Adjustment to Salinity in Irrigation Regions:
Ex Post Evaluation of the Tragowel Plains Plan[1] [2]

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An early-mid project evaluation of the benefits and costs of the Tragowel Plains Salinity Management Plan estimated the net cost after six years at A$ 5.5 million. The cumulative cash flows for the water transfer, drainage and halophyte programs were all positive with benefit to cost ratios (BCRs) of 3.2, 1.3 and 1.1. Inclusion of estimated future benefits and costs to year 30 gave BCRs of 13.7, 1.3 and 4.0 with net present values (NPVs) of A$ 18.8 million, 2.5 million and 0.4 million respectively. Net costs for other integrated programs including salinity survey, whole farm planning, facilitation of structural adjustment, revegetation and coordination of implementation reduced the NPV of the first six years of implementation to A$ 12.1 million. The water transfer program NPV was comparable to the market value for water right over the period. Only a small proportion of water right was transferred to land outside the plan area, indicating that the Tragowel Plains remained competitive for resources.

Key Words: Salinity, structural adjustment, water transfer, water market, Tragowel Plains

1. BACKGROUND

A project funded by Murray-Darling Basin Commission and the government of Victoria to investigate the validity of a number of the key assumptions of the Tragowel Plains Salinity Management Plan (TPSMP) was undertaken during the period 1995-97.

These assumptions are:

- that information from the soil salinity surveys will lead farmers to concentrate irrigation water on soil salinity classes A and B,
- that transferring water will not redistribute soil salinity across the farm, and
- that the viability of the Tragowel Plains farms within the existing structure will improve.

The project consisted of four staged components :

- Stage 1 : Updated sociological survey to determine the extent of adoption of farm management initiatives and structural adjustment
- Stage 2 : Resurveying of farms surveyed for soil salinity in 1990 to determine if movement of water within farms has redistributed salinity
- Stage 3 : Using Multi-temporal Landsat TM satellite imagery to determine historical change in regional irrigated land cover.
- Stage 4: An economic study of the implementation of the Plan to evaluate the effect that water transfer has had on both adopters and non-adopters, at the farm and community level.

This paper discusses the findings from Stage 4.

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1.1 Objectives

The main aim of stage four of the project was to test the third assumption that the viability of the Tragowel Plains farms within the existing structure will improve. This was be tested by carrying out an economic study of the implementation of the plan to evaluate the effect that water transfer has had on both adopters and non-adopters, at the farm and community level.

2. METHOD

A benefit cost analysis was used to calculate the net benefit from the plan. The costs of the Plan were obtained from the TPSMP annual financial reports and were summed to give an aggregate of costs for the first 6 years of the plan. These costs were shared by both community members and government bodies. However specific data for many of the community costs, such as those associated with land transfer, farm re-layout and other activities, were not available and were therefore excluded from the analysis.

The major components of the plan considered were:

1. Mapping
2. Planning
3. Water Transfer
4. Re-vegetation
5. Drainage
6. Structural Adjustment and
7. Implementation.

Costs and, where appropriate, benefits were calculated for each of these components.

2.1 Assumptions

The quantitative benefits were calculated using the results from stages 1, 2 and 3 of the project and various assumptions. The following assumptions were used to calculate the benefits of water transfer, sowing of halophytes and drainage.

2.1.1 Gross Margins

The gross margins per ML of irrigation given in Table 1 are indicative of the dairying and mixed farming enterprises in the Tragowel Plains for the period 1989 to 1996. These figures were calculated on the basis of average farm gate prices for the period, productivity levels for the various soil salinity classes and average stocking rates across the area.

Table 1. Economic Gross Margins (GM) for Dairy and Mixed Enterprises in the Tragowel Plains for the period 1989 - 1996.

Soil Class	Dairy GM ($/ML)	Mixed GM ($/ML)
A+	110	80
A	90	50
B	50	17
C	10	0
D	-20	-20

NB. The GM of -$20 for D class soil for both enterprises, represents the approximate cost of one megalitre of irrigation water.

