

**WATER CHALLENGE AND INSTITUTIONAL RESPONSE:
A CROSS-COUNTRY PERSPECTIVE**

R. Maria Saleth¹ and Ariel Dinar²

Last Modified 2/5/99

The views expressed in this report should not, however, be attributed to the World Bank.

¹Reader, Institute of Economic Growth, Delhi, India.

²Senior Economist, Rural Development Department, The World Bank, Washington, D.C., USA.

TABLE OF CONTENTS

Acknowledgements	ii
Executive Summary	iii
Introduction	1
Evaluation Context	1
Water Sector Problems and Institutional Responses	3
Water Sector and Institutional Change: Country-Specific Focus	5
Mexico	6
Chile	7
Brazil	9
Spain.....	11
Morocco	13
Israel	14
South Africa	16
Sri Lanka	18
Australia	22
China	25
India.....	27
Selected Best Practices	29
Common Trends and Patterns	34
Conclusions and Policy Implications	39
References	43
Appendix-a (List of Experts Met)	47

ACKNOWLEDGEMENTS

This study was supported by the budget allocation from the Rural Cluster within the Development Research Group, Visiting Research Fellows Program, and supplemental funds of the Rural Development Department, the World Bank. While the intellectual contributions of all the experts met in the sample countries are gratefully acknowledged, (see Appendix-A), few of them deserve a special mention due to their crucial help and logistic support. They include: Miguel Solanes, Sam Johnson, Jose Trava, Jose Simas, Nelson Pereira, Jose Olivares, Laudo Fernandes, Larry Simpson, Alberto Garrido, Mohamed Jelali, Jose Maria Pliego, Elisha Kally, Saul Arlosoroff, Claus Triebel, Alan Conley, Gerhard Beckeburg, Piet Maritz, Terrence Abeysekara, Nihal Fernando, Douglas Merrey, Douglas Vermillion, Warren Musgrave, John Pigram, Warren Martin, Zhang Hai Lun, and Yuri Steklov.

Valuable written and oral comments on the initial draft of this report received from John Braden, John Briscoe, Miguel Solanes, Yoav Kislev, Lambert Smedema, Manuel Contijoch, Conseulo Varela Ortega, and Fernando Rodriguez are also gratefully acknowledged.

Written comments on the country sections were provided from Adel Bichara for Morocco, Douglas Olson for China, Robert Hunt and Nihal Fernando for Sri Lanka, the Staff of the South Africa Country team, Karin Kemper for Brazil, Jose Simas for Mexico, Keith Oblitas and Christina Wood for India. We acknowledge theseir suggestions and corrections. However, all remaining errors are ours.

Finally, both the excellent secretarial support of Michelle Riguard and Fulvia Toppin as well as the efficient data processing assistance of William Fru are also appreciated.

EXECUTIVE SUMMARY

Water institutions, i.e., formal as well as informal water law, water policy, and water administration, are undergoing remarkable changes worldwide. Despite country-specific variations, the institutional changes observed at the international level evince certain common trends and patterns. This study aims to unravel these trends and patterns by addressing the following questions. Which are the key factors that motivate these institutional changes? What are their nature and direction? What effects can they have on overall water sector performance? And, finally but more importantly, is it possible to use cross-country experience for deriving an international agenda for encouraging institutional change within the water sector?

While country-specific descriptive studies dealing with either water institutions or water sector performance in isolation are common, studies evaluating the institutional underpinnings of water sector performance with a cross-country perspective are rather rare. With globalization and an increasing integration of the world economic system, countries have begun to realize that learning from mutual experience is an important means for improving their mutual performance in various spheres including water management. Documentation and analytical evaluation of cross-country experience in the realm of water institutions can facilitate cross-country flow of policy information enable international funding agencies to frame national/global initiatives to improve and sustain water sector performance through institutional reforms. It is this fact that provides the motivation and justification for this study.

As to the approach and evaluation context, this study relies on a combination of field-based appraisal technique and judgmental perception of water sector experts obtained through a survey instrument. The countries selected for a comparative evaluation of water institutions are: Mexico, Chile, Brazil, Spain, Morocco, Israel, South Africa, Sri Lanka, Australia, China, and India. Since the sample covers different continents, historical backgrounds, political systems, development stages, demographic trends, water law traditions, and, more importantly, water scarcity levels, it can represent well the reality of global water institutions in all their relevant dimensions. Since water institution falls in a domain intersected by economics, law, and public policy and is strongly influenced by resource endowment, demography, and science and technology, the basic approach here is inherently inter-disciplinary in orientation and analytical in character.

The preliminary evaluation of water sector across sample countries shows that the key issue is no longer resource development and water quantity but resource allocation and water quality. The notion of water provision as a public good and welfare activity has giving place to the concept of water as an economic good and input in economic activity. The old development paradigm centered on centralized decision-making, administrative regulation, and bureaucratic allocation is fading fast to pave the way for a new paradigm rooted in decentralized allocation, economic instruments, and stakeholder participation. Some of the tentative conclusions and implications emanating from this study are:

(1) As to the overall thrust of water sector reform strategy, the intimate multi-dimensional linkages among key water sector problems suggest two crucial policy tips. First, although isolated attempts in one dimension of the water problem will certainly influence other dimensions as well, an integrated approach will have the maximum effects through the phenomenon of inter-dimensional synergy. And, second, at the heart of such an integrated approach lie institutional changes that aim to modernize and strengthen the legal, policy, and administrative arrangements governing water sector as a whole.

(2) The occurrence of actual institutional changes across almost all countries can be taken as an indirect and informal observational evidence for the fact that the opportunity costs (i.e., the potential net gain) of institutional change are increasing to surpass the corresponding transaction costs in most contexts. But, the fact that institutional changes are uniform neither across institutional components nor across water sub-sectors suggests that both the opportunity and transaction costs do vary by context.

(3) From the viewpoint of international funding agencies, the main planks of their strategy in the institutional arena of their borrowing countries, i.e., the formulation of water policy and water law, and the reorganization of water administration, should continue. But, to gain tactical advantage and maximize the return on their institutional investments, the funding agencies need to concentrate their efforts and resources in countries, areas, and sub-sectors already with a critical mass of institutional building that assures lower transaction costs and a greater probability for success.

(4) In view of the positive effects of scale economies and political pressures for further change from reform constituencies, transaction costs decline and political balance improves as one moves along the institutional change continuum. This means that it is prudent from a political economy perspective to proceed on a logically linked, prioritized, and sequentially designed scheme of reforms where water sub-sectors and institutional components are taken one at a time.

(5) And, finally, since both the transaction and opportunity costs of institutional change are influenced by forces both external and internal to water sector, it is important to fully exploit the political economy context provided by these factors for gaining momentum to promote institutional changes at a faster rate.

WATER CHALLENGE AND INSTITUTIONAL RESPONSE: A CROSS-COUNTRY PERSPECTIVE

INTRODUCTION

Institutional arrangements governing water sector are undergoing remarkable changes in recent years. Although both the nature and direction of these institutional changes vary by country-specific economic, political, and resource realities, there are clearly identifiable trends and patterns. To unravel these trends and patterns of change at the international level, it is necessary to address the following questions. Which are the key factors that motivate these institutional changes? What are the nature and direction of these changes? How adequate are these changes for addressing both the existing and emerging water sector challenges? What do they ultimately mean for overall water sector performance? Is it possible to use cross-country experience for deriving a workable agenda for institutional changes especially in countries that are at the threshold of water sector reform? The answers to these and related questions help in understanding the water sector challenges and in delineating the contours of ongoing institutional responses.

With an increasing integration of world economic system under the ongoing process of globalization, countries have begun to realize that learning from each other's experience is an important means for improving their mutual performance in various spheres including water management. While country-specific studies dealing with either water institutions or water sector performance in isolation are common, studies evaluating the institutional underpinnings of water sector performance with a cross-country perspective are rather rare. Although country-specific approaches are useful, the "best practice" cases identified through a cross-country exercise is particularly more relevant for promoting institutional changes. Documentation and analytical evaluation of cross-country experience in the context of water sector and its institutional arrangements are valuable, at least, on two counts. While cross-country experience provides countries with the option of learning/adapting from each others' experience with minimal cost of experimenting new institutions under uncertainty, it also enables international funding agencies in developing a basis for both framing and perfecting national and global initiatives to improve water sector performance and sustainability. It is this current relevance and policy significance that motivate and justify the present study aiming at a cross-country evaluation of recent institutional responses to water sector challenges.

EVALUATION CONTEXT

The value and credibility of cross-country approach as a tool of analysis is critically predicated on the choice of sample countries selected for field-based first-hand evaluation. The sample needs to be large enough to capture variations in socio-economic conditions, political settings, and water sector realities but small enough to permit a rapid field-based

appraisal of major water sector challenges and key institutional responses observed at the international level. After a process of careful screening, the countries finally selected to form the sample for cross-country comparison are: Mexico, Chile, Brazil, Spain, Morocco, Israel, South Africa, Sri Lanka, Australia, China, and India. Since the sample covers different continents, historical backgrounds, political systems, development stages, demographic trends, water law traditions, and, more importantly, levels of water scarcity, it can represent well the reality of global water sector in all its relevant dimensions. The representative character of the sample is enhanced further by the fact that it also covers the full spectrum of recently observed institutional changes and water sector reforms in terms of their coverage and effectiveness.

Of the 11 sample countries, all, but India, were visited during October-December 1997. In each country, 4 to 5 days were spent mainly for meeting and discussing with key water sector experts (see Appendix-A for the list of experts interacted) as well as for collecting recent materials on water sector and water institutions. Considering this list of experts--with differential experience and disciplinary orientation--as a sample, a pre-designed questionnaire was administered so as to gather both factual and judgmental information on various aspects of water institutions and water sector performance. This information forms the basis for a quantitative evaluation of issues operating in the interface between water institutions and water sector performance that is reported in Saleth and Dinar (1998). But, the information, which is derived from personal interactions with a cross-section of water experts and a partial review of recent materials gathered during field visits, remains the basis for the analysis reported here.

Since water institution falls in a domain intersected by economics, law, and public policy and is also strongly influenced by factors like resource endowment, demography, and science and technology, the basic approach here is inherently inter-disciplinary in orientation and analytical in character. The focus of comparison will be on major water sector problems and recent institutional responses of each of the sample countries. While water sector covers all its sub-sectors, the institutional change covers changes in water law, water policy, and water administration. Although the comparison confines almost exclusively to the 11 sample countries, the experience from other countries and regions will be brought to reinforce some points in few relevant contexts.

As to the structure of this paper, after a general discussion on the linkages between water challenge and institutional change, a quick review of country-specific situation is attempted with a focus on key physical and institutional features of water sector, its key challenges, and recent/proposed institutional responses. This is followed first by the identification of best practices and then by the delineation of certain common trends and tendencies observed in water sector problems and institutional arrangements. Finally, the paper concludes by indicating the major implications for Bank's policy and operation, particularly in framing both country-specific and general strategies to encourage institutional changes conducive for market-based allocation and sustainable water resource management.

WATER SECTOR PROBLEMS AND INSTITUTIONAL RESPONSES

Available documentation of water sector problems--both at the national and global levels--does not present a rosy picture overall. Water resource development either has reached or is fast approaching the limit of ultimate utilizable potential in most countries. Even in areas with undeveloped water resource potential, further resource development is constrained by environmental concerns, technical inadequacy, and budgetary limits. Meanwhile, the demand for water is on an ever-increasing spree due to the formidable effects of population expansion, economic development, and life-style changes. The main result of a growing demand-supply gap is the intensification of inter-sectoral and inter-regional water conflicts. The growth in urban water demand has both quantitative and qualitative dimensions. Ironically, the quality dimension is subject to the contradictory influence of two opposing effects. On the one hand, since urban groups have higher living standards and greater political articulation, every increase in urban water quantity is likely to be accompanied by a higher demand for better water quality. On the other hand, since the growth in urban water demand means more residential sewerage and industrial pollution, every increase in urban water consumption, if not addressed properly, could lead to a concurrent deterioration in water quality. The unfavorable effects of water scarcity--both absolute and relative--are magnified further by rapid deterioration in water quality that discounts the utility of an already inadequate water supply.

Although, the scarcity value of water is increasing, the politically-rooted system of public provision and subsidized water charges insulate the water economy from the influence of actual market forces. Low water charges and poor recovery rates risk the efficient maintenance of existing water infrastructure as well as the additional investments on future water development projects. Declining water sector investment and deteriorating physical health of water infrastructure have raised questions about the unfavorable effects on the quality and sustainability of water services. The growing recognition of the close linkages among financial status, physical health, and service quality in the water sector remains the motive force to prompt reforms in water pricing and cost recovery policies in most countries (see Dinar and Subramanian, 1997). While the water sector is gradually, but steadily, emerging out of the grip of political and other myopic considerations, it has not yet reached the stage where economic and sustainability considerations can have a dominant role in guiding water sector decisions.

The crisis in the water sector has also made apparent the inherent limitations of the existing institutions in dealing effectively with the new set of problems that are not related to resource development but to resource allocation and management. Allocation and conflict resolution mechanisms have to be either created or strengthened/updated both in the legal and policy spheres. Water users, who were customers or clients in the surplus era of water development, have now become important players in the scarcity era of water sector. The water administration and water sector decision process have to accommodate now an increasing role of user organizations, non-governmental agencies, and women, environmental, and other self-help groups as well as to explore the ways in which emerging water and information technologies can be gainfully utilized. In short, as countries move from a state of plenty to a state of scarcity, water institutions, that define the rules of wa-

ter development, allocation, and utilization, have to be concurrently reoriented to reflect the changing supply-demand and quantity-quality realities.

Institutional reorientation involving fundamental changes in the three interrelated dimensions of water institutions, i.e., water law, water policy, and water administration, though crucial, is not an easy task. The main issue here is what explains these institutional changes and how these changes are interrelated. One of the key premises in institutional economics literature is that institutional change occurs only when its transaction costs are less than the corresponding opportunity costs. In the particular context of water institutions, transaction costs cover both the real and monetary costs of instituting the regulatory, monitoring, and enforcement mechanisms needed for water resource development, allocation, and management. Similarly, the opportunity costs cover both the real and economic value of opportunities foregone or the net social loss due to '*status quo*'. With increasing water scarcity, the opportunity costs of *status quo* are indeed tremendous and increasing fast to exceed the corresponding transaction costs.

The theoretical literature elaborating the additional gains possible from institutional changes--both in the general and in the water sector contexts--are vast and growing. While the literature in a general institutional context covers the seminal works of Olson (1971), Bromley (1989), and North (1990), that in the water institution context covers the important works by Frederikson (1992), Le Moigne, et al., (1994), and Picciotto (1995). Apart from this theoretical literature on the gains from institutional change, there are also few recent studies which try to quantify the potential gain from changes in a particular segment of water institutions like water markets, inter-regional transfers, and water quality institutions (e.g., Vaux and Howitt, 1984; Dinar and Latey, 1991; Zilberman, et al., 1998; Howitt, 1994; and Herne and Easter, 1997). There are also few studies which provide some rough numerical estimates for the opportunity cost (i.e., the potential social gain) of change in water institution as a whole for countries like Chile (Gazmuri and Rosegrant, 1994:24) and India (Saleth, 1996:274). In both cases, the calculation involves first an estimation of actual or potential efficiency-induced additional irrigated area and then the estimation of the cost of creating that area by new construction. The estimated opportunity costs vary from \$ 400 million for Chile to \$ 14 billion for India. Similar, but simulation-based, estimates for the context of San Joaquin valley place the opportunity cost to be \$ 223 million (Archibald and Renwick, 1998). As distinct from the approach of trying to estimate the opportunity costs of institutional change, there are also attempts which tries to directly estimate the transaction costs of reform (e.g., Colby, 1990; Easter, 1998).

