WHEN TOO MUCH LANDCARE IS BARELY ENOUGH

Colin Campbell
Department of Agriculture
Western Australia

Abstract

This paper presents a case study for a catchment in the Avon Districts area of Western Australia. Benefit-cost analysis of catchment management for landcare has highlighted both the trade-off between private and social objectives in land management, as well as the "win/win" situation which occurs when private and social goals are complimentary. The use of benefit-cost analysis has also provided a method for prioritising conservation works.

Often the optimal level of landcare for the individual farmer, from an economic perspective, will be less than the level that society deems optimal. This raises issues of who should pay for landcare in situations where there is no financial reward for farmers carrying out the work, but where there are positive externalities outside catchment boundaries. The issue of externalities between farms within a catchment is also examined.

The work highlights the trade-off between private and social objectives that may occur in the management of land degradation resulting from agriculture. We discuss this trade-off and the implications for individual farmers, catchment groups and regional planners.

Introduction

The work presented in this paper has been funded by the Land and Water Resources Research and Development Corporation.

The project has two aims:

1. To assist catchment groups and individual farmers to identify, analyse and adopt land uses and conservation strategies that are biologically and economically sustainable.

2. To improve the planning and management of land conservation programs at the regional and State levels by using benefit-cost analysis in goal setting and prioritisation.

The work presented here is the first stage of a benefit-cost analysis study to investigate the financial and economic consequences of a catchment plan for the Westdale catchment in the Avon districts region of Western Australia.

The Westdale catchment was selected for several reasons. First, the catchment group have been involved in a sponsored landcare program with Alcoa since 1991. As a consequence of this involvement the group have completed a catchment strategy to address the land degradation issues they face. Second, all of the farms within the catchment have begun to implement some of the strategy recommendations. For these reasons, alot of the information that is required for a meaningful economic analysis had already been collected.

Description of the Westdale Catchment

The Westdale Catchment is situated in the Avon Districts region, roughly 95km east south-east of Perth along the Brookton highway. The average annual rainfall is 550 mm. Total arable area of the catchment is approximately 7140ha containing 10 farms.

Even though the Westdale catchment is surrounded by State Forest, clearing on farms within the catchment has caused problems with excess surface water and in localised areas rising groundwater. This leads to waterlogging, salinity and water erosion.

The main thrust of the catchment strategy is to increase groundwater use and to control surface water drainage. These objectives can be achieved through a variety of conservation/management strategies; through changing rotations to more productive/higher water-using crops, planting of fodder shrubs and trees to intercept subsurface recharge and reduce groundwater recharge, construction of drains and graded banks to control both surface and subsurface water flows.

Method of analysis

Benefit Cost Analysis (BCA) was used to assess the Westdale Catchment Strategy by comparing what would happen to future cashflow if nothing is done to address land degradation (the without scenario) as opposed to what would happen if conservation strategies are undertaken (the with scenario).

A computer spreadsheet model SALTPLAN was used to compare these two scenarios.

The without scenario assumes that no conservation works are carried out in the catchment and that as a result land continues to degrade over the 15 years of the analysis to the point where all of the land that is susceptible to salinity will be saline and unproductive. Similarly, it is assumed that waterlogging and water erosion will have a consistent annual effect in depressing yields of crops and stocking rates on areas that are affected. This provides a base case scenario with which to compare the effect on cashflow of implementing each conservation strategy.
Initially each conservation strategy was analysed seperately to assess the individual contribution to financial and conservation objectives. Finally a range of combined strategies were assessed.

The likely impact of strategies on achieving conservation objectives was determined through consultation with hydrologists, biologists, landcare advisors and farmers. This approach is in contrast to techniques that involve complex modelling to simulate hydro/biological relationships and then linking this with economic analysis.

The advantage of the simpler approach is that it is very flexible (can be applied to any catchment), is very cost effective, assumptions are highly transparent and can be subject to sensitivity analysis. Perhaps more importantly, the approach encourages wide consultation with the normal participants in the catchment planning process and in so doing gives a sense of ownership of results.

Results

For the purposes of the Westdale Catchment Strategy the catchment has been divided into 6 component Land Management Units (LMU's).

The 6 component LMU's are:

Description	Area		% of Arable land
1. Hillside Loams	3715	ha	52%
2. Valley Soils	1545	ha	22%
3. Gravels	835	ha	11%
4. Sand	190	ha	3%
5. Saline	258	ha	4%
6. Waterlogged	596	ha	8%
Total area	7139	ha	

Strategy 1. Changing rotations.

The following yields were assumed: Wheat 2 tonnes/ha, Oats 2.5 tonnes/ha, Hay 7 tonnes/ha, Lupins 1.2 tonnes/ha, Barley 2.5 tonnes/ha.

The catchment strategy recommends the following rotations:

Hillside Loams: WLWPPP
WPP
WLOPPP
WL
WLO

Valley Soils:	PPP PPO (Hay or Grain) PPB O(grain)O(hay)PPP
Gravels:	PPPW LW Continuous Pasture
Sand:	Deep rooted permanent pasture
Waterlogging/Salinity:	Permanent pasture or fodder shrubs

W = Wheat O = Oats B = Barley
L = Lupins P = Pasture

Following the recommendations results in the following changes (Assuming rotations with the highest gross margins).

Current rotations	New rotations
- 800ha Lupins	- 1636ha Lupins
- 500ha Wheat	- 1579ha Wheat
- 1300ha Oats	- 1241ha Oats
- 600ha Hay	- 226ha Hay
- 3939ha Pasture	- 1440ha Pasture
	- 226ha Barley

The predicted change in the Net Present Value (NPV) of the catchment income that results from changing rotations in this way is $223,000 . This assumes no change in the rate of spread of salinity or in waterlogging.

Strategy 2. Graded Banks

The catchment strategy recommends graded banks on all slopes greater than 3%. This strategy is primarily aimed at reducing the incidence of water erosion.

The total area in the catchment that has a slope greater than 3% is approximately 4550 hectares. Assuming this area is roughly square, it would require 414km of banks spaced at 110m intervals to comply with the catchment recommendations.

If we assume that the average bank is 2m wide, then 5km of banks occupies 1 ha. Similarly, if we assume that each bank affects an area 40m downslope, then 1ha of banks will affect 20ha of land. The analysis assumes a cost of $500/km for graded banks which equates to $2500/ha of land occupied by the banks.

The benefits from banks is the reduction in water erosion that results from extreme summer and winter rainfall events. The concommiltant increases in crop and pasture production also help to reduce waterlogging and salinity spread through reducing groundwater recharge.

An average annual per hectare loss from water erosion was calculated in the following manner. Using rainfall data for the Beverley Shire over the past 100 years, the probability of extreme rainfall events occuring was estimated. These probabilities were combined with the assumed losses in production that resulted from the erosion associated with these events, to give an average loss over a 100 year period. This figure was estimated 100 times and also averaged.

The average loss per hectare per year as a result of water erosion was estimated to be $23. So that the benefit from banks if they were 100% effective would be $23 per hectare of land they protected from erosion.

However, for this analysis the effectiveness of the banks is assumed to diminish with increasing areas, based on the assumption that the first banks established will be placed where they are most needed and will be more effective. The next banks will be placed in the next most vulnerable area etc. Increased areas of banks are assumed to increase the area of saltland saved.
The assumptions for the effectiveness of banks and their estimated effect in changing NPV are et out in the following table

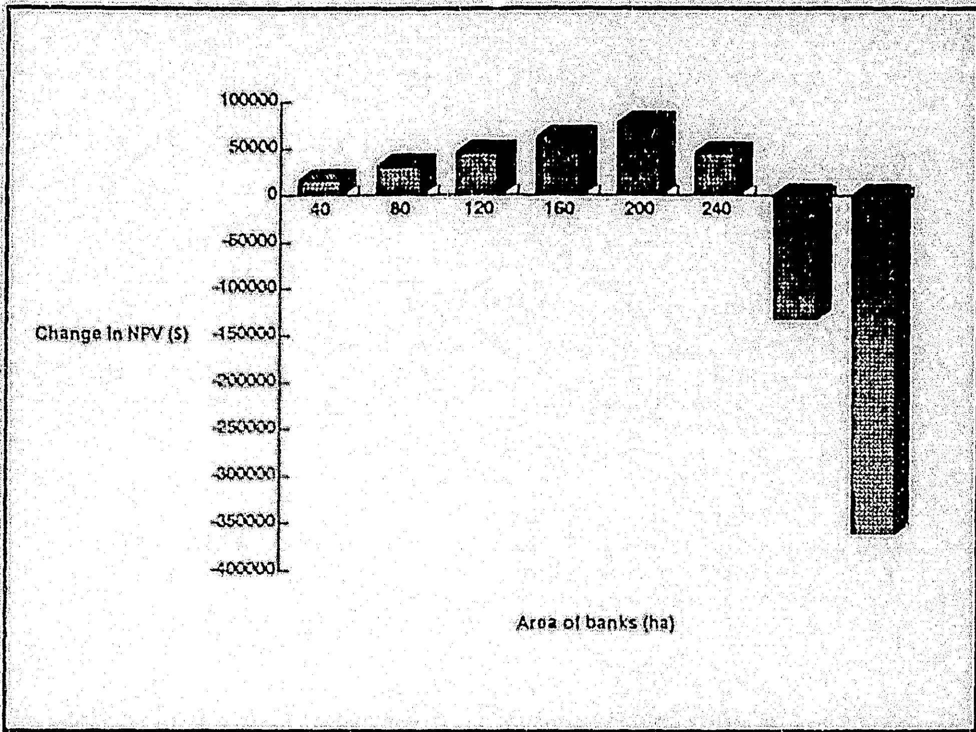
Table 1. Assumptions for effectiveness of banks and their effect on changing NPV in the Westdale Catchment

Area of banks ha	Saltland saved ha	Benefit/ha	Effectiveness in halting Water Erosion	Change in NPV
0	0	460	100%	$0
40	4	460	100%	$15,442
80	8	460	100%	$30,885
120	12	460	100%	$46,327
160	16	460	100%	$61,769
200	20	460	100%	$77,212
240	24	435	95%	$44,124
280	28	354	77%	$-131,965
320	32	273	59%	$-360,467

From Table 1, we can see that the optimal area of banks is around 200ha, leading to a change in NPV of $77,212.

This is illustrated graphically in Figure 1.

Figure 1. Change in catchment NPV and area of salinity, as a result of interceptor banks on gravelly loams.



Strategy 3. Spoon-drains or W-drains

Spoon-drains or W-drains are recommended for the flat areas susceptible to waterlogging and salinity. These drains can be effective in removing surface water from large areas and can significantly increase the stock carrying capacity of this land.

The area in the catchment affected by waterlogging is 600ha. This would require 30km of drains if the drains are assumed to relieve waterlogging on land 100m either side. If we also assume that the drains are 3m wide, then they will occupy 9ha of land.

The analysis assumed a cost of $500/km ($1666/ha) for the drains. The benefits associated with establishing drains on this land are dependant upon the assumed increase in stocking rate that results. Table 2 sets out the benefits from the drains for a range of assumed increases in stocking rate. Note that the drains are not assumed to reduce the rate of salinisation of land.

Table 2. Benefits from Spoon/W–drains with a range of assumed increases in stocking rate.

Area of Drains (ha)	Increase in Stocking rate (dse/ha)	Benefit per hectare	Change in NPV
9	0.12	$ 1.10	($11,152)
9	0.50	$ 4.55	$ 8,651
9	1	$ 9.11	$ 34,190
9	2	$ 18.22	$ 85,267
9	3	$ 27.33	$136,259

Results in table 2 indicate that to cover the costs of the drains would require an increase in stocking rate over the area affected by the drains of 0.5 dse per hectare. Evidence from catchment farms that have implemented drains on waterlogged flatlands, suggests that the stocking rate increase is likely to be in the order of 2 dse per hectare. This being the case, the benefits from drainage will easily cover the cost of constructing spoon drains on these areas.

Strategy 4. Saltbush on saline land

The catchment strategy recommends planting some saltbush on saline land in an attempt to reduce saline groundwater sufficiently to allow establishment of perennial pastures (puccinellia or tall wheat grass) at a later date.

A number of analyses have been done on the economics of establishing saltbush in different regions of the state (Salerian et al '87, Howard '88, Bathgate et al '90, Herbert '93). These have been both wholefarm analysis and gross margins analysis, with the value of saltbush estimated ranging from zero to $38 per hectare. The range in value is due mainly to assumptions regarding the digestability of dry matter and the yield of saltbush.

This analysis has used a rather optimistic value for saltbush of $30 per hectare. Most recent research by the Department of Agriculture suggests that the value of saltbush as a feed substitute is minimal. The change in catchment income that results from planting saltbush is shown in Table 3. Note that the table also sets out the assumptions made regarding the effectiveness of saltbush in saving potential saltland.

Table 3. Change in NPV of catchment income with area of saltbush planted and assumed area of saltland saved.

Establishment cost ($/ha)	Value of Saltbush ($/ha)	Area Planted (ha)	Area Saltland saved (ha)	Change in NPV
$ 100	$ 30	10	1	$ 1,110
$ 100	$ 30	50	2	$ 2,265
$ 100	$ 30	70	3	$ 3,046
$ 100	$ 30	90	4	$ 3,619
$ 100	$ 30	100	5	$ 4,298
$ 100	$ 30	150	6	$ 2,898
$ 100	$ 30	200	7	$ - 483

Figure 2. Change in catchment NPV with area of Saltbush planted.

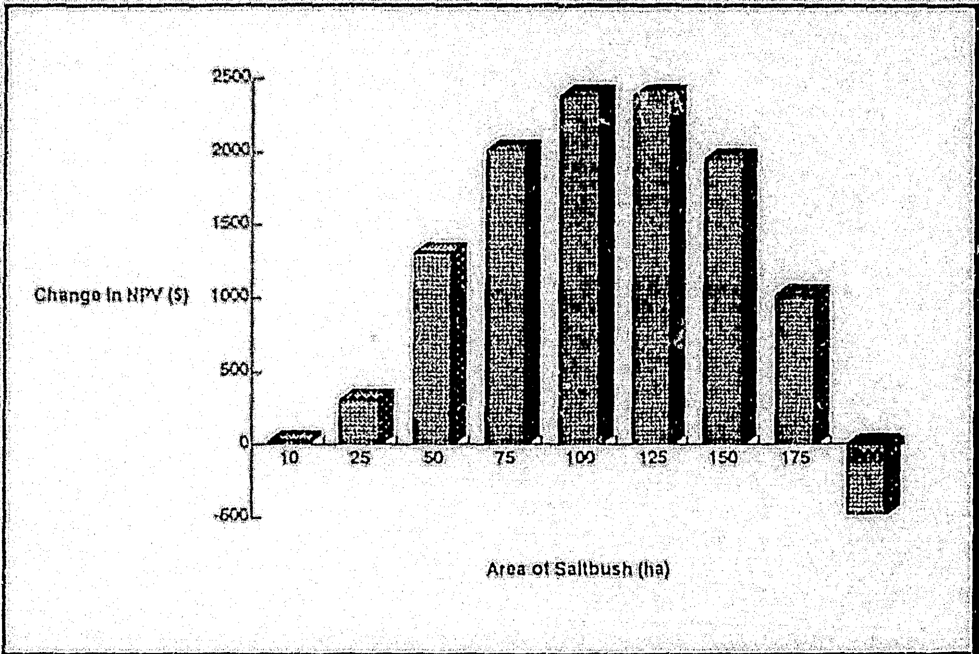


Table 3 and Figure 2 illustrate that the most profitable area of saltbush planted is around 100ha.

Strategy 5. Fodder shrubs

The catchment strategy recommends Tagasaste be planted on deep white sands. The area of deep white sand in the catchment is 190ha. Tagasaste can be established at a cost of about $160 per hectare. This cost assumes 6 meter interrow spacings and allows for the cost of fencing and changes to stock watering points.

Benefits from Tagasaste include increased stocking rate and greater water use which reduces groundwater recharge and hence the rate of salinisation. Tagasaste is recommended for grazing with cattle rather than sheep, since with appropriate grazing management, cutting of bushes can be avoided. However given that sheep are the dominant enterprise in the Westdale catchment, there will be costs involved in changing to a cattle enterprise. These costs have been taken into account in comparing the change in catchment income that results from changing to a cattle enterprise on areas that support Tagasaste.

Analysis suggests that changing to cattle grazing Tagasaste on the deep white sands would result in a $87,555 increase in the NPV of catchment income.

Strategy 6. Trees

Trees are recommended to be planted along interceptor banks, creek and fence lines. This amounts to an area of about 80ha. The benefits from trees stems from their ability to provide shelter for stock and crops and their ability to reduce groundwater recharge. These benefits are reflected financially through increases in stocking rates and crop yields as well as possible reductions in the rate of soil salinisation. There is also the possibility of commercial returns from trees sold as firewood, for fence posts, or even for pulp although this last option is questionable given the long haulage distance to the nearest pulp-mill.

Financial analysis shows that growing trees for firewood in the Westdale Catchment is more profitable than growing trees for pulp. However the relative profitability of each enterprise changes according to the price for firewood/pulp and the assumed yields of timber. Table 4 shows the change in Net Present Value of catchment income at each level of planting of trees.

Results indicate that there is a small positive change in catchment income from this strategy. It is likely that the commercial returns received from trees will cover the costs of establishment, while the landcare benefits that are difficult to estimate will provide additional incentive to plant trees.

Table 4. Change in NPV of catchment income with area of trees planted and assumed area of saltland saved.

Area of trees (ha)	Establishment cost ($/ha)	Net Return as firewood ($/ha)	Area Saltland saved (ha)	Change in NPV
10	$ 700	$ 3,050	0	$ 104
20	$ 700	$ 3,050	1	$ 1,167
30	$ 700	$ 3,050	1	$ 1,272
40	$ 700	$ 3,050	1	$ 1,376
50	$ 700	$ 3,050	2	$ 2,439
60	$ 700	$ 3,050	2	$ 2,544
70	$ 700	$ 3,050	3	$ 3,607
80	$ 700	$ 3,050	3	$ 3,711

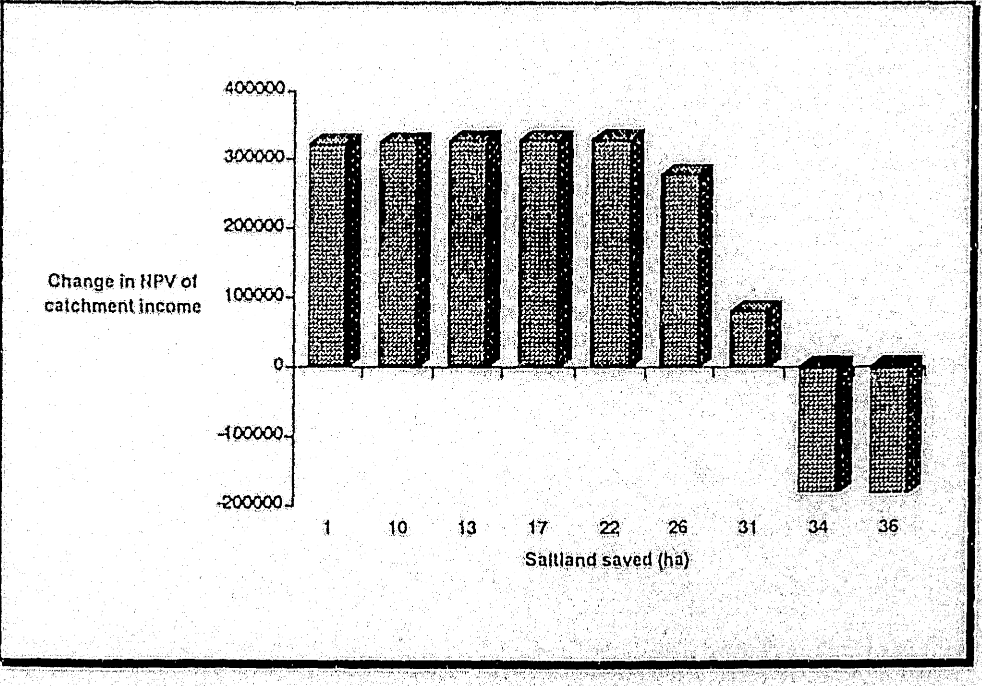
Combining all strategies

Table 5. sets out the combination of assumed changes in catchment strategies and resulting change in the Net Present Value of catchment income.

Table 5. Change in NPV of catchment income from combined strategies.

Reverse bank inter-ceptors (ha)	Spoon drains (ha)	Saltbush (ha)	Trees (ha)	Tag. (ha)	Salt-land saved (ha)	Change in NPV
40	9	10	10	10	1	$ 322,182
80	9	20	20	30	7	$ 324,657
120	9	30	30	50	13	$ 327,089
160	9	40	40	70	17	$ 327,479
200	9	50	50	90	22	$ 328,816
240	9	60	60	110	26	$ 278,451
280	9	70	70	130	31	$ 81,272
320	9	80	80	150	34	$ (180,373)
320	9	90	80	170	36	$ (181,995)
320	9	100	80	190	36	$ (195,681)

Figure 3. Change in NPV of catchment income with combination of all strategies and resulting saltland saved.



Discussion.

It should be noted that even with the combination of all strategies, the analysis assumes that only 36 hectares of saltland is saved. This highlights the fact that the main benefits of the conservation strategies arise from their effect of increasing production on farms within the catchment. These benefits can be attributed to more efficient use and management of subsurface and surface water. So while historically the catalyst for much of the landcare work has been the control of land degradation, specifically salinisation of land, the major benefits are realised through increased production from systems of management that are more suited to the environment, rather than a significant effect on reducing land salinisation.

With this in mind, it is possible to prioritise conservation works according to there long term benefits.

By far the most effective strategy is the use of Spoon or W-drains to drain waterlogged flats. The benefits of this strategy are relatively immediate with increased stocking rates in the first few years after implementation. Higher rates of fertiliser application are often required on previously waterlogged areas to make up for excessive leaching of nutrients from the soil in the past.

Graded banks are also highlighted by the analysis as a profitable strategy. Along with reducing the production losses that result from water erosion, graded banks have the added advantage of forcing farmers to work on the contour. Working on the contour is in itself an effective strategy for reducing water erosion to some extent.

Planting of saltbush on salt affected land cannot be recommended for its value as a feed substitute, however it may have a role in reducing groundwater levels to allow establishment of other pasture species. This analysis suggests that planting saltbush has marginal benefits and should be at the bottom of the list of landcare works in the catchment.

The analysis indicates that planting Tagasaste on the deep white sands within the catchment can be profitable when used for grazing cattle. Individual farms may be limited in implementing this strategy by the area of deep white sand on the property.

Planting trees along contour banks and fence lines can also be a profitable strategy. There is a considerable time lag (10 years) between the cost of establishing trees and any potential income through wood products. This should be considered carefully in the context of yearly cashflow. More often trees are being considered as a form of superannuation by farmers.

The results indicate that a trade-off exists between private and social objectives in the management of land degradation. This can be seen most clearly in Figure 3 where saving more than 22ha of land results in significant reduction in potential income for the catchment. If the catchment existed in isolation from other catchments and the consequence of its' actions don't impede any one else, then there would be no economic problem. The catchment could maximise its' financial well being simply by employing strategies that saved only 22ha of saline land. However this ignores two important points. First, this analysis has not addressed the issue of distribution of the benefits or costs between farms within the catchment, that result from implementation of the catchment plan. Second, the analysis has ignored external effects that may occur outside the catchment boundary.

The first point is being addressed in the second stage of this analysis which will not be presented here, however it is interesting to note that the "culture" of the catchment group has encouraged farmers to approach the degradation problems within the catchment as a group rather than as individuals seperated by farm boundaries. In this way many of the between-farm externality issues have effectively been internalised.

The second point, of externalities occuring outside the catchment boundary, while not being directly addressed by the analysis, can be discussed in relation to the results. The trade-off between private and social objectives will arise if there is a perceived need by people outside the catchment boundary for greater land degradation measures to be implemented within the catchment.

This may occur for example, if there is evidence of nutrification/silting of the Dale River that runs through the catchment and feeds into the Avon-Swan river system. The results give a clear indication of the financial compensation or subsidisation that would be required for members of the catchment group to undertake land degradation control measures beyond the level that maximises their (private) catchment income. For example, Figure 3. indicates that the change in NPV of catchment income that results from saving 36ha of land as opposed to 22ha is a loss of $500,000. Logically farmers within the catchment group would require compensation of $500,000 in order to save the extra 14ha of land if society deemed it necessary to do so.

If society are aware of the costs associated with achieving desired levels of land degradation control then they should be better able to make decisions as to how much they are willing to pay to achieve these levels. In this way it should be possible to achieve a Pareto optimal outcome where farmers are compensated by society for the financial losses incurred from moving past their privately optimal level to the socially optimal level of land degradation control. The method of raising money from society could be in the form of increased rates for people with properties that front the river and/or a direct tax on river users (eg. boat owners).

Conclusion.

The use of benefit–cost analysis to examine the Westdale catchment strategy has allowed conservation works to be prioritised. The study has also raised issues of private versus social objectives in conservation work and has indicated the likely financial costs of achieving land degradation control beyond the privately optimal point. This information can be used to arrive at pareto optimum levels of land degradation control by allowing appropriate levels of compensation to be paid to those that incurr costs through implementation or non–implementation of conservation strategies.

References.

Bathgate, A.D., Young, J. and Barrett–Lennard, E. (1990). Economics of revegetating saltland for grazing

Herbert, A. (1993). What value saltbush? Management Matters Dept. of Agric. W.A., Miscellaneous Publication No. 15/93 ISSN 0725–847X Agdex 810

Howard, B. (1988). The value of saltbush. Management Matters Dept. of Agric. W.A., Miscellaneous Publication No. 16/88 ISSN 0725–847X Agdex 810

Salerian, J.S., Malcolm, C.V. and Pol, E. (1987). The economics of saltland agronomy. Technical Report (56), Division of Resource Management, Dept. of Agric. W.A.