The weighted average differential in the gross margin for moving water to A and B class soils $72 per megalitre.

It should be noted that these figures are used only as an average for the enterprise according to soil salinity status and do not indicate the range of technical expertise of farm management.

2.1.2. Water Transfer

- Using the results from Stage 1 of the project (Barr 1997) it was assumed that 6.8% of total water right of the Tragowel Plains was moved from C and D class soil to A and B class between 1989/90 and 1995/96. Of this 1.7% of total water right was moved to annual pasture and the remaining 5.1% was moved to perennial pasture. Of the water that was transferred to annual pastures, 50% was allocated to Dairy farms and 50% to mixed farms. All of the water moved to perennial pasture was assumed to be used on dairy farms. This change in water location bought about an increase in water use efficiency which was subsequently the basis for calculating the benefits of the water transfer.
- According to Stage 3 (Abuzar et al 1997) of the project, summer cropping made up approximately 4.5% of the total irrigated area of the Tragowel Plains in 1996. It was assumed that change in this area was insignificant and this cover type was excluded from the economic analysis.
- Water was assumed to be transferred from annual pasture on C and D class soils, 50% of which came from dairy farms and 50% from mixed farms.
- Due to the increase in perennial pasture in the Tragowel Plains, as indicated in Stage 3 of the project, it was assumed that water transfer was accompanied with 2000 hectares of land forming per year. This land forming and subsequent pasture establishment was assumed to have an estimated associated cost of $85 per megalitre of water transferred.
- It was assumed that the water right transferred to perennial pasture also had an additional 30% sales water attached.

2.1.3. Halophytes

- The area of halophytes sown during the first six years of the plan was determined by the plan coordinators. It was assumed that all of the halophytes were sown on C and D class soil.
- The average carrying capacity of the halophytes was estimated to be 1 DSE/ha[5] (pers. comm. Jones 1997) with a gross margin valued at $9.05/ha (Branson and Shaw 1994).

2.1.4. Drainage

- It was assumed that those farms which had retired water from C and D class soil would also receive benefits from the drainage program. The on-farm benefits of the drainage were mainly in the form of increased production and water use efficiency. These benefits are accounted for in the gross margins shown in Table 1.
- Drainage benefits to roads are also included due to the reduction in maintenance costs. These benefits were calculated according to the amount of drainage carried out during the first 6 years of the plan[6].
- It was assumed that at June 1996, the total length of community surface drains in the Tragowel Plains was 985 km. The maintenance cost of the drains was assumed to be $300/km/yr.

2.1.5. Soil Salinity

- Stage 2 (Terry et al 1997) of the project found that there had been a slight improvement in the salinity status of the soils in the Tragowel Plains over the first five years of the plan. However, in terms of economics, this change was deemed insignificant and was therefore not included in this analysis.

These assumptions along with the results from stages 1, 2 and 3 were used to calculate the quantitative costs and benefits of the plan and the net benefit in present value terms. The NPV (net present value) can be used to determine the cumulative net benefits of the plan to date. The present value of the expected stream of future benefits can be added to obtain the NPV of the Plan based on the information obtained by the project.

[5] The value of 1 DSE/ha was assumed on the basis that the seed contained an even mix of Puccinellia and Tall Wheat Grass.

[6] Road benefits were calculated in the original Plan. These calculations were used as a basis for calculating the actual benefits. The proportion of actual drainage construction to the estimated amount was calculated. This percentage was used to calculate the actual road benefits gained from the plan, as a direct proportion of those benefits that were originally expected.

3.0 RESULTS AND DISCUSSION

3.1 Costs

3.1.1 Cost Share

The following table shows the cost share percentages for the various activities of the TPSMP between the years of 1989 and 1996. These were calculated on the basis of the figures given in the TPSMP annual financial reports (TPSMP 1990/91 - 1995/96).

Table 2. Cost share percentages for the TPSMP from 1989 - 1996.

Activity	Government Contribution	Land holder Contribution
Water Transfer	0%	100%
Salinity Survey	90%	10%
Drainage - Farm	50%	50%
- Community	60%	40%
Whole Farm Planning	85%	15% *
Structural Adjustment	100%	0% *
Revegetation - Tree Planting	50%	50%
- Fencing	100% materials	labour
Sowing Halophytes	50%	50%
Implementation	100%	0% *

* All costs are not included.

Table 2 shows the government contribution to all of these activities. Much of this assistance was in the form of rebates and subsidies. However some of the activities were not shared by both contributors.

Water transfer costs were totally met by the land holder. These costs were associated with the transfer of water from C and D class soil to A and B class soil. As stated in the assumptions, there was an assumed water transfer cost of $85/ML. There was also some loss in agricultural production of C and D class soils, however considering the GMs for these soils, this was more generally a benefit rather than a cost.

In the case of Whole Farm Planning the contribution of 15% of the costs by the land holder represents the planning stage only, costs of carrying out the plan, except those associated with the transfer of water, are not included.

Costs allocated under the activity of Structural Adjustment were only met by the government, in the form of Stamp Duty Rebates. This program provided funds to reimburse eligible landholders the cost of stamp duty on land purchased within the Tragowel Plains. Costs of purchasing the land and benefits to the land sellers were not included as they were considered to cancel each other out.

Implementation of the plan included all of the activities that were carried out in order to ensure that the TPSMP is administered, managed and monitored effectively. This included the costs of employing extension officers, a farm management economist, workers for the demonstration farm, the implementation team and general monitoring. Although community expenditure in this section was great, the calculated costs only deal with Implementation Support. All of these costs were allowed for in the Government contribution budget.

3.1.2 Expenditure

The present value of implementing the plan from 1989 - 1996 were calculated from the annual reports of the TPSMP and the assumptions given in Section 2.1. The results are tabulated in Table 3 for each activity, with both land holder and government contributions given according to the cost share percentages in Table 2.

Table 3. Government and Land holder costs for the TPSMP from 1989 - 1996.

Activity	Government	Land holder	Total
Water Transfer	$0	$1,475,357	$1,475,357
Salinity Survey	$1,516,276	$168,475	$1,684,751
Drainage-Farm	$210,345	$210,354	$420,708
- Community	$1,311,823	$874,548	$2,186,371
Whole Farm Planning	$1,145,777	$202,196	$1,347,973
Structural Adjustment	$292,755	$0	$292,755
Revegetation -Tree Planting	$166,301	$166,301	$332,602
- Fencing	$219,658	$219,658	$439,316
Sowing Halophytes	$60,275	$60,275	$120,550
Implementation	$5,476,857	$0	$5,476,857
TOTAL	**$10,373,074**	**$3,777,240**	**$13,777,240**

Table 3 shows that the government contributed 53% of the total cost of the plan, with the landholders meeting 47% of the costs. The major cost to land holders was the land forming and pasture establishment expenses associated with the transfer of

water. Activities that had a large government outlay included salinity surveys, community drainage, whole farm planning and implementation of the plan.

3.2 Benefits

Using activity estimates from stages 1, 2 and 3 of the project, TPSMP annual reports and the given assumptions, benefits were calculated for Water Transfer, Drainage and Sowing Halophyte activities. These benefits are given in Table 4 in Present Value (4% discount rate) dollar terms. The costs totaled in Table 3 are shown and the present value of the overall net benefit of the plan has been calculated and included in the table.

Table 4. Present value of occurred benefits, costs and net benefits of the TPSMP, as at June 30th 1996.

Activity	PV Benefit	PV Cost	NPV
Water Transfer	$4,722,025.	$1,475,357	$3,246,668
Drainage	$3,470,467	$2,607,079	$863,388
Halophytes	$132,239	$120,550	$11,689
Others	$0	$9,574,254	-$9,574,254
Total	**$8,324,730**	**$13,777,240**	**-$5,452,509**

Benefits resulting from the transfer of water and the sowing of halophytes were brought about from an increase in productivity resulting in a greater GM, the assumptions for these calculations are set out in sections 2.1.1 and 2.1.3. The drainage benefits calculated in this table were calculated on the basis of decreased road maintenance costs.

The totals in Table 4 indicate that between the years of 1989 and 1996 the overall costs of the Plan have been greater than the occurred benefits. This would be attributed to the costs associated with :

- Salinity survey
- Farm drainage
- Whole farm planning
- Structural Adjustment
- Tree planting and fencing off of C and D class soils
- and Implementation Support.

These activities are beneficial to the region, however the benefits are not readily quantified. These activities have contributed to the achievement of agricultural, environmental or social benefits. They are not described in this report, but some have been addressed in Stage 1 of the project.

Looking at the regional costs and benefits of the individual activities, it can be seen that at the end of the first 6 years of the plan, the transfer of water and sowing of halophytes produced net benefits. With a total cost of $1.5 million, the activity of transferring water had an overall benefit of $3.2 million. This shows that transferring water from C and D class soil to A and B class soil was a viable activity for the regions between 1989 and 1996. It can therefore be assumed that it is also viable at a farm level.

Although sowing halophytes had much smaller associated costs and benefits, it was also a viable activity during the first 6 years of the plan. The benefits of the drainage program also had a positive net benefit in the short term.

Table 4 only shows the benefits and costs at the 30th of June 1996. This is where the costs for the period stop, however the works carried out will generate a flow of benefits into the future. These future benefits have been calculated for the total 30 years of the plan to the year 2018 and are included in Table 5.

Table 5. Present value of already completed TPSMP works, as expected to June 30th 2018.

Activity	PV Benefit	PV Cost	NPV
Water Transfer	$20,261,145	$1,475,357	$18,785,788
Drainage	$10,991,981	$8,517,079	$2,474,902
Halophytes	$482,541	$120,550	$361,991
Others	$0	$9,574,254	-$9,574,254
Total	**$31,735,668**	**$19,687,240**	**$12,048,428**

The results in Table 4, show that there is no immediate economic gain from the Plan. However the results in Table 5, show a 30 year net benefit of $12 million, which indicates that the implementation of the TPSMP between the years of 1989 and 1996 has been successful in economic terms.

3.3 Sensitivity Analysis

In order to test the robustness of the evaluation to changes in some of the assumptions, a sensitivity analysis was carried out to see what influence the water transfer costs and gross margins have on the 30 year NPV of the plan. Table 6 shows these results.

Table 6. Sensitivity of 30 year NPV to Water Transfer costs and Gross Margins.

NPV ($)	Gross Margin ($/ML)		
Water Transfer Costs	**$50**	**$72**	**$90**
$40	$6,638,593	$12,829,499	$17,894,785
$85	$5,857,522	$12,048,428	$17,113,714
$170	$4,382,165	$10,573,071	$15,638,357

These results indicate that while the Water Transfer costs and the Gross Margins assumptions do effect the NPV of the plan, however in all scenarios the value remains positive.

3.3 Benefits from continued implementation

Stage 1 of the project has looked at the future adoption rates of the various activities associated with the TPSMP. The findings suggest that adoption rates have slowed over the past 3-4 years of the plan and they will continue to slow in the future. Although the future stream of benefits given in Table 4 will remain, additional benefits from continued implementation of the plan will be reduced as the future amount of works carried out are reduced. An economic review of the TPSMP in a further five years would be needed to verify this.

In order to obtain a greater understanding of the structural adjustment patterns of farms within the Tragowel Plains, it is recommended that a detailed socio-economic study be carried out. This type of study would have implications for basin-wide regional policy development and the future activities of the TPSMP.

4.0 CONCLUSIONS

This study showed a 30 year net benefit of $12 million, which indicates that the implementation of the TPSMP between the years of 1989 and 1996 has been successful in economic terms.

The plan has also been successful in that the viability of those farmers who adopted the suggested salinity management techniques has been increased.

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