Improving Institutional Arrangements for Conjunctive Water Use in Australia: A Case Study of the Shepparton, Coleambally and Burdekin Irrigation Areas

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ABSTRACT

This paper attempts to determine the institutional arrangements required to make effective implementation of conjunctive water management possible to limit salinity problems and to maintain the economic viability of irrigated agriculture in Australia. The institutional arrangements in three irrigation regions in Australia were compared, being the Shepparton Irrigation Region in Victoria, the Coleambally Irrigation Area in New South Wales and the Burdekin Irrigation Region in Queensland. The research was based on literature studies and discussions with people involved in the management of the irrigation areas.

In all three irrigation areas, water is used conjunctively to mitigate or prevent salinity problems and increase the total volume of water available. It can, therefore, increase the production and profitability of irrigated agriculture. Conjunctive water use also improves the timing of water supply in all three areas, as groundwater is also available during periods of channel maintenance. In the Shepparton Irrigation Region and the Burdekin region conjunctive use also increases the quality of irrigation water.

INTRODUCTION

Continued productivity and environmental sustainability of irrigation areas are threatened by both poor water management practices and increasing competition for irrigation water. The long-term productivity in irrigated areas is threatened by a number of environmental sustainability issues, which include over-pumping of groundwater resulting in aquifer depletion and up-coning of the fresh-saline water interface, over-irrigation of surface water resulting in water-logging and salinisation, and the use of marginal to poor quality water resulting in soil salinisation and sodification (IIMI and ACIA, 1997). It is estimated that globally, the irrigation area going out of production each year due to land degradation is approximately equal to new areas brought under irrigation (Ministry of Foreign Affairs, The Netherlands, 1998).

In Australia, problems of rising watertables and soil degradation emerged soon after the establishment of the first irrigation schemes. Now, few irrigation areas are free of problems and all

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indications show that, without major remedial measures, they will get worse (Hallows and Thompson, 1995).

Salinity problems related to irrigation can be addressed through conjunctive management of surface water and groundwater. Conjunctive management is the combined and integrated management of surface and groundwater for optimal productivity and allocation efficiency. Conjunctive water use was developed in the 1960s as a resource management objective to maximise water availability. Other objectives of conjunctive water use as found by Vincent & Dempsey (1991) covers improved availability of water, environmental objectives to reduce waterlogging and salinity, increased production, equity and poverty alleviation objectives, and fiscal objectives to optimise expenditure on rehabilitation and state disengagement from canal irrigation management. It is claimed that conjunctive use of water can contribute to improved agricultural performance, sustainability and equity (Prasad and Verdhen, 1990).

Conjunctive management of multiple sources of water is good in theory, but has not worked well in practice (Vincent and Dempsey, 1991), as there are many difficulties for its implementation. The main difficulty is that the means for actually carrying out effective and sustainable conjunctive water management have not been established. Effective conjunctive water management requires: Effective technologies for controlling surface water applications, waterlogging, groundwater withdrawal, and artificial recharge of aquifers.

Institutional arrangements and rules to control the use of the surface water and groundwater. Institutions include laws and policies, water allocation rules and principles, water markets, management organisations and regulatory organisations.

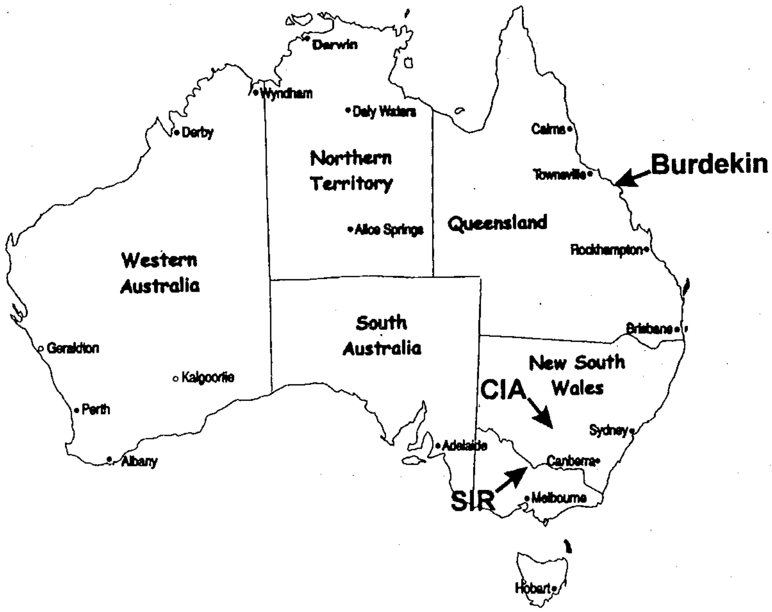
Information and management tools to enable water managers to manage multiple sources of water (IIMI and ACIA, 1997).

In addition, conjunctive use demands the integration of surface water and groundwater management systems under one planning authority or user group, but in practice, separate authorities often govern surface water and groundwater, and consequently rivalries and poor co-ordination may result. Furthermore, surface water may be owned and managed by the government while groundwater pumps may be privately owned. Hence, regional authorities may have better control over surface water management and pricing than over groundwater, and policies may be ineffective (Vincent and Dempsey, 1991). Moreover, data on different water resources in irrigated areas, where it exists, is often fragmented among various entities, so that effective conjunctive water management is not possible (e.g. Raju et al., 1994 and Murray-Rust and van der Velde, 1994).

THE AUSTRALIAN STUDY AREAS

Three irrigated regions in Australia were chosen for analysis of their conjunctive water management practices. These regions are the Shepparton Irrigation Region (SIR) in the State of Victoria, the Coleambally Irrigation Area (CIA) in the Sate of New South Wales and the Burdekin region in the State of Queensland (Figure 1). The selection of the regions in three different states was due to the different laws and policies in each state, as under Australian law natural resource management comes under State jurisdiction.

Figure 7. Locality map of the study areas.



Summaries of the biophysical characteristics of each region are given in Table 1.

Table 1. Characteristics of the study areas:

	Shepparton	Coleambally	Burdekin
State	Victoria	New South Wales	Queensland
Average annual rainfall (mm)	500	400	1,000
Total area (ha)	500,000	85,000	~96,000
Area irrigated (ha)	280,000	~50,000	~70,000
Main crop	Pasture	Rice	Sugar cane
Surface water use (ML/yr)	1,400,000	480,000	300,000
Groundwater use (ML/yr)	45,000	45,698	In the BRIA: 20,000 In the Delta: unknown
Number of inhabitants	98,000	1,384	18,957
Major environmental problem	Waterlogging and salinity	Waterlogging and salinity together with drainage water quality	Sea water intrusion, potential for waterlogging and salinity, impact of drainage water on the wetlands
Type of conjunctive water use	Salinity control and additional supply	Salinity control and additional supply	Additional supply, alkalinity mitigation and prevention of salinity problems and seawater intrusion

Conjunctive water use in the Shepparton Irrigation Region (SIR) is the combined use of surface water and shallow (< 20 m) groundwater. This is promoted by the Shepparton Irrigation Region Land and Water Salinity Management Plan as a salinity remediation measure. The shallow groundwater is saline and has to be shandied with surface water before it can be used. The reuse of groundwater leads to an increase in soil and aquifer salinities and thus may threaten the long-term sustainability of the area.

In the Coleambally Irrigation Area (CIA) deep (>100 m) groundwater is used in conjunction with surface water and is pumped by Coleambally Irrigation Co-Op (CIC), and individual farmers. The Coleambally Land and Water Management Plan promotes deep aquifer pumping as this increases vertical leakage from the shallow more saline aquifer to the deep aquifer and thus helps in providing salinity control. Water pumped by Coleambally Irrigation is mixed with surface water in the supply channel. The deep aquifer is already over-allocated (Personal communication S. Lawson, DLWC). Therefore, an increase in deep groundwater pumping will lead to mining of the finite resource. It is planned that shallow groundwater pumping will take place in the future as well. Part of this water will be reused and another part will be disposed of to the surface drainage system.

The Burdekin region is divided in three management areas; the delta north of the Burdekin river managed by the North Burdekin Water Board (NBWB), the delta south of the Burdekin river managed by the South Burdekin Water Board (SBWB) and the Burdekin River Irrigation Area (BRIA) managed by State Water Projects (SWP).

Conjunctive water use in the BRIA is needed to prevent watertable rise and salinity problems. Conjunctive water use is promoted by SWP by allocating 1 ML of groundwater for each 8 ML of surface water. This 1 ML is the average deep drainage loss. Conjunctive use of surface water and more saline groundwater also prevents soil surface crusts formation caused by the high alkalinity and low salinity of the surface water. Water use on the edge of the irrigation area close to the bedrock increases the inflow of salts from the bedrock and causes groundwater salinisation. Excessive groundwater use in the northern part of the BRIA can also lead to seawater intrusion.

The Burdekin delta is an older irrigation area and used to be dependent on groundwater. In the 1930s and 1960s excessive groundwater pumping led to seawater intrusion events. In 1965 and 1966 the North and South Burdekin Water Boards respectively were established as Underground Replenishment Boards to utilise a part of the flow of the Burdekin River to replenish the delta aquifer and to thereby increase the quantity and improve the quality of groundwater supply. Since the completion of the Burdekin Falls Dam in 1986 surface water is available all year round and the area has become less dependent on groundwater. The water boards now experience problems in obtaining water of low turbidity that can be used for artificial recharge. They promote surface water use because this reduces the need for artificial recharge, as less groundwater is pumped and surface water use spreads recharge over a large area. The use of surface water on the coastal margins pushes the saltwater wedge to areas that did not experience salinity problems before. Conjunctive use in areas near the bedrock leads to an increase of saline flow from the bedrock and groundwater salinisation.

ANALYSIS OF CONJUNCTIVE WATER MANAGEMENT IN THE IRRIGATION AREAS

Bio-physical Conditions

Shepparton Irrigation Region

The Shepparton Irrigation Region is located in northern Victoria at the confluence of the Goulburn and the Broken Rivers. It is one of the largest irrigation areas in Australia both in area irrigated and volume of water used.

The SIR totals about 500,000 ha with some 487,000 ha of farm holdings. Of this, 430,000 ha are suitable for irrigation and about 280,000 ha is irrigated any year. Of the irrigated area, the largest proportion is used for pasture production for dairying (80%) and a small proportion is used for high value perennial horticulture crops (3%). The size of properties and water use varies widely. The impact of waterlogging and salinisation is not uniform over the landscape but is dependent upon the landform, which affects soil type and natural drainage conditions. The implemented solution to waterlogging and salinity problems include the development of a surface drainage network, tile drains for horticulture and shallow groundwater pumping for pasture and horticulture also. Water from groundwater pumping is disposed of, if it is of low quality or, used conjunctively with surface water if it is of good quality.

Evidence so far is that only a small part of the local recharge finds its way, by deep seepage, to the deeper aquifers. Most of the local recharge is dissipated as watertable rises and groundwater discharges associated with flows in the shallow aquifer. Prior to irrigation, watertables in the Shepparton Region were some 25 metres below the surface. In 1997, the long-term watertable trend for the region was still upward (Goulburn-Murray Water, 1997a). The area where the groundwater table is within 2 m from the soil surface was about 160,000 ha in 1989; this is predicted to increase to an estimated 247,000 ha in the year 2025. This would have serious impact upon the productivity of the region. To combat this problem, the Shepparton Irrigation Region Land and Water Salinity Management Plan (SIRLWSMP) was developed in the late 1980s and had the government's endorsement for implementation in 1990.

Water right available per irrigated hectare averages 3.57 ML/ha. Average actual application rate of surface water supplies is around 5.5 ML/irrigated ha/yr or about 3.5 ML/ha/yr of land commanded. Total deliveries to the region average about 1,400,000 ML/yr. There are some 1,100 licensed bores in the region with allocations in excess of 2,600,000 ML annually. Most of this (75%) is allocated against the Upper Shepparton Formation (shallow aquifer <20m). The lower Shepparton Formation (deeper aquifer 20-40m) has limited development across the region, accounting for 2% of licensed groundwater usage. Licensed extraction from the Calivil/Renmark aquifer (deep lead >100m) is the remaining 23% of total groundwater allocation (Goulburn-Murray Water, 1997b). Various surveys suggest that average groundwater irrigation usage is 20% to 50% of allocation but usage increases markedly in dry years. The reuse of surface drainage water is significant, totalling about 77,500 ML/yr or 6.5% of the surface water allocation. This occurs in about 52% of the area with groundwater extraction (Personal Communication K. Sampson, Institute of Sustainable Agriculture, Tatura).

The quality of surface irrigation supply water is very good, in the order of 0.05-0.13 dS/m, as it originates from the alpine areas of eastern Victoria. The groundwater quality is not that good or highly variable, 0.8 dS/m being typical of the best quality, generally being around 2 dS/m, but ranging to an excess of 15 dS/m. The quality of groundwater requires mixing with the fresher surface water before use. Generally on-farm use of groundwater is restricted to groundwater with salinities less than 3.5 dS/m. Groundwater, more saline than this, is only pumped for salinity control and is disposed of into major surface irrigation supply channels or directed to surface drains which flow to the river system.

Coleambally Irrigation Area

The Coleambally Irrigation Area (CIA) is a relatively small irrigation area. Farming is dominated by rice production. Other irrigated enterprises in the CIA are rice, sheep/annual pastures, winter crops (mainly wheat), soybeans and some horticulture (grapes, fruit, and potatoes).

In 1996, with average rainfall conditions, 27,000 ha or 34% of the area was underlain by shallow watertables. Shallow watertables are concentrated in the central and southern part of the CIA, the northern part does not seem to be affected at this stage. From hydrological modelling results (Van der Lely, 1994) it is found that the area with watertables within two metres below the surface will increase from about 27,000 ha in 1993, to about 60,000 ha by the year 2023. Especially the southern and central part of the CIA part will be affected.

Deep groundwater pumping lowers the pressure in the deep aquifer promoting vertical leakage from the shallow aquifer. The main Coleambally Irrigation bore pumping about 3,000ML/year induced a lowering of the groundwater level by 20-40 cm over a radius of several kilometres (Lawson and Van der Lely, 1992). Therefore, deep groundwater pumping is seen by Coleambally Irrigation Co-Op as a measure to combat salinity problems. However, studies by Prasad et al. (2001) show that deep pumping has to be carefully controlled to prevent salinisation of the aquifer. Salinisation will occur if deep pumping induces excessive movement of the saline water in the upper aquifers downward.

Water allocation within the CIA averages 6.7 ML/ha. The total surface water allocation for the CIA amounts to 480,000 ML/yr. Annual consumption ranges between 380,000 ML/yr and 600,000 ML/yr. There are 23 bore licences for privately owned and operated pumps by the landholders in the CIA. Coleambally Irrigation Co-Op operates one deep bore and mixes water from this bore with surface water in the supply channel. During 1997/98, 2,800 ML of water was pumped from the Coleambally deep bore and sold to irrigators in the CIA. The private pumpers within the CIA pumped a total of 45,698 ML. This is about 10% of the surface water allocation.

Irrigation water diverted to the CIA is considered to be of uniform high quality of 0.15 dS/m (Coleambally Land and Water Management Plan 1996 Draft). Salinity of the shallow groundwater ranges from 1dS/m to >20 dS/m. Salinity of deep groundwater increases from 0.5 dS/m in the northern part of the CIA to around 1.0 dS/m in the southern area.

Burdekin Irrigation Region

The Lower Burdekin is a large irrigation area dominated by sugarcane production. Salinity problems occur on the coastal margins due to seawater intrusion and on the border areas adjacent to the bedrock because of salt inflow from the bedrock.

In 1986, the Burdekin Falls Dam was built, allowing the development of the Burdekin River Irrigation Area (BRIA). In the BRIA there is potential for the development of high watertables and salinity problems. To prevent this situation, groundwater pumping is promoted by allocating groundwater volumes equal to average deep drainage losses, i.e. 1ML/ha/yr.

Water use in the Lower Burdekin is given in Table 2. Groundwater use in the delta is not metered and therefore not known.

Table 2 Water use in the different parts of the Burdekin region

	BRIA		NBWB		SBWB	
	(ML/yr)	(ML/ha)	(ML/yr)	(ML/ha)	(ML/yr)	(ML/ha)
Surface water	200,512	6	60,841	3	38,124	3
Groundwater	20,000	1	Not measured / unknown		Not measured / unknown	
Total	220,512	7	105,570	5	67,432	5

The North Burdekin Water Board diverted 105,570 ML from the river in 1997/1998 of which 60,841 ML were directly used as surface water (NBWB, 1998). Within the Northern delta, there are areas where only groundwater is used because the farmers do not have access to surface water. There are also areas where only surface water is used because there is no access to groundwater or because the groundwater is of poor quality.

In the southern delta, 67,432 ML of water was pumped from the river in 1997-98 of which 38,124 ML was used directly by the farmers. The remaining went to groundwater replenishment via pit recharge and in channel intrusion (SBWB, 1998a). In the southern delta, all land has sufficient groundwater supply and no land solely depends on surface water.

In practice, artificial recharge takes place from May to July and surface water is used directly by the farmers from August to February.

Surface water quality is low in salinity and high in alkalinity. This sometimes leads to crust formation and reduced infiltration. Mixing with more saline groundwater increases the infiltration characteristics. Groundwater quality in most areas is good with salinities generally lower than 1.0 dS/m. Higher salinities occur on the coastal margins and adjacent to the bedrock (more than 3.0 dS/cm) (Sinclair Knight Merz, 1997).

Watertable levels in the delta vary considerably with the dominant influence being climate. The peaks associated with floods and other major recharge events tend to fall away reasonably quickly (within a year), suggesting a higher rate of discharge to the sea at these times, and/or the movement of groundwater to deeper aquifers (Sinclair Knight Merz, 1997).

Examination of the salinity of bores over time indicate a trend to marginally increasing salinity of water through the period 1974 to 1987, followed by a sharp reduction in salinity relating to the flood of 1991. It appears that salinity levels increase during dry seasons but there is a considerable diluting and flushing effect from major flood events, reducing salinity (Sinclair Knight Merz, 1997). Maximum salinity levels in the bores further away from the river have not increased over time, although reductions in salinity have not reached the lowest recorded levels, suggesting that there may be an overall increasing level of salt input (Sinclair Knight Merz, 1997).

The history of seawater intrusion in the delta is not well known. The extent of seawater intrusion in 1996 suggests that the toe of the seawater wedge is being actively moved inland. In the northern delta the use of surface water for irrigation pushes the salt-water wedge to areas that had no salinity problems before (Personal communication J. Tait, James Cook University, Freshwater Research Center).

Institutions

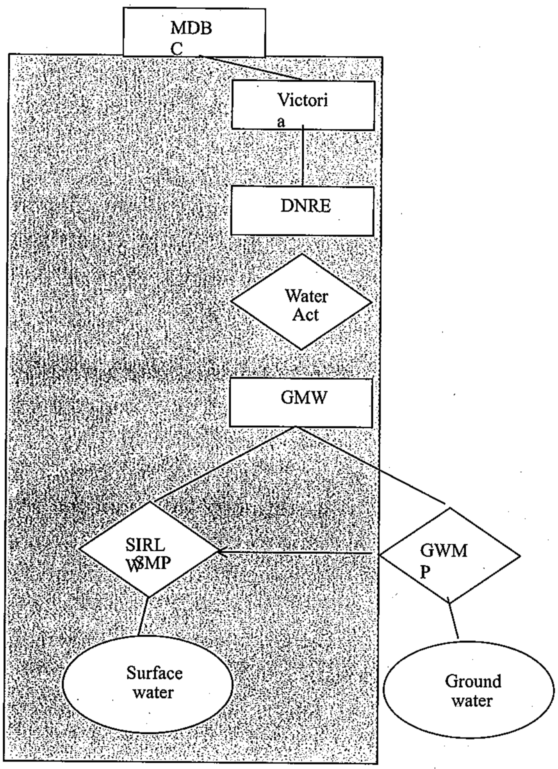
Introduction

In Australia water resources management normally falls entirely within the jurisdiction of the States with no Federal government involvement. The Federal government of Australia does not have power to intervene in natural resource management issues unless they affect international obligations. The management of waters and rivers that are shared between states are usually covered under identical legislation enacted in the two states sharing the resource. The SIR and CIA are located within the Murray Darling Basin and are, therefore, also influenced by the policies of the Murray Darling Basin Commission, which is a multistate, plus Federal government organisation.

Shepparton Irrigation Region

There are many and varied organisations that have jurisdiction or influence in the allocation and use of water resources in the SIR. These organisations range from local community groups to the water provider to the Catchment Management Authority to State government. Also, since the SIR is within the Murray Darling Basin it is influenced by the policies of the Murray Darling Basin Commission, Figure 2. The main controlling bodies in the SIR are the Catchment Management Authorities and Goulburn Murray Water.

Figure 2. Schematic representation of the institutional arrangements in the SIR.



The Shepparton Irrigation Region is located in the areas of two Catchment Management Authorities, the Goulburn Broken Catchment Management Authority and the North Central Catchment Management Authority. The Implementation Committees of the Catchment Management

Authorities tackle the catchment issues identified in the Regional Catchment Strategies of the Catchment Management Authorities. The Implementation Committees act as a link between the board and the people of the catchment ensuring natural resource management reflects the views and concerns of the community. The Irrigation Committee is the Implementation Committee of both the North Central and the Goulburn Broken Catchment Management Authority for the Shepparton Irrigation Region; as it is the key institutional body in the region. The Irrigation Committee is responsible for the implementation of the SIRLWMSP but has delegated the responsibility for most of the on-ground implementation to Goulburn Murray Water, the Rural Water Authority in the area. During the implementation of the SIRLSWMP, Goulburn Murray Water identified the need for a groundwater management plan to compliment the SIRLWSMP, and as such, is also responsible for administering and enforcing the groundwater management plan.

Goulburn-Murray Water is responsible for the management of the major water systems within its boundaries, provision of bulk supplies to (Non-Metropolitan) Urban and Rural Water Authorities and the delivery of irrigation water, domestic and stock supplies and drainage services and has been delegated responsibility by the Catchment Management Authority for most of the on-ground implementation of the SIRLWSMP. During the implementation of the SIRLSWMP Goulburn Murray Water identified the need for a groundwater management plan to compliment the SIRLWSMP, and as such, is also responsible for administering and enforcing the groundwater management plan.

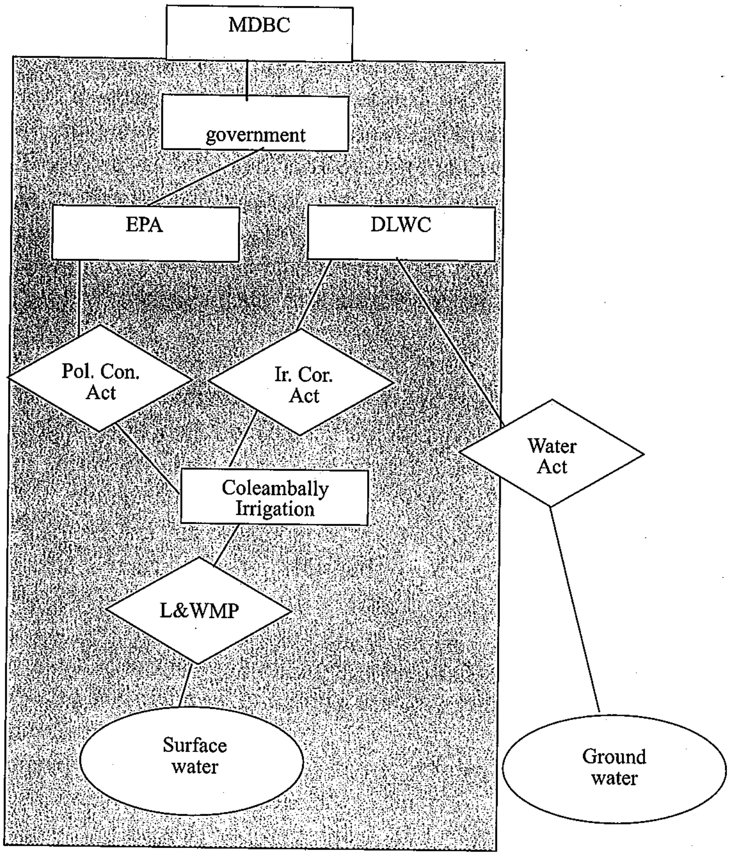
The local governments realising the long-term economic threat of salinity to the region have formed a regional body, Municipalities Against Salinity in Northern Victoria (MASNV), and appointed a Municipal Salinity Liaison Officer to co-ordinate local government participation in the SIRLWSMP. The municipalities have developed uniform planning regulations for the implementation of drainage works under the SIRLWSMP. Furthermore, the local governments pay 17% of the annual costs of public salinity works constructed under the plan and have used provisions of the Local Government Act to support community salinity control projects (surface and sub-surface drainage) (Sampson, 1996).

Coleambally Irrigation Area

There are varied organisations that have jurisdiction or influence in the allocation and use of water resources in the CIA. These organisations range from local community groups to the water provider to the Catchment Management Committee to State government. Also, since the CIA is within the Murray Darling Basin, it is influenced by the policies of the Murray Darling Basin Commission. The main controlling bodies in the CIA are Coleambally Irrigation, an independent company that controls the allocation of surface water and the implementation of the Land and Water Management Plan and the Department of Land and Water Conservation (A State department that controls groundwater allocation), Figure 3.

Coleambally Irrigation (CI) was formed on 1st July 1997 under the Irrigation Corporations Act, 1994. The NSW Government Ministers for Treasury and for Regional Development and Rural Affairs are shareholders of Coleambally Irrigation. CI is responsible for supplying water to farms in the CIA. CI is also the single entity to implement the Coleambally L&WMP. CI is, therefore, responsible for both the commercial and environmental aspects of irrigated land use.

Figure 3: Schematic representation of the institutional arrangements in the CIA.



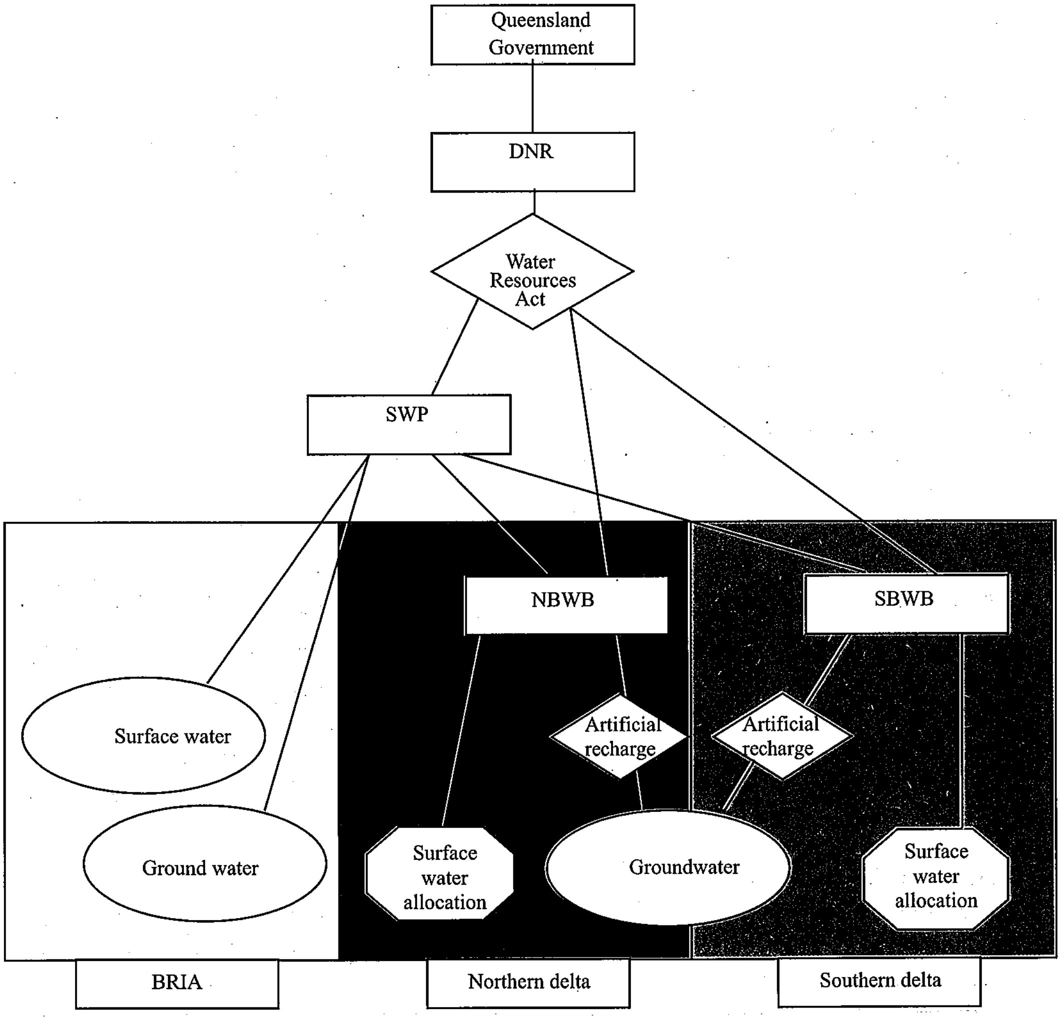
Burdekin Irrigation Region

The main controlling body in the Burdekin irrigation region is the Department of Natural Resources as this department controls both the water boards and SWP. The most important water allocation bodies are the North Burdekin Water Board, the South Burdekin Water Board and State Water Projects. SWP is the most important water provider as SWP delivers water to the farmers in the BRIA and the water boards, Figure 4.

State Water Projects was gazetted as a business activity of the Department of Natural Resources under the Queensland Competition Authority Act and operates in accordance with Treasury guidelines. State Water Projects is responsible for the management of state owned water infrastructure.

The North Burdekin Water Board and South Burdekin Water Board are structured under the provisions of the Water Resources Act. The Boards were constituted as underground replenishment Boards. The initial concept was to supplement the aquifer by diverting natural river flows into flood overflow channels in the delta. Artificial recharge was affected by natural percolation through the bed and banks of these natural watercourses in addition to intake through artificially constructed soakage pits. Today, artificial recharge and natural percolation still play an important but somewhat diminished role in the mode of operation, as the emphasis has shifted from pure recharge to aquifer management via conservation.

Figure 4: Schematic representation of the institutional arrangements in the Burdekin Region.



This is achieved by encouraging growers to take surface water directly from the Board's distribution system (NBWB, 1998). The water boards hold an allocation from SWP and decide to either use this water for artificial recharge or to supply it directly to farmers. The water boards have to report annually to the Minister (Department of Natural Resources).

There is no Catchment Management Authority or Committee that provides integration of the irrigation region with the upper catchment or the integration of water management with other environmental issues.

Plans and Policies

Shepparton Irrigation Region

In the SIR there are two key policy instruments, the SIR Land and Water Salinity Management Plan (SIRLWSMP) and the Groundwater Supply Protection Management Plan (GSPMP).

The SIRLWSMP was initiated in late 1980s due to community and governmental concern about increasing salinisation in the area. The local community, especially farmers have been intimately involved in the development of the SIRLWSMP from the outset.

The Groundwater Supply Protection Management Plan (GSPMP) is a more recent initiative. Goulburn Murray Water initiated the GSPMP after considering their role in implementing the SIRLWSMP. They found that the management of groundwater allocation and pumping in the region was inadequate in terms of meeting the SIRLWSMP objectives. They have used the GSPMP to bring groundwater resource management under their control and to align it with the SIRLSWMP objectives. Another development are the Regional Catchment Strategies, which are catchment wide strategies that have adopted the SIRLWSMP as their Irrigation Program.

The policies of the Murray Darling Basin Commission have a large influence upon the policy directions and socio-economic conditions of the region. New initiatives including "The Cap", which put a limit on surface water use and water market reform have the potential to fundamentally change the resource allocation system and the price for water. They can create a period of rapid change and structural adjustment. These factors may have a great impact upon the socio-economic position and viability of the region.

The Shepparton Irrigation Region Land and Water Salinity Management Plan

Victoria's Salinity Program has been a major ongoing initiative of the community and the State Government since 1986. In 1988 "Salt action: Joint Action", a state strategy for managing land and water salinity in Victoria was released. The principal long-term goal of the program was: " *...to manage the salinity of the land and water resources throughout Victoria in order to maintain, and where feasible, improve the social well being of the communities and the environmental quality and productive capacity of the regions".*

The strategy divided the state into nine catchment-based salinity control regions. It also defined a need for 20 sub-regional salinity management plans or regional salinity strategies covering those irrigation and dryland regions affected by salinity or contributing to salinity damage in Victoria or downstream within the Murray Darling Basin. The SIRLWSMP was one of the first sub-regional plans endorsed by the Victorian government.

The goal of the SIRLWSMP is: "To manage the salinity of land and water resources and the quality of water in the Shepparton Irrigation Region in order to maintain, and where feasible, improve social well-being, environmental quality and productive capacity of the Region". The original SIRLWSMP is now an integral part of the Regional Catchment Strategies of the North Central and Goulburn Broken Catchment Management Authorities. The Irrigation Committee of the Catchment Management Authorities is charged with the implementation of the SIRLSWMP (SPACC, 1989). Goulburn Murray Water has been delegated the responsibility for most of the on-ground implementation.

The farm program of the SIRLWSMP has the goal of reducing groundwater accessions, soil salinisation and waterlogging on farms. The main components of this program include whole farm planning, irrigation re-development, improved water management, environmental enhancement, tree growing and improved productivity.

The sub-surface drainage program has the goal of, where possible and justified, protecting and reclaiming the region's land and water resources from salinisation through management of the region's groundwater. Sub-surface drainage will be provided by activities of individual farmers under the farm program and by community activity in priority project areas where pump operation will be managed to provide seasonal watertable control in conjunction with regulated disposal of salt both within the region and to the river Murray. The main components of this program are installation of groundwater pumps, tile drains and low capacity pumps, and disposal. The groundwater pumps can be either private if the groundwater salinity is less than 3.5 dS/m or public when the groundwater salinity is more than 3.5 dS/m. Private groundwater bores are used for irrigation after dilution with surface water to a salinity of 0.8 dS/m. Irrigation water quality of 0.8 dS/m has been adopted as the critical level, as research in the area has shown that it does not cause any productivity loss for pasture (Heuperman, 1988). This program is one of the most readily adopted parts of the SIRLWSMP, especially the private pumps. This has been due to the great support for this aspect of the plan, including a previous waiving of all statutory charges on groundwater use by the Minister and the attraction of a supplementary water supply to farmers. The public pumps have not been as readily adopted, as they cannot be used for water supply. However, in recent times the demand for public pumps has increased as the community becomes more aware of and educated about the threat of salinity. At present the demand for both private and public pumps outstrips the funds available and hydrological investigation capacity of Goulburn Murray Water.

During both the preparation of the SIRLWSMP and the subsequently implementation, particular emphasis has been placed on ensuring broad community input into its development and on-going refinement, and ensuring continued community support for its implementation. This has been a major strength of the Plan. The key to success of the plan is to include the community through a framework of community education and supports.

Coleambally Irrigation Area

In the CIA the key policy instrument is the Land and Water Management Plan (L&WMP). The Coleambally community prepared and endorsed a Draft L&WMP in March 1994. The 'Final Draft' was issued in March 1996 (Coleambally Irrigation, 1999). The L&WMP addresses the increasing salinity problems in the area and is also used by Coleambally Irrigation to satisfy the EPA Pollution Control License with respect to the level of nutrients and pesticides in the drainage system.

A more recent development is the Murrumbidgee Catchment Action Program (MCAP), which is a catchment wide strategy. The MCAP supports L&WMPs and their priorities but does not incorporate it. The actions proposed by the MCAP apply to all irrigation enterprises and do not replace the detailed actions of the LWMPs.

At state level the NSW water reform package has been developed and will influence the allocation and price of water. It also provides regulations for environmental flows. The policies of the Murray Darling Basin Commission have a large influence upon the policy directions and socio-economic conditions of the region. New initiatives have the potential to fundamentally change the resource allocation system; the price and availability of water can create a period of rapid change and structural adjustment and may have a great impact upon the socio-economic position of the region.

The Coleambally Land and Water Management Plan

The objective of the Coleambally Land and Water Management Plan is stated as follows: "To ensure the Coleambally Irrigation Area remains a sustainable irrigation area and will address specifically the control of watertables and salinity, downstream effects of the Coleambally Irrigation Area and future research needs for the area, and to ensure that the final plan is acceptable to the Coleambally Irrigation Area landholders, townspeople of Coleambally, residents of those areas serviced by water from the Coleambally Irrigation Area and any government instrumentalities associated with the Coleambally Irrigation Area" (Coleambally Irrigation, 1999).

To achieve the objectives, the L&WMP has been organised into two major implementation components: net recharge management and drainage water quality control (Coleambally Irrigation, 1999). These two components are linked and facilitated by an Education component.

The Community Environmental Committee is responsible for assessing the progress of the various projects being conducted and the overall progress of implementation of the L&WMP. It is their role to maintain community ownership of the plan and to identify priority issues and the needs of the community with regard to implementation of the plan.

A reduction in accessions of 29 GL/yr is believed to be required to achieve sustainability. Consequently, a 29 GL/yr reduction in accessions was adopted as a tentative target for integration of the options. Furthermore, it was agreed that overall areas affected by soil salinity should not exceed 15% of the area over the longer term and has to be achieved in all of the four main parts of Coleambally – North, Central, South and West.

The key to farmer adoptions of most of the on-farm proposals is incentive schemes. The incentive schemes aim to encourage a community mind-set that acknowledges the importance of farm planning (especially in respect of drainage) and farmer education (particular in the environmental implications of farm management). From a conjunctive water use perspective, deep bore pumping and shallow groundwater pumping is important. It is expected that up to 75% of the deep bore volume can be sold by auction to landholders outside the CIA (Coleambally Land and Water Management Plan 1996 Draft). Shallow groundwater pumping is not required immediately but increases to a maximum by year 30 of the plan. It is supposed to take place in the southern parts of the Coleambally Irrigation Area only.

Burdekin Irrigation Region

There are no integrated policies for the whole Burdekin Irrigation Region and there are no Land and Water Management Plans for the region. The allocation policies of the water boards and SWP are, therefore, the most important policies.

Allocation Rules and Policies

Shepparton Irrigation Region

Under the Water Act the Department of Natural Resources and the Environment (DNRE) gives a bulk water entitlement for both surface water and groundwater to Goulburn Murray Water, which redistributes this water to the farmers who hold an individual allocation. New allocations can only be obtained through purchases from other farmers.

Coleambally

Surface water is allocated by Coleambally Irrigation, which holds a bulk water entitlement from DLWC. An allocation scheme has been based on historical usage rather than seasonal crop usage provides a distribution of water resources to all users.

The Department of Land and Water Conservation allocates groundwater. Groundwater allocations are based on the property area and the amount of surface water allocated to that property; the higher the surface water allocation, the lower the groundwater allocation (Personal communication S. Lawson, DLWC). At this time there is a statewide moratorium on new groundwater developments. Existing entitlement holders that do not use their entitlement (sleepers) can get a new license to increase pump capacity and use the entitlement. Total groundwater use can, therefore, still increase.

Burdekin

Water licences in the BRIA are issued by DNR under the Water Resources Act but are completely based on recommendations and approval of SWP. The allocation procedure is based on a maximum allocation of 10 ML/ha. The granting of this allocation is determined by the yield of the system. The groundwater system already has its natural sustainable yield fully allocated and the only extra groundwater that is granted is 1 ML for every 8 ML of surface water allocated. This is done to minimise the effects of deep drainage losses and to encourage the use of groundwater to control watertables but it is not compulsory to use this 1 ML of groundwater. The 1 ML of recharge for every 8 ML of surface water used is an average based on the soils in the BRIA.

Anything in excess of the 8+1 ML/ha up to a maximum of 10 ML/ha of surface water has to take into account environmental constraints, usage patterns, soils, and depth to groundwater, groundwater salinity, and watertable trends. The surface water system has constraints due to design capabilities i.e. the design flow rate of a channel may restrict the delivery ability. State Water Projects does not allocate above the designed maximum flow rate for any system.

In the delta the water boards hold a surface water allocation from the Burdekin Falls Dam. This water is delivered to the water boards by SWP. The water boards decide either to use it for artificial recharge or to distribute it directly to the farmers.

All growers close to surface water supply in the delta are encouraged to use surface water. The use of surface water is encouraged as a management tool to preserve groundwater for those growers who do not have access to surface water. There are no restrictions on the maximum use of surface water by licensed users. However, usage is modified to some extent by the implementation of an excess usage charge based on the prescribed allocation for that year. This allocation is subject to board decision, depending on prevailing weather conditions influencing the availability of supply. To date this pricing index has varied from 8 to 10 ML/ha in the northern delta and 4 to 6 ML/ha in the southern delta. A grower can use surface water as required but always has to roster in advance in the southern delta and in periods when demand exceeds supply in the northern delta. Farmers in the southern delta are only allowed to pump at a maximum flow rate of 90 L/sec for a maximum of 5 days over 50 ha and can do this twice a month with a minimum 10-day gap between the two irrigation periods (SBWB, 1999).

The situation in the CIA is different. The regional authority has control over surface water while the State authorities control groundwater. Differences in opinion and poor co-ordination between the two do occur. This is limiting effective implementation of conjunctive water management and makes implementation of the L&WMP by the regional authority dependent on the State authorities to allocate groundwater for salinity control purposes. The grey area indicates the area of influence of the MBDC through the Cap. In the BRIA, surface water and groundwater are managed by SWP. This enables effective implementation of conjunctive management. Furthermore, conjunctive water use is promoted by allocating surface and groundwater conjunctively.

The water boards hold an allocation on behalf of the farmers in the delta. The water boards manage surface water and groundwater in the delta but the water boards depend on the SWP for surface water. The boards only redistribute the water that they get from their allocation from SWP. Furthermore, the two water boards manage the same aquifer; this makes efficient and effective management difficult. Poor co-ordination in the Burdekin takes place; for example, water from the dam is not always released from the top so that the water boards can use low turbidity water for artificial recharge. DNR prefers turbid water as this reduces grass and weed growth in the channels.

Other control problems in the delta are related to the allocation system. The boards have difficulties in managing the aquifers because they do not know how much groundwater is used, as there are no volumetric allocations and the bores are not metered. The SBWB measures watertables themselves and can adjust recharge consequently. The NBWB is completely dependent on DNR for groundwater data. Although these difficulties exist, the water boards have been effective in managing the watertables and reducing seawater intrusion. This is shown by increased sugarcane production since the late 1960s when the water boards were established (38).

