Paper presented at the AARES 2006 Conference, 8-10 February, Sydney

Enhancing the capacity of Australian irrigation industry through better policy making: what can we learn from the past?

Tian Shi [a, b, *]

[a] *Corporate Strategy and Policy, Primary Industries and Resources South Australia, GPO Box 1671, Adelaide, SA 5001, Australia*

[b] *Policy and Economic Research Unit, CSIRO Land and Water, PMB 2, Glen Osmond, SA 5064, Australia*

Abstract:
Water resource management is a complex process, which requires suitable policy tools that are able to meet objectives of economic efficiency, social equity and environmental sustainability. Meanwhile, irrigation industry has to change its habitual behaviour in managing water when faced with increasing environmental and community concerns and new government policies. As a result, policy makers and irrigation practitioners are increasingly challenged to strike a balance or make trade-offs between the diverse economic, social and environmental effects of water usage.

With this in mind, this paper attempts to analyse the interactions between water policy and irrigation practice in Australia and outline the synthesis of some findings from the reform experiences of selected countries. The insights drawn from this study are aimed to facilitate the irrigation industry make proactive response to policy changes in the future to realise the sustainable development of industry, community and the environment.

Keywords:
Water management, Irrigation industry, Policy making, Institutional arrangement, Policy-practice interaction, Australia

1. Introduction: irrigation in a changing world

1.1 International background

Water is one of the most important natural resources. Today, nearly 40% of the world's food supply is grown under irrigation, and a wide variety of industrial processes depend on water. Agricultural production accounts for an average of 69% of freshwater use worldwide, whereas industry uses 23% and households 8% (Sherbinin, 1998). However, as the proportion of water available for irrigation decreases, irrigation industry is challenged to meet the food demands of increasing population (Meyer, 2005). While nations may differ in their aspirations, stages of development and level of water scarcity, the allocation and use of water resources are often critical to achieving specific regional and national goals such as efficiency, equity and overall social welfare (Livingston, 2005).

In this regard, the question of how to manage water resources in a sustainable way is crucial for the future development. Awareness has increased and water policy issues are on the agenda of

[*] Tel: +61 8 8226 0561; fax: +61 8 8226 0221; email address: tian.shi@state.sa.gov.au

The views expressed in this paper are the author's only and do not necessarily represent the views of the organizations the author is affiliated with.

many countries, such as Mexico (CNA, 1990), Australia (COAG, 1994, 2004), Spain (DGOH, 1996) and South Africa (DWAF, 1997). More recently, new policies and legal and institutional reforms aimed at more efficient and equitable distribution of water among competing users have been discussed and developed, such as the European Union Water Framework Directive (EU, 2000), and the United Nations Millennium Development Goals on water and environmental sustainability[1].

A common problem associated with water management is that the water sector is large and diverse, and responsibility is highly fragmented, or at least divided amongst several agencies. Hence one of the challenges is to coordinate the flow of necessary information and different views among them. In this regard, the World Bank (1993) has set forth a series of principles for the development and management of water resources, especially in irrigated agriculture:

- Dealing with water in a comprehensive analytical framework;
- Promoting reforms of institutional and regulatory systems;
- Incorporating incentives for efficient use of water;
- Promoting water conserving technologies;
- Promoting decentralization of public water services;
- Promote participation of different interest groups;
- Including environmental protection considerations; and
- Allowing capacity building of agencies and individuals.

1.2 Australian domestic setting

Although Australia does not have the same level of concern about water security to meet its food demand as in other parts of the world, the country still faces a number of significant water resource issues that affect irrigated agriculture. Through the mid 1980s it became clear that existing water resource management arrangements in Australia were inadequate to deal with emerging issues. A national water reform process commenced in 1994 to make the necessary changes in water industry (COAG, 1994). As a result, states are required to develop and implement a comprehensive system for water use and management, and environmental issues and community concerns have been put on the agenda of government policies. These changes corresponded to an international trend for water management to shift from a centralized command and control approach towards devolved processes of markets and community responsibility (Saleth and Dinar, 2004).

Government policies have also identified establishing competitive markets for tradable water entitlements as the most appropriate instrument for allocating scarce water among different uses and users. Transfers of water entitlements between river basins and regions along rivers may be needed, but these raise many environment, social, economic and jurisdictional issues that an unfettered market alone could not address (Dunlop et al., 2002). Effective water management requires collaboration among researchers, policy makers and community participation to develop the means to deal with externalities associated with trade. Recently, the concept of integrated water resource management has been explicitly articulated in the National Water Initiative (NWI), which attempts to achieve equitable access to and sustainable use of water resources by all stakeholders (including environment), while maintaining the characteristics and integrity of water resources within agreed limits (COAG, 2004).

2 Research background and purpose

[1] See http://www.un.org/millenniumgoals/index.html

In Australia, the interaction between irrigation and policy is a complex process. On the one hand, irrigators make decisions every day and frequently complain about the degree of uncertainty associated with policy reform processes. They express particular concern about centralized government policy reform processes that can run for long periods of time and explore propositions that threaten or, at least, place a risk at, investments and local reforms that are already underway. On the other hand, policy makers always realise the difficulty of applying policy initiatives "on the ground". It is often perceived that those involved in the public arena give too little consideration to the impact of such reform processes on irrigation investment and practice at the local level (Young et al., 2006).

For successful water policy reform and implement, appropriate decision-making processes associated with timely information processing are required. However, policy makers do not often know what information they need, and relatively little work at the policy level has been conducted (Goninon et al., 1997; Stakhiv, 1998). Despite a recent study (i.e., Young et al., 2006) to investigate the impacts of high level policy reform on irrigation practice and investment, until now, there has no explicit analysis of the nature of irrigation and policy interactions in Australia, both in terms of the past experience and potential opportunities, to enhance the capacity of irrigation industry for sustainable water resource development and management.

This research project attempts to identify what we know and what we do not know and the opportunities and barriers associated with institutional arrangements designed to implement the water policy reform agenda. It will interact with three other CRC IF Synthesis Paper projects as part of an overall effort to tease out the understanding of these issues. By conducting literature review and relevant stakeholder consultation, this research will:

- Explore the nature of interactions between water policy and irrigation practice from an institutional perspective;
- Identify Australia's position in the world in terms of policy reform and irrigation industry performance;
- Draw some lessons from the study;
- Identify relevant policy issues; and
- Recommend a future research agenda.

3 Irrigation, policy and governance arrangements

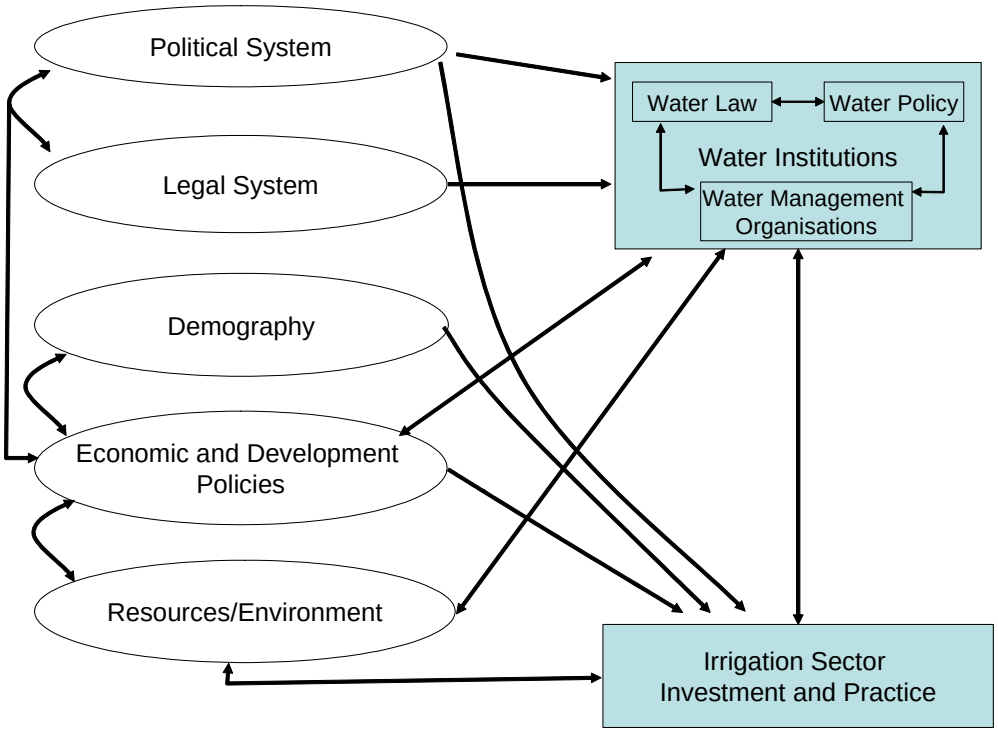
From an international perspective, irrigation has made significant contributions to socio-economic development at variable scales (i.e., local, regional, national and international). However, it has also created problems (e.g., salinization of land and water resources, adverse socio-economic and cultural effects, and environmental damage) (Van Schilfgaarde, 1994). As Worster (1985) claims that irrigation systems dominated by centralized (top-down) management always are not in the best interest of farmers and the local community. This large-scale irrigation development inevitably leads to a concentration of power and wealth through the development of a hierarchical system of management and, thus, social structure.

However, many of these problems in irrigated agriculture could be mitigated or avoided by improved technology, policy and management, and by adequately addressing cultural, social, and environmental aspects. As a general rule, gradual development of existing local irrigation practices and farmer (bottom-up) management may ultimately be more successful (Van Schilfgaarde, 1994). In other words, as the view from the top may be very different from the view from the bottom, the bottom-up management style is more responsive to farmer demands and local conditions, which may ultimately lead to a shift towards more efficient production systems.

Generally speaking, water institution reform can be separated into its legal, policy and organizational components (see Figure 1). The development of water policies is a complex

process, which mixes legal requirements with issues of technical feasibility, scientific knowledge and socio-economic aspects, and also requires intensive multi-stakeholder consultations. As a result, water policy reforms are subjective, path dependent, hierarchical and embedded within the social, cultural, economic and political context (Saleth and Dinar, 2004).

Figure 1 Irrigation, policy and institutional environment



Source: After Saleth and Dinar (2004).

In terms of water policy reforms, on-going discussions are taking place among stakeholders (e.g., scientific researchers, policy makers and irrigation practitioners) to examine the needs of research-policy-practice coordination. These discussions have highlighted the importance of improving and increasing the information and communication flow within and between these communities. In this context, consideration of interactions between irrigation practice and water policy represents a key aspect for the review of existing policies and design of new ones.

Policy implementation is essentially a complex socio-political process to meet the requirements of political and social acceptability, economic and technical feasibility and administrative reality. Gunn (1978) has identified 10 conditions for successful policy implementation:

- The circumstances external to the implementing agency do not impose crippling constraints;
- Adequate time and sufficient resources are available to the program;
- The required combination of resources is actually available;
- Policy is based upon a valid theory of cause and effect;
- Relationship between cause and effect is direct and there are few, if any, intervening links;
- There is a single implementing agency, or at least a dominant one;
- Complete understanding of, and agreement upon, the objectives to be achieved, and these conditions persist throughout the implementation process;
- Tasks are fully specified in correct sequence;

- Perfect communication and co-ordination; and
- Those in authority can demand and obtain perfect compliance.

In practice, however, it is nearly impossible to meet all these 10 conditions at the same time. As Pigram and Mulligan (1991) point out that conflicts and resistance always emerge because of the nature and complexity of the policy, the environmental conditions, and the way it is perceived by implementing organizations and target groups. In addition, other elements need to be considered in the process of policy implementation (e.g., monitoring, policy champion, political stability, trust, public relations and timing).

To a large extent, government policies and strategies for water development, allocation, and management determine the effectiveness of irrigation industry performance. Water policy consists of guiding principles and legal frameworks, while strategy refers to the means by which policy is put into practice. Water policy and strategy are dynamic (i.e., what is considered best practice today will change in the light of experience, changes in technology and prices). In this regard, adaptive management approach is adopted to ensure water policies are based on sound understanding of natural resources and technology, combined with a thorough knowledge of law, institutions, economics and communities (Carter and Howsam, 1998; Howsam et al., 1999).

In addition, policy change is not a one-time event but rather a continuous process that moves in line with the changes of both endogenous factors (e.g., water scarcity, performance deterioration, and financial non-viability) and exogenous factors (e.g., macro economic crisis, political reform, natural calamities, and technological progress). From a policy perspective, the synergy from these factors can be exploited with a sequential reform strategy where water sub-sectors and institutional components are prioritized in terms of relative performance impact, fiscal significance, facilitative roles for downstream reforms, and political acceptability (Saleth and Dinar, 2005).

4 International irrigated agriculture at a glance

4.1 International common trends and patterns

In the last 50 years, population growth and urbanization, together with changes in production and consumption patterns, have placed unprecedented demands on water resources worldwide (see Table 1). Humans have already used more than one half of all accessible surface water runoff. This proportion is expected to increase to 70% by 2025, thereby reducing the quantity and quality of water available for aquatic ecosystems (Postel et al, 1996).

In light of these trends, new approaches and policies are urgently needed to manage water resources rationally and equitably, which entail efforts to simultaneously address population dynamics, consumption patterns, and environmental management. Table 2 has outlined some major reforms in irrigated agriculture in selected countries.

According to Meyer (2005), from an international perspective the irrigation industry has gone through the following changes in the past decades:

- Few major new storages being built (except China’s Three Gorges Dam);
- Improvements being made in structures and piping;
- Emphasis on whole system (catchment) management and multiple use;
- Increased use of recycled water; and
- Start conjunctive use with aquifer storage and recovery.

Table 1 Socio-economic profile and configuration of factors behind water institutional reforms in selected countries

Particulars	Years	Selected Countries					
		Australia	Chile	Morocco	Namibia	South Africa	Sri Lanka
Total population (million)	1999	19	15	28	2	42	19
Urbanization (%)		85	85	55	30	52	23
Rainfall/year (cm)	2000	13–127	5–125	13–76	5–70	5–135	30–234
Total annual water withdrawal (billion m^3)	Various years	15.1	21.4	11.1	0.3	13.3	9.8
Used for irrigation (%)		33	84	92	68	72	96
Total net irrigated area (million ha)	1994–97	2.4	2.16	1.13	0.01	1.16	0.28
% of arable land		5.1	54.3	13.1	0.9	7.9	30.7
GNP/capita ('000$)	1999	22.45	8.37	3.19	5.37	8.32	3.06
Water scarcity[2]/conflicts		**	*	**	**	**	*
Droughts/salinity		***	–	***	*	**	–
Macro economic reforms		***	**	***	–	–	***
Political reforms		–	***	–	***	***	*
Social issues		*	–	*	**	**	–
Institutional synergy/ pressures		**	***	*	*	*	*

Source: Saleth and Dinar (2005).
Note: The number of "*" signifies the relative importance of the factors in the context of each country; "–" means not applicable or not evaluated.

Despite country-specific variations, Saleth and Dinar (2000) have identified four common trends and clear patterns in institutional changes observed in the global water sector:

- From water development to water allocation;
- Towards decentralization and privatisation;
- Towards integrated water resource management; and
- Towards economic viability and ecological sustainability.

[2] As a general rule each person requires about 1500 m^3 water each year for drinking, cooking and to grow the food they consume. Countries that have 1500 m^3/capita are considered to be water sufficient. Those that have between 1000 and 1500 m^3 are considered to be under water stress. Countries which have between 500 and 1000 m^3 are said to experience water scarcity while those with less than 500 m^3 are said to be experiencing extreme scarcity.

Table 2 Major reforms in irrigated agriculture in selected counties

Country	Change	Result
Mexico	A massive transfer of public irrigation systems to user groups Encourage private investment in irrigation and strengthen the regulatory and enforcement capabilities of water administration	Irrigation management transfer has led to a dramatic improvement in cost recovery, system maintenance, and water use efficiency
Chile	Market-based water allocation, decentralized management, and private sector participation New Water Code of 1981 and Constitution of 1988, in which water use right is treated as a private property independent of land	More effective both in facilitating water transfers and in tackling local water conflicts
Brazil	Constitution of 1988, National Water Resource Policy Law 1997 and state laws authorised private use rights Transfer water administration from Ministry of Mining and Energy to newly created Ministry of Environment, Water Resources and Legal Amazon in 1995	Change the overall policy environment Institutional condition created for integrated water management
Spain	14 river basin organizations established, Water Commissions set up at federal and basin levels New initiatives in legal, policy and administrative sphere of water sector	Resolve conflicts at the local levels and facilitate technical and policy coordination Strengthen water institutions
Morocco	Towards decentralization and functional specification Water law of 1995 and national and basin water plans in place Ministerial reorganization – ministry of Agriculture, Equipment and Environment	Changes in water policy and water administration Enhance administrative cohesion between water and agricultural sector agencies
Israel	The progressive block rate pricing was introduced in 1987 A market-based approach and privatization within a strong framework of public regulation	Irrigation water subsidy has declined from 75 to 50% Water productivity has increased by more than 250% in agriculture and 80% in industry since 1987
South Africa	New water law of 1998 in place White Paper on National Water Policy gives top priority for capacity building, information gathering, and human resource development in the water sector Water use authorities given full responsibilities for water distribution, cost recovery, and system maintenance	Led to a new system of water rights and concessions Created conditions conducive for management decentralization, market-based water allocation, full cost recovery and integrated water management
New Zealand	Promote more efficient pricing of irrigation services and water resources Granting irrigators financial and management independence from government	Increased water use efficiency Improved full cost recovery

Source: Modified from Saleth and Dinar (2000).

4.2 International experience

From an international perspective, Saleth and Dinar (1999) have identified two powerful factors that enhance the prospects for water institutional reforms in most countries:

- The potential for economic benefits from allocation-oriented institutional change are substantial with the increase in water scarcity; and

- In a given political economy context, the cost of transacting institutional reform can be minimized and the usual inertia associated with the reform can be overcome through a gradual but sequential reform strategy.

Taken together, these two factors have the additional effect of offsetting residual political resistance (Saleth and Dinar, 1999). For example, in the past, management of irrigation systems and delivery of water services to farmers was characterized by an excessive reliance on government. Now countries such as Mexico, Turkey and Colombia are achieving better-quality service by decentralizing the responsibility for delivering water to local governments and transferring operations and maintenance functions to water user associations and farmers (Dinar, 1998).

Meanwhile, the problems caused by water scarcity demand important changes in the criteria and objectives of water policies. Past experiences suggest that the effects of alternative policies for irrigation water are strongly dependent on regional, structural and institutional conditions (Varela-Ortega et al., 1998). In this regard, Sherbinin (1998) identified four broad criteria for designing water policies:

- Take into account potential reciprocal impacts and responses;
- Be sensitive to local contexts, draw on multidisciplinary knowledge, and employ multi-sectoral strategies in problem analysis, policymaking, project design, implementation, monitoring, and evaluation;
- Account for upstream and downstream effects and the shared nature of water resources; and
- Use adaptive management to adjust to the changing relationships between water, population and landscape over time.

In addition, the complex interactions among various policies need to pay more attention. Sometimes, original policy objectives may be overtaken by unintended consequences (i.e., side effects that undermine the policy's effect or create new problems). In this regard, strategies should identify needs for long-term irrigation industry developments and establish a science-policy interface so that community concern, industrial needs and research and development results can be synthetised to efficiently feed the implementation and further review of water policies.

5 Irrigated agriculture in Australia

5.1 Current situation

The history of Australia's irrigated agriculture industry extends back over 100 years with the first irrigation scheme made possible by the enactment of the Victorian Water Conservation Act of 1888 (Hallow and Thompson, 1998). Today, Australia's irrigated agriculture occupies 2.5 million hectares of land, and has an annual gross value of production of $8.6 billion (ABS, 2004).

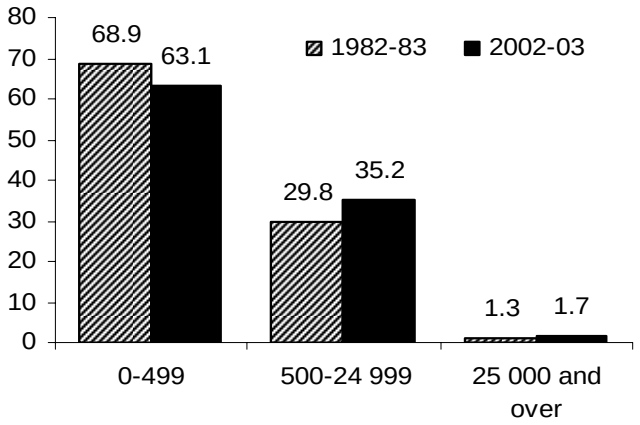
Australia's agriculture sector has undergone considerable change over the last few decades. While continuing to grow in absolute terms, the relative size and importance of agriculture has declined relative to the rest of the economy. According to a recent Productivity Commission (2005) report, the changes in agriculture are characterized by:

- In absolute terms, real agricultural output has more than doubled over four decades to 2003-04;
- Agricultural exports have almost tripled in value since the mid-1970s;
- In 2003-04, the agriculture sector directly generated 4% GDP and employed 4% of the workforce (i.e., 375,000 people);
- Agriculture's share of GDP fell from around 14% in the early 1960s to 6% in the early 1980s. Over the last two decades, it has ranged between 4 and 6 %; and

- A strong inverse relationship between per-capita income, GDP and employment shares accounted for by agriculture.

Over the last 15 years water use (mainly in the Murray-Darling Basin) has increased dramatically. Total water use increased by 65% between 1984 and 1997, surface water use increased by 58% (mainly in NSW, Queensland and Victoria), groundwater use increased by 88% (mainly in WA, NSW and Queensland), and water use for irrigation increased by 76% (AWRA, 2000). Community concern and scientific knowledge about the state of waterways are steadily increasing and placing significant downward pressure on allowable levels of water withdrawal.

Figure 2 Distribution of farms by size (ha), 1982-83 and 2002-03 (%)



Source: Productivity Commission (2005).

Consistent with global trends, a main feature of change is that there are fewer (i.e., farm numbers declined by around one-quarter or almost 46,000 farms over the twenty years to 2002-03) and larger farms in Australia (Productivity Commission, 2005; see Figure 2).

5.2 Major policies and key drivers

Since 1994, there has been a series of high level water policy reforms in Australia designed to address the issues in water industry. These policy reforms were associated with a variety of inter-governmental, Murray-Darling Basin (MDB) wide and state level processes (Young et al., 2006). The main building blocks include:

- COAG 1994 – As part of a National Competition Policy agenda all Australian governments agreed on a COAG Water Reform Framework that would improve water use and management across the nation;[3]
- NCC 1995 – Governments agreed to establish a National Competition Council that audits reform progress and, using a tranche payment system, makes a proportion of transfer payments from the Commonwealth to States conditional upon meeting performance targets set out in the 1994 COAG agreement;
- NAPSWQ 2000 – National Action Plan for Salinity and Water Quality; and

[3] COAG adopted the recommendations of the COAG report in April 1995 and in 1997 the Prime Minister confirmed that the COAG report was to define the reform process for water management in Australian states and territories. The framework embraces pricing reform based on consumption-based pricing and full-cost recovery, the reduction or elimination of cross-subsidies and making subsidies transparent. It also involves the clarification of property rights, the allocation of water to the environment, the adoption of trading arrangements in water, institutional reform and, also, expanded public consultation and participation.

- NWI 2004 – A blueprint for the next decade of reform of Australia's water management signed by the Commonwealth and most State and Territory governments.

A feature common to all states has been the preparation of new water legislation and followed by a series of further amendments.

Although the specific issues may vary from state to state, there are some commonalities in the issues faced by the water industry that act as key drivers shaping policy changes in Australia, which include:

- Motivations of reducing the impacts of droughts;
- Emerging concerns to increase the share of water allocated to environment;
- Improving the efficiency of water delivery and irrigation;
- Changing consumer demands and relevant government policies; and
- Developing water markets and increasing the security of entitlements.

5.3 Institutional arrangements

In addition to these high level policy reforms, the Commonwealth government introduced four programs designed to provide money to assist states, communities, businesses and individuals to invest in the restoration and protection of Australia's natural resources and environment. The four programs are:

- In 1997, the Australian government set up a Natural Heritage Trust to help restore and conserve the nation's environment and natural resources. A $3 billion fund was established to provide grants to community groups and organisations for environmental and natural resource management projects;
- The NAPSWQ provided a funding package of $1.4 billion to tackle major natural resource management issues through working with people in communities to find local solutions for local problems;
- A $2 billion Australian Government Water Fund; and
- The Commonwealth government joined with NSW, Victoria, SA and ACT in a $500 million investment to address the declining health of the Murray-Darling River system through the Living Murray initiative.

In parallel with these national reform processes, the MDB Commission has implemented a number of reforms. These include:

- Cap 1995 – Introduction of a "Cap" that restricts the volume of surface water that can be extracted from the MDB [4];
- Pilot Trading 1998 – Introduction of a Pilot Interstate Water Trading Trial;
- SDS 2001 – Adoption of a Salinity and Drainage Strategy; and
- Living Murray 2002 – Development of the Living Murray process.

5.4 Major changes over time

Over the last decade, there have significant changes associated with irrigation industry in Australia. These changes are mainly reflected in three aspects:

---

[4] Diversions refer to water that is diverted or taken from the river. Diversions include water supplied to irrigators for agriculture, and supplied to satisfy stock and domestic and urban needs.

(1) Policy change

- Policy shift to treat water as an economic good. In the past, water for irrigation has been heavily subsidized for various reasons. As a result, farmers have little incentive to grow water-sensitive crops or conserve water
- A comprehensive water policy framework is emerging that accounts for the future needs of all water users, including the environment
- Reforms in water policies associated with marketing reforms in the agricultural sector, especially in commodity pricing and trade

(2) Community participation and interaction

- Involvement of irrigation community in facilitating the policy implementation process
- Communities have an increasing role in the management of national and regional droughts
- Self-management of irrigation schemes has been strengthened by significant rises in water charges and perceived inefficiencies in operation, maintenance and management by public authorities

(3) Water resource planning and management

- Changing from a ‘construction’ (supply side) to a ‘management’ (demand side) approach to solve water problems
- Efficient use of existing resources and exploring new ways that might enhance the incentives for water users to use water more efficiently
- Privatization of water infrastructure (e.g., NSW MIA in 1997) and corporatization of water services (e.g., Qld SunWater in 2000) as an alternative to government control

6 Australian irrigation industry's position in the world

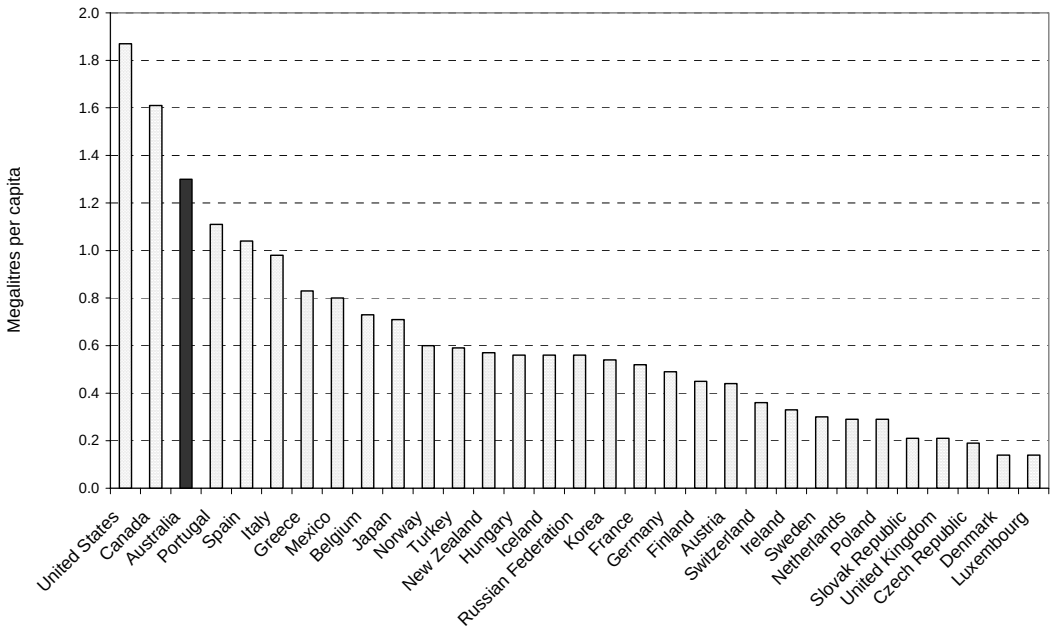
The section aims to identify Australia’s position in the world in terms of policy reform and irrigation industry performance. Countries may at different stages in terms of the extent and effectiveness of institutional reforms. The comparison attempted here allows a tentative placement of countries within the spectrum of water institutional change. Countries such as Australia and Chile (as well as the US states such as California and Colorado) are in an advanced, though not yet in an ideal, stage of institutional evolution.

Australian water institutions are more mature than most other countries. This has been benefited partly from the changing water industry realities and partly through deliberate COAG water reforms effected since 1994. Reform process in Australia has been relatively smooth and fast compared to that in other countries.

An international comparison of productivity is a way of benchmarking the performance of Australian agriculture, especially among OECD countries.

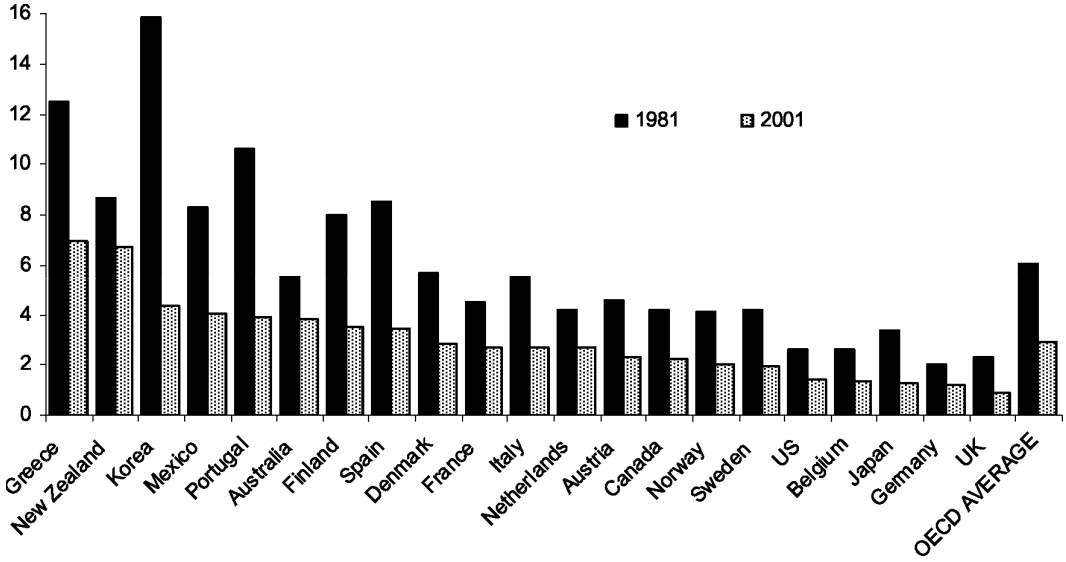
Australia as a whole has the third largest level of per capita water extraction in OECD countries, only after US and Canada (see Figure 3).

Figure 3 Water extraction per capita in OECD countries, 1999



Source: OECD (2003).

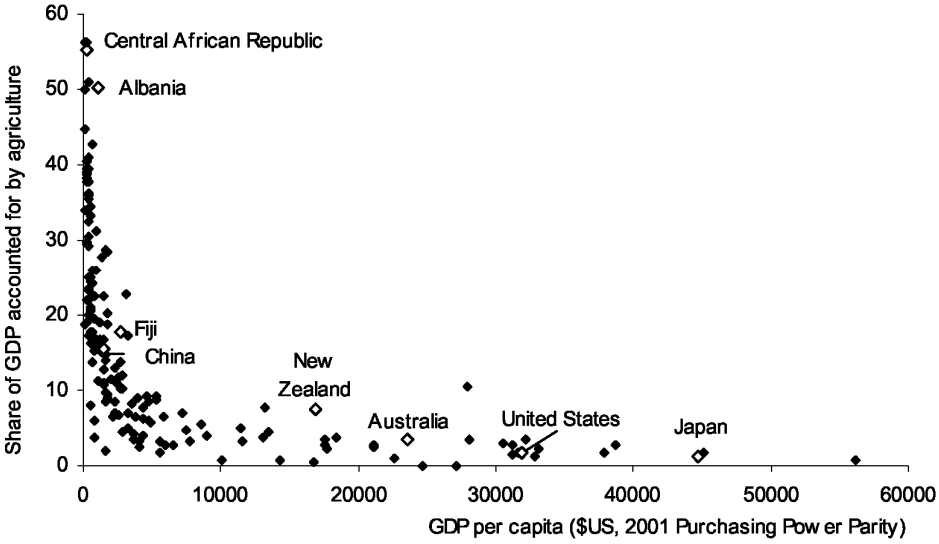
Figure 4 Output share contributed by agriculture in OECD countries (percentage of share of gross value added – basic prices)



Data source: OECD (2004).

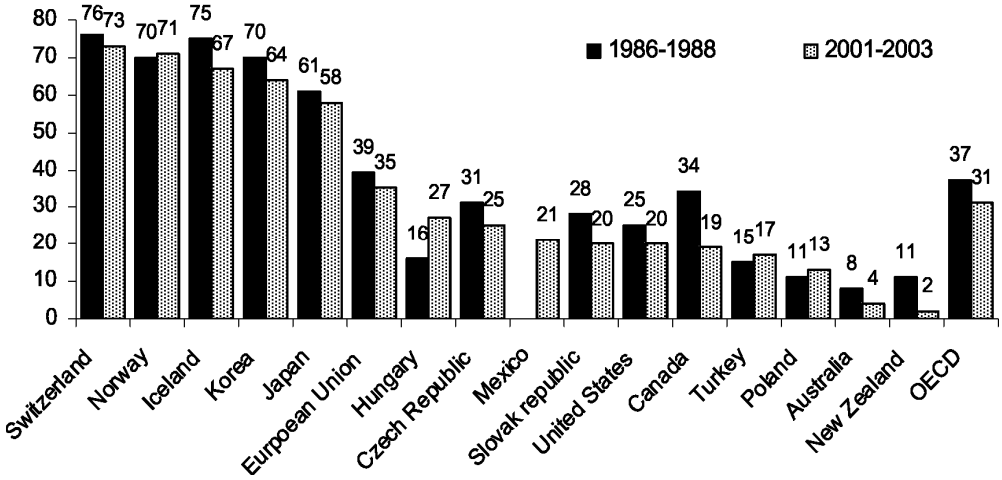
It is a common phenomenon among OECD countries that there is a relatively small share of economic activity directly accounted for by agriculture, and a declining trend can be observed since 1981. In 2001, agriculture accounted for less than 5% of GDP for almost all OECD countries, with the exceptions of Greece (7%) and New Zealand (6.7%) (see Figure 4). Australia's share (3.8%) is above the OECD average. There is a similar trend in agricultural employment (Productivity Commission, 2005).

Figure 5 Agricultural GDP share (%) and per capita income, 2000-01



Source: Derived from Productivity Commission (2005).

Figure 6 Agricultural producers support estimated in OECD countries (percentage of value of gross farm receipts)



Data source: OECD (2004).

An examination of a broader set of countries reveals a clear inverse relationship between per capita income levels and the share of the economy accounted for by agriculture (see Figure 5). Environmental Kuznets Curve hypothesis proposed that there is an inverted U-shape relation between per capita income and environmental degradation. In this regard, Australia is among the countries (at the bottom part of the figure) that environmental concerns are playing an increasing important role in the agricultural activity.

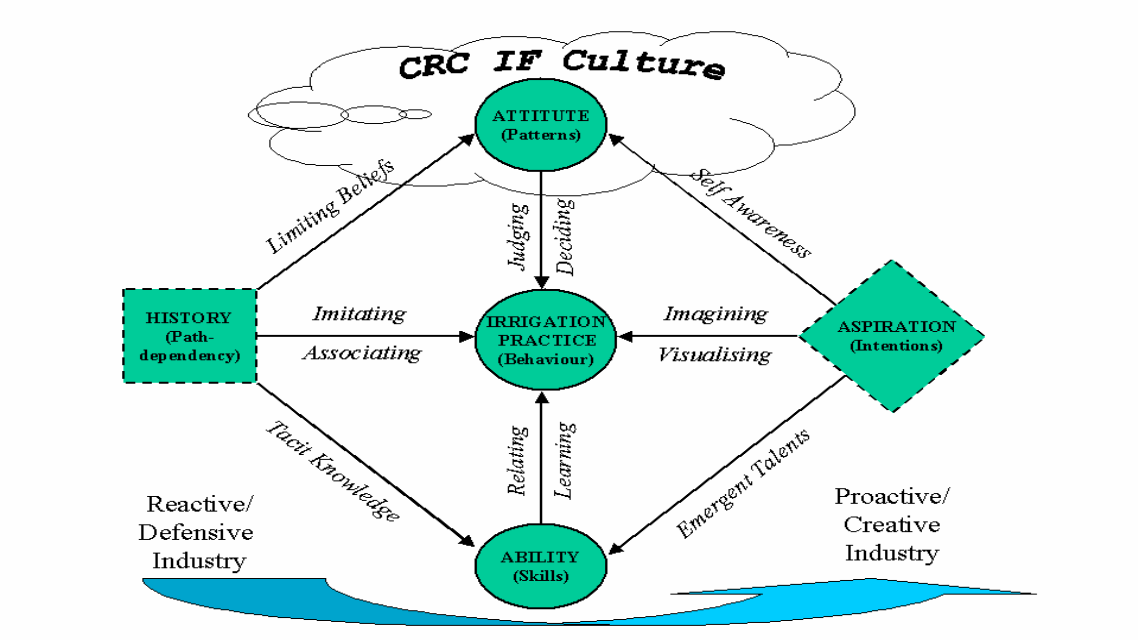
Australian governments have employed a wide range of measures to provide assistance to the agricultural sector. However, Australia is the second lowest level of support to agriculture, after New Zealand, among OECD countries (see Figure 6). Water policy and irrigation industry reforms may have, among other factors, largely contributed to the relatively low government subsidy to agricultural producers in Australia.

7 Some lessons from the study

The developments in the irrigation industry are complex processes, which mix the legacy of its predecessors and aspirations of future development with factors of attitude (e.g., CRC IF culture)

and ability (e.g., training and education, available new irrigation technology) (see Figure 7). Since there is a slippage and time lag between policy implementation and actual changes, it is important to ensure that reform intentions are regularly considered and examined against results (Saleth and Dinar, 2004). Meanwhile, it is important to realign political groups and create a pro-reform atmosphere that is conducive to substantive change. When water sector reform becomes part of larger political or economic reforms, its implementation will be easier. Through this way, it enables the irrigation sector to become a creative industry that is proactive to intended water policies that aim to realise the sustainable development of industry, community and the environment.

Figure 7 Factors determining the evolution of irrigation practice



From the history of irrigation development in Australia as well as the experiences of other countries, some lessons can be drawn from this study.

7.1 Community participation

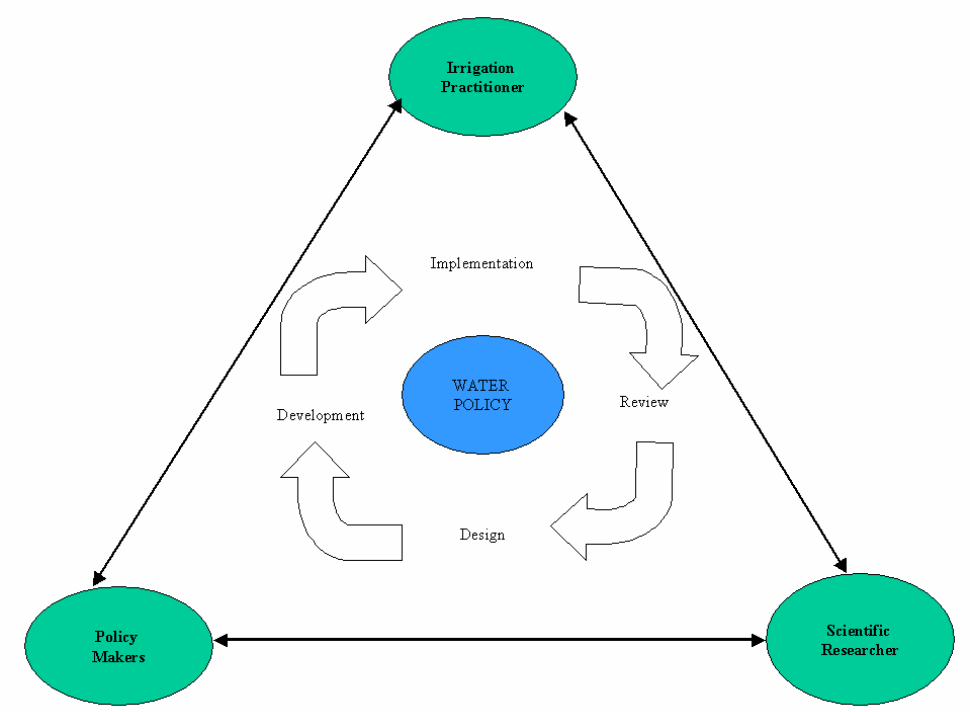
As Corish (2004, p. 9) points out "With Australian farmers responsible for the management of over 62 per cent of the Australian landscape and over 80 per cent of our water resources, farmers are central players in natural resource management". In addition, it is difficult to change many informal micro-level rules as they are strongly nested in the socio-cultural context of the community. There for, involving communities is crucial to understanding local conditions, creating a sense of ownership, strengthening community capacity, and ensuring sustainable management of water resources.

7.2 A multidisciplinary approach for policy-making

Water policy development and implementation is a complex process. A research integration and public input is required at the various stages of policy developments (i.e., design, development, implementation and review) (see Figure 8). As the policy cycle encourages consistency, through consultation and interaction a new policy will fit into the wider picture of government activity. In this sens, water resource management can benefit from a multidisciplinary team approach involving hydrologists, engineers, economists, ecologists and social scientists who, together with local stakeholders, collaborate in all phases of problem identification and analysis, policy dialogue and formulation, program design and implementation, enforcement, and monitoring and

evaluation. This practical element is inherently part of demonstration projects and clearly constitutes a means to reduce the gap between the needs and expectations of policy makers, scientists and irrigation practitioners.

Figure 8 Integration of science and consultation process into policy-making



7.3 Collaborative water management

As Pigram and Mulligan (1991) point out, in Australian irrigation industry here is a gap between the perspectives of policy makers at the `top' and the views held by policy practitioners (e.g., irrigators) at the `bottom'. A further gap appears to exist between those who claim to represent irrigator interests (i.e., industry groups and associations) and irrigators themselves. As a result, for a successful policy implementation process, ‘top-down' planning processes of water authorities must be combined with ‘bottom-up' involvement of the irrigators. Collaborative management of water resources (i.e., sharing of responsibility between communities and state authorities) may be one mechanism for improving local access, especially in irrigation schemes. Collaborative management agreements between governments and local communities should be encouraged.

7.4 Education and communication

In many instances, the lack of communication and of clear coordination mechanism may lead to research outputs not being used or simply unknown by policy-makers, and policy research needs not being communicated to the scientific communities in a timely fashion (Quevauviller et al., 2005). Communities and grassroots organizations also need educational materials and training to improve their understanding of and ability to manage water resources. Campaigns through the mass media can convey a sense of urgency regarding the need for improved water management. As the same time, the technical capacity and institutional viability of existing water management institutions (environmental agencies, water boards, and government ministries) should be strengthened.

8 Opportunities and further research

8.1 Potential opportunities for irrigation industry

From an irrigation industry perspective, this research aims to provide a better knowledge and understanding of national and regional water management systems and environment in which water policies operate (e.g., the complex interaction between the evolving science and technology, policy and socio-economic factors). An important part of this study is how to transform the role of irrigation industry in response to water policy from reactive to proactive. In this regard, some potential opportunities are identified for the irrigation industry:

- Shaping and influencing the development of industry water management policies and programs, especially at the catchment level;
- Developing close partnerships with scientific research groups to share the research results;
- Establishing a roundtable to facilitate policy dialogue (e.g., with policy makers, researchers, and environmentalists);
- Changing the perception of stakeholders and decision makers at different levels;
- Developing good policy proposal and sound advice and timely communicating to policy makers;
- Developing strategies for enhancing the productivity of water at different scales; and
- Incorporating environmental and indigenous concerns into water management practice.

8.2 Future research agenda

In this study a future research agenda is recommended for further investigation:

- Identify the drivers for policy;
- Develop instruments to assist policy choice that will facilitate sustainable irrigation practice;
- Explore the reasons for success and failure of past policy implementations;
- Understand the effects of policy changes on regional water management;
- Identify the options of intervention in the irrigation sector by evaluating the impact of past policies on irrigation investment and practice;
- Examine the legal and institutional constraints to effective water management;
- Identify and monitor key factors that affect water productivity and irrigation industry performance; and
- Develop methods to increase the agricultural productivity of local small-scale irrigation systems.

9 Concluding remarks

This paper attempts to explore the interactive nature between water policy and irrigation practice and draw some lessons in institution and policy reforms that aim to build up the capacity of Australian water industry in dealing with water management problems in the future. However, the main purpose of this paper is not to offer prescriptive guidance on how the irrigation industry should be engaged in the policy making process, but rather to inform the industry and other interested parties some insights on policy and irrigation practice interactions. Some potential opportunities for irrigation industry to make proactive respond to policy changes in the future are also highlighted.

It needs to recognize that each irrigation industry has its own way to respond to policy changes. To some extent, changes in the economic role of irrigation industry and in the attitudes of local

communities towards irrigation practice and investment may have an even greater weight than water policy itself. Since the relationships between population, irrigation and landscape change are dynamic and locally shaped, it should pay more attention to the perceptions and practices of local communities.

References

ABS (Australian Bureau of Statistics), 2004. Water Account Australia 2000-01. Australian Bureau of Statistics, Canberra.

AWRA (Australian Water Resources Assessment), 2000. Surface water and groundwater – availability and quality. National Land and Water Resource Audit, Canberra.

Carter, R. C., Howsam, P., 1998. Water policy and policy implementation. Waterlines, 16 (3): 2-3.

CNA (Comision Nacional del Agua), 1990. Water policies and strategies, Mexico City.

COAG (Council of Australian Governments), 1994. Communiqué. Meeting of COAG in Hobart, 25 February.

COAG (Council of Australian Governments), 2004. Intergovernmental Agreement on a National Water Initiative between the Commonwealth of Australia and the Governments of New South Wales, Victoria, Queensland, South Australia, the Australian Capital Territory and the Northern Territory.

Corish, P., 2004. A 21st Century vision for modern Australian agriculture. Telstra Address by National Farmers Federation President, 4 August.

Dinar, A., 1998. Water policy reforms: information needs and implementation obstacles. Water Policy, 1 (4): 367-382.

DGOH, 1996. Institutional framework and the water use in Spain. Madrid: Ministerio de Obras Publicas, Transportes, y Medio Ambientes.

Dunlop, M., Turner, G., Foran, B., Poldy, F., 2002. Decision points for land and water futures. Resource Futures Program Working Document 2002/08, CSIRO Sustainable Ecosystems, Canberra, Australia.

DWAF (Department of Water Affairs and Forestry), 1997. Republic of South Africa, white paper on a national water policy for South Africa. Department of Water Affairs and Forestry, Pretoria, South Africa.

EU (European Union), 2000. The EU Water Framework Directive - integrated river basin management for Europe. Directive 2000/60/EC (available at http://www.europa.eu.int/comm/environment/water/water-framework/index_en.html).

Goninon, T., Pretto, P., Smith, G., Atkins, A., 1997. Estimating the economic cost of hydrologic data collection. Water Resources Management, 11: 283-303.

Gunn, L. A., 1978. Why is implementation so difficult? Management Services in Government, 33: 169–176.

Hallows, P. J., Thompson, D. G., 1998. The History of Irrigation in Australia. Mildura.

Howsam, P., Leeds-Harrison, P. B., Weatherhead, E. K., 1999. Water policy in practice. Water & Environment International, May, 34-35.

Livingston, M., 2005. Evaluating changes in water institutions: methodological issues at the micro and meso levels. Water Policy, 7 (1): 21-34.

Meyer, W. S., 2005. World trends in irrigation technology innovation. Presentation at the CRC IF Annual Research Forum, Mildura, 19 September.

OECD (Organization for Economic Co-operation and Development), 2003. OECD Environmental Data: Compendium 2002, Inland Waters. OECD, Paris.

OECD (Organization for Economic Co-operation and Development), 2004. OECD Agricultural policies 2004: at a glance. OECD, Paris.

Pigram, J. J., Mulligan, H. K., 1991. Private sector involvement in irrigation agriculture: An Australian perspective. Land Use Policy, 8 (2): 133-142.

Postel, S. L., Daily, G. C., Ehrlich, P. R., 1996. Human appropriation of renewable fresh water. Science, 192: 785-788.

Productivity Commission, 2005. Trends in Australian Agriculture. Research Paper, Canberra, June.

Quevauviller, P., Balabanis, P., Fragakis, C., Weydert, M., Oliver, M., Kaschl, A., Arnold, G., Kroll, A., Galbiati, L., Zaldivar., J. M., Bidoglio, G., 2005. Science-policy integration needs in support of the implementation of the EU Water Framework Directive. Environmental Science & Policy, 8: 203-211.

Saleth, M. R., Dinar, A., 1999. Water challenges and institutional response (a cross country perspective). Policy Research Working Paper No 2045. World Bank, Washington, DC.

Saleth, R. M., Dinar, A., 2000. Institutional changes in global water sector: trends, patterns, and implications. Water Policy, 2 (3): 175-199.

Saleth, R. M., Dinar, A., 2004. The Institutional Economics of Water: A Cross-Country Analysis of Institutions and Performance. Edward Elgar, Cheltenham, UK.

Saleth, R. M., Dinar, A., 2005. Water institutional reforms: theory and practice. Water Policy, 7 (1): 1-19.

Sherbinin, A. D., 1998. Water and Population Dynamics: Local Approaches to a Global Challenge. See http://www.aaas.org/international/ehn/waterpop/desherb.htm

Stakhiv, E. Z., 1998. Policy implications of climate change impacts on water resources management. Water Policy, 1(2): 159-176.

Van Schilfgaarde, J., 1994. Irrigation — a blessing or a curse. Agricultural Water Management, 25 (3): 203-219.

Varela-Ortega, C., M. Sumpsi, J., Garrido, A., Blanco, M., Iglesias, E., 1998. Water pricing policies, public decision making and farmers' response: implications for water policy. American Economics, 19(1): 193-202.

World Bank, 1993. Water resources management. A World Bank policy paper, World Bank, Washington, DC.

Worster, D., 1985. Rivers of Empire. Pantheon Books, New York.

Young, M. D., Shi, T., McIntyre, W., 2006. Informing Reform: Scoping the affects, effects and effectiveness of high level water policy reforms on irrigation investment and practice. CSIRO Land and Water Client Report, November, Adelaide.