The present approaches towards estimating both the opportunity and transactions costs of institutional change in the water sector remain admittedly partial. For, they do not adequately account either for the segment-specific institutional needs of different water sub-sectors or for the component-specific cost variations across various components of water institution (i.e., water law, water policy, and water administration). Variations in the opportunity and transactions costs across water sub-sectors and water institution components make institutional changes easier in some contexts but difficult in other contexts. For example, it is easier to formulate and declare a water policy than to design and promulgate a water law. Similarly, it is much easier to have both water policy and water law than to create new or reform existing administrative structures needed for an effective field

level translation of legal provisions. Since institutional change is a continuum, the easier reforms initiated in the early stages brightens the prospects of further and higher level institutional changes. This means that there is an intricate and functional linkage between the transaction costs of subsequent reforms and the opportunity costs of earlier reforms. Although these linkages appear to be highly abstract and theoretical, their practical influence within the political economy of reform process should neither be ignored nor be underestimated.

Since the magnitude of net benefits from institutional changes in water sector is a direct function of the degree of water scarcity, the economic incentives for institutional change increases with every increase in the level of water scarcity as induced by factors like population growth, economic development, and climate change. Increasing water scarcity also magnifies the real and economic costs of inappropriate water sector policies (e.g., treating water as an 'open access' resource and subsidized water provision) which can be approximated by the gap between the scarcity value of water and the prevailing water charges. Besides, the opportunity cost of institutional change within the water sector is also strongly influenced by some factors that originate outside the strict confines of the water sector. These factors, which are often underestimated, include the macro economic adjustment policies and socio-political liberalization and reconstruction programs. Macro economic reform magnifies the fiscal implications of the opportunity costs of institutional change. In contrast, the socio-political reform attempts (e.g., in Chile during the 1970s, Spain during the 1980s, China since the 1980s, and South Africa since the 1990s) reduces the transaction costs directly because the institutional changes in water sector form part of a system-wide reform. The opportunity cost of institutional change is also being magnified further by water-related natural catastrophes such like droughts (e.g., California), floods (e.g., China), and soil salinity (e.g., Australia). This means that the original opportunity costs of a crisis-ridden water sector, though remain a potent force for change, need, however, additional supports and contexts to get the much needed political economy thrust to prompt and sustain the process of institutional change.

WATER SECTOR AND INSTITUTIONAL CHANGE: COUNTRY-SPECIFIC FOCUS

Water sector crisis is linked to institutional changes through a chain of economic, political, and natural factors both within and outside the water sector. Current knowledge does enable the tracing of this causative chain of change including its nature and direction. But, current information can allow neither a precise quantification of the true transaction and opportunity costs of institutional change nor a rigorous evaluation of the extent institutional inter-linkages can be exploited to promote water institutional changes with the least transactions cost. However, the occurrence of institutional changes in almost all countries does suggest the presence or the emergence of the necessary conditions for institutional change. To see this, it is necessary to study the nature of both the water challenges and recent institutional changes in each of the 11 sample countries.

Mexico

Mexico covers an area of about 2 million square kilometers (sqkm) with most of its territory (2/3) being arid or semi-arid. It has a population of about 98 million people. Rainfall varies widely from 150 millimeter (mm) in the deserts in north west regions to over 1,700 mm in the humid tropics in the south. The mean annual precipitation is 780 mm. The total renewable water resource potential from rainfall is estimated at 441 billion cubic meter (bcum)--410 bcum from surface and 31 bcum from sub-surface sources [see Commission Nacional del Agua (CNA), 1990:4]. The actual water extraction is about 185 bcum of which agriculture accounts for over 80 percent leaving the rest for domestic and industrial uses. The non-consumptive use of hydro-power generation uses 60 percent of the total surface water withdrawn. Although agriculture accounts for 66 percent of the total groundwater use, it is groundwater that supports 70 percent of domestic and industrial water needs (Simas, 1997). The water use in Mexico is, therefore, centered essentially around its irrigation segment.

Mexico has a strong centralized government and water resource management issues are with the central government. Prompted by the macro-economic crisis of the late 1980s, Mexico has undertaken unprecedented reforms beginning first with the irrigation sector in 1988 and gradually covering water sector as a whole. The irrigation sector reform has taken the form of massive transfer of public irrigation systems to user groups (see Trava, 1994; Gorriz, et al. 1995; Johnson, 1996 and 1997). By 1996, 2.9 million hectares (mha)--representing 87 percent of the area under major and medium irrigation and 46 percent of the total area under all irrigation--have been transferred to 386 Water User Associations (WUAs). This irrigation management transfer (IMT) has led to a dramatic improvement in cost recovery, system maintenance, and staff reduction as well as some notable improvements in yield and water use efficiency (see Johnson, 1996; Palacios, 1997). There were also significant changes in the legal sphere with the enactment of the National Water Law in 1992 and the Federal Law of Regulations in Water Matters in 1994. Similar changes can also be seen in the policy arena with the government's desire to decentralize urban water supply and encourage private investment in water sector. Despite these positive developments, the Mexican water sector still faces the following key challenges.

- Addressing the second-generation problems of IMT (e.g., organizational issues and water conflicts among WUAs as well as between WUAs and municipalities);
- Strengthening the institutional linkages between WUAs and government agencies providing farm inputs, farm and water technologies, and extension services;
- Deepening and extending water sector reform to cover groundwater as well as urban and industrial uses;
- Developing institutions for inter-sectoral/regional water allocation (i.e., basin level entities) including an effective usage of National Registry of Water Users as the technical and information base for water allocation at various levels;
- Creating both the macro and micro level institutional structures for arresting groundwater depletion and water quality deterioration; and

- Promoting private sector participation in irrigation investment and technology transfer.

Recent policy changes have both positive and negative implications for these water sector challenges. With a reduced role in the irrigation sector and passage of the private-oriented water law, the government can take an active role in the critical areas of regulation, monitoring, and enforcement. For accomplishing such a role, in 1995 the CNA moved to the Secretariat of Environment, Natural Resources, and Fishing. But, with reduced staff and budget, the CNA is in a position neither to play the regulatory function effectively nor to dovetail WUAs within the existing structure of agriculture and water-related institutions. The new water law allows private and transferable use rights but limits such transfers only within the sector as water transfers involving a change of use need prior approval. From the viewpoint of water sector decentralization and privatization, there are, at least, four positive developments.

- The initiatives for moving water supply functions to state and municipal governments and also for creating financially self-dependent utility-type systems for that purpose;
- With the success of Llerma Basin Council (1989) that solved the most contentious inter-state water conflicts in Mexico, basin level organization as an instrument for stakeholder participation and negotiated settlement is also being extended for experiment in the Rio Bravo (1994) and the Valley of Mexico (1996) basins;
- The New Agrarian Act has recently relaxed the land-ceiling for irrigated land from 20 to 100 ha to provide incentives for private investment in irrigation; and
- The current efforts to separate the broad issue of water resource management from narrow sectoral biases and make, thereby, a clear distinction between water *as a resource* and water *as an usufruct*.

While institutional changes in Mexico are remarkable, still they are not adequate enough to address the key water sector challenges facing the country. Fortunately, Mexico has now a strong enough institutional foundation to build a comprehensive framework for effectively addressing both water quantity and quality problems across all water sub-sectors and uses. Since the solution lies not in the mere creation of sophisticated institutions but in their effectiveness as enforcement organs, the focus should be on both the hardware (e.g., organizations, and water storage and distribution networks) and software (e.g., law, policies, and capacity building) aspects of water institutions.

Chile

Chile, an elongated littoral country on the Pacific Coast of South America, covers an area of about 0.75 million sqkm with a population of about 14 million. Since rainfall varies from less than 50 mm in arid north to 1250 mm in the temperate south, both the water availability and water needs show marked regional variations. Total water use is estimated to be about 34.21 bcum--10.88 bcum of consumptive use and 23.33 of non-consumptive use. Of the total consumptive use, irrigation sector accounts for 89 percent and domestic sector takes 6 percent with the rest going to the mining and industrial sectors (Brehm and Quiroz, 1995:3). Of the cultivable area of 5.1 mha, 1.9 mha are irrigated--1.24 mha by surface water and 0.68 mha by groundwater (Gazmuri and Rosegrant, 1994:32). Despite

the predominant share of irrigation in total water use, a high level of urbanization (85 percent) and an extreme dominance of hydro-power in total energy (93 percent) make Chilean water sector to orient towards its non-irrigation segments.

Being a small country, Chile has a unitary form of government. Unlike most other countries in the sample, it presents one of the earliest and most well developed institutional arrangements quite favorable for market-based water allocation, decentralized management, and private sector participation. Although the law considers *water resource* as a common property, for all practical purposes, *its use* is treated as a *de facto* private property attached to land. The perception of water use rights as a private property has become sharper since 1976 when the expropriation of land and water made during the late 1960s and early 1970s were reversed by a new government. Thanks to the 1981 Water Code and 1988 Constitution, water use right is treated--both legally and practically--as a private property independent of land that can be traded, used as collateral, and treated as assets for tax purposes (see Gazmuri and Rosegrant, 1994). Added to a relatively mature legal system, Chilean water administration also has a better demarcation of responsibilities between water-related state organizations, water supply and sewerage service agencies, private construction companies, and WUAs. While the state grants quantified water rights to all users, an active water market facilitates reallocation of such entitlements both within and across sectors with WUAs and courts resolving all water-related conflicts (see Gazmuri and Rosegrant, 1994; Brehm and Quiroz, 1995; Herne and Easter, 1995).

Interestingly, project construction by state agencies is made conditional on users' prior agreement to pay the full project cost over time and WUAs--both at the project, canal, and channel levels--are responsible for system maintenance, water distribution, and fee collection. Since WUAs in Chile, unlike their counterparts in other countries, involve users with individual water use rights, they are more effective both in facilitating water transfers as well as in tackling local level water conflicts. In urban sector, although 92 percent of the water supply and sanitation systems are public, most of them are trying to be financially autonomous by increasing the equity participation of both general public and private investors. The corporatization and privatization of state-owned water supply agencies as well as the entry of private water companies have led to an increase both in coverage and quality of water supply and sanitation services (Gazmuri and Rosegrant, 1994:25). Notably, the policy of market allocation and privatization in Chile is also accompanied by state protection to poor farmers and urban users through a policy of demand, rather than supply, side subsidy, i.e., the poor pay the same price but get lump sum subsidy to cover their excess water bill.

While Chilean water sector is institutionally far advanced than many countries, it still faces some key challenges. The most important among them are:

- Growing inter-sectoral conflicts between irrigation and power sectors (a phenomenon quite unique to Chilean topography) as well as between irrigation and urban uses;
- Countering speculation in water rights especially by electric power companies that encourages non-use and crowds out farmers and other smaller users;

- Infusing spatial aspects to water rights (i.e., definition of what a water right means in terms of volume in different diversion points) to avoid third-party-effects and thin water markets (Saleth, Braden, and Eheart, 1991; Donoso, 1996; Blanco; 1996);
- Ensuring minimum in-stream flow in ecologically sensitive rivers/streams especially by assigning the right on return flows to environment); and
- Reducing water pollution from industrial waste disposal and urban sewerage and protecting, thereby, an acceptable level of water quality;

Currently, there are notable legal and policy initiatives to address some of these problems. The recent decision of the supreme court that upheld farmers' claim over that of electric power companies provides a legal basis for resolving the conflict between consumptive and non-consumptive uses. To avoid speculation and discourage large scale water rights transfer from agriculture to power and urban sectors, the 1992 legislative proposal has suggested two key aspects: forfeiture if non-use for over 5 years and limiting water rights to specific use. Although these proposed changes are interpreted as risking both the security and transferability of water rights (e.g., Gazmuri and Rosegrant, 1994:23), they are, however, needed to maintain a balance in inter-sectoral allocation, prevent monopoly tendencies, and encourage better water utilization. On the water quality side, the Environmental Law of 1994 not only mandates water supply agencies to treat urban waste water before its discharge but also requires water allocation for meeting ecological needs (i.e., minimum in-stream flows). Following this law, water treatment plants have already been established in Santiago and Arica and the treated water is targeted for agricultural use in both cases.

Brazil

Brazil, the fifth largest country in the world, covers an area of 8.5 million sqkm and a population of about 150 million. Being a country of continental size, rainfall varies from 600 to 3600 mm and, as a result, water resource potential has an uneven regional pattern. Of the total water resource potential of 2587 bcum, 80 percent occur in the Amazon region with 63 percent territory but 5 percent population whereas just 4 percent occur in the north-eastern part with 13 percent area but with 33 percent population. Water scarcity is, therefore, acute in areas of population concentration and economic importance. Irrigated area is about 2.8 mha representing just 5 percent of the cultivated area and 10 percent of the ultimate irrigation potential. Although irrigation sector has a dominant share in water use, the main motivation for most water development schemes comes from hydro-power/urban water supply. With 75 percent of the population in urban areas and 93 percent of the total energy from hydro-power, Brazilian water sector is essentially oriented towards non-irrigation sectors.

Brazil is a federal country with relatively stronger regional governments. Since 1988, there were notable developments in the legal and organizational spheres of water management both at the federal and at the state levels. By delineating 'federal waters' from 'state waters', the 1988 Constitution has made both the federal and state governments responsible for managing water in their respective jurisdiction (see Azevedo and Simpson, 1995). While the abolition of the notion of 'private waters' precludes ownership

rights in water, authorized private use rights are, however, allowed. The long domination of the power sector in water sector development finally ended in 1995 with the transfer of water from the Ministry of Mining and Energy to the newly created Ministry of Environment, Water Resources, and Legal Amazon. The Secretariat of Hydraulic Resources created under the latter Ministry is given planning and regulatory powers over all water uses. The National Water Resource Policy Law, though delayed since 1991 due to federal-state disagreements, was finally passed in 1997 [see Federative Republic of Brazil (FRB), 1997]. In the meantime, eight major states have also passed their water laws. Since these changes effected at the national level are neither given time to pervade through lower echelons of water administration nor accompanied by clear-cut operational policies, their impact on water sector performance is obviously limited. As a result, serious problems like the following continue to haunt water sector performance.

- Ensuring managerial and regulatory coordination between federal and state waters;
- Promoting consistent water laws and policies among states within the federal structure;
- Creating participatory mechanisms for inter-state/inter-sectoral water conflicts;
- Strengthening water planning and administrative structures through capacity building and technological upgradation;
- Addressing water pollution to preserve water quality in the industrially advanced south-eastern region while solving water scarcity in rural-based north-eastern regions;
- Increasing users' participation and cost recovery; and
- Preparing the way for the development of water permit and pollution license systems to provide incentives for efficient water use and effective pollution control.

There are several recent initiatives with the express purpose of improving managerial coordination and resolving water conflicts within the federal framework. These initiatives include the creation of the National Water Resource Management System--covering National Collegiate as well as Basin Commissions--and the establishment of national, basin, and state level water councils. However, these institutional structures are in a formative stage and need time to articulate themselves well within the existing system. Notwithstanding the serious attempt to consolidate water issues within a single administrative apparatus, there are many water-related functions (e.g., irrigation, extension, pure and adaptive research, urban water supply, and water quality) that still remain administratively dispersed requiring effective integration with broader water management concerns. The 1997 law also remains largely silent on water pollution especially from urban sewerage that has become a critical problem in major cities like Sao Paulo and Rio de Janeiro. Decentralization and privatization programs (e.g., urban water supply) also need to be packaged well within the overall reform strategy.

The legal and policy changes remain incomplete as long as the intermediary institutional structures are still to be put in place both at the federal and state levels. However, it cannot be denied that Brazilian water sector environment and management approach did undergo remarkable change thanks to the policy level articulation of many progressive ideas and approaches. These ideas and approaches include water as an economic good, integrated approach to water resource management, targeted strategies to address region

and sector-specific water challenges, decentralization through user participation (e.g., ‘water democratization’) and basin level organizations (e.g., ‘watershed committees’), water concession/permits, and cost sharing based on user pay principle. Judging by the general direction of institutional changes observed till now and the politically committed government to deepen the reform process, Brazilian water sector is in a stronger position to strengthen its institutional foundation and to realize, thereby, tangible gains in terms of performance improvement in the near future.

Spain

Spain, a peninsular country in Europe with frequent drought problems, covers an area of about 0.5 million sqkm and a population, more or less, stabilized around 40 million. Mean annual precipitation is 668 mm. Uneven seasonal and regional patterns in water availability necessitate large storages and extensive intra and inter-basin water transfers. While the total water resource potential is estimated to be 114 bcum, annual withdrawal is only 47 bcum--41.5 bcum from surface and 5.5 bcum from sub-surface sources [Direccion General de Obras Hidraulicas (DGOH), 1996:2]. Of the total consumptive withdrawal of 31 bcum, the respective shares of agriculture, urban supply, and industrial sector are 81, 13, and 6 percent. Irrigated area is 3.2 mha--2.3 mha from surface water and 0.9 mha from groundwater--representing 13 percent of the total cultivated area. About 35 percent of total water withdrawal is also used for the non-consumptive purpose of hydro-power generation. Unlike most European countries, the water sector in Spain has a strong orientation towards its irrigation segment.

Although Spain is a federation of ‘Autonomous Communities’ (AC), it has a strong federal government playing a dominant role in the water sector. Being a member of the European Community (EC), the water sector in Spain is also influenced by EC’s agricultural and environmental policies. This external influence and the unique tradition of water administration through river basin organizations (RBOs) dating as far back as 1926 distinguish Spain from the rest of the sample. Spain has 14--nine inter-community and 5 intra-community--RBOs known as ‘Confederaciones Hidrograficas’ which are responsible for water development, inter sectoral allocation, water pricing, authorization of water and discharge permits, and water quantity and quality monitoring as well as enforcement in their respective jurisdictions. Although they are autonomous with formal mechanisms for stakeholders’ participation, their budgetary dependence due to low water charges and poor recovery makes them less autonomous and more bureaucratic. Operating below the RBOs are the municipalities and irrigation communities which distribute water, collect charges, and resolve conflicts at the local levels. The federal government, apart from its budgetary support to inter-community RBOs, enacts laws, sets overall policies, and provides overall regulatory guidance.

The 1985 water law that replaced the 1879 water law, though makes water resource as a public property, allows users to obtain use-specific water and discharge permits from RBOs. Such a legal distinction made between water as a resource and water as a usufruct is very crucial to reconcile the conflicts between the public and private goods

properties of water. As mandated by this law with a basic thrust on integrated approach to water management, a comprehensive National Water Plan together with Basin Water Plans has been prepared in 1993 [see Ministerio de Obras Publicas Y Transportes (MOPT), 1993]. But for its irrigation component, the Plan is yet to be adopted. In the meantime, similar plans with time-bound targets for sewerage treatment and discharge regulation have also been prepared during 1994-95 so as to meet EC directives in this regard. On the water administration side, Water Commissions both at the federal and basins levels have also been set in place to serve as advisory bodies for technical and policy level consultations. While Spain has all the right set of water-related institutional arrangements, their impact on water sector performance is far from satisfactory partly due to weak links among institutions and partly due to politically entangled and poorly implemented water pricing and cost recovery policies. The major challenges facing Spanish water sector are:

- Implementing the legal provision of full-cost recovery including investment costs;
- Modernization of water storage and distribution networks and extending the installation of water measuring devices to all irrigation systems (Ortega, et al., 1997);
- Enhancing the use efficiency and productivity of irrigation water with a better integration of water delivery with farm inputs, technologies, and extension services;
- Strengthening the RBOs with financial self-sufficiency, functional autonomy, and a still deeper involvement of users;
- Addressing environmental issues including groundwater depletion, water quality, and minimum flow requirements;
- Encouraging private sector investment and participation in water management, sewerage treatment, and pollution control; and
- Removing the legal and organizational rigidities to permit market-based solutions to inter/intra-sectoral/regional water allocation and quantity-quality conflicts.

It is easier to meet EC's targets for subsidy removal and water quality maintenance than to resolve the socio-economic problems due to a 10 percent reduction in irrigated area required under EC's commodity restriction programs. Apart from an accurate commodity planning and a carefully designed diversification program, there is also the critical need for creating mechanisms for protecting/compensating the water permits of farmers and regions subject to such restrictions. Since water markets can be a part of the solution in such situations (Garrido, 1997), deliberate policies and legal provisions are needed to facilitate the emergence and growth of such markets. Recently, there are notable initiatives both in the legal, policy, and the administrative spheres of Spanish water sector. These initiatives include the proposals to introduce private and transferable use rights, grant full financial autonomy to RBOs, make construction of new projects dependent on users' prior agreement to pay full costs (as in Chile), and encourage private sector participation in construction, distribution, sewerage treatment, and pollution control. With EC's directives exerting strong pressure for financial discipline and quality standard, these proposals, if implemented soon with least compromise, could strengthen existing water institutions and place the Spanish water sector on a sustainable path of performance improvement.

Morocco

Morocco stretches along the coast of north-west Africa. It covers an area of 0.7 million sqkm and a population of about 27 million. Since the mean annual precipitation is only about 200 mm, water resource availability is extremely limited both seasonally and spatially. Of the total 20 bcm water resources which could be mobilized, 11 bcm are currently being used. Of the total water utilized, agriculture accounts for 90 percent, and domestic and industrial uses share the rest. The irrigated area is approximately 1.0 mha, of which 50 percent is irrigated by large schemes. It covers only 11 percent of cultivable area but 80 percent of the potentially irrigable area (World Bank, 1993:2). While agriculture constitutes just 17 percent of GDP, it accounts for 40 percent of employment and 30 percent of export earnings. Despite the ethical and political eminence of drinking water, Moroccan water sector is basically centered on its irrigation segment.

Although provincial governments are gaining importance since the democratization process started in the 1960s, Morocco remains still highly centralized. In contrast, water administration evinces considerable decentralization and functional specialization. The Directorate General of Hydraulics under the Ministry of Equipment (MOE) plans and develops water resources. The National Office of Potable Water, again under MOE, acquires and distributes water not only on a retail basis to households and industries in major urban centers but also on a bulk supply basis to municipal/provincial governments. The nine Regional Authorities for Agricultural Development (RAADs) under the Ministry of Agriculture (MOA) develop and maintain water distribution networks, acquire and distribute water, collect water charges, and provide farm inputs and extension services. In smaller systems including groundwater areas, on the other hand, local governments and farmers play a stronger role in water distribution and system maintenance.

The new Water Code of 1995 has led to significant changes both in the spheres of water policy and water administration. The law makes the Supreme Water Council (involving all major water sector stakeholders) as the key agency for water policy at the national level and River Basin Organization (covering one or more RAADs) as the nodal agency for water administration at the regional level (the first RBO has been created in 1997). The National Water Plan and Basin Water Plans are to provide technical framework for formulating both national and regional strategies for water management. The law that advocates the user-pay principle and full cost recovery allows for the imposition of both water abstraction and pollution taxes. On the legal side, although water is brought to the public domain, the new law permits authorized use rights and also recognizes the ownership rights obtained as per the 1914 law. While these macro level developments are indicative of a positive change in the overall institutional environment within the water sector, key challenges continue to limit water sector performance. They include:

- Enhancing water use efficiency and conservation especially in the agricultural sector through the installation of water meters and the adoption of water saving technologies as well as the modification of existing cropping patterns;
- Improving cost recovery and system maintenance through the promotion of active WUAs and by the effective application of the 1995 Water Code;

- Strengthening further the existing practice of integrating water delivery with the provision of farm inputs and extension services;
- Ensuring administrative and operational cohesion between agricultural and water sector agencies both at the national and at the local levels;
- Extending the current policy of making urban water supply agencies operationally autonomous and financially self-dependent;
- Protecting water quality and developing cost effective schemes for waste water treatment and water reuse; and
- Encouraging private sector participation in water technology development and extension, urban water distribution, and waste water treatment.

The element common to all these problems is that their solution requires effective and cohesive implementation of water sector policies and programs. A recent ministerial reorganization that brought together agriculture, water, and environment under the Ministry of Agriculture, Equipment, and Environment was meant not only for enhancing administrative cohesion between water and agricultural sector agencies but also for pursuing an integrated approach towards water quantity and quality management. However, following 1998 elections, this situation was reversed where Agriculture and Environment are now two separate ministries and Environment is now a department in the Ministry of Territories.

The ongoing programs for canal lining, pressurized canal water supply, and the application of sprinkler and drip systems need to be pursued still more vigorously to enhance water use efficiency and conservation. The urban water conservation achieved in cities like Rabat thanks to demand-side management instruments including price policy and water education has to be extended to other urban centers. The recent agreement that a French company had with the city of Casablanca for water distribution has generated considerable interest among other major cities for similar privately managed water supply arrangements. Private consulting firms--both domestic and foreign--have tremendous service, technology, and investment potential for participation in various water-related activities including waste-water treatment for reuse. As Morocco begins to consolidate the implementation capacity of its water institutions and exploit available local and private sector organizational, technical, and financial capabilities, it will be relatively well placed to gain from an improved water sector performance in the coming years.

Israel

Israel, a tiny but one among the most innovative countries in water management, is stretched along the eastern Mediterranean coast covering an area of about 0.002 million sqkm and a population of 5.7 million. The mean annual precipitation varies from 355.6 mm in the north to just a 25.42 mm in the southern desert. Of the total water supply of 1.93 bcum, 82 percent represent fresh water and the rest are treated effluents (12 percent) and brackish water (6 percent). As Israel has already exhausted its fresh water supply, the only additional supply sources available within its borders are the indirect supplies from treated sewerage and water saving effected from strict demand-side management (Arlossoff, 1997a:8). Of the total water demand of 1.93 bcum (same as the supply), the respec-

tive shares of agricultural, domestic, and industrial sectors are 63, 30, and 7 percent. Since domestic and industrial sectors have higher priority, the fresh water allocation to agriculture is declining but the allocation of brackish and treated sewerage waters is increasing. With relative water scarcity and high cost of fresh water for irrigation, the irrigation sector (0.23 mha) is constantly substituting capital and technology for water. With the overarching concern for supporting population settlements, Israeli water sector, oriented initially towards its irrigation segment, has now shifted its focus on its non-irrigation segments.

Being small, Israel has a unitary form of government. The 1959 water law that makes water a public property remains the foundation for present water policy and water administration. The Water Commission (WC), previously under the Ministry of Agriculture (MOA) but now under the Ministry of Infrastructure (MOI), implements the water law, plans, develops, allocates, and manages water, and sets and annually revises water prices with the approval of a special parliamentary committee. Apart from the MOA and MOI, both the treasury and commerce ministries also have a strong influence on the water sector. At the operational level, the WC relies on Mekorot, a state-owned water company that produces and distributes around 70 percent of water supply in the country. Mekorot operates the National Water Carrier, the pipeline system that moves water southwards from Lake Galilee to Negev desert. In recent years, Mekorot has also entered in spheres like urban water retail, sewerage treatment, and sea water desalination. The WC receives technical planning as well as research and development support from Tahal, a large engineering consulting firm. Although this firm used to be the official and sole water planner for the past 20 years or so, now it is made to compete with other engineering companies within Israel to obtain project contracts from government.

Although water policy and administration are centralized with considerable political overtones, the water sector in Israel is subject to a much stronger economic influence than its counterparts in other countries. This is partly due to metered volumetric allocation and partly due to a relatively stricter economic water pricing system. While intersectoral water allocation is done administratively on political grounds to favor domestic and industrial sectors, water prices in these sectors are higher and cover full costs. Even though irrigation water is subsidized, the subsidy has declined from 75 to 50 percent since the progressive block rate pricing introduced in 1987 that penalizes large and fresh water consumers (Yaron, 1997). Water wastage is the least in all sectors and water productivity has increased more than 250 percent in agriculture and 80 percent in industry. While Israel has one of the best performing water sector in the world, it still faces crucial challenges most of which are characteristic of a mature water economy operating in an acute water stress condition. These challenges include:

- Addressing the potential side-effects for increasing brackish and waste water use in agriculture (e.g., groundwater contamination, soil sanity, and health hazards);
- Allowing and facilitating the exchange of water permits to promote market-based water allocation and compensation;
- Redefining the role of public agencies to avoid centralization and permit private sector participation;

- Making WC free from political pressures and rebuilding its own planning and regulatory capabilities;
- Building consensus on crucial areas of disagreement (e.g., supply augmentation through water transfers from Lebanon and Turkey and sea water desalination, installing national/regional carriers for saline/waste water collection and distribution, and decentralization and privatization of Mekorot); and
- Sharing water with Jordan and the Palestinian Authority and creating institutional structures for the joint management of shared groundwater aquifers.

Most of the issues, except the last three, have been addressed by the 1997 report of the Public Commission on Water Sector (Arlosoroff, 1997b). With an already exhausted fresh water supply, an estimated future annual growth in water demand of 0.03 bcum means the inevitable need for costly options like sea water desalination. However, the immediate adoption of this option can bury the scope for considerable water saving through effective demand management and market-based inter-sectoral transfers. It is, therefore, necessary to first undertake water sector reform that can permit a strategic short-run delay so as to pave a strong long-run economic and institutional foundation for the eventual adoption of the desalination option (see Arlosoroff, 1997a and 1997b).

The heart of the Commission's reform proposal involves market-based approach and privatization within a strong regulatory framework. A legislative proposal, which is currently before the Israeli parliament, aims to enhance private sector role in areas like urban water distribution, operation and maintenance, and sewerage treatment. There is an increasing support for the promotion of market-based water allocations as well as the adoption of pricing schemes that include also a shadow price (rent) for water as a resource (see Kislev, 1993). While the eventual need to share the scarce water with the Palestinian Authority is recognized, academic efforts outside the official circle are afoot to explore feasible joint management mechanisms for managing shared aquifers within the existing institutional set-up (see Feitelson and Haddad, 1995).

South Africa

South Africa, a country building a democratic polity out of an erstwhile apartheid system, covers an area of 1.3 million sqkm and a population of 42 million. Mean annual precipitation is 497 mm. The total utilizable water resource potential is 35.4 bcum--30 bcum from surface and 5.4 bcum from sub-surface sources. Of the total potential, 50 percent of surface water and 37 percent of groundwater are already developed and utilized [Department of Water Affairs and Forestry (DWA), 1985]. As to the inter-sectoral share, agriculture accounts for 55 percent, domestic sector for 8 percent, and mining and industrial sectors for 16 percent with the rest is being to meet environmental needs. Although the irrigated area of 1.3 mha--1.1 mha by surface water and 0.2 mha by groundwater--represents just 10 percent of the cultivable area, irrigation cannot be expanded much beyond due to the limited availability of irrigable lands [see Water Research Commission (WRC), 1996:28]. Of the total irrigated area, 44 percent is under private (mostly groundwater) irrigation, 30 percent is under irrigation boards, and the rest is under public irrigation (WRC, 1996:35). The use of irrigation technology is very high in South Africa as indicated by the area

shares of sprinklers (54 percent) and micro irrigation (12 percent). Human right and socio-economic issues that become important in the new South African setting have reoriented the focus of water sector from its power, mining, and industrial segments towards its irrigation and domestic segments.

South Africa has a three-tiered federal system with national, provincial, and local governments. According to the new Constitution, water resource planning and development functions are with the national government whereas agriculture, the major water user, is with the provincial governments. The local municipal governments have the responsibility for domestic and industrial water supply. The water sector in South Africa is undergoing radical changes due to the new water law that forms part of an overall process of post-Apartheid economic and political reconstruction. As a result, the 1956 water law is going to be soon replaced by a new law currently at the approval stage. The new law that aims to correct existing inequalities in the water sector defines a modern framework conducive for decentralization, market-based water allocation, full cost recovery, and economically rooted water management (see DWAF, 1997).

Although the law makes water resource as a public property, it does allow private and tradable use rights obtainable through application from the DWAF. While the law aims to reorient and strengthen existing water administration including research organizations, it also calls for the creation of new structures like basin entities (e.g., the Catchment Management Agencies) within which existing water distribution agencies like irrigation boards and municipalities will participate as stakeholders along with farmer groups. Although WUAs are there at present only in the sugarcane zones and in the public irrigation systems having farmer liaison committees, they are to play an active role in water distribution and management in future. In urban sector, utility-type autonomous organizations are planned. The water courts created under the earlier law are to be replaced by more accessible Natural Resources Courts and any conflicts not solved either by these courts or by the DWAF can go to regular courts for their resolution. Since these reform proposals address most of the traditional water sector concerns, they, if implemented effectively, could vastly improve the capability and performance of the water sector. The key challenges facing the South African water sector at present are, therefore, related essentially to implementation aspects like:

- Building technical and information capacity within the water sector;
- Modernizing existing projects to allow volumetric allocation and improve delivery efficiency necessary for the eventual introduction of the proposed water permit system;
- Enhancing the regulatory and monitoring capabilities of the DWAF for establishing permit-based water allocation system;
- Developing strong WUAs as an organizational basis for water distribution, system maintenance, cost recovery, water transfers, and conflict resolutions;
- Achieving high degree of coordination not only among various layers of water administration--both the existing and the proposed ones--but also among various levels of government;
- Resolving the conflict between the economic goal of full cost recovery with the equity goal of supporting the underprivileged; and

- Integrating water quality and ecological concerns within the system of private and group-centered water allocation and management.

The document titled as the 'Fundamental Principles and Objectives of a New Water Law in South Africa' as approved by the Cabinet in November 1996 provides an agreed framework for a new water law. Similarly, the 'White Paper on a National Water Policy for South Africa' prepared by the DWAF (1997) outlines the contour of a new water policy. Notably, both these documents give top priority for capacity building, information gathering, and human resource development in water sector. The critical need to link existing research, training, and technical agencies--both in the public and private sectors--with the main line water administration is recognized. As a way of promoting regulatory/monitoring specialization within water administration, there is also a recent proposal for creating a National Public Water Utility for the express purpose of financing, developing, and operating all water infrastructures in the country (see DWAF, 1997:29).

The relative success of water boards, the regional public utilities for bulk water supply, has led to the proposal for the creation of new regional water utilities. Some of these proposals have already been crystallized as in the case of Lesotho Highlands Water Project and Komati Basin Water Authority. Water charges, which are prevalent only in public irrigation at present, will be increased and extended also to private irrigation to cover not only the operation and maintenance (O&M) and capital costs but also other components like research levy and water conservation/management fees. To preserve equity, water charges will vary by regions and projects with an added scope for subsidizing the poor on the demand rather than on the supply side.

One of the major gaps in the reform proposal is related to water use-induced environmental effects including waterlogging and salinity that are serious problems in a quarter of the area currently under irrigation. Under the present set-up, it is not clear whether it is the national or provincial governments that will address these problems as both have concurrent responsibility in environment management. This issue, like the general issue of achieving administrative and operational coordination in water management, can, however, be addressed by establishing effective liaison committees. The major reform challenge lies in achieving the equity goal of water redistribution to favor the hitherto neglected groups without creating uncertainty among investors. However, if the reform proposals are operationalized in their original form without much political compromise, South Africa can be in a stronger position than many African and Asian countries to improve its water sector performance.

Sri Lanka

Sri Lanka, an island nation in the Indian Ocean, covers an area of 0.066 million sqkm and a population of about 17.6 million. Although annual average precipitation is fairly high at about 2000 mm, in view of its seasonal concentration and the drainage-related topography of the country, its water supply implication is somewhat limited. The total water resource potential of the country is estimated at 43 bcum. The total amount of water withdrawal is 6.3 bcum per year. Irrigation uses about 92 percent of the water with the rest being used for meeting domestic and industrial uses, 0.1 and 7.9 percent, respectively. (World Bank,

1997: Table 10, pg. 232). The irrigated area is about 0.595 mha. The composition of irrigated area is as follows. Medium and major surface water schemes (0.30 mha) (command area 80-600 ha and > 600 ha respectively), which are under public surface irrigation systems (there are no private surface irrigation systems) maintained by the Irrigation Department and Mahaweli Authority. Minor surface water schemes (0.235 mha) (command area <80 ha) which are supposed to be maintained by the farmers under the technical guidance of Provincial Irrigation Departments. Groundwater irrigation using shallow open-dug wells mainly in the North-Western, Northern and North-eastern areas covers 0.060 mha, which are 100 % privately owned by individual farmers.

Since 80 percent of the industrial units are located in and around Colombo, the capital city, industrial water use in Sri Lanka is essentially a part of the water supply task of this city. Although urbanization is not a serious problem (as 80 percent of the population is either rural or semi-urban), domestic water supply needs are also growing. With limited water resource potential, water deficit projected for the year 2000 is 0.2 bcum in Mahaweli development regions, 0.92 bcum in the Southwest dry zone, and 1.4 bcum in the northern dry zone [see Water Resources Council (WRC), 1997:3]. Since hydro-power accounts for about 75 percent of the country's energy supply, the non-consumptive use of power generation is also equally important. Despite the growth in non-irrigation needs, the continuing importance of irrigation for both food self-sufficiency and farm exports keep the focus of the Sri Lankan water sector almost exclusively on its irrigation segment.

Sri Lanka, formerly with a unitary form of government, has adopted the federal system through a constitutional amendment in 1987. Following the constitutional amendment, water sector responsibilities were divided between the central government and provincial councils in 1990. While intra-provincial irrigation planning, implementation, and management are with the provincial governments, the responsibilities for inter-provincial irrigation schemes and overall water resource planning, water storage, drainage, and flood protection are with the union government. However, the definition of authority with respect to domestic and industrial water supply, and recreational needs continues to remain blurred (Upadhyay, 1996). Although the Water Resources Board Act (No. 24 of 1964) authorizes Water Resources Board to control, regulate and develop as well as conserve and protect water resources including groundwater, it has failed to fulfill its mission. At present, although Irrigation Department and Mahaweli Authority regulate and control surface water development and use, management of groundwater resources is no one's responsibility.

Of some 40 government agencies that wield a varying degree of influence over the Sri Lankan water sector, seven are most important as they form the core of water administration at the national level (see Nanni, 1996). The Ministry of Irrigation, Power, and Energy and the Ministry of Mahaweli Development are both responsible for water resource planning and irrigation development. The National Water Supply and Drainage Board and the Urban Development Authority--both under the Ministry of Housing, Construction, and Public Utilities--are responsible for domestic and industrial water supply.

Since there is no single agency responsible for groundwater development and use, Agriculture department as well as National Water Supply and Drainage Board, Ministry of Industries, private industries and groundwater farmers are engaged in groundwater development and use without any legislative or administrative control. The Central Environment Authority under the Ministry of Transport, Environment, Forest, and Women Affairs is responsible for all ecological aspects of water development including water quality.

There are inter-ministerial bodies (e.g., the Central Coordination Committee on Irrigation Management and the Steering Committee on Water Supply and Sanitation) to promote coordination in specific segments of water sector. However, neither they are effective in ensuring administrative cohesion nor can be a substitute for the currently missing national level body needed for sector-wide coordination, allocation, and management. While over 50 different acts influence the water sector, Sri Lanka has neither an enacted water law nor a declared water policy needed to provide the legal framework for an integrated approach to water resources management. A draft Water Resources Bill being discussed since the early 1980s, though not adopted, has all the right ingredients for a modern water law. The Bill advocates water permit systems, full cost pricing, inter-ministerial Water Resources Council (WRC) as a coordination mechanism, and water courts for conflict resolution (see World Bank, 1992:168). Recently, with the technical and financial support from donor agencies like the Asian Development Bank, Food and Agriculture Organization, and technical support from the International Water Management Institute (IWMI), the government is planning a major change in the legal and administrative spheres of the water sector. The Action Plan for Comprehensive Water Resources Management that calls for the development of water policy, water law, autonomous water administration, basin planning, and water information base (WRS, 1997:3) has suggested the creation of both the WRC and its executive organ, the Water Resources Secretariat (WRS). Both the WRC and WRS have already been established as transitory arrangements to advise, develop, and oversee a permanent institutional arrangement.

While macro level institutional changes are gradually building up, there are significant micro level initiatives particularly in the irrigation sector. When the failure of cost recovery attempts initiated in 1984 has become transparent in 1989, the government adopted the policy of turning over the overall management responsibilities to legally registered WUAs. With policy and technical inputs from international organizations like IIMI, specialized agencies within both the Ministry of Irrigation and the Ministry of Agriculture have played a concerted role in promoting WUAs. By March 1997, 757 WUAs have been registered with an operating area of 85700 ha [Mahaweli Economic Authority (MEA), 1997]. Notably, following the government policy of promoting women WUAs initiated since 1995, there are now 249 women WUAs excluding 149 other active women organizations in rural areas.¹ Since the WUAs are registered under the Agrarian Services

¹ As was commented by a reviewer, One has to be very cautious in reporting the number of WUAs for a number of reasons; (i) the WUAs that are discussed in the write-up are in major schemes and do not refer to farmers organizations in medium and minor schemes; (ii) the statistics of WUAs vary from report to report; (iii) except in Mahaweli, most of the WUAs have been formed under donor funded projects. A large majority of these WUAs have become defunct or weak after the projects were

Act, they can obtain loans from banks and serve as the organizational basis for an integrated delivery of water with other farm inputs and extension services. The Project Management Committees--functioning as the top layer of WUAs at the system level--have also been promoted to vertically integrate the process of user participation in irrigation management. Although there are notable management improvements in the turned over areas, many key problems like the following continue to disturb the overall performance of the Sri Lankan water sector:

- Achieving a national consensus for expediting the creation of the institutional arrangements outlined in the Action Plan;
- Developing the implementing rules for water law including the creation of allocation and regulatory mechanisms as well as water and pollution permit systems;
- Linking the macro level allocation and regulatory mechanisms with their project and local level counterparts like WUAs;
- Reviving, creating, and strengthening basin level organizations through a concurrent process of debureaucratization and stakeholder participation;
- Advancing management decentralization in irrigation sector and expanding it to cover urban water sector particularly through the creation of administratively autonomous and financially self-dependent water utilities;
- Building the necessary technical, managerial, and informational capabilities;
- Addressing major sustainability concerns like catchment degradations, groundwater depletion, and water quality deterioration, and;
- Increasing political commitment of government for cost recovery in irrigation.

Addressing the macro and micro level institutional issues is the key for realizing the overall goal of creating a market responsive, financially self-dependent, and environmentally sustainable water sector. Although environmental legislation has adequate provisions for ensuring required safeguards, they need to be strengthened further with realistic water quality standards, complementary institutions, and, above all, political commitments (Ratnayake, 1997). Potential influence can be expected from the ongoing, Bank-funded Mahaweli Restructuring and Rehabilitation Project (MRRP), and proposed Land Titling Project/Water Entitlements Study in resolving some of those issues. The Mahaweli Authority was not converted to Mahaweli Ministry. Instead, a new `Mahaweli ministry was created to oversee the Mahaweli Authority. The ongoing MRRP has helped the Mahaweli Authority to reduce its redundant staff from 10,000 to 4,000 and would assist it to become a River Basin Agency.

The blue print for a new institutional structure developed by the WRC and WRS, though could not be established by 1998 as initially planned, is now expected to be put in place by the year 2000 (see Berkoff, 1997). The cascade system of water use, where

closed; (iv) Under the World Bank-funded, ongoing NIRP about 1,100 farmers organizations have been formed in 1000 project's minor schemes and 34 medium major schemes - a large majority of them are organizationally and financially weak; (v) although WUAs in major schemes are usually participating in decision making with respect to seasonal cultivation planning and water release planning and monitoring, there is no significant evidence that they are self-financing the O&M of `taken-over' irrigation facilities.

the water wasted in upper reaches gets used and reused at lower reaches, ensures a high level of physical water use efficiency of up to 80 percent. But, economic efficiency in water use can be achieved only with a carefully structured water permit system implemented through the WUAs. While the institutional changes planned under the Action Plan could enhance the role of WUAs, the government has to continue with its current efforts to expand WUAs to cover all large irrigation schemes.

Although Sri Lanka has a long experience with basin level planning and organization, the dissolution of earlier basin organizations like Gal Oya and the recent conversion of Mahaweli Development Authority into a Ministry lead to a reversal of its declared policy of management decentralization. However, as a part of its declared commitment for promoting private sector participation, the government, in 1997, has piloted the operation of a water company with shares owned by farmers and farmer groups in the Ridi Bendi Ela area. Since most part of the farmland in Sri Lanka belongs to the state (60% state owned), the objective promoting private sector participation is linked with land privatization. That is, as a part of its commitment to reform its water institutions, Sri Lanka has to also adjust its agrarian laws and policies. With the creation of the proposed institutional structures at the macro level and the consolidation of management decentralization and privatization efforts initiatives at the micro level, the Sri Lankan water sector will be favorably placed to adequately meet its water quantity and quality challenges of the next millennium.

Australia

Australia, a thinly populated continental country, covers an area of 7.7 million sqkm with a population of just 18 million. The annual average precipitation is 465 mm--the lowest among continents--but varies widely from 200 mm or less in the two-thirds of desert inland to 2400 mm or over in the one-third of the country forming the east and north coast of the continent. The total exploitable water resources potential is estimated at 188 bcum--117.6 bcum of surface water and 70.4 bcum of groundwater (Pigram, 1986:23&27). Current use, however, forms only less than 20 percent of the surface and 10 percent of the sub-surface water resource potential. Such a low level of utilization is partly due to water quality constraints and partly due to spatial inconsistency between water availability and water demand. Of the 12 drainage divisions, only five covering just 26 percent of national territory accounts for 88 percent of the total exploitable water resources. Agriculture accounts for about 80 percent of the total water use and irrigates about 1.7 mha. Almost four-fifths of this irrigated area is concentrated in the Murray-Darling basin--the major inter-state river basin covering parts of New South Wales (NSW), Victoria, and Southern Australia. While the water sector in Australia, as in most countries, is oriented towards its irrigation segment, urban as well as recreational and ecological concerns still remain on top the of water sector agenda.

Australia is a federation or commonwealth of government with highly autonomous states. Although the states have the constitutional responsibility for water resource management, nevertheless, the central government also has a considerable influence on the water sector. The main conveyers of such influence are the financial leverages and the

generally subscribed practice based on the mutually accommodative principle of ‘cooperative federalism’ (see Pigram, et al., 1994). In view of state-specific variations in water issues and institutional features, national level generalization can be difficult. However, the 1994 Water Reform Agreement of the Council of Australian Governments (COAG) that aims to unify and strengthen both state and national level water institutions can still justify a national level perspective of water institutions in Australia. Since it is useful to provide a state level perspective, NSW, the state located in the economically and politically most important region of south-eastern Australia, is considered as a representative case for both the broad national level water sector concerns and past and ongoing state level institutional responses.

In view of strong British tradition and common law influence, the water institutions of Australia originally had features suitable more to a water abundant situation than to the dry reality prevalent in larger parts of Australia. Although these institutions underwent a process of natural evolution in line with changing water resource realities, a series of deliberate reforms effected since the late 1980s has led to some metamorphic changes (see Musgrave, 1997:17). The riparian system of water use was replaced by water license system which, over time, allowed quantitative entitlements, metered supply, and volumetric pricing of water (see McGlynn, 1997). These licenses are issued and regulated by government departments [e.g., the Department of Land and Water Conservation (DLWC) in NSW]. Although these licenses were originally attached to land, the reforms undertaken in the 1980s have enabled them to be transferable creating the basic framework not only for cost recovery but also for the emergence of water markets.

Water is metered widely and pricing is based on volumetric consumption. The water charges, which were lower and subsidized as in most other countries, have been increased following the recommendation of the Industry Commission’s Report of 1992. Water charges usually include an access/license fee, volumetric use charge, and a ‘management fee’ in irrigation sector but a ‘refurbishment fee’ in urban sector. Inter-state and inter-regional issues are addressed through river basin organizations operating within an inter/intra-regional allocation framework conducive for market-based solutions. Community involvement is also very high due to the economic stake being created by volumetric water license system and high level of literacy. In general, the NSW water sector in particular and Australian water sector in general have one of the best institutional arrangements that not only delineates the respective sphere of influence for various government layers and water sector stakeholders but also promotes a desirable mix of administrative regulations and economic instruments. Although water institutions in Australia are far more advanced than that in many other countries, they are not immune to the constant strains engendered by the physical of limits to water resource potential. The demand pressure on available water resources has become intense especially after the legally mandated water entitlements for environment (i.e., to maintain water quality and in-stream water needs). As such neither the water sector is free from serious problems nor are the existing water institutions adequate to meet all future water allocation challenges. The outstanding problems facing the Australian water sector are:

- Maintaining water quality and protecting water-based ecological systems;

- Controlling further stress on the already expropriated rivers and depleted aquifers;
- Fine-tuning the institutional basis for water sharing and market-based allocation;
- Extending the substitution of economic instruments for administrative regulations;
- Reshaping the relationship between government and community on the one hand and the government and private sector on the other hand;
- Improving the physical health of water storage and distribution infrastructures; and
- Enhancing the financial and investment self-dependency of the water sector.

All these are challenges facing a maturing water economy that tries to operate increasingly on an economic rather than on an administrative or political realm. Most of these issues are being addressed by the reform initiatives undertaken since 1994 when the Water Reform Agreement was signed by the COAG. The key components of the agreement are: improving water quality and environment, refining water rights system and water allocation procedures, pricing water through independent review, and promoting community participation (see DLWC, 1998:1). Since compliance with these principles entails attractive federal money, most states have already come out with time-bound action plans for initiating additional water sector reforms. The NSW government is the first to establish the Independent Pricing and Regulatory Tribunal for reviewing the water pricing process and also to have both a comprehensive reform package as well as a framework for its implementation. As part of its reform initiatives, NSW has adopted a three level stress-based classification of its rivers and aquifers as the framework for controlling water pollution and water over-exploitation. The state has also constituted the Healthy River Commission with the task of monitoring and maintaining water quality and in-stream flows in all stressed rivers. Community-based Water Advisory Councils have been established both at the state as well as at the level of all stressed river and aquifer areas with the express purpose of involving users in the water sector reform process (see DLWC, 1997a and 1997b).

Another very unique experiment involving inter-state initiative to control water stress and water quality deterioration is the agreement reached by the Murray-Darling Basin Ministerial Council in 1995 calling for a collective cap on water extraction at the 1993-94 level. It is certainly a difficult challenge to reverse water use to a reduced level observed in the past. But, both the existing system of volumetric water allocation across regions, sectors, and individuals as well as a high level of political commitment prompted mainly by an imminent threat to everyone within the basin enhance the prospects of achieving the agreed cap. There are also notable developments at sub-sectoral levels. Corporatization, i.e., the conversion of public water utilities into commercially viable autonomous entities, and privatization are also increasing both in the urban (e.g., Hunter Water in 1991 and Sydney Water in 1994) as well as in the irrigation (e.g., Murray Irrigation Area and Coleambally and Murrumbidgee Irrigation Area in 1997) sectors (see DLWC, 1997a:8). The ongoing institutional changes in Australia are going to further strengthen the role of economic instruments and market-based water allocation while, at the same time, improve the physical health and sustainability of water sector.

China

China, a country of continental size with the world's highest population, covers an area of 9.6 million sqkm and a population of about 1.2 billion. The annual average precipitation is 648 mm. The renewable water resource potential, which was originally estimated at 2812 bcum--1989 bcum from surface and 823 from sub-surface sources [see Ministry of Water Resources and Electric Power (MOWREP), 1987], has been recently revised upwards to 3540 bcum--2711 bcum from surface and 829 bcum from sub-surface sources (Zhang Hailun, Personal Communication). Recent estimates also place total water withdrawal to be about 511 bcum--425 bcum from surface and 86 bcum from sub-surface sources. As to the inter-sectoral break-up of total water use, the respective shares of agriculture, domestic, and industrial sectors are: 73.4, 9.2, and 17.4 percent. The irrigated area of about 51 mha--42 mha by surface water and 9 mha by groundwater--represents 51 percent of the cultivated area and 80 percent of the potentially irrigable area in the country. The non-consumptive uses of water are also important for hydro-power generation (18 percent of total energy) and inland water-borne freight traffic (42 percent of total freight traffic) in China [see Economic Commission for Asia and the Pacific (ESCAP), 1997:26-27]. While non-irrigation needs are projected to increase steadily by 5 percent as against just a 0.5 percent growth for irrigation use [Nanjing Institute of Hydrology and Water Resources (NIHWR), 1996], the ever crucial food supply and rural income considerations tend to orient the Chinese water sector towards its irrigation segment. This picture cannot be completed without referring to several issues that characterize the water sector in China: First, the water availability in China is unevenly distributed across major provinces. For example, China's total water resources are 2,100 cum/year per capita. But the Hai, Huai, and Huang River Basins with 34% of China's population and about 42% of its irrigated land, have a limited amount of water resource reaching 310 cum per capita. Second, China is a drought and flood prone country, which is affected frequently and severely. These two fact may shed more light on the situation of the water sector in the country.

China has a centralized political system with considerable decentralization of power across the five layers of government at the national, provincial, prefectural, county, and community levels. In water sector, legislative and regulatory powers as well as planning and development responsibilities are with the national government but actual management and maintenance functions are with lower level governments depending upon the size and location of projects. Although the ministries of agriculture (influencing irrigation), geology and minerals (controlling groundwater), and rural and urban construction and environmental protection (controlling domestic water supply and water quality) have a strong influence on the water sector, it is the Ministry of Water Resources (MOWR)--carved out of the erstwhile Ministry of Water Resources and Power in 1988--that forms the core of the national level water administration in China. The next level administrative organs are the seven Water Conservancy Commissions (WCCs), which are essentially the regional administrative arms of the MOWR, designed to manage inter-provincial river basins and lake zones. While the administrative organs at the provincial, prefectural, and county levels are the departments or bureaus of water conservancy, the same at the community level are the water conservancy stations and Irrigation area congresses (similar in

spirit to WUAs). Although the water administrative organs are vertically integrated from top to bottom, there is substantial functional specialization and management decentralization across government layers. For instance, 77 percent of the total water projects in the country are managed at the county level and only the rest (inter-country and inter-provincial) are managed either at provincial levels or by the MOWR and its WCCs (Ke Lidan, 1997:655).

For enhancing inter and intra-ministerial coordination and solve inter-regional and inter-sectoral water conflicts, there is the National Leading group of Water Resources and Water and Soil Conservation Works, a high level inter-ministerial and inter-regional body chaired by the Vice-Premier. Similar coordinating bodies were also set up at lower levels. The basic mechanism for resolving water conflicts is based on mutual consultation and administrative mediation. Unresolved conflicts go to the next administrative levels and, if remain still unresolved, can go to the court. The 1988 water law, passed after a decade-long consultation, aims to strengthen the regulatory powers of the existing administrative system and formalize the existing mechanisms for management coordination and conflict resolution [see Peoples Republic of China (PRC), 1988]. It marks a fundamental change both in the water policy and water administration of China. Considering water as people's property, the law distinguishes clearly the management and allocation rights of the state from the use rights of the people. It calls for permit-based water allocation and full cost-based water charges. The law stipulates basin as the basic unit of water management and mandates the formulation of a national water plan including its regional and sectoral components. In many provinces, local water management laws and regulations area also in force (see Chen, 1992:179). While the 1988 law is unique for a socialist country, its implementation will not be easy, even in a socialistic system with a strong state control, because of the size of the country and its unique water sector with the dual problem of floods and droughts. The major challenges facing the Chinese water sector are:

- Protecting a tenth of the country--with a half of population and two-thirds of agricultural and industrial output--from the pernicious effects of periodic floods;
- Arresting flood-induced soil erosion affecting two-fifths of rural areas;
- Addressing the perpetual drinking water shortage in over 600 cities located mostly in the economically important northern part of the country;
- Controlling water pollution and its health and environmental effects that threaten 436 of the 532 monitored rivers in the country;
- Reducing groundwater depletion and pollution especially around Beijing and 20 other major urban centers;
- Resolving inter-regional/sectoral water sharing conflicts to maintain social stability;
- Strengthening administrative coordination to promote an integrated approach to floods, water shortage, groundwater, and water quality; and
- Creating the administrative and regulatory mechanisms needed for an effective implementation of water law provisions.

In 1997, the Chinese government has undertaken notable steps including the enactment of the Law of Flood Control and the declaration of the National Policy on Pollution Control and Aquatic Protection to address flood and pollution problems. Targets for

a unified management of water resources were also set for various water-related departments at all levels with the specific objective of integrating groundwater and water quality issues with the overall water management concerns. Still then, the administrative dispersal of responsibility continues to be a major hurdle in controlling water pollution and groundwater depletion. The State Water Industry Policy declared in December 1997 is a major step as it allows, for the first time, the entry of private and non-governmental organizations in water sector and also stipulates the operation of all public water projects on commercial lines (see PRC, 1997:1). While this policy complements and strengthens water law, it is necessary to create the administrative mechanisms needed for the practical translation of the legal provisions and policy intentions. Realizing this, the MOWR has already prepared the Master Plan of the Water Law and Regulation System as well as the Water Legal System Construction (see Ke Lidan, 1997: 642&645). While the issuing of water drawing permits is already in progress, the creation of the full institutional structures needed to support the permit-based water allocation system is expected to be in place by the year 2010. When this happens, China will be the first country to have a national level water institution centered on a legalized system of water allocation.

India

India, the second most populous and the seventh largest country, covers an area of 3.29 million sqkm and a population of about 960 million. Being a large country, the annual average precipitation varies from 130 mm in Rajasthan dessert to 11000 mm--the world's highest rainfall--in Assam mountains. The total utilizable water resource potential is placed at 1074 bcum--621 bcum from surface and 453 bcum from sub-surface sources--of which about 60 percent has already been developed. Of total water use, agriculture accounts for 84 percent with the rest being shared by domestic supply (5 percent) and industrial use (9 percent). The irrigated area of 86 mha--44 mha by surface water and 42 mha by groundwater--represents 76 percent of the ultimate irrigation potential and 46 of the area under cultivation. About 40 percent of the developed surface water is also used for the generation of hydro-power that represents 33 percent of total energy in India. Although non-irrigation demand is likely to quadruple due to population growth, economic development, and urbanization, the essentially rural and agricultural basis of Indian economy has oriented the water sector towards its irrigation segment. However, as discussed in the recent India Water Resources Management (WRM) sector review (World Bank-Government of India, 1998) burgeoning demands from other sectors and rapidly developing scarcity and water quality issues, makes comprehensive intersectoral water management, including across state boundaries, a critical need.

India has a federal form of government with a strong central government. But, in the water sector, both the development responsibilities and some of the legislative powers are with the state governments. However, the central government has some indirect leverages through its role in project clearance and inter-state dispute resolution. It also have a direct control over major planning and technical resources and organizations such as the Central Water Commission, the Central Ground Water Board, and the National Water Development Agency--all under the Union Ministry of Water Resources. Nevertheless, the lack of constitutional power makes the central government too weak to coordinate in-

stitutional issues at the state and inter-state levels, and achieving country-wide consensus on national policies has also proven difficult. Since legislative power, technical capabilities, planning skills, and operational responsibilities are dispersed across government layers, water institutions in India remains legally weak, functionally disjoint, sectorally biased, and regionally uncoordinated. While physical stress and financial crisis have exposed the legal, policy, and administrative weakness of water sector, myopic political issues and administrative resistance have impeded institutional change.

The two events that prompted a significant change in recent water policies are the drought of 1987 and the macro economic crisis of the late 1980s. The drought led to the first ever National Water Policy (NWP) of 1987. The austerity measures that followed the economic crisis reduced water sector investment and induced irrigation departments to look for internal resources from improved cost recovery and external resources mobilized through specifically created semi-autonomous agencies (e.g., Narmada Valley Development Authority and Krishna Valley Development Corporation). While the NWP advocates full cost pricing, the 1992 Committee on Pricing Irrigation Water suggests higher water charges and group-based volumetric distribution of canal water [Government of India (GOI), 1992]. The Model Groundwater Bill that advocates, for the first time in India, ideas like well permits, water metering, and withdrawal limits was circulated in 1992. Since irrigation departments have realized the value of farmers' participation in water distribution, cost recovery, and system maintenance, they are beginning to actively promote WUAs and system turn-over programs. Despite the commitments and efforts, the turn-over process has been very slow, with the area under WUAs less than 1% in the early 1990s. Significant policy efforts by central and state governments have occurred since then, and piloting is accelerating in states such as Orissa, Tamil Nadu and Rajasthan. Most notable have been the recent initiatives by Andhra Pradesh state which in 1997 issued a Farmers Management of Irrigation Systems Act and has subsequently turned over management of lower systems of the entire state surface irrigation network to some 10,300 farmers WUAs.

Recently, as part of the World Bank funded Water Resource Consolidation Projects (WRCPs), states like Andhra Pradesh, Tamil Nadu, and Orissa have restructured their water administration and formulated their own water policies. The Basin-type organizations are not new to India (e.g., the Damodar Valley Corporation and various river boards). But, the basin organizations which are being planned in states like Tamil Nadu are aimed not only to decentralize water administration on hydrological lines but also to make them as stakeholder-centered tools for water allocation and conflict resolution (see Oblitas, et al., 1996). While Indian water sector does show significant localized progress in key areas of water policy and water administration, the major performance challenges and institutional issues continue to persist.

Recognition of the progressively more serious water sector issues facing India in the new millennium led to a collaborative major review between the World Bank and Government of India of the country's water sector issues and strategy. The review (India, Water Resources Management, World Bank-Government of India, 1998a, 1998b, 1998c, 1998d, 1998e, 1998f) comprises five specialist reports and a synthesis report, tackling both the issues of intersectoral and interstate water management and the specific needs of

the major water services. Apart from the traditional water sector concerns like cost recovery, system health, and use efficiency, the issues of importance from an institutional perspectives of intersectoral and interstate issues are:

- Enhancing the legislative power and coordination capacity of the central government to encourage concerted initiatives within water sector;
- Legislating water laws based on the principle of water as an economic good, full cost payment, and use rights essential to support market-centered approaches;
- Formulating national, regional, and sectoral water plans as the basis for establishing regional and sectoral water allocations or entitlements;
- Establishing both central, state, and basin level mechanisms for negotiation-based conflict resolution and payment-based water allocation;
- Strengthening water administration both through a sharper functional focus and broader disciplinary basis as well as with the application of modern management technologies;
- Modernizing the storage and distribution systems conducive for accurate water measurement and efficient delivery; and
- Promoting coordinated decentralization necessary for participatory water resource management within an integrated economic framework.

Since existing center-state organizations (e.g., National Water Resource Council and National Development Council) are ineffective to promote inter-state coordination in water resource management, it is necessary to bring water into the concurrent² list so that the central government can be a vehicle for coordinated institutional changes in the water sector. This means a dose of centralization can be strategically useful to advance the cause of 'coordinated decentralization'. In recent years, the interest in privatization is also growing. A high level committee appointed by the central government in 1994 has made favorable recommendations for private sector participation (GOI, 1995). Few states have already tried to exploit private investment directly by inviting bids for project construction and indirectly by establishing autonomous corporations for mobilizing private funds through public bonds (Saleth, 1996:271-272). With maturing WUAs and extensive adoption of water measuring devices, both the technical and organizational scope for the practical application of a water rights system is increasing. Since the key issue before the Indian water sector is not resource development but efficient allocation and utilization, the overall thrust of institutional reforms in India should be on an increasing reliance on economic incentives rather than on the usual administrative mechanisms. Given the kind of institutional challenges that India faces, they need to be addressed better in order to prevent it from taking too long before the impact of these institutional changes can be felt on water sector performance.

SELECTED BEST PRACTICES

The best practices are important as they help in unraveling the general principles underlying success stories. The best practice cases observed among the sample countries occur in

² While this concept is palatable, it probably will be difficult to include it in future reforms.

all water sub-sectors and cover all facets of water institution. Generally, these practices are of two types, i.e., those to be emulated within the country of occurrence and those to be emulated beyond the country or countries of occurrence. Besides, some of these practices (e.g., the basin organizations in China and Spain), though not the best under present conditions, have the potential to become the best with suitable modifications (e.g., by enhancing their autonomy and user participation). Again, in the same case of basin organization, we also have a whole spectrum of variations in terms of both organizational basis (compare the case in Morocco with that in Australia or China and Spain) and operational effectiveness (compare the case of Spain and China with that in Australia). With these points in mind, some of the prominent best practice cases observed in one or more of the sample countries can now be identified.

Mexico offers three best practices. They are the irrigation management transfer to WUAs, the formation of three basin organizations, and the system of water permit registry. While the second practice is worthy of replication elsewhere in the country, others are worthy of emulation at the international level. The most noteworthy feature of the Mexican turn-over program is the speed with which it was implemented and the extent to which other supportive legal and administrative changes were effected both before, during, and after the turn-over process. The Mexican experiment, though offers support for the big-bang approach to turn-over, indicates the indispensability of both a high degree of political will and farmers' cooperation for the success of this approach. Unlike the turn-over program, the initiatives for basin organizations came from few provincial governments and the main inducement came from a threat of unprecedented water pollution and depletion problems within the basins concerned. Since the registry of water permits, which is maintained at all levels, keeps the record of quantified permits for both surface and sub-surface sources, it can ensure one of the key technical requirements for the operation of water markets. But, legal changes are needed to explicitly allow change-of-use and encourage, thereby, water transfers both within and across sectors.

Chile offers three major sets of best practices. The first set consists of practices that facilitate market-based water allocation like transferable water use rights, registry of water rights, user-based two or three-tiered organizations (in irrigation sub-sector), and the administratively enforced third-party protection. The second set that supports project viability consists of a clear demarcation of responsibility between water administration and users, project construction being conditional on prior payment commitment from users, and the mandatory formation of user organizations up to the project level. The third set that improves the performance of urban water sector consists of de-bureaucratization and privatization of urban water supply agencies, full-cost pricing with protection of poor consumers through demand rather than supply-side subsidy, and the mandatory treatment of urban sewerage to protect water quality. The major problems requiring immediate solutions are the deleterious 'crowding out' role that the power companies play in water rights allocation, non-use of water rights mostly by power companies, and the bureaucratically rooted conflict resolution mechanisms.

The best practices that Brazil offers include its region and sector-specific water strategies where regions and sectors are classified and prioritized in terms of their relative

water quantity and quality problems. Another possible practice that needs greater articulation and extension within Brazil is the program for 'water democratization' aiming at promoting user participation. While the constitutional division of federal and state waters provides a legal basis for federal-state coordination, a more effective way of achieving this at the operational level requires both the basin level organizations like 'watershed committees' and inter-state mechanisms like 'water resources councils'. Other federal countries with similar problems like India can learn much from Brazilian experience regarding what to do and what not to do in delineating the water sector responsibilities of different government layers.

The best practices in Spain can be observed both at the macro and micro levels. At the macro level, the most notable one is the practice of inter-regional water transfers. Although these transfers are effected through basin-based water administration, they can function as a potential administrative framework for market-based inter-basin water transfers. There are already cases for such economically-rooted water transfers between regions. Besides, the practice of basin level organizations making inter-sectoral allocations within their respective jurisdictions, though yields essentially an administrative allocation, also qualifies for a best practice in so far this practice advances decentralized allocations. At sub-sectoral levels is the growing practice of encouraging urban water supply agencies (e.g., Canal Isabel II in Madrid) to be autonomous and financially self-dependent. At the local level are the well known traditional community-based water allocation systems operating in Valencia as well as the extensive water markets observed in Canary Islands. The Valencia system, evolved since the Arab invasion of Spain, is known for its local level conflict resolution and an almost quantitative inter-farm water allocation effected without water meters. Although technologies are complementary to water institutions, the Valencia case where water measuring technology is being substituted by social organization suggests that there is an economically relevant margin where institutions and technology can be substitutable.

The best practices in Morocco are observed mostly at the sub-sectoral level. They include both the granting of autonomy to financially self-dependent urban water supply agencies and the privatization of urban water supply in cities like Casa Blanca. Similarly, the use of a revolving fund for providing loans to urban consumers for water meter installation and water appliance upgrading is also an innovative practice of making users to self-finance conservation. In irrigation sub-sector, the Moroccan basin organizations are unique as some of them do not have any river system. These organizations are essentially project based and hence, cover both the hydrological boundaries and demand areas including agricultural zones. Unlike the basin organizations observed elsewhere, those in Morocco are managed by the agricultural agencies and are used as the organizational means for integrating the provision of farm inputs with water supply--an approach so crucial for enhancing water productivity and farm output. More importantly, these organizations also play the role of assigning inter-sectoral water entitlements within their area of responsibility.

Israel, being one of the most water-wise innovative countries in the world, offers a range of best practices covering all facets of its water sector. Israel is noted for its water

conscious users and policy-makers. The application of water conservation technologies and cropping systems is quite extensive leading to a high productivity of water in value terms. Similarly, although inter-sectoral water allocations are still based on administrative means due to unavoidable socio-political reasons, water pricing is based increasingly on sound economic rationale (e.g., full-cost pricing in urban sector and the three-part progressive tariff in irrigation sector). Other best practice cases include the proposal for a selective privatization of water administration and the unmistakable tendency towards water recycling and reuse. While most of these practices are the outcome of the precarious water supply regime on which the country is based, they have useful lessons for other countries that are going to face a similar situation in future.

Most of the best practices in South Africa are in the legal provision of the proposed water law. These provisions include the creation of a market-based water sector and the imposition of water charges to cover not only the O&M and capital costs but also the cost of water management, conservation, and research. There are also few other best practice cases that are already observed in practice. These cases include the importance attached to catchment management, the operation of water courts, and an extensive application of sprinkler and drip systems in irrigation. Besides, the Vaal River basin with an extensively inter-connected storage and both-way water movement facilities--somewhat a unique water storage arrangement in the world--presents an interesting case of an engineering basis for the equalization of demand and supply over time and space. In urban sector, Hermanus, a coastal town of tourist importance in Western Cape, presents an interesting case for the best practices observed in urban water management. Unlike other urban centers of South Africa, this town faces a peculiar set of problems like a finite water supply with no chance for supply augmentation from inter-regional water transfers, poor quality groundwater, and an uneven seasonal pressure on demand caused by the influx of tourists and summer home owners. Hermanus tries to solve these problems through demand management techniques that include a multi-tiered water pricing scheme, retrofitting, and water education.

The most important among the best practices of Sri Lanka are its irrigation management turn-over program, the recent piloting of a share-based and farmer managed irrigation water company, and the cascade system of water use. Although Sri Lankan turn-over program is not as extensive as that in Mexico, the key feature in Sri Lanka is that the WUAs are being developed as multi-purpose agencies covering not only water allocation but also as contact points for farm input delivery including credit. Sri Lanka is trying to both widen the spatial coverage of its turn-over program as well as upgrade the decentralization process to create commercial water companies in irrigation systems. The recent piloting of water company concept is in line with the latter aspect of management decentralization. The cascade system of water use, where the unused water flowing from the upper reaches of the system is used and reused several times before the water reaches the sea, leads to a system level physical water use efficiency of up to 80 percent. This system of water use--essentially an outcome of basin topography--is also relevant in other countries (e.g., the southern parts of India) with many sequentially connected surface water bodies.

Australia, like Israel and Chile, has many best practices to offer. The most important among them are the ones that provide the basis for a market-responsive water economy. These practices include the permit-based volumetric water allocation, transferable permits, and user-oriented government organizations but with effective regulatory and coordination capabilities. This framework is now used to achieve the target set by the COAG for reducing water use to its 1993-94 level in the Murray-Darling basin. The next in line of importance is the operation of the well known inter-state water management organization operating in the Murray-Darling River basin that regulates and coordinates water allocation and water quality control. Thanks to the effectiveness of this basin organization, this basin is now relatively free from both salinity and water sharing conflicts. Another unique feature of Australian water administration is the role played by independent tribunals (e.g., Independent Pricing and Regulatory Tribunal) in setting both urban and rural water prices. In urban sector, the best practices take the form of granting autonomy to urban water supply agencies (e.g., Sydney Waters) as well as allowing private companies in water provision (e.g., Adelaide, Southern Australia). On the water quality front, Australia is having one of the best information base for quality grading and regulatory system (based on transferable pollution permits) for controlling water quality in its rivers and streams.

Among the best practices that China offers, the most important ones are related to the recent institutional initiatives to liberalize its water sector. The 1988 water law makes a clear distinction not only between the regulatory and allocative functions of the state but also the use rights and payment and maintenance responsibilities of users. Although the legal distinction between water as a resource and water as a usufruct is found in the water laws of Chile, Brazil, Israel, Mexico, South Africa, and Spain, the Chinese law makes such a distinction more clear and operational. This legal feature and the policy level demarcation of the sphere of operation between social and commercial sectors within water economy made explicit in the Water Industry Policy of 1997 are the key aspects that the water law and policy of any country need to have. For, these aspects could help in reconciling public interests with private incentives in water sector. On the water administration side, the basin based administrative arrangement, though reels heavily under the bureaucratic influence of the MOWR, can be a basis for further administrative decentralization within water sector. Although centralization is often considered to be inevitable in China given its political system, provincial and local level administrations assume considerable importance in flood protection and drought proofing efforts. The administrative arrangements for flood protection in China, evolved over time, are considered to be the best in the world.

Although India is the only country in the sample that has not undertaken any major national level institutional initiatives in recent years, it does have important best practice cases as the water economy is undergoing crucial internal changes particularly at the state and local levels. The most important among the best practice cases observed at the state level are the major institutional reforms initiated under the World Bank-funded Water Resource Consolidation Projects being implemented in Andhra Pradesh, Orissa, and Tamil Nadu. Other state level best practices include the formation of river valley development corporations in Gujarat, Karnataka, and Maharashtra as independent statutory bodies for

mobilizing funds from the market as well as the rare initiative by Maharashtra state government to solicit corporate sector participation in project construction and operation. At the micro level are the community-based *Pani Panchayat* (Water Council) system and the cooperative river-based lift irrigation schemes in few areas of Maharashtra as well as the sporadic groundwater markets in parts of Gujarat, Uttar Pradesh, Tamil Nadu, and West Bengal. Also to be mentioned here is the case of an implicit inter-regional and inter-sectoral water market as water from Andhra Pradesh is transferred to Chennai city with Tamil Nadu paying for the full project cost.

COMMON TRENDS AND PATTERNS

Despite the fact that the sample countries vary in terms of their size, political system, and development stage, they share certain commonalities in terms of their main water sector problems and key institutional responses. The water sector problems common to all or most sample countries are:

- Increasing relative water scarcity;
- Water quality deterioration;
- Inter-sectoral and inter-regional water allocation conflicts;
- Poor cost recovery and operational performance;
- Excessive government involvement and bureaucratic control; and
- Out-of-date institutional arrangements.

While these problems are rather too obvious, their origin and inter-linkages are of particular importance in formulating both common and country-specific strategies for water sector reform. Water scarcity is the natural outcome in countries that have already exhausted or been close in exhausting their fresh water potential (e.g., Israel, India, Morocco, and Sri Lanka). What is notable the most is the scarcity in countries with excess water potential. In these cases, water scarcity is caused either by acute spatial demand-supply imbalances (e.g., Australia, Brazil, and China), poor water quality (Australia, Brazil, China, and South Africa), environmental constraints (e.g., China and India), or consumptive vs. non-consumptive conflicts due to recreational and in-stream needs (e.g., Australia and South Africa) and power generation demand (e.g., Chile). In these contexts, water scarcity is intimately linked not only to water quality but also to inter-sectoral and inter-regional allocation conflicts. Notice the three-way causative linkages among water scarcity, water quality, and allocation conflicts.

Similar linkages between cost recovery in and operational performance of water development schemes are easy to visualize once the intermediary variables like project maintenance and end-result variables like service quality are traced out. The far-reaching effects these linkages on the financial, economic, and physical dimensions of water sector are obvious. What is not that obvious is the fact that these linkages have their origin in the institutional dimension in so far as they flow from legal issues like ownership, policy issues like water pricing, and administrative issues like investment and cost recovery arrangements. The central problem is that too much government involvement in water development and the resultant bureaucratic control in project operation often create passive users and rigid administrative system incapable of quickly responding to market forces. The

stagnancy in water sector apart, government's excessive involvement also fritter away the limited administrative resources in routine matters that can very well be transferred to user and other non-governmental groups. As a result of poor allocation of its own administrative resource and the problems in augmenting such resources from private and non-governmental groups, the government is administratively ill-equipped to the critical functions that it ought to perform in the policy and regulatory spheres. There is, therefore, a need for a clear demarcation of the spheres of responsibility between government, user groups, and non-governmental agencies to improve functional specialization and operational coordination within water administration.

With binding physical, financial, and ecological limits to supply-side solutions, countries trying their best, within their political economy constraints, to set right the institutional foundation of their water sector. These efforts get reflected in terms of legal, policy, and administrative reforms. While water sector reforms differ across countries in terms of their actual coverage and effectiveness, the kind of water institutional changes currently observed at the international level are remarkable for their commonality of focus and direction. These commonalties are:

- Shift from development to allocation;
- Emphasis on Decentralization and privatization;
- Integrated approach to water management; and
- Premium for economic viability and physical sustainability.

The paradigmatic shift from water development to water allocation cannot be effected overnight by mere policy rhetoric. Fundamental changes are needed to reorient all the three components of water institutions. While it is easier to have allocation-oriented water laws and policies, it is rather difficult to build an allocation-oriented organizational structure out of an existing water administration with insufficient skills, built-in biases and archaic traditions. Understandably, efficient administrative system is needed to translate the legislative provisions and policy intentions into concrete actions at the field level. Realignment of existing water administration with new skills and information techniques along with the creation of additional inter-sectoral and inter-regional organizations are, therefore, critical to face the challenges of an allocation paradigm. Unlike the development era characterized by bureaucratic and closed-loop decision structure with a domination of political and engineering considerations, the allocation era demands an open and participatory decision process with a priority for economic and ecological issues and a premium for consensus.

Some countries (e.g., Australia, Chile, as well as regions like California and Colorado in the US) already have the capability for meeting the challenges of the allocation paradigm. This is mainly due to their historically evolved tradition of distinguishing allocation functions from development functions within water administration as well as the recently developed reliance on water markets as an allocation mechanism. Others (e.g., Spain and China) could develop the needed institutional potential faster whereas the remaining countries are to go a long way in this regard. Nevertheless, recent developments indicate that most of the laggard countries are already trying to develop the much needed allocation-oriented policies and mechanisms. All sample countries either already have or

show the commitment to eventually create the necessary institutional capabilities for ushering their water sector into the allocation paradigm.

Inter-sectoral allocation priorities have been established either by law or by declared policies in all countries. High level inter-sectoral and inter-ministerial mechanisms (e.g., water resource councils) are formed to enable an integrated water sector perspective and to resolve allocation conflicts. Most countries either have or will have soon their national water plan useful to provide the necessary technical framework for fine-tuning inter-sectoral and inter-regional water allocation patterns. While some countries (e.g., Australia, Israel, Mexico, and Spain) already have a national water plan, others (China, Brazil, Morocco, South Africa, and Sri Lanka) have the mandate to develop such a plan under their recently enacted/proposed water laws. India has tremendous technical and informational capabilities to develop its national water plan. However, the uneven dispersal of constitutional responsibilities and technical capabilities across government layers found in India delays the materialization of such a water plan.

In all sample countries (except Australia, Chile, Spain, and China), inter-sectoral water allocation mechanisms at the basin and lower levels still remain largely undeveloped. Even in the case of the last two of the four countries noted above, regional mechanisms like basin organizations, though exist, are not autonomous but bureaucratically linked to centralized state apparatus. Decentralization of water administration is logically linked to the paradigm shift and, therefore, needed to catalyze a faster transition to the allocation paradigm. The dominant tendency towards decentralization--both in the policy and administrative spheres--is an unmistakable feature of water sector worldwide. This is in contrast to the hypothesis of Wittfogel (1957) that increasing water scarcity is likely to reinforce centralized state control in hydraulic societies. All countries, even those with tradable private water use rights (e.g., Australia and Chile), have asserted the overall regulatory and allocative rights of the state. But nowhere, even in China, is state's absolute ownership of water established to exclude private use rights. On the contrary, all countries have explicitly recognized private use rights and most countries (except China, and Sri Lanka) already have or are going to have transferable water rights including pollution permits. Countries have begun to recognize the functional distinction between centralized mechanisms needed for coordination and enforcement and decentralized arrangements needed for user participation and local level solutions. The key feature of the ongoing process of decentralization evident both at sectoral and sub-sectoral levels is an increasing importance attached to:

- *River basin organizations;*
- *Turn-over program in irrigation sub-sector; and*
- *Utility-type bodies in urban water sub-sector.*

Almost all countries have realized the importance of basin level organizations both as a planning and as an allocation mechanism. These organizations are called differently in different countries (e.g., Watershed Committees in Brazil, Water Conservancy Commissions in China, Basin Councils in Mexico, and Hydro-geological Federations in Spain). They also evince notable variations in terms of their administrative arrangements and functional autonomy (compare the Murray-Darling Basin Commission in Australia with

the Water Conservancy Commissions in China). Nevertheless, it is not possible to ignore their common conceptual basis and organizational features. Basin organizations observed in most countries are designed mostly on hydro-geological rather than on administrative boundaries. This feature allow them to function as an organizational basis for pursuing an integrated approach to water resource management as well as for resolving regional and sectoral water allocation conflicts especially in countries with a federal form of government (e.g., Australia, Brazil, India, Mexico, Spain, and Sri Lanka). While Australia has created one of the best managed basin organizations in its Murray-Darling basin, countries like Spain and China have considerable experience and success with their basin-based water administration. But, in the latter two countries (and also in Morocco), the basin agencies remain essentially as regional arms of concerned ministries. Unfortunately, some countries (e.g., Sri Lanka) with substantial experience with basin-based water management have bureaucratized some of their basin level organizations by covering them as ministries. In all cases, however, there is a tremendous institutional potential and also receptiveness for creating regional mechanisms for decentralized management and stakeholders participation.

Considering the nature of decentralization at sub-sectoral levels, the main mode of decentralization in irrigation sector is IMT under which the managerial responsibilities including cost recovery and system maintenance are transferred to legally registered WUAs. The involvement of users in local level irrigation management is quite extensive in Mexico, Chile, Spain, and Sri Lanka (as well as in Turkey and Philippines) and it is also picking up fast in other countries like India, Indonesia, and Morocco (also in Pakistan. While China has a tradition of community involvement in lower level irrigation management (especially through labor contribution for system maintenance), both Australia as well as the western parts of US have arrangements such as irrigation districts wherein farmers have far greater managerial and financial responsibilities. In Sri Lanka, the turn-over program has evolved into a higher stage with the piloting of a share-based and farmer-managed water company in 1997. In Spain, the current proposal to make basin organizations more autonomous and financially self-dependent is likely to advance decentralization still further.

Decentralization in the urban water sector occurs in the form of creating autonomous and financially self-dependent utility-type organizations for the provision of urban water services. Instances for such companies can be found in all countries except India, Sri Lanka, and China. Although there are no such utilities in China at present, the 1997 Water Industry Policy aims to create them in the near future. Meanwhile, in countries like Australia, Chile, Spain and Morocco, urban water supply agencies, though still remain publicly owned, are allowed to operate on commercial lines with almost full autonomy. In Morocco (and also in Philippines and Argentina), urban water sector decentralization have often taken the form of privatization as the water supply functions are currently performed by private (foreign-owned) water companies.

Privatization is linked to urban water sector decentralization just like user participation is linked to decentralization in irrigation sector. However, privatization and user participation can transcend sectoral boundaries given the role of private sector in water sector financing and technology development as well as the necessity of user participation

in water planning and allocation. The effectiveness of basin and project level organizations depends on an active participation of users as major stakeholders. While privatization and decentralization are obviously in an advanced stage in countries with a relatively advanced and privatized water sector like Australia and Chile, even countries with a highly bureaucratized water sector like China and India are now actively exploring the ways to tap private financial, managerial, and technical resources. While all countries are actively promoting user organizations as an indispensable ally for improving their water sector performance, only a few countries (e.g., Australia and Chile) have developed the incentive structures (e.g., water entitlements) and the institutional mechanisms (e.g., basin or project level organizations) essential for sustaining user participation.

While the paradigmatic change in water sector logically leads to decentralization, the latter opens the door for privatization and user participation. The sequential linkages among these aspects on the one hand and the critical linkages that water scarcity has with water quality in particular and environment in general on the other hand call for an integrated approach to water resources management. Since such an approach recognizes well the inter-linkages among water sector problems, it can exploit fully the inter-linkages and synergy among institutional aspects. All countries have recognized the critical linkages between financial health and physical performance of water sector and the indispensable role of such linkages in sustaining user participation and privatization. As the Mexican and Sri Lankan experiences have shown, participation has succeeded mostly in areas with modernized irrigation schemes. There is unanimity among countries that a phased improvement in cost recovery is the key first step to salvage the water sector from financial crisis and physical degeneration. Although full recovery of O&M costs is the stated objective in all countries, countries like Australia and Chile have gone a step ahead of others by trying at an annuity-based capital cost recovery. Notably, South Africa is attempting to recover also the costs involved in water conservation, management, and research. But, the basic problem still remains as no country including Australia, Chile, and Israel has eliminated the water sector subsidies completely.

Although the physical health of water distribution and drainage infrastructures affects water quality, the most serious factors damaging water quality are: industrial pollution, urban sewerage, and agricultural chemicals and pesticides. The common approach to deal with water quality involves water quality grading, quality standards, and pollution control regulations. All the sample countries grade their water in terms of quality categorization defined by chemical properties and usability of water. Although almost all countries have provisions for pollution permit systems, they differ in terms of its effective implementation and monitoring. Some countries (e.g., Australia and Israel) have very strict implementation of quality standards, others lack the necessary institutional mechanisms and political will to make much headway on the water pollution front. But, policy level awareness of water quality problems and their health and environmental effects are evident in all countries which often manifest in moving water to environment or natural resources ministries. Countries like Australia have water within the overall portfolio of natural resources from the start. But, others (e.g., Brazil, Mexico, Spain, and Morocco) have only recently moved water matters to the environment ministry. Another administrative manifestation is the effort to bring together most of the water-related functions within one or-

ganization (e.g., Indian states such as Tamil Nadu and Orissa). These changes, though inadequate, aim, however, to correct sub-sectoral biases within water sector and inculcate broad sector-wide perspective necessary for an integrated approach to water management. Another change quite positive from the viewpoint of integrated approach is the incorporation of catchment management considerations within basin management plans. Such a change, though more significant in China, South Africa, and Sri Lanka, is, nevertheless, visible in all sample countries.

Finally, it is important to recognize the key forces that have motivated both the observed and ongoing water sector reform initiatives. In this respect, distinction is needed between the fundamental factors and the proximate factors of institutional change. While the water sector crisis remained the dominant fundamental factor, the proximate or immediate factors for change came from elsewhere in the economy. In all countries except those with matured water economies (Israel and Australia), the immediate context for reforms was provided by changes outside the water economy. For instance, macro economic crisis of the late 1980s remained as the main motive force not only for an extensive turn-over program of Mexico but also for the ongoing debates on water sector reform in India, Australia, and Chile. In South Africa, water sector reform forms part of the program for reconstructing a broad-based democratic system out of an erstwhile apartheid system. In Spain, the water sector reforms form part of the country's transition from a controlled system to a liberalized one and its subsequent obligations as an EC member. In Sri Lanka, international lending agencies (e.g., World Bank and Asian Development Bank) and technical/donor organizations (e.g., IIMI and FAO) have played a facilitating role for institutional change. In Chile, China, and Brazil, on the other hand, water sector reforms have benefited from the synergetic influences of political and economic liberalization policies. This means that water sector reforms and institutional changes observed in these three countries forms an integral part of an economy-wide liberalization program. The reform process in all countries—both within and outside our sample—has also received impetus from an increasing international awareness on environmental sustainability.

CONCLUSIONS AND POLICY IMPLICATIONS

The cross-country evaluation of water sector problems and institutional responses attempted here shows rather clearly that the dominant water sector concerns revolve no longer around water development and water quantity but around water allocation and water quality. With a shifting nature of water problems, the development paradigm underlying current water institutions is also undergoing irreversible changes. These changes include an increasing recognition of the indispensable role that decentralized allocation mechanisms can play in enhancing the influence of economic forces and the participation of stakeholders in water sector decisions. As the notion of water provision as a public good and welfare activity is giving way for the concept of water as an economic good and input in economic activity, cost recovery and financial viability concerns are getting increasingly reflected at the policy level.

While there is a clear policy commitment in all countries to amend past policies and existing institutional structures that caused the present water sector crisis, countries are

obviously at different stages in actual water sector reform through institutional change. The comparative evaluation allows a tentative placement of countries within the spectrum of institutional capability in the water sector. Countries like Australia and Chile (as well as states like California and Colorado in the US) have reached an advanced, though not yet in an ideal, stage of institutional evolution. Israel, with its technologically advanced water sector, could very well be ahead of these countries when the proposal to allow water transfers and decentralize its water development and distribution systems takes a practical shape. While Mexico and Sri Lanka have made substantial progress in reforming their irrigation sub-sector, they are yet to make a comprehensive and sector-wide institutional reform. Among these two, Mexico is ahead in terms of the required institutional potential for a comprehensive water sector reform.

Spain, followed by China, also has the organizational potential as well as the water law and water sector reform proposals to decentralize its basin organizations and introduce market solutions which could actually strengthen the institutional foundation of its water sector. Although its partial success in reforming urban water sector and scarcity-induced openness for change place Morocco favorably for an eventual sector-wide institutional reform, the political weight of food and employment considerations can still stifle progress in its irrigation sub-sector. Brazil, though shows considerable political commitment followed by concrete actions in the form of water law enactment and administrative reorganization, is constrained, however, by the present constitutional division of water sector responsibilities between the federal and state governments. To circumvent this constraint, Brazil needs to strengthen and develop inter-state and federal-state organizational mechanisms to drive towards coordinated actions in water sector. Although India, with problems similar to Brazil, remains at the bottom within the spectrum of water sector reform at the national level, notable progress is observed, however, at the level of few states like Andhra Pradesh, Orissa, and Tamil Nadu.

The analytical evaluation of water challenge and institutional change, though performed with a cross-country comparison of a small set of countries and based on observational evidences, does have notable implications both for the literature on institutional economics as well as for the policy of promoting institutional change within water sector. Some of the major implications, which can provide policy inputs and operational guidance to both national governments and international lending/development agencies like the World Bank, can be summarized as follows:

First, as to the overall thrust of water sector reform strategy, the intimate multi-dimensional linkages among key water sector problems suggest two crucial policy tips. Although isolated attempts in one dimension will certainly influence other dimensions as well, an integrated approach will have the maximum effects through the phenomenon of inter-dimensional synergy. At the heart of such an integrated approach lie institutional changes that aim to modernize and strengthen the existing legal, policy, and administrative arrangements governing water sector as a whole.

Second, the mere fact that institutional changes are actually occurring in all sample countries can be taken as an indirect and informal observational evidence for the fact that

the opportunity costs (i.e., the potential net gains) of institutional change are increasing to surpass the corresponding transaction costs in most contexts. But, the fact that institutional changes are uniform neither across institutional components nor across water sub-sectors suggests that both the opportunity and transaction costs vary by context. This explains why countries like India find it easier to have a water policy than a water law or countries like Morocco find it easier to initiate reform in the urban sector than in the irrigation sector.

Third, the variations in both the extent and coverage of institutional reform across countries also provide evidence for the influence that forces outside the water sector have on both the opportunity and transaction costs of institutional change within the water sector. While the ongoing democratic reconstruction reduces the overall transaction cost of water sector reform in South Africa, the general process of economic and political liberalization reduces the same in China. These two recent cases as well as the earlier cases of Chile (in the early 1970s) and Spain (in the 1980s) also suggests the presence of considerable scale economies in the transaction cost of institutional change. In Mexico and also, to some extent, in India, the overall fiscal discipline induced by macro economic reforms played an important role in magnifying the opportunity cost of institutional change within water sector. Since EC plays a strong role in Spanish water sector reforms through its farm product restriction policies, water quality directives, and environmental regulations, the transaction and opportunity costs of institutional change in Spain also acquire a trans-national dimension. In contrast to these cases, national security considerations form an important part of the transaction costs of water sector reform in Israel.

Fourth, the experience of Australia and Chile provides some evidence for the fact that the earlier institutional changes tend to reduce the transaction costs of subsequent institutional changes. This suggests that in countries with only partial reforms at present, further institutional reforms can advance fairly at a faster pace, that too, with lesser financial costs and political opposition. This is because the earlier reforms could not only reduce the transaction costs of subsequent reforms but also realign political balance by creating a strong pro-reform constituency. The operational linkages between each subsequent reform phases/components and their transaction costs have considerable value in relaxing the political economy constraints and minimizing the overall costs of institutional change. Notice that transaction cost declines and political balance improves as one moves on the spectrum of institutional change due to the positive effects of scale economies and strong pro-reform constituency. It is, therefore, prudent from a political economy viewpoint to proceed on a logically linked sequence of reforms wherein sub-sectors and institutional components are taken one at a time within a prioritized scheme.

Fifth, from the viewpoint of international lending/development agencies like the World Bank, their current emphasis on both the formulation of water policy and water law as well as the reorganization of water administration in their member countries needs to continue. But, there is a critical need now to concentrate their funds and efforts in countries, areas, and sub-sectors already with a critical mass of institutional build-up. Since the probability of success in these cases is more than in others due to a relatively lower transaction cost, the overall economic return on their capacity building investments will not

only be maximized but will also be quick. Quick economic return and faster repayment can allow a faster recycling and reinvestment of resources in the capacity building portfolio of international lending/development agencies.

Sixth, both the transaction and opportunity costs of institutional changes in the water sector are strongly influenced also by forces external to the strict confines of water sector (e.g., political reforms, economic liberalization, multi-lateral agreements, and international trade). It is, therefore, crucial to strategically exploit the political economy context provided by these forces so as to gain momentum for an accelerated reform in the realm of water institutions.

And, finally, so as to promote concerted policies and programs for institutional change especially at the international level, cross-country-based policy studies have considerable value in sharpening the overall understanding of the mechanics of institutional change and their ultimate impact on water sector performance. There is a particular need for research studies which are able to trace and quantitatively evaluate not only the multi-dimensional linkages among various components of water institutions but also the way their influences are channeled through various institutional layers and get finally reflected in water sector performance. Such a quantitative evaluation of issues operating in the interface between institutional change and water sector performance can provide a credible basis for deriving both generic and country-specific strategies for institutional changes within water sector. While there cannot be an unique prescription for institutional changes applicable everywhere, the blue print of an ideal water institution derived from cross-country experience, could serve as the initial framework to iteratively plan both national and global initiatives in the realm of water institutions. International lending/development agencies like the World Bank, with its declared commitment for capacity building, have a clear stake in promoting policy studies of the kind needed now.

REFERENCES

- Archibald, Sandra O., and Mary E. Renwick, 1998, "Expected Transaction Costs and Incentives for Water Market Development", in K. William Easter, Ariel Dinar, and Mark Rosegrant.
- Arlosoroff, Saul, 1997a, "Israel: A Case Study of Water Resources Management", *EAWAG News*, 43E, December.
- Arlosoroff, Saul, 1997b, "The Public Commission on the Water Sector Reform (The General Ideas Underlying Its Recommendations)", *International Water and Irrigation Review*, 1-9.
- Azevedo, Luiz Gabriel, and Larry D. Simpson, 1995, *Brazil: Management of Water Resources*, Economic Notes No. 4, Country Department I: Latin American Region, the World Bank, Washington, DC.
- Berkoff, D.J.W., 1997; *Water Policy: Functional Analysis*, Institutional Strengthening for Comprehensive Water Resources Management, WRC/WRS, Colombo.
- Blanco, Alejandro Vergara, 1997, "La Libre Transferibilidad de los Derechos de Aguas: A Caso Chileno" *Revista Chilena de Derecho*, 24(2):369-395.
- Brehm, Monica Rios, and Jorge Quiroz, 1995, *The Market for Water Rights in Chile: Major issues*, Technical Paper No: 285, The World Bank, Washington, DC.
- Bromley, Daniel, 1989, *Economic Interests and Institutions: The Conceptual Foundations of Public Policy*, Basil Blackwell, New York.
- Chen, Zhikai, 1992, "Water Resource Development in China", in Guy Le Moigne, et al., ed., *Country Experiences with Water Resources Management: Economic, Institutional, Technological, and Environmental Issues*, Technical Paper No: 175, The World Bank, Washington, DC.
- Colby, Bonnie, 1990, "Transaction Costs and Efficiency in Western Waters", *American Journal of Agricultural Economics*, 72(5):1184-1192.
- CNA, 1990, *Water Policies and Strategies*, Mexico City.
- DLWC, 1997a, *Water Reforms: Information for Users*, Government of New South Wales, Sydney.
- DLWC, 1997b, *Report to the Minister on NSW Water Reforms*, Water Management Task Force, Government of New South Wales, Sydney.
- DLWC, 1998, *Submission to IPART on Rural Bulk Water Pricing*, Government of New South Wales, Sydney.
- Dinar, Ariel and J. Latey, 1991, "Agricultural Water Marketing: Allocative Efficiency and Drainage Reduction", *Journal of Environmental Economics and Management*, 20: 210-223.
- Dinar, Ariel and Subramanian Ashok, eds., 1997, *Water Pricing Experience: An International Perspective*, Technical Paper No: 386, The World Bank, Washington, DC.
- DGOH, 1996, *Institutional Framework and The Water Use in Spain*, Ministerio de Obras Publicas, Transportes, y Medio Ambiente, Madrid.
- DWAF, 1986, *Management of the Water Resources of the Republic of South Africa*, Pretoria.
- DWAF, 1997, *White Paper on a National Water Policy for South Africa*, Pretoria.

- Water Research Commission, 1996, *Policy Proposal for Irrigated Agriculture in South Africa*, WRC Report No: KV96/96, Pretoria.
- Donoso, Guillermo, 1996, *El Mercado de Derechos de Aprovechamiento como Mecanismo Asignador del Recurso Hidrico*, Departamento de Economia Agraria, Pontificia Universidad Catolica de Chile, Santiago (*mimeo*).
- Easter, K. William, Ariel Dinar, and Mark Rosegrant, eds., 1998, *Markets for Water: Potential and Performance*, Kluwer Academic Press (*Forthcoming*).
- ESCAP, 1997, *China: Water Resources and Their Use*, Study on Assessment of Water Resources of Member Countries and Demand by Use Sector, United Nations, New York.
- Feitelson, Eran, and Marwan Haddad, 1995, *Joint Management of Shared Aquifers: Final Report*, Truman Institute for Advancement of Peace and the Palestine Consultancy Group, Jerusalem.
- Frederikson, Harald D., 1992, *Water Resources Institutions: Some Principles and Practices*, Technical Paper No: 191, The World Bank, Washington, DC.
- Garrido, Alberto, 1997, "A Mathematical Programming Model Applied to the Study of Water Markets within the Agricultural Sector", Paper presented in the 8th European Agricultural Economists Association Congress, Edinburgh, United Kingdom, September.
- Gazmuri, Renado and Mark Rosegrant, 1994, "Chilean Water Policy: The Role of Water Rights, Institutions, and Markets", Paper prepared for the *Irrigation Support Project for Asia and the Near East (ISPAN)*, International Food Policy Research Institute, Washington, DC.
- GOI, 1992, *Report of the Committee on Pricing Irrigation Water* (Chairman: A. Vaidyanathan), Planning Commission, New Delhi.
- GOI, 1995, *Report of the High Level Committee on Private Sector Participation in Irrigation and Multi-purpose Projects*, Ministry of Water Resources, New Delhi.
- Gorriz, Cesilia M., Ashok Subramanian, and Jose Simas, 1995, *Irrigation Management Transfer in Mexico: Process and Progress*, Technical Paper No: 292, The World Bank, Washington, DC.
- Guoliang, Tan, 1993, ed., *Water Resources Development in China*, China Water and Power Press, Beijing.
- Hartman, L.M., and D. Seastone, 1970, *Water Transfers: Economic Efficiency and Alternative Institutions*, John Hopkins Press, Baltimore.
- Herne, Robert, and K. William Easter, 1995, *Water Allocation and Water Markets: An Analysis of Gains-from-Trade in Chile*, Technical Paper No: 315, The World Bank, Washington, DC.
- Herne, Robert, and K. William Easter, 1997, "The Economic and Financial Gains from Water Markets in Chile", *Agricultural Economics*, 15:187-199.
- Howitt, Richard, 1998, "Spot Prices, Option Prices, and Water Markets in California" in K. William Easter, Ariel Dinar, Mark Rosegrant.
- Johnson, Sam H., 1996, "Irrigation Management Transfer in Mexico: Moving Toward Sustainability", Paper presented at the 6th Annual Conference of the International Association for the Study of Common Property, June 5-6, University of California, Berkeley.

- Johnson, Sam H., 1997, "Irrigation Management Transfer: Decentralizing Public Irrigation in Mexico", *Water International*, 22(3):159-167.
- Ke Lidan, 1997, "Water Law and Water Management" in Qian Zhengying, ed., *Water Resources Development in China*, China Water and Power Press/Central Board of Irrigation and Power, Beijing/New Delhi.
- Kislev, Yoav, 1993, *The Water Economy of Israel: Principles and Their Application*, Policy Studies No: 14, Institute of Advanced Strategic and Political Studies, Jerusalem.
- Le Moigne, Guy, Ashok Subramanian, Mei Zie, and Sandra Giltner, 1994, *A Guide to the Formulation of Water Resources Strategy*, Technical Paper No: 263, The World Bank, Washington, DC.
- Maetsu, Josefina, 1996, *Comparing Water Prices in Europe: Water Prices in Spain*, ECOTEC Research and Consulting Ltd., Madrid.
- MEA, 1997, *Progress Report-1997*, Ministry of Mahaweli Development, Colombo.
- McGlynn, Tony, 1997, *Making Sense of Water Licenses and Transfers*, Sydney (*mimeo*).
- MOPT, 1993, *Plan Hidrológico Nacional Memoria*, Madrid.
- MOWREP, 1987, *Water Resources and Hydro-Power Development in China*, Beijing.
- Musgrave, Warren F., "Australia", in Ariel Dinar and Subramanian Ashok, 1997, *Water Pricing Experience: An International Perspective*, Technical Paper No: 386, The World Bank, Washington, DC.
- NIHWR, 1996, *Report on the Mid and Long-term Plans for Water Demand and Supply in China*, Nanjing (*in Chinese*).
- Nanni, Marcella, 1996, *Preliminary Report on National Water Resource Laws and Institutions in Sri Lanka*, Water Policy and Law Advisory Programme, CGP/INT/620/NET, Food and Agriculture Organization, Colombo.
- North, Douglas, 1990, *Institutions, Institutional Change, and Economic performance*, Cambridge University Press, Cambridge, Massachusetts.
- Oblitas, Keith, Peter Rogers, and Harshadeep Rao, 1996, "Combining Stakeholder Participation with Interactive Modeling as an Approach to Basin Planning and Water Management", Paper presented in 'Water Week' at the World Bank, Washington, DC.
- Olson, Mancur, 1971, *The Logic of Collective Action*, Harvard University Press, Massachusetts.
- Ortega, Consuelo Varela, et al., 1997, *Water Pricing Policies, Public Decision Making and Farmers Response: Implications for Water Policy*, Departamento de Economía Agraria, Universidad Politécnica de Madrid, Madrid (*mimeo*).
- Palacios, Enrique V., 1997, *Benefits and Second Generation Problems in Irrigation Management Transfer in Mexico*, EDI Participatory Irrigation Management Case Studies, The World Bank, Washington, DC.
- PRC, 1988, *Water Law of the People's Republic of China*, Ministry of Water Resources, Beijing.
- PRC, 1997, *China Water Resources News* (December 4), Ministry of Water Resources, Beijing.
- Pereira, Nelson, 1997, "Irrigation Policies and Irrigation Management Transfer Programs in Chile", CNR, Santiago (*mimeo*).

- Piccotto, Robert, 1995, *Putting Institutional Economics to Work: From Participation to Governance*, Discussion Paper: 304, The World Bank, Washington, DC.
- Pigram, John J., 1986, *Issues in the Management of Australia's Water Resources*, Longman Cheshire Pvt. Ltd., Melbourne.
- Ratnayake, Ranjit, 1997, "Water Resources and Environment: Institutional Aspects", Discussion Draft, Colombo (*mimeo*).
- Saleth, R.M., J. B. Braden, and J.W. Eheart, 1991, "Bargaining Rules for Thin Spot Water Market", *Land Economics*, 67(3):326-339.
- Saleth, R.M., 1996, *Water Institutions in India: Economics, law, and Policy*, Commonwealth Publishers, New Delhi.
- Saleth, R.M., and Ariel Dinar, 1998, "Water Institutions and Water Sector Performance: Evaluating Their Linkages with Cross-Country Data", Rural Development Department, The World Bank, Washington, DC (*mimeo*).
- Simas, Jose, 1997, *Mexico: Policy Options for Managing Aquifer Over-exploitation*, World Bank Mission, Mexico City (*mimeo*).
- Trava, Jose, 1994, "Transfer of the Management of Irrigation Districts to WUAs in Mexico", in Water and Land Management Institute, *Indicative Action Plan and Proceedings of National Seminar on Farmers' Participation in Irrigation management*, Aurangabad, India.
- Upadhyay, S.N., 1996, *A Critical Analysis of the Legal Regime on Water Resources in Sri Lanka*, Irrigation Management Support Activity, Colombo.
- Vaux, Henry, and Richard Howitt, 1984, "Managing Water Scarcity: An Evaluation of Inter-regional Transfers, *Water Resources Research*, 20:785-792.
- WRC/WRS, 1997; *Water Policy Review and Issue Identification*, Institutional Strengthening for Comprehensive Water Resources Management, WRC/WRS, Colombo.
- WRS, 1997, *Approach for Comprehensive Water Resources Management in Sri Lanka*, Colombo.
- Wittfogel, Karl A., 1957, *Oriental Despotism: A Comparative Study of Total Power*, Yale University Press, New Haven, Connecticut.
- World Bank, 1992, *Asia Water Resources Study: Stage 1*, Vol. 2, Annexes, Agricultural Division, Asia Technical Department, Washington, DC.
- World Bank, 1993, *Kingdom of Morocco: Irrigated Areas Agricultural Services Project*, Staff Appraisal Report (No. 11947-MOR), The World Bank, Washington, DC.
- World Bank-Government of India, 1998, *India- Water Resources Management Sector Review. Report on Inter-Sectoral Water Allocation, Planning and Management*, June 27, (No. 18322), Washington, DC.
- World Bank, 1997, *World Development Report 1997*. World Bank, Washington, D.C.
- Yaron, D., 1997, "Israel" in Ariel Dinar and Ashok Subramanian eds., *Water Pricing Experience: An International Perspective*, Technical Paper No: 386, The World Bank, Washington, DC.
- Zilberman, David, et al., 1998, *Private and Institutional Adaptation to Water Scarcity During the California Drought, 1987-1991*, Forthcoming as a Staff Paper of the Economic Research Service, US Department of Agriculture, Washington, DC.

APPENDIX-A (LIST OF EXPERTS MET)

MEXICO

- Mr. Jose Simas, World Bank Mission, Mexico City.
Dr. Jose Luis Trava, Former Head of Irrigation Districts, Commission Nacional del Agua (CNA), Mexico City.
Dr. Enrique Palacios, Colegio de Postgraduados, Programa de Hydrociencias, Mexico City.
Sr. Manuel Contijoch Escontria, Director General, FIRCO, Ministry of Agriculture and Former Deputy Director General, CNA, Mexico City.
Dr. Enrique Aguilar Amilpa, International Consultant, Mexico City.
Dr. Ing. Jose Eduardo Mestre, Basin Council Expert, Queretero.
Sr. Emiliano Rodriguez, Irrigation Engineer and Consultant, Queretero.
Sr. Eduardo J. Viesca de la Garza, Water Law Expert, Secretaria de Hacienda Y Credito Publico, Xochimilco, Mexico City.

CHILE

- Sr. Humberto Pena, Director General de Aguas, Ministerio de Obras Publicas (MOP), Santiago.
Sr. Eduardo Bartholin Zanetta, Director Nacional de Riego, MOP, Santiago.
Sr. Ernesto Schulbach Borquez, Secretario Ejecutiva, Commission Nacional del Riego (CNR), Santiago.
Sr. Nelson Pereira Munoz, Jefe Dpto. Ejecutivo, CNR, Santiago.
Sr. Michael Racznski, Coordinador, Programa de Construccion y Rehabilitacion de Obras de Riego Medianas y Menores, Santiago.
Sr. Juan Carlos Jofre Chamy, Comision Nacional de Medio Ambiente, Santiago.
Sra. Ampara Nunez Sandoval, Empresa de Metropolitana de Obras Sanitarias, Santiago.
Dr. Jose Olivares, International Consultant, Santiago.
Sr. Miguel Solanes, International Expert on Water Law, Economic Commission for Latin America and the Caribbean (ECLAC), United Nations, Santiago.
Sra. Eugenia Muchