, flood risk and biodiversity in Western Australia. Preliminary computer modelling, assessment and financial analysis. Unpublished report to State Salinity Council of Western Australia.
- Hatton, T.J. and Nulsen, R.A. 1999, 'Towards achieving functional ecosystem mimicry with respect to water cycling in southern Australian agriculture', *Agroforestry Systems*, vol. 45, pp. 203-14.
- Hatton, T. and Salama, R. 1999, 'Is it feasible to restore the salinity affected rivers of the Western Australian wheatbelt?' in Rutherford, I. and Bartley, R. (eds.), *Proceedings of the 2<sup>nd</sup> Australian Stream Management Conference, Adelaide, 8-11 February 1999*, pp. 313-18.
- Heaney, A., Beare, S. and Bell, R. 2000, Targeting reforestation for salinity management, *Australian Commodities*, vol. 7, pp. 511-518.
- Keighery, G. 2000, Wheatbelt wonders under threat, *Landscape*, Summer 2000-2001.
- Kington, E.A. and Pannell, D.J. 2001, 'Dryland salinity in the upper Kent River catchment of Western Australia: Farmer perceptions and practices', *Journal of Environmental Management*, (submitted).
- National Land and Water Resources Audit 2001, *Australian Dryland Salinity Assessment 2000*, National Land and Water Resources Audit, Canberra.
- Pannell, D.J. 2000a, Salinity Policy: A tale of fallacies, misconceptions and hidden assumptions, SEA Working Paper 2000/08, Agricultural and Resource Economics, University of Western Australia. <http://www.general.uwa.edu.au/u/dpannell/dpap0008.htm>
- Pannell, D.J. 2000b, Salt levy? The complex case for public funding of salinity. SEA Working Paper 2000/01, Agricultural and Resource Economics, University of Western Australia. <http://www.general.uwa.edu.au/u/dpannell/dpap0001.htm>
- Pannell, D.J. 2000c, Market-based mechanisms, financial incentives and other institutional innovations: Assessing their potential for addressing dryland salinity, SEA Working Paper 2000/09, Agricultural and Resource Economics, University of Western Australia. <http://www.general.uwa.edu.au/u/dpannell/dpap0009.htm>
- Pannell D.J. 2001a, Explaining non-adoption of practices to prevent dryland salinity in Western Australia: Implications for policy. In: Conacher A (ed) *Land Degradation*, Kluwer, Dordrecht, pp.335-346.
- Pannell, D.J. 2001b, Dryland salinity: Economic, scientific, social and policy dimensions, *Australian Journal of Agricultural and Resource Economics* 45(4): 517-546.
- Short, R. and McConnell, C. 2001, *Extent and Impacts of Dryland Salinity*, Western Australian component of Theme 2 prepared for the National Land and Water Resources Audit, Resource Management Technical Report 202, Agriculture Western Australia, South Perth.
- Stauffacher, M., Bond, W., Bradford, A., Coram, J., Cresswell, H., Dawes, W., Gilfedder, M., Huth, N., Keating, B., Moore, A., Paydar, Z., Probert, M., Simpson, R., Stefanski, A., and Walker, G. 2000, Assessment of Salinity Management Options for Wanilla, Eyre Peninsula: Groundwater and Crop Water

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- Balance Modelling. Technical Report 1/00, CSIRO Land & Water, Canberra, Bureau of Rural Sciences, Canberra.
- Toyne, P, and Farley, R. 2001, The decade of Landcare, looking backward – looking forward, *State Landcare Conference 2001, 11-14 September 2001, Mandurah Western Australia*, pp. 61-63.
- Virtual Consulting Group and Griffin NRM 2000, *National Investment in Rural Landscapes, An Investment Scenario for NFF and ACF with the assistance of LWRRDC*.
- Walker, G., Gilfedder, M. and Williams, J. 1999, *Effectiveness of Current Farming Systems in the Control of Dryland Salinity*, CSIRO Land and Water, Canberra, 16 pp.

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## **About the Author**

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### **Background**

David Pannell's research interests include: management of natural resources; adoption and diffusion of innovations; bioeconomic modelling; agricultural risk; evaluation and prioritisation of research; and agricultural extension policy. In these areas and others he has published two books and 80 journal articles and book chapters. His current research focuses on "Sustainability and Economics in Agriculture", with salinity as a prominent theme. He has recently been a prominent commentator on salinity policy, building on research into various aspects of the problem, including farmer adoption of salinity treatments, farmer attitudes, economics of salinity treatments at farm and catchment scales, and the implications of new hydrological findings for efficient management of salinity externalities. David's research has been recognised by awards from the Australian Agricultural and Resource Economics Society, the Canadian Agricultural Economics Society and the Agricultural Economics Society (UK).