Evaluating the economic benefits of salinity management in irrigated agriculture

Dailin Kularatne

Paper presented at the 45th Annual Conference of the Australian Agricultural and Resource Economics Society, January 23 to 25, 2001, Adelaide, South Australia.

Evaluating the economic benefits of salinity management in irrigated agriculture

Dailin Kularatne[*] Economics Group,

Institute of Sustainable Irrigated Agriculture, Tatura, VIC 3616.

Abstract

Salinity management in irrigated regions is a significant challenge for rural communities, agricultural industries and the governments and there is considerable policy and community interest in evaluating the benefits and costs of salinity management programs. This paper discusses methods currently being used to evaluate irrigation salinity management plans in Victoria.

Economic evaluation supported by spatial analysis allows us to see how and where profitable achievements are being made and also where further work is required for more beneficial results. The paper presents several different analytical procedures adopted to evaluate the achievements of Salinity Management Plans in irrigated regions in Victoria, incorporating Benefit-Cost analysis (BCA), Geographic Information Systems (GIS) and Gross Margin analysis.

Key words: Benefit –cost analysis, Salinity management, GIS

1. Introduction

Management of salinity is a necessity for sustainable growth of irrigated agricultural industries in Victoria. The development of shallow water tables and subsequent salinisation of land and water resources directly impacts on agricultural productivity and regional economies. At the same time, salinity causes adverse impacts for the environment and for water users downstream of irrigation areas.

[*]*Author gratefully acknowledges the helpful comments of Mike Morris of the Institute of Sustainable Irrigated Agriculture Tatura. The views in this paper are expressed by the author and not necessarily those of the Department of Natural Resources and Environment of Victoria.*

Recognising this, the Victorian Government initiated the *Salt Action: Joint Action* strategy for managing the land and water salinity in 1988. Since the launch of *Salt Action: Joint Action*, continuous commitment by both the Government and regional communities to address the problem of salinity in irrigation areas has been demonstrated by the development and implementation of ten subregional salinity management plans (SMPs) covering all the major irrigation regions of Victoria, Australia (Table1).

Table 1. Salinity Management plans in Irrigation areas

Salinity management Plan	**Year commenced**
Barr Creek/ Torrumbarry-East of Loddon	1987
Shepparton Irrigation Region	1989
Tragowel Plains	1991
Nangiloc-Colignan	1991
Campaspe West	1991
Sunraysia	1991
Kerang Lakes/Swan Hill	1993
Nyah to SA Border	1993
Lake Wellington	1994
Boort West of Loddon	1995

Salinity management is costly and time consuming. The direct cost of salinity in Victoria is estimated to be $50 million per year, with some 140,000 hectares of irrigated land and 120,000 hectares of dryland significantly affected (Salinity Management in Victoria Future Directions DNRE 2000). Every year the Government and the community in Victoria allocate significant resources for salinity management. In 1998/99 alone, the Victorian Salinity Program expended approximately $27 million on implementing salinity management plans (SIRLWSMP Annual Report 1998/99).

An accurate assessment of benefits or outcomes of salinity management in terms of sustained agricultural production and environmental protection is difficult to measure. This is partly due to the complexity and time gaps between actions and reactions related to the salinity problem. A meaningful economic assessment of salinity

management needs to be based on thorough biophysical, technological and economic investigations and accurate information on past, present and future trends of both biophysical and economic variables

2. Analytical procedures

It is generally agreed that, there are no quick and accurate fixes to the salinity problem in irrigated regions. Similarly, there is no easy and accurate single methodology to evaluate all the benefits of salinity management activities in an irrigated region. This paper discusses three different analytical procedures that are being using to evaluate the achievements of Salinity Management Plans (SMPs) in irrigated regions in Victoria Australia.

They are:

- Assessment of achievements against the plan targets.
- Using GIS and predictive modelling to evaluate the plan benefits through for example, the estimated increase in value of production due to improved drainage and changes in watertable depths.
- Evaluating the benefits and costs of salinity management plans using the Murray Darling Basin Commission (MDBC) Drainage Evaluation Spreadsheet Model (DESM).

2.1 Assessing achievements against plan targets

This procedure involved several logical steps.

Firstly, all available annual reports, draft project plans and other relevant project documents were collected, primarily from the coordinators of each SMP. Then the reported, quantified achievements of all sub–program and major program components in the annual reports were scrutinised and tabulated. While this initially appeared to be a straightforward task, collation of a complete data set has not been feasible

For the analyses undertaken in this paper the following four major programs were considered as the most important and common program components in SMPs in irrigated regions in Victoria.

- Farm program
- Environmental program
- Surface drainage program
- Sub-surface drainage program.

Table 2 shows the groupings used to relate common sub-programs to the major program groups.

Table 2. Major program and sub-program components of SMPs in irrigated regions

Program	**Sub program**
Farm Program	Laser grading Soil salinity surveys Whole farm plans Reuse systems
Environmental Program	Tree planting Native vegetation establishment Protection of wet lands
Surface Drainage Program	Public ground water pumping Private ground water pumping Tile drainage
Surface Drainage Program	Arterial drains Community drains Other drains

Whenever targets were not listed in the annual reporting process, the draft plan documents or any other available review documents or reports were consulted for such information. To maintain the continuity of analysis in some instances, target

values for some program and sub-program components were interpolated where they were not available at all. Sub-program achievements were compared with the stated targets and achievement percentages against the targets were calculated.

At the next stage of analysis, the expenditure aspects of the SMP were scrutinised and tabulated. The proportion of the program budget that was expended on each sub-program component was calculated and then multiplied by the achievement percentage of the sub program. These were then summed to produce a weighted achievement index (AI) for each program of the SMP. Similarly, an overall AI for SMP was calculated. If this AI is above 100, the respective program or the plan as a whole can be considered to be exceeding the expected achievements.

All SMPs in irrigation regions required an *ex ante* evaluation prior to their implementation. For the purpose of this assessment the achievement percentage of individual sub-programs against targets was considered the main criterion of success in achieving expected outcomes. This assumes that if the plan or an individual program component within the plan is successful in achieving the set targets, it would generate the expected BCR and IRR, provided there are no significant changes in the underlying assumptions of the *ex ante* evaluations.

Considering the difficulties in obtaining completed and quantitative data on some achievements and their targets, the calculated achievement indices are indicative measurements only.

2.2 Evaluating the plan benefits using GIS and predictive modelling.

An example of the second approach discussed in this paper involves evaluation of the benefits of a SMP in terms of changes in the value of agricultural production due to improved drainage and changes in regional watertable depths. GIS has great potential as a tool to assist in these types of natural resource economics applications.

In this particular case, GIS has been used to identify the areas of improved drainage and changed watertable depth due to implementation of a SMP. An analysis of

watertable trends was used to extrapolate ten years of extensive regional watertable monitoring data in order to predict probable watertable levels over thirty years if the SMP was not implemented. A GIS was used to make a direct comparison between these predicted “without plan” watertable levels and monitored watertable levels since the SMP implementation. The resultant map showed estimated changes in watertable levels due to the SMP, which were then intersected with mapped irrigated agricultural enterprises in the region. Available cost of production and gross margin data then allowed the value of benefits and costs to agricultural enterprise in the SMP area to be estimated.

2.3 Evaluating the Benefits and costs of salinity management plans using the MDBC Drainage Evaluation Spreadsheet Model (DESM).

The third approach for evaluating the benefits of SMP implementation in the irrigation regions employs the MDBC Drainage Evaluation Spreadsheet Model (DESM). This approach is useful for SMPs such as the Shepparton irrigation Region Land and Water Salinity Management Plan (SIRLWSMP) which features surface drainage as a significant component of plan implementation.

The DESM was developed by the MDBC specifically to accommodate the differences in the engineering, environmental and economic aspects of drainage programs and projects. The model allows comparison between drainage projects funded by MDBC. The DESM spreadsheet model evaluates ‘with’ and ‘without’ project scenarios to quantify the expected changes that would occur in the entire irrigation catchment. It calculates the impact of surface drainage in minimising or preventing agricultural losses due to waterlogging, flooding and salinity.

The model is a Microsoft Excel worksheet and the calculations are macro-driven. The Worksheet has 14 linked sheets as follows.

- Agricultural production with the project,
- Agricultural production without the project,
- Agricultural salinity losses,

- Waterlogging and flooding losses,
- Drainage effectiveness,
- Drainage and landforming with project,
- Drainage and landforming without project,
- Drainage and landforming capital and O & M costs,
- Road benefits,
- Downstream costs,
- Re-use benefits,
- Summary cash flow,
- Results and summary and,
- Data input summary.

The model undertakes an economic evaluation in terms of Net Present Value (NPV) and Benefit-Cost Ratio (BCR) using the MDBC recommended discount rate of 5 per cent over 50 years. It is set up to carry out *ex-ante* analyses.

In order to complete *ex-post* (after the project) analyses, the data sets needed to be modified. This involved incorporating recent survey data on nominal values of gross margins and indexing annual expenditure to current values using the Consumer Price Index (CPI). In addition to the capital expenditure on SMPs the operating and maintenance costs of drainage and pumping systems and other relevant farm costs such as landforming, extra livestock and labour etc, needed to be considered for the 'with' and 'without' the plan scenarios.

Though the DESM can calculate the benefits due to land use change, it does not provide input cells for costs associated with changing the land use. There is no room for entering the obvious additional costs such as costs on permanent pasture establishment, purchase of additional livestock and construction of farm drains. This limitation can be overcome by modifying the “Other benefits and costs” category and adding the calculated Net Present Value to the capital cost category.

3 Conclusion

Three approaches to evaluate the benefits or achievements of SMPs have been discussed. The first approach assesses achievements with respect to plan targets and provides a measure of plans effectiveness in meeting its stated implementation targets (km of drains dug, number of trees planted, number of hectares laser graded etc,). This provides an indicative evaluation based on the *ex-ante* evaluations undertaken as part of plan development as well. Advantages of the approach are that it is conceptually simple and can be consistently applied.

Limitations to this approach include:

- Incomplete or inconsistently reported achievement and target data in some cases,
- Omission of plan expenditure on activities that do not have direct quantifiable outputs, such as plan coordination and community education activities,
- Reliance on the assumptions and possible limitations of the ex-ante evaluations performed as part of SMP development in determining the benefits of achievements with respect to targets.

The second approach uses predictive modelling of changes in biophysical conditions either through statistical extrapolation of monitoring data or through process modelling in a GIS.

The approach has significant advantages for a large SMPs such as SIRLWSMP, that covers large area that are biophysically diverse and support a range of irrigation enterprises because analysis can be performed at whole plan, sub-catchment or even farm scales if the resolution of the data allows. Limitations of this approach are that the approach relies on an integrating process model, spatial data and economic analysis. This method is complex and requires significant resources and a range of expertise to establish as well.

The third approach adopts the MDBC DESM for ex –post evaluation. The advantage of this approach is that the DESM is a well-known and accepted evaluation tool. Its

obvious limitation is that it evaluates drainage only and therefore cannot be applied to non-drainage works, which for some SMPs limits its value and applicability significantly.

An important limitation common to all three approaches arises from the limited availability of some types of data in the reporting of SMPs. For most of the SMPs, except for the total expenditure from the Government sources, no other detailed data on expenditure, especially on community contributions were collected or reported. Case studies or key informant surveys to collect data on expenditure and some achievements may overcome this shortcoming. This kind of multi procedural analyses however, can provide a more precise account of the economic value of SMPs. The analysis of plan achievements against targets highlights the need for standard methods for reporting the details of expenditure and achievements.

4. REFERENCES

- *Annual Reports, Draft plan documents and Review reports of Salinity Management Plans in Irrigated Regions of Victoria, 1987 – 1999.*
- *Background Papers, Shepparton Irrigation Region Land and Water Salinity Management Plan Volume I, II & III*. Rural Water Commission, August 1989
- Goulburn-Murray Water. 1996/97. *The Underground Flood (Watertable Maps for the Shepparton Irrigation Region).* Tatura, Victoria 3616.
- Gyles, O *et al* (1999), *Targeting areas for beneficial Structural Adjustment in the Southern Murray Darling Basin* NRMS project I 6040 final report Murray Darling Basin Commission Canberra.
- Kularatne, D and S. Rollings. (1997) *Resource base, gross margins and gross value of production of irrigated agricultural enterprises of the Shepparton Irrigation Region,* Institute of Sustainable Irrigated Agriculture, Tatura.
- Monticillo O, *et al*, (2000) *Expost evaluation of the CSD program in Shepparton Irrigation Region, (Draft report) DNRE, Echuca.*
- Murray Darling Basin Commission (1995*) Drainage Evaluation Model User Manual version 3*, Canberra, ACT 2600.
- Salinity Pilot Program Advisory Council, (1989) *Goulburn Broken Region. Shepparton Land and Water Salinity Management Plan* (draft). Shepparton,

- Salinity Program Advisory Council. (1995) *Shepparton Irrigation Region Land and Water Salinity Management Strategic Plan: The Second Five Years.* Prepared by Mike Young for the Irrigation Committee. Institute of Sustainable Irrigated Agriculture, Department of Agriculture, Energy and Minerals, Tatura,
- *Salinity management in Victoria Future directions (2000)* Department of Natural Resources and Environment.
- Walpole, S.C and J.A. Sinden, (1996) *BCA and GIS: Integration of economic and environmental indicators to aid land management decisions.* Dept. of Agricultural and Resource Economics, University of New England, Armidale, NSW.