Water allocation

It is evident that only in the SIR do the water allocation principles provide an incentive to increase water use efficiency, as water use above allocation is not allowed and all surface water is paid through the usage fee. Water savings in the CIA are not promoted as much, as a large part of the total costs is a fixed charge. Water use above allocation in the BRIA is allowed but is discouraged by the high excess rates. High losses to the aquifer are not sustainable as they lead to watertable rises, increasing the salinity risks and leaching of agricultural chemicals. Higher losses increase the need for groundwater pumping and conjunctive water use.

The allocation system in the Burdekin delta promotes water losses. This is in agreement with the board policies of recharging the aquifer but leads to off-site impacts as chemicals are leached to the aquifer as well and eventually end up in the wetlands or near shore areas causing environmental degradation. It is, therefore, recommended that the boards change their policy and no longer promote losses. Without jeopardising watertable control, this can only take place when more surface water is used.

Water trading

Water trading provides an incentive to increase water use efficiency and thus reduces accessions to the aquifer and groundwater rise and salinity problems as unused water has an economic value. It also prevents leakage of agricultural chemicals. Water trading takes place on a large scale in the SIR and CIA only. Because the Burdekin Falls Dam is not fully allocated yet, allocations for new irrigation areas can be obtained from SWP and do not have to be purchased from other farmers. It is expected that water trading will increase when the dam is fully allocated. Under the present water allocation structure of the water boards, water trading is not possible.

Integration

In the SIR there is good integration between water management and other environmental management issues and between the irrigation area and the rest of the catchment as the land and water management plan is an integral part of the Catchment Strategy. In the CIA there is some integration between the CIA and the rest of the catchment and between water management and environmental management. However, this is only a weak link as the L&WMP is not an integral part of the Catchment Action Plan and the link between CI and the MCMC is informal. In the Burdekin there is no integration between environmental management and water management; between the three management areas; and the irrigation region and the upper catchment. Furthermore, there is no integration between SWP, the NBWB and the SBWB. Integration would prevent actions in one area have negative consequences in another area or environmental compartment and thus promotes more effective and efficient policies.

Community involvement

In all three areas, there is some form of communication between the farmers and the water suppliers and managers. In the SIR and the CIA, the community is involved in salinity management through the Land and Water Management Plans. Only in the SIR is the whole community (also the non-farmers) involved and contributing financially to salinity management.

Enforcement

In all three areas conjunctive water use is voluntary. Some enforcement is needed, as a minimum volume of groundwater has to be pumped for salinity control in dry years when additional water is not needed. In the BRIA groundwater pumping is promoted by not charging for it. This promotes conjunctive water use.

In general, farmers are willing to pump groundwater as this increases their total water allocation and increases production. The high investments needed for a groundwater pump can keep farmers from installing a pump. Only in the SIR, are incentives available for pumping groundwater.

In the CIA, CI does deep groundwater pumping under the L&WMP. This reduced the task to control groundwater pumping, as only one authority instead of all farmers has to be controlled.

Long-term Sustainability Issues

Watertable control

In the SIR, CIA, and BRIA, groundwater pumping provides watertable control. Groundwater pumping in the Burdekin delta and some places in the BRIA leads to seawater intrusion. Deep groundwater pumping in the CIA leads to lowering pressures and groundwater mining as the aquifer is already over allocated.

Aquifer salinisation

Although conjunctive water use is implemented to prevent or reduce salinity problems it can also exacerbate them. In the SIR and CIA, conjunctive water use leads to aquifer and soil salinisation but the problems in the CIA are smaller as the aquifer is larger and groundwater is less saline than in the SIR. For the major part of the Burdekin conjunctive use of groundwater and surface water does not lead to aquifer salinisation as dilution during floods and leakage to the sea takes place. When managed in a proper way conjunctive water use does not lead to seawater intrusion. Aquifer salinisation related to conjunctive water use does occur on the margins close to the bedrock and on the coastal margins where surface water pushes the seawater wedge to other areas. Conjunctive water use does not provide a solution for salinity control on the coastal margins and the areas close to the bedrock in the Burdekin. Irrigation in these areas should, therefore, be stopped. On the coastal margins, use of groundwater leads to seawater intrusion, surface water use pushes the salt-water wedge to other areas and conjunctive water use is likely to lead to both effects. From modelling it is known that irrigation on the margins adjacent to the bedrock can not be sustainable as groundwater use leads to salinisation, surface water use leads to the movement of salts into the board area and conjunctive water use leads to both effects.

Downstream salinity effects

Salt disposal is a problem for the SIR and CIA. Discharge of salt in the river Murray leads to downstream problems and is restricted by the MDBC Salinity and Drainage Strategy. Reuse of groundwater reduces the need for salt disposal and thus provides more protection for the downstream users than groundwater pumping without reuse. The Burdekin is located close to the sea and salts can, therefore, be discharged.

Acceptance and equity issues

Conjunctive water use leads to an increased production in all three areas because of the increased supply of water and salinity benefits. This is the most important reason why farmers accept (and implement) conjunctive water use.

Community awareness programs have increased the awareness and knowledge of the environmental problems faced by the people. A high level of awareness together with the high level of community involvement and participation in the development and implementation of the land and water management plans makes the people in the SIR and CIA feel that it is their plan and they accept it.

As the land and water management plans are developed in close consultation with the community, they are developed in such a way that the community can accept and implement them. For example, groundwater pumping up to 3 ML/ha in the SIR is allowed while only 1 ML/ha is needed for salinity control. A trade off between environmental protection and community acceptance has thus been made.

Plan managers accept that some land will go out of production. In the SIR it is accepted that 10-20% of the area will be difficult to manage. In the CIA it is accepted that 15% of the land will be affected by soil salinity. This will not only lead to environmental degradation but also to production decline for the farmers in these areas. The land and water management plan thus excludes some areas.

Groundwater pumping in the SIR and CIA leads to an increase in salinity of the river Murray and thus imposes a cost on downstream users. The MDBC Salinity and Drainage Strategy address this issue by setting a limit on salt disposal.

Table 3: Comparison and summary of conjunctive water use in the three regions.

	SIR	CIA	BRIA	Burdekin Delta
Type of conjunctive water use				
Surface water	Yes	Yes	Yes	Yes
Groundwater	Yes -shallow	Yes - deep	Yes	Yes
Drainage water reuse	Yes	Yes	Yes	No
Objective of groundwater use	Salinity control and supply	Salinity control and supply	Watertable control and supply	Irrigation supply and watertable control
Water use				
Average groundwater use (ML/ha/yr)	2.16	0.6	1	Unknown-
Average surface water use (ML/ha/yr)	3.6	6.7	8	Unknown
Crop water requirement for main crop (ML/ha/yr)	10 – perennial pasture 7- horticulture	15 -rice	10 - sugar	10 - sugar
Average groundwater price ($/ML)	20	0.60	0	10
Average surface water price ($/ML)	21	15	36	15
Benefits of conjunctive water use				
Increased supply	Yes	Yes	Yes	Yes
Increased flexibility	Yes	Yes	Yes	Yes
Reduced costs	Insignificant	Insignificant	Yes	Insignificant
Increased quality	Yes	Insignificant	Yes	Insignificant
Institutional issues				
State owns and controls both groundwater and surface water	Yes	Yes	Yes	Yes
Groundwater and surface water same management institute	Yes	No	Yes	Yes/No(*1)
Integration with surrounding area	Good	Average	Poor	Poor
Integration with other environmental issues	Good	Average	Poor	Poor
Community involvement in environmental and water management	Good	Average	Poor	Poor
Allocation				
Metered groundwater	Yes	Yes	Yes	No
Metered surface water	Yes	Yes	Yes	Yes
Specified maximum allocation groundwater	Yes	Yes	Yes	No
Specified maximum allocation surface water	Yes	Yes	Yes	No
Excess usage of groundwater allowed	No	Yes	Yes	No
Excess usage of surface water allowed	No	Yes	Yes	No
Fixed fee groundwater	Yes	Yes	Yes	Yes(*2)
Usage fee groundwater	Yes	Yes	No	No(*2)
Fixed fee surface water	Yes	Yes	No	No(*2)
Usage fee surface water	Yes	Yes	Yes	Yes for cane(*2)
Trading surface water	Yes	Yes	Yes	No(*2)
Allocation system promotes water savings	Good	Poor	Adequate	Very poor(*3)
Long term sustainability issues				
Aquifer salinisation	Large problem	Problem	Problem on margins (*4)	Problem on the margins (*4)
Salt export	Problem	Problem	No Problem	No Problem
Acceptance and equity issues				
Increased production and profitability	Yes	Yes	Yes	Yes
Accepted by the farmers	Yes	Yes	Yes	Yes
Some land lost due to salinity	Yes	Yes	No	No
Downstream increase in salinity	Problem	Problem	No Problem	No Problem

*(*1) Water boards hold an allocation from SWP and are thus dependent on SWP*

*(*2) In theory small crop growers can choose to pay a usage fee but in practice they choose the area fee*

*(*3) In agreement with Board policy*

*(*4) Seawater intrusion is not an inherent problem related to conjunctive water use and can be avoided by proper management of the watertable.*

CONCLUSIONS AND RECOMMENDATIONS FOR THE SEPARATE AREAS

Shepparton Irrigation Region

Water is allocated, controlled and managed by the same authority. This makes effective implementation of conjunctive water use possible. The management authority is also responsible for salinity management, thus being able to combine water management and environmental management. Through the integration of the SIRLWSMP in the Catchment Strategy, conjunctive water use for salinity control in the SIR is well integrated in general environmental management and with the upper catchment. As the community is very much involved in the management and salinity mitigation program as well, it can be said that the institutions for the implementation of conjunctive water use are working well and promote effective implementation.

Conjunctive water use is the only option for salinity management in the SIR but may not provide a long-term sustainable solution as it leads to an increase in aquifer salinity. It, therefore, only buys time. At this time there is no solution that provides enough protection and is economic at the same time. Buying time may suggest waiting until scientists find a solution. It is, therefore, recommended to provide as much protection as possible to minimise the rate of aquifer salinisation as far as possible by only pumping for salinity control, not for supply and to prevent groundwater from being used in an area that is smaller than the area of influence. This will then buy as much time as possible.

Coleambally Irrigation Area

Groundwater and surface water are allocated, controlled and managed by separate authorities. This limits the effectiveness of implementation of conjunctive water use. It is, therefore, recommended that DLWC shall give control over groundwater in the CIA to CIC by allocating a bulk groundwater entitlement to CI, as it is done for surface water. This will prevent groundwater pumping having adverse effects on other groundwater users and would allow CIC to manage conjunctive water use to provide salinity control. It is not recommended to increase the area to include primarily the whole aquifer and the bore pumpers outside the CIA because CIC is not a CMA but a water delivery corporation. Integration of the CIA with the catchment and the integration of water management with environmental management could be better. It is recommended to make the L&WMP part of the Catchment Action Plan. There is another option suggested to leave the responsibility for the implementation of the L&WMP with CIC as they have more contact with the community and have greater affinity with the area than the MCMC. The MCMC is concerned with the whole catchment while the CIA is only a small part of the Murrumbidgee catchment.

Conjunctive use of deep groundwater and surface water helps in achieving a water balance but leads to mining of groundwater as the aquifer is already over-allocated. It is, therefore, recommended to further reduce the accessions to the aquifer for watertable control and introduce shallow groundwater pumping for salt balance to reduce the volume of deep groundwater that has to be pumped. Charging only usage fees will provide an incentive in reaching the goal of reduced accessions. To make effective management and implementation of shallow groundwater pumping possible, it is recommended to give CIC the authority to manage shallow groundwater.

Burdekin River Irrigation Area

Water is allocated, controlled and managed by the same authority, SWP. This makes effective implementation of conjunctive water use possible. There is no integration of water management in the BRIA with the delta or the upper catchment. Furthermore, there is no integration of water management with other environmental issues. This leads, for example, to the deterioration of wetlands as the hydrology is changed and drainage water ends up in the wetlands. It is, therefore, recommended to integrate water management in the BRIA with environmental management in the whole catchment by developing a LWMP for the irrigation region and a Catchment Strategy for the Burdekin catchment. To be able to develop and implement the catchment management a Catchment Management Authority is needed.

It is recommended to cease the practice of farmers using more water than allocated to them or to increase the price of water above allocation so that it becomes unattractive. Furthermore, it is recommended that it becomes obligatory to pump 1 ML of groundwater for every 8 ML of surface water to ensure that farmers do pump in wet years when the additional supply is not needed and watertables do not rise.

Burdekin Delta

The water boards manage groundwater and surface water but as water is not allocated, the boards do not have the exact information about its use. This limits effective management. Furthermore, the two boards try to manage the same aquifer. There is no integration between the northern and southern delta; between the delta and the BRIA; between the delta and the rest of the catchment; and between water management and other environmental issues. It is, therefore, recommended to create one management body for the irrigation areas (see also below) and to create a Catchment Management Authority to promote the integration of water management with other environmental issues and the integration of the floodplain with the hinterland. It is recommended that a Land and Water Management Plan be developed for the Lower Burdekin. This should be the local implementation plan of the Catchment Strategy.

Some conjunctive water use is needed to increase the infiltration capacity and to prevent a crust formation caused by the high alkalinity and low salinity of the surface water. Installing a central bore in the area to mix surface water with some groundwater before it goes into the supply channels, would be a good way to control groundwater use and prevent over pumping. Conjunctive water use might also be needed on the less permeable soils. It is recommended to change to an allocation system with a fixed maximum and a usage fee to promote efficient use when only surface water is used.

It is recommended that only one authority manage the Lower Burdekin because three different authorities in one area lead to ineffective measures as they all deal with the same aquifer but have no control over the actions of others. It is also suggested that SWP manages the area and gives all farmers their own allocation for both surface and groundwater instead of a combined allocation to the water boards.

RECOMMENDATIONS REGARDING INSTITUTIONAL ARRANGEMENTS FOR CONJUNCTIVE WATER MANAGEMENT

A state needs to own and control all water within the state. The state, via a Natural Resources Agency should then redistribute water to the inhabitants by allocating bulk water entitlements for surface water and groundwater to a Local Water Management Authority (LWMA) like G-MW, CIC, or SWP. A Catchment Management Authority (CMA) needs to be responsible for the environment in the catchment. An Irrigation Committee (IC) of the CMA is required to ensure oversights of the environment in the irrigation area. An outline of the possible key institutions for improved conjunctive water management of surface water and groundwater is given in Figure 5.

The community should be involved in the development and review of the catchment management plan through a Catchment Community Panel (CCP) that is made up of catchment members who are elected by the inhabitants of their region and representatives of the peer groups (agriculture and environment). The environment would need to be represented on the Catchment Board, Catchment Community Panel and the Environmental Committee. The possible make up of these institutions is given in Table 4.

Table 4. Analysis of appointment to, and make up of key institutions in the ideal situation.

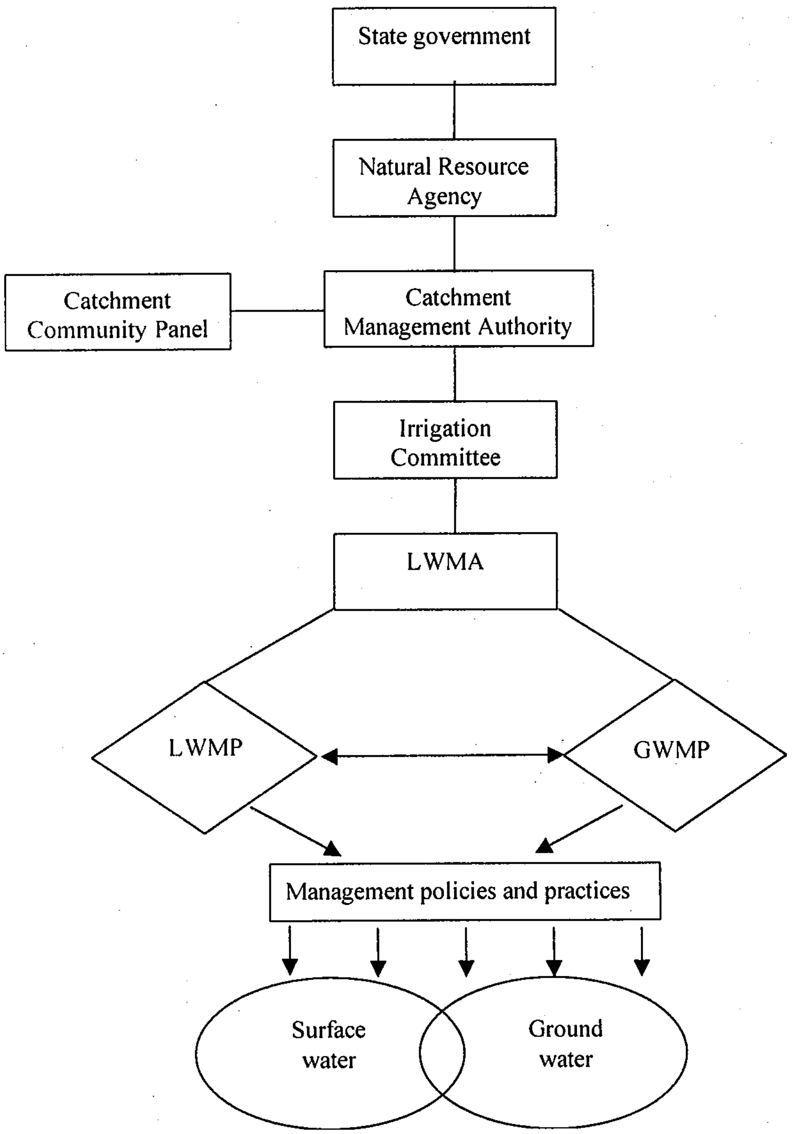
	Appointed by	Elected by	Reports to / responsible to	Role is communication to the public	Peer group representation	Peer group Lobby	Local*
Catchment Management Authority							
Board	Minister	-	Minister**	-	X	-	C
IC	CMA Board	-	CMA Board	X	X	-	R
CCP		Inhabitants	CMA Board	X	X	-	R
Local Water Management Authority							
Board	Minister	Water users	Minister	-	-	X	R
Water Users Committee	-	Water users	LWMA Board	X	-	-	R
Environmental Committee	Local government	Inhabitant	LWMA Board	X	X	X	R

**C = from the catchment, R = from the region*
***The community nominates the board members of the CMAs for appointment by the minister.*

The LWMA will divide the bulk entitlements it receives for both groundwater and surface water to the users in the area. To ensure alignment with state or national policies, the LWMA would be controlled by the government departments responsible for the management of natural resources and the environment.

The LWMA should be responsible for allocation and delivery of water and environmental management in the region. The authority, therefore, needs to be divided into two sections: Water Delivery and Environmental Management in order to minimise the possibility of conflict of interest. Half of the board members could be elected by the water users in the area and the other half could be appointed by the management of the LWMA or the responsible state department for their expertise in agriculture, environmental and resource management, financing, fisheries, etc. This ensures that local people who have affinity with the region manage the local authority and that enough expertise is available on the board as well. The board members would need to communicate with the water users in the area through a water users committee whose members are elected by their peers. The board can communicate with the community on environmental issues by establishment of an environmental committee made up of community members, local government and environmental representatives.

Figure 5: Possible institutions for improved conjunctive water management



Allocations for surface water and groundwater need to be volumetric and must contain an absolute maximum. To promote conjunctive use, surface water and groundwater could be allocated conjunctively. Allocations also need to set a minimum usage for groundwater when pumped for salinity control. Water usage must be measured and paid for by the users. Water prices could be tried to provide incentive to save water but keeping the price for an average water user at the same level and thus enable him to invest in measures that improve water use efficiency.

Water trading of surface water within a river system needs to be encouraged as it provides an incentive to increase water use efficiency. However, a minimum volume should be kept within a certain area or on a farm to avoid steep rises in the delivery costs for other farmers. A central body (the State Natural Resource Management Department) needs to regulate water trading. Transfers would only be allowed after approval from the local water management authority to ensure compatibility with environmental management objectives and channel capacity.

Land and Water Management and Groundwater Management Plans (LWMP & GWMP) have been powerful tools in the past and are recommended to address the environmental problems related to land and water management in the region. The community needs to be involved and play a major role in the development and review of such plans. General community ownership of the plans must be ensured through the Environmental Committee of the LWMA. The LWMA will be responsible for the implementation of the plans. The farmers and the federal, state and local government who provide the funding subsidies will finance implementation of the plans. However, the whole community should contribute to the implementation through a general levy as everyone benefits from the implementation of the plan. This is on the basis that land and water management is not a problem facing farmers alone; it affects the whole community in one way or another.

Land and Water Management and Groundwater Management Plans are an integral part of the Catchment Strategy to ensure integration of the irrigation region within the whole catchment and integration of water management with environmental management. The Catchment Management Authority can pass responsibility for implementation of environmental programs in the irrigation area to the Irrigation Committee but keeps overall control on the implementation of the Catchment Strategy. The irrigation committee will delegate responsibility for on ground works of the plans to the LWMA. This provides better adjustment to the local or regional situation and increased community participation. This is especially important in large catchments where an irrigation area only forms a small part of the catchment and the catchment board members have less affinity with the irrigated region. A member of the LWMA should also be member of the catchment management board in order to provide better communication between the two. The Catchment Management Authority should be funded by state and federal government and by all inhabitants of the catchment through a catchment-tax. All inhabitants contribute because all inhabitants are beneficiaries. The landholders in the catchment could also pay a landholder-tax based on the size and value of the land, as they are the direct beneficiaries.

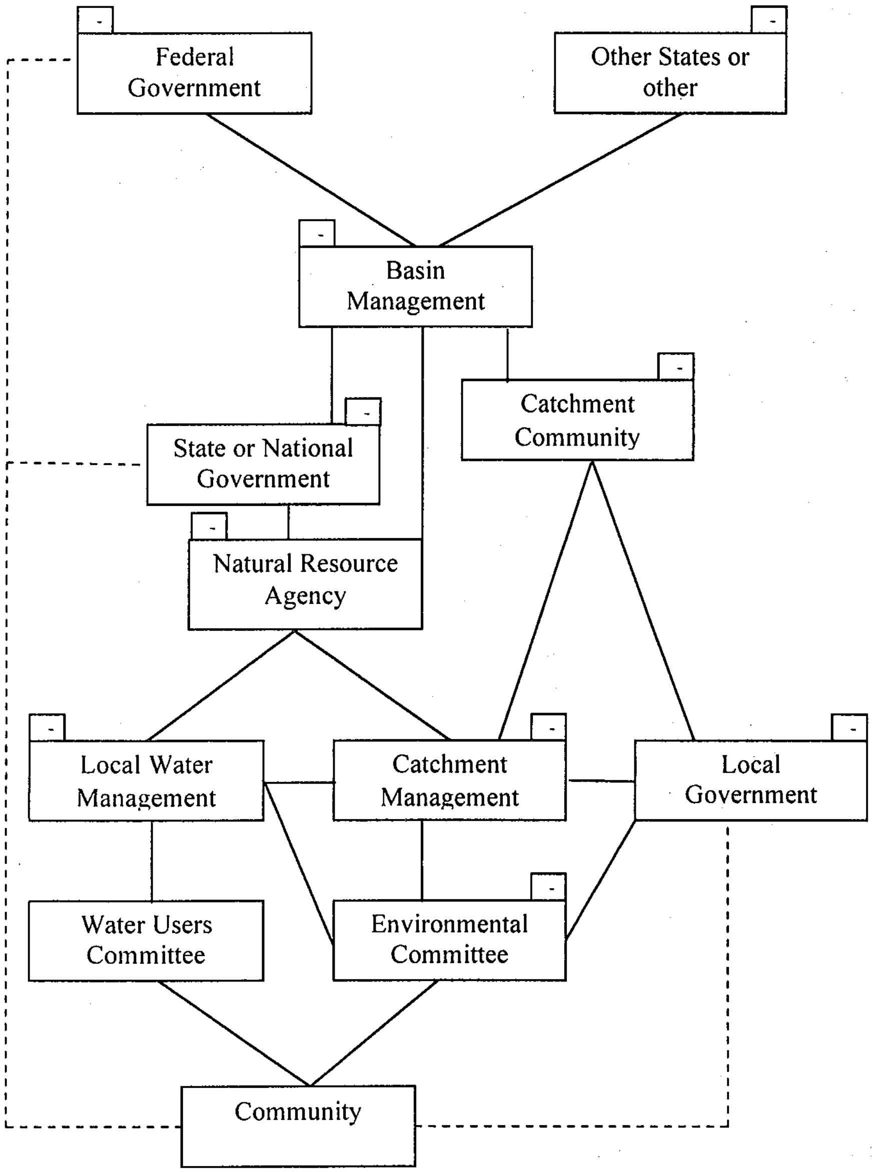
How these institutions sit within the greater picture of basin management and local government and how these should communicate is outlined in Figure 6.

Implementation of conjunctive water use should be mostly voluntary, based on farmer initiatives and incentive schemes to reduce the need for legislational enforcement. Extensive community education and awareness campaigns are required to make all farmers aware of the subsidies available and the benefits of conjunctive water use. Subsidies are only given to farmers with the whole farm plans to optimise expenditure. Enforcement, where necessary is dealt with using the licensing system, this specifies minimum and maximum water use. Non-compliance may result in a withdrawal of the license.

Figure 6. Required formal linkages between authorities and the community

Communication between the different authorities

___	Formal direct link
----	Indirect link through elections
R	Representation of agricultural and environmental groups
L	Lobby of agricultural and environmental groups



ACKNOWLEDGEMENTS

This research was jointly funded by CSIRO Land and Water, Griffith, Australia and the Australian Center for International Agricultural Research (ACIAR), Canberra.

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