Chapter 17
Evaluation of Salinity Offset Programs in Australia

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Abstract This chapter provides an ex-post policy evaluation of three offsetting programs designed to mitigate irrigation induced salinity in Australia. Environmental effects from salinity are substantial in Australia, with the estimated cost of environmental degradation due to salinity of some A$300 million per year. Offsetting, as an economic policy instrument, is cost-effective in comparison to the conventional regulatory approaches (e.g. engineering approaches or mandate based policies) as it allows environmental improvement to be achieved at reduced cost. Salinity offsets are designed to compensate for salinity impacts from a given agricultural activity by providing a commensurate reduction of salinity impact elsewhere. Policy evaluation of salinity offsetting programs was approached by collecting, collating and processing data pertinent to three Australian case studies. A key finding is that salinity offsets in Australia have been reasonably successful since their implementation. While it was not possible to precisely discern the environmental effectiveness of the offsetting programs, there is clear evidence that the salinity problem has subsided in Australia in the time since the introduction of the offsets, and that they can be at least partly credited for this outcome. At the same time, robust findings about the economic effectiveness of salinity offsetting programs emerged from the study.

Keywords Offset programs • Salinity • Economic effectiveness • Murray-Darling Basin Australia

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17.1 Introduction

Salinity of river water and soil has been a long-standing problem in Australia, in particular in areas with significant irrigation development, such as the lower reaches of the Murray-Darling Basin (MDB). The problem manifested strongly in the 1980s and 1990s, leading to significant research efforts into ways to mitigate it. Around the same time, the use of economic policy instruments (EPI) became prominent in resource management. Salinity offsets have been proposed as an effective EPI for mitigating irrigation induced salinity, and have been subsequently implemented in several areas throughout Australia. This chapter closely examines three salinity offset schemes: the one implemented in the Coleambally Irrigation Area; the Ulan coal mine salinity offset program; and the salinity zoning with offsetting in South Australian portion of the River Murray.

Salinity offsets are designed to compensate for salinity impacts from a given agricultural or other productive activity in a particular area by providing a commensurate reduction of salinity impact elsewhere. The end result is that there is no net increase in the overall salinity impact. The key mechanism of this EPI is to recognise the heterogeneity in abatement cost structures across space and across different enterprises. The main idea is to allow an enterprise with relatively low cost of abatement, or located in an area where the environmental impact is low, to provide an offset for the effects of another, higher cost enterprise located in an area where environmental effects are high. For instance, salinity impact of an irrigated agricultural activity can be offset by establishing new perennial pastures or by revegetation, both of which have an effect of reducing salt loads, and are also low-cost options. In general, salinity offset programs can be used to mitigate salinity at a cost that is an order of magnitude lower than using on-site engineering measures alone to achieve the same reduction (Connor 2004). Salinity offsets can also be an important feature of other policies for irrigation induced salinity mitigation. For example, under an irrigation zoning policy (e.g. the one currently in place in South Australia), salinity offsetting can allow for less costly and more effective reduction of salinity compared to a policy without offsetting (Spencer et al. 2009). This reduces the cost of meeting a given overall salinity load target.

Policymakers in Australia have been active in considering, testing and implementing policy instruments based on economic incentives in relation to water and salinity management. Several policies designed to address increasing water scarcity and salinity problems have been instigated in Australia in general, and in MDB in particular, over the last two decades (Lee et al. 2012; Connell and Grafton 2008). Examples of initiatives within the policy mix to address salinity are: the Joint Works Program (Basin Salinity Management Strategy) and the Natural Heritage Trust, National Action Plan for Salinity and Water Quality, and the current National Water Quality Management Strategy (Lee and Ancev 2009). In addition, many initiatives to explore the possibilities to use various EPIs for salinity mitigation were put in place such as the National MBI (market based instruments) pilot program for natural resource management (BDA Group 2009).

This chapter provides ex-post policy evaluation of three salinity offsetting programs – Coleambally Irrigation Area (CIA), Ulan Coal Mine (UCML), and the South Australian (SA) Irrigation Zoning Policy – with an aim to evaluate their performance since implementation on a range of criteria, and to discern the noted shortcomings of the programs, or the noted features that have been working particularly well. An additional aim is to identify aspects where possible improvements in the existing offsetting programs could be achieved. The literature that reports on evaluation of salinity offset programs (Connor 2008) has been fairly sparse, both in Australia and internationally. This chapter fills that gap by providing a comprehensive evaluation of the considered salinity offset programs.

17.2 Setting the Scene: Challenges, Opportunities and EPIs

In terms of hydrology, Australia is the driest continent in the world on the basis of runoff per unit area. This is due to the high rate of evapotranspiration, the unparalleled temporal and spatial variability of rainfall intensity and frequency, and the generally flat topography across most of the continent (National Water Commission 2005). Nevertheless, significant irrigation activities have been established, mostly throughout the twentieth century: the irrigated area has grown from 350,000 ha in 1941 to more than 2 million hectares in 1997 (ANRA 2008). A large proportion of irrigation – 52 % of total irrigated land – takes place within the Murray-Darling Basin (MDB).

An inadvertent follower of the agricultural and irrigation development, salinity is one of the most significant environmental threats in Australia. It affects the ecological health of rivers, wetlands and streams, and reduces the productivity of crops and pastures. The estimated cost of environmental degradation due to salinity is substantial. Total annual cost of land and water degradation in Australia was estimated at A$1,365 billion, large proportion of which can be directly or indirectly attributed to salinity related degradation (Pigram 2007). Estimated annual costs of salinity include A$130 million in lost agricultural production, A$100 million in infrastructure damage, and at least A$40 million in loss of environmental assets (CSIRO 2008).

In general, offsets can be defined as actions that are undertaken away from the physical location of an activity to compensate for its negative environmental impact. A pollution offset can ensure with some level of confidence that there is no net increase in the load of a particular pollutant entering the environment as a result of a given activity (Tietenberg 2006). Offsetting allows new or expanding pollution sources to commence operations in a given area where there are attainment standards for a particular pollutant, provided they acquire sufficient offsetting credits from existing sources. Offsetting credits can be obtained by certified reduction of environmental impact from existing sources. Salinity offsets were recently used in three separate cases within the Murray-Darling Basin in Australia. These are the Coleambally Irrigation Area (CIA), the Ulan Coal Mine (UCML), and offsets under the South Australian (SA) Irrigation Zoning. The effect that offsetting has had in each of these case studies is briefly presented in the following sections.

17.3 Salinity Offsets in Action

The Coleambally Irrigation Area (CIA) is located in South Western New South Wales (NSW) within the MDB (Fig. 17.1). It was developed for irrigated agriculture between 1958 and 1970. Main crops that are grown are rice and other cereal crops and pastures. CIA has experienced significant problems of waterlogging and salinity (Whitten et al. 2005). Prior to irrigated agriculture, watertables[1] in the CIA were about 20 m below the surface. This was followed by dramatic increases in the period between 1981 and 1991 due to deep drainage of irrigation water below the root zone of the crops, and into the shallow aquifer (Rowe 2005). The extent of area with a

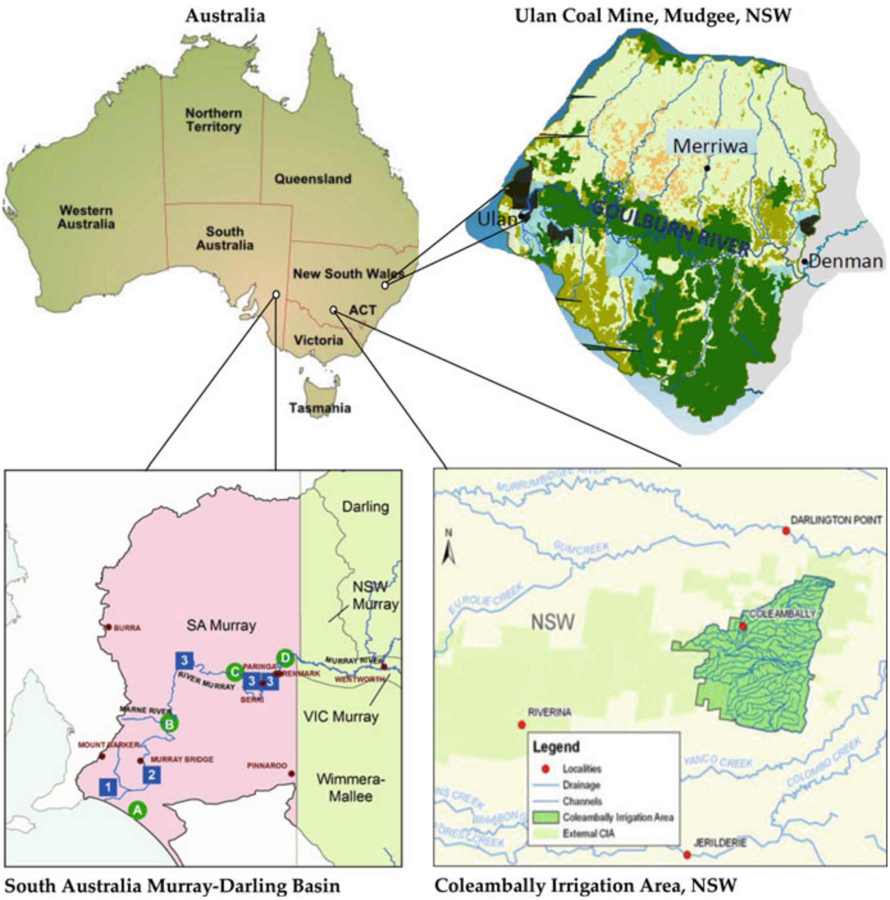

Fig. 17.1 Location of salinity offset case study areas (Source: Own elaboration)

[1] Watertable is the surface where the water pressure head is equal to the atmospheric pressure. Simply it can be visualized as the surface of the subsurface materials that are saturated with groundwater in a given vicinity (Freeze and Cherry 1979). Individual points on the water table are typically measured as the elevation that the water rises to in a well screened in the shallow groundwater.

watertable within 2 m of the surface was about 26,800 ha in 2000/2001. It was predicted that the land area within the CIA under which the watertables are very shallow (less than 2 m from the surface) would rise to 50,000 ha by 2013 and to 60,000 ha by 2023 if no further watertable and salinity management actions were taken (Rowe 2005). To address these problems, a Net Recharge Offsetting Policy has been implemented in the area since 2005 under the auspices of the Coleambally Land and Water Management Plan (LWMP).

Ulan Coal Mine (UCML) is located in the Central West of NSW (Fig. 17.1). It is a 'surplus water' mine: approximately 8.2 ML more water per day is generated through underground mine dewatering than can be re-used through mining activities. This surplus water has historically been released into the Ulan Creek flowing into the Goulburn River, which is a tributary of the Hunter River. As Ulan mine is the only major mine within the Hunter Valley Catchment not involved in the widely known and studied Hunter River Salinity Trading Scheme (Shortle and Horan 2008), it has developed an offsetting program to mitigate salinity impacts resulting from irrigating agricultural crops using the water from the mine. Salinity offsetting is based on the establishment of the Bobadeen Irrigation Scheme (BIS) in 2003. With commissioning of the BIS, surplus mine-water was used to irrigate about 250 ha of land under perennial pasture. As part of the implementation of the BIS, a salinity offset area was established to offset residual salt loads from irrigation activities.

The South Australian Murray-Darling Basin covers 70,000 km^2 (about 7 % of South Australia), and its landscape varies from the low-lying coastal plains of the Coorong to the flat expanse of the Mallee to the steeper slopes of the Eastern Mount Lofty Ranges. Highly saline groundwater naturally flows into the River Murray from the surrounding landscape. Irrigation has accelerated the rate at which the saline groundwater is now entering the River Murray and the floodplain. To address the issue, irrigation zoning policy that restricts the location of new irrigation developments to areas where salinity impact is relatively low has been in place in the irrigation regions along the River Murray in South Australia since 2005 (DWLBC 2005). Salinity offsets are a constituent part of this policy.

17.3.1 The EPI Contribution

17.3.1.1 Environmental Outcomes

The Coleambally Irrigation Area is currently implementing a Net Recharge Policy to mitigate salinity impact of irrigation farms. The offsets under this policy are in the form of planting certain crops that are capable of reducing the level of groundwater recharge, or directly reducing groundwater table. In the period 2002–2008, annual allocations to irrigation water holders have been significantly reduced due to the effects of the prolonged drought (Grafton and Hussey 2007). This period coincides with the time of introducing the Net Recharge Offsets in the CIA in 2005. As a consequence of the dramatic restriction of annual allocations, but also as a result of activities designed to mitigate salinity, including the Net Recharge Offset policy, the area with groundwater levels within 2 m from the surface in the CIA reduced from over 25,000 ha in year 2000 to some 1,700 ha in September 2006. The area of land with watertable within 2 m from the surface reduced further to just 400 ha in 2007 (CICL 2007), and even further to 258 ha in September 2010 (CICL 2010a).

Table 17.1 shows the monthly average salinity over the period 2007–2010, including a benchmark year. It is observed that the salinity level at the two licensed discharge sites and one licensed monitoring site has remained below 200 μS/cm over the period, which indicates a significant improvement in comparison to the benchmark salinity. Lower salinity at the drainage monitoring sites is due to the lowering of groundwater tables within the CIA. The reduction in watertables below the level of the bed (base) of the drainage channels means there is no salt intrusion from watertable into drainage water.

The Bobadeen irrigation scheme and the associated salinity offset program are integrated in the Ulan Coal Mine's environmental management system. The salinity offset program has had positive environmental outcomes. During the period 2009–2010 the average daily discharge of water at Ulan Creek was calculated to be 6.78 ML/day, while the mining activities involved discharging around 11 ML/day before the implementation of the salinity offset program in 2004–2005 (Table 17.2). The pH range for the discharged water was 6.5–8.5 for 2009–2010, with the average pH of 7.41. The average Electrical Conductivity (EC) was 730 μS/cm, with the maximum EC recorded at about 1,000 μS/cm (Table 17.2). The above values are compared to the measurements observed before the offsetting program was implemented, as displayed in Table 17.2.

Table 17.1 Average monthly salinity (μS/cm) at three licensed discharge, and one monitoring point, CIA (CICL 2010a)

Location	Benchmark[a]	2007/2008	2008/2009	2009/2010
Coleambally catchment drain	117	115	161	138
Coleambally drainage channel	510	151	272	232
West Coleambally channel (discharge point)	660	45	167	154
West Coleambally channel (monitoring point)	712	163	108	159

[a]Benchmark includes average data from 1996/1997, 1997/1998 to 1998/1999

Table 17.2 Change in some environmental variables before (2004–2005) and after (2009–2010) the implementation of the salinity offset program, Ulan Coal Mine (UCML 2006, 2010)

Environmental variables	2004–2005	2009–2010
Daily discharge of water (ML/day)	11.0	6.78
pH range	6.7–9.8	6.5–8.5
Electrical conductivity (μS/cm)	1,000–1,200	277–1,013

Natural inflows into the River Murray in South Australia have been at record lows over the last 7–8 years, with an absolute minimum of 360 GL in 2007. Such dismal water availability was paralleled with severe restrictions of water allocations to irrigated agriculture (SADW 2011, Government of South Australia Department for Water. Personal communication, Mr. Christopher Wright). This situation was reflected in significantly reduced interest in establishing new irrigation activities within the SA Murray. The reduced river flows over the last 10 years also had implications on the dynamics of salinity itself. One possible implication is that due to minimal water inflows, which may be insufficient to dilute the natural saline inflows, there could be significant rise in river salinity. On the other hand, as a result of actions taken at the MDB level (e.g. Murray-Darling Basin Salinity and Drainage Strategy implemented 1988–2001 (MDBC 2003), the salinity pressures in the lower parts of the River Murray eased. The trend analysis on the average salinity levels measured at Morgan[2] since 1980 shows that measurements of electro conductivity taken in 2003 were averaging about 525 μS/cm, which was considerably lower than the previous 20-year average (MDBC 2009). Current measurements of electro conductivity at Morgan are around 300 μS/cm (River Murray Data, 2011; http://data.rivermurray.sa.gov.au).

17.3.1.2 Economic Outcomes

The economics of net recharge policy for Coleambally Irrigation Area can be assessed by evaluating the changes in net farm income (gain or loss) that result from changing farming activities due to the net recharge policy. The costs and benefits of the net recharge policy depend on the dynamics of the area of land planted with perennial and annual deep rooted crops, in relation to the area planted with rice. It may be argued that the net recharge salinity offset is more cost-effective than any other available option to reduce groundwater table, in terms of operational and implementation cost. There is evidence that the offset program was considerably less costly than other options for salinity mitigation, including desalination by reverse osmosis, which was seriously considered as an alternative (Whitten et al. 2005).

In case of the Ulan Coal Mine, the salinity offset program required an initial investment by the mine of an estimated A$1.4 million, with annual operating and maintenance costs of about A$94,000 (DEC 2005a). On the other hand, establishing a desalination plant that would have been used to treat the effluent discharge from the mine to the locally acceptable stream ambient concentration levels would have required an initial investment of about A$15 million, with ongoing operational cost

[2] Morgan is a town on the River Murray in South Australia, which is often used as a location for benchmarking water quality, especially salinity, as the salinity readings at Morgan are good indication of the possibility to use river water for drinking water supply to the city of Adelaide. The 'magic' number is 800 EC (electroconductivity) units (or μS/cm), which is the maximum allowed value for the electroconductivity indicator for drinking water.

of about A$6 million per year. This implies that savings of approximately A$91 million in terms of net present value over the next 20 years can be achieved by using the salinity offsets as opposed to installing a desalination plant (DEC 2005a). The cost-effectiveness of the salinity offsetting program for Ulan Coal Mine can be assessed based on the annualised cost of the program, and the estimated residual salt loads that are avoided as a result of the program. Assuming a total productive life period of 20 years for the mine, the annualized cost of the initial investment (A$1.4 million) can be estimated at A$132,150 using an interest rate of 7 %. Adding this to the annual operation costs of A$93,500 gives a figure for the total annualised cost of the salinity offset at A$225,650. Combining this figure with the predicted residual salt load of around 280 tonnes a year avoided as a result of the offsetting program, gives the unit cost for salinity impact reduction through the salinity offsets at A$806 per ton of salt load avoided. This compares very favourably with the costs of any other alternatives.

There is currently no ex-post information available on the value, costs, or prices involved with salinity offsets within the irrigation zoning policy in South Australia. Spencer et al. (2009) compared ex-ante the cost-effectiveness of standalone irrigation zoning policy to an irrigation zoning policy with salinity offsets. Their findings show that offsetting policy provides a better salinity outcome that can be achieved at lower cost than with standalone zoning policy. Average cost of reducing salinity for the salinity offsetting policy is A$148,980/1 EC unit, which is A$48,850/1 EC unit lower than that for standalone zoning policy.

17.3.1.3 Distributional Effects and Equity

The initial salinity problem in the Coleambally Irrigation Area is a clear example of an ownership externality. Each individual irrigator has an incentive to apply irrigation water to their crops, parts of which will drain in the shallow groundwater, raising the water table and aggravating the salinity problem for everyone. Thus, the distributional effects of the offset program are to ‘privatise’ a ‘public bad’, which is achieved by requiring each farm to take into account its contribution to the raising water table and, when the circumstances are critical, to offset that contribution. All salinity mitigation programs in CIA, including net recharge offsetting, contribute to long term social equity and sustainability, as they contribute to overcoming the possibility of widespread soil salinisations, which could seriously threaten farming in this region, and consequently threaten the affected rural communities.

In the Ulan Coal Mine the distributional effects of the offsetting scheme are in relation to the transformation of the environmental damage cost to the public (when the salty water was directly discharged in the river system) into abatement cost to the private entity that is the source of the environmental threat (the cost of the offsetting scheme to the UCML). This is a desirable outcome in its own right. The success of this scheme is even more apparent when the magnitude of the abatement costs is considered in relation to other possible alternatives, indicating that improvement of distributional effects from environmental degradation has been achieved in a cost-effective way.

The irrigation zoning policy in South Australia has a clear distributional effect of favouring established irrigation activities over new irrigation activities. Perhaps inadvertently, this policy effectively applies ‘grandfathering’ to the ‘right’ to generate salinity impact. The offsetting feature rectifies this bias, by clearly expressing the opportunity cost of irrigation activities in terms of their salinity impact. Standalone irrigation zoning policy provides perverse incentives for old, possibly technologically obsolete irrigation enterprises that may be using irrigation water inefficiently and creating substantial salinity impact to remain in operation, as they will not be able to capitalise on their implied ‘right’ to create salinity impact, due to the restricted transferability of water rights among salinity impact zones (e.g. without offsetting, an existing enterprise in a high salinity impact zone will not receive any reward should they decide to cease their operation). The offsetting removes this perverse incentive, as an established operation can get a monetary reward by ‘selling’ their offset, should they decide to cease operation. The institutions of property, or ‘use’, rights that are implied by the salinity offset in this case have been gaining popularity in water management applications in Australia. These institutions are increasingly better understood and accepted by the public.

17.3.2 The EPI Setting Up

17.3.2.1 Institutions

In Coleambally Irrigation Area, the net recharge offset policy is being implemented under the management of the irrigation cooperative. The use of offsets within the cooperative is an excellent example of institutional innovation, where the community itself (in this case the community of irrigators) recognises the inadequacy of the existing institutions (i.e. open access treatment of the environment), and comes up with a new institution that is designed to deal with an environmental problem. Other institutions partly involved in this program include the Murrumbidgee Catchment Management Authority, NSW Office of Water, Department of Primary Industries (NSW), Coleambally Outfall District Water Users Association, Department of Land & Water Conservation (now DNR), and Department of Environment and Climate Change. The Coleambally Irrigation Cooperative Limited is currently taking part in activities under the “Water Smart Australia” program under the Australian Government’s Water for the Future plan to reduce the environmental footprint (including salinity) of irrigated agriculture.

The salinity offset program for the Bobadeen Irrigation Scheme is operated by the Ulan Coal Mine Limited as a part of its environmental protection licence that is issued by the NSW Department of Environment, Climate Change and Water (DECCW). The license stipulates that UCML must develop a program to offset the residual salinity load arising from the irrigation of mine-water generated at the premises so that there will be no net increase in salinity load in the Macquarie and Hunter catchment areas as a result of the irrigation activities. Other institutions such as the Hunter-Central Rivers Catchment Management Authority (CMA), the local municipal council and the community consultation committee were involved to implement the salinity offset program.

Within South Australia, the irrigation zoning policy is administered by the South Australian Department of Water (SADW). Other agencies concerned with management of salinity along the River Murray in SA are the Murray-Darling Basin Ministerial Council, and the South Australia Murray-Darling Basin Natural Resources Management Board.

17.3.2.2 Transaction Costs and Design

Transaction costs are an important factor to consider while assessing the feasibility of EPIs for managing water resources and environmental quality. For example, the initial costs of setting up a cap and trade scheme, including unbundling land and water rights, are thought to be high. In a recent study Ancev (2011) found that the transactions costs of mandating the agricultural sector in a tradeable permit scheme for Green House Gas mitigation would be high. This is in line with previous findings specific to the Coleambally irrigation area (Whitten et al. 2005), which suggested that cap and trade mechanism for salinity mitigation in this case is not feasible, at least partly due to high transactions cost such as early implementation costs, establishing a register of permits, and the costs of trading in salinity permits. There are also ongoing public costs associated with administering salinity permit trades, monitoring water use and maintaining the integrity of the trading system through enforcement. Relatively lower transactions costs under offsets was part of the reason why a salinity offsetting program was preferred to a cap and trade mechanism in the CIA.

Transaction costs of the salinity offsetting program for Ulan Coal Mine Limited are not overly high. These involve mainly the costs of producing reports and other compliance documents; cost of publishing those reports; cost of monitoring of ambient environmental quality; cost of early termination of lease contracts with farmers. Early implementation costs of the salinity offsetting program were estimated at about A$921,000 (Source: DEC 2005b).

The existence of significant transactions costs are possibly a reason for observing limited use of salinity offsets in practice in South Australia. It appears that no activities have been taken by the South Australian government in relation to aiding potential participants in salinity offsetting: there is no register of offsets, trade register, or some sort of clearance house. These usually represent a large proportion of the early implementation costs (Jaraite et al. 2010). However, the absence of registers probably makes transactions costs for potentially interested irrigation developers prohibitively high. Because there is an absence of structured government approach towards salinity offsets within the irrigation zoning policy, the requirements on individual participants willing to buy or sell offsets are very large. This comprises the need to search for a counterparty, the need for adequate contracting, the need to navigate through administrative requirements, and the need to ensure compliance with the policy. The costs of these are likely to be very high, which probably acts as a deterrent for potentially interested parties to engage in offsetting.

17.3.2.3 Implementability

There are number of principles underlying the net recharge policy that serve the purpose of its implementation. The CIA undertakes an annual assessment of farm-based irrigation intensity across all farms within the Coleambally Irrigation Area against two specific criteria (CICL 2010b): (a) If total farm water use (including on-farm bores) exceeds 6.5 ML/ha, the shareholder must demonstrate that net recharge is being controlled by using the Swagman Farm Model or Net Recharge Offsets (Madden and Prathapar 1999), and (b) If the area of the CIA with a watertable within 2 m of the surface is greater than 10,000 ha (based on piezometer data) and if total farm water use (including on-farm bores) exceeds 5.5 ML/ha, then the shareholder must demonstrate that net recharge is being controlled by using the Swagman Farm Model or Net Recharge Offsets. There is a range of prescribed penalties for breaching the above irrigation intensity limit including sanctions against non-compliant rice growers. Within the corporation, rice growers who contravene the environmental policies will be invited to discuss the issue. If a breach is deemed to have occurred, sanctions can be applied, including (i) reductions in rice area and/or refusal to supply water, (ii) mandated soil testing, and (iii) other penalties as determined by the relevant jurisdiction.

In case of Ulan Coal Mine the offsetting program was implemented under the environmental protection licence, which is stemming from the Protection of the Environment Operations Act of NSW. The offsetting was first instigated under a pollution reduction program negotiated between NSW DECCW and Ulan Coal Mine Limited, before becoming the part of the environmental protection licence. The implementability and enforceability of the program is straight forward, as incentive compatibility of the offsetting instrument to the objectives of the mine is evident.

The salinity zoning policy in South Australia has been developed in relation to the salinity management goals of the Water Allocation Plan for the River Murray. This policy ensures that South Australia's salinity management is in line with the salinity management provisions of the Murray-Darling Basin Agreement. Under the Agreement, the states of New South Wales, Victoria and South Australia have committed to keep an up-to-date salinity register, which is used to record all activities that reduce or increase salt loads. Actions that increase salt loads, such as new irrigation developments result in a debit, whereas actions that mitigate salt loads result in a credit (Young et al. 2000). Under the agreement the register needs to be in surplus (credit) at all times. These provisions are directly related to the provisions of the Irrigation Zoning Policy for new developments in the low salinity impact zones.

17.4 Conclusion

The findings that emerged from the collected evidence are mostly consistent across the three considered offsetting programs. In terms of environmental effectiveness, it is not possible to clearly discern the effects of the offsetting programs from the effects pertinent to the climatic and hydrologic conditions over the last 7–8 years. At any rate, the salinity threats in Australia have abated over the period, and various salinity mitigation initiatives, including offsets, can probably claim at least some credit for it. The real environmental effectiveness of the offsets will be tested when the climatic conditions allow for improved irrigation water availability, as is currently the case.

The economic effectiveness of salinity offsetting programs is clear. In all cases, salinity offsets provided a cost-effective way to mitigate salinity when compared to alternative approaches. In addition, salinity offsets have desirable distributional effects, as they transform the costs associated with the environmental damage borne by the public at large, to costs associated with providing the offsets borne by those who cause the environmental damage. The social effects of the offsets are minor, and in principle they can be seen as enhancing social equity in relation to environmental health.

The institutional innovation represented through the implementation of salinity offsets is probably the most exciting and promising feature of these programs. Incentive based approaches to deal with environmental problems, including tradable permits, taxes, and offsets, have become widely accepted in Australia over the last decade. Given that this type of approach effectively corrects for an outdated institution that has governed resource use and environmental management (i.e. the institution of 'open access') in the past, it is satisfying to witness that new institutions that highlight the importance of property rights, are slowly but surely taking the front stage in this domain.

The shortcomings of the reviewed offsetting programs relate to potentially high transactions costs, especially in relation to the environmental outcomes from salinity offsets. While in some cases the transactions costs appear to be acceptable (UCML) due to the small number of affected agents, they are likely to be very high in other cases (Irrigation Zoning in SA). In the latter case, there is clear opportunity for the Government of SA to provide some services (e.g. register of interest for salinity offsets in the high salinity impact zones) that will reduce the transactions costs for the prospective participants in the salinity offsetting. Governments can also be instrumental in improving the performance and uptake of salinity offsets by supporting further research into quantification and management of the uncertainty related to environmental offsets in general, and salinity offsets in particular.

Overall, this chapter finds that salinity offsets in Australia have been reasonably successful since their implementation. Their very existence is a positive development, and an important addition to the policy mix to deal with future environmental and natural resource challenges related to agricultural water use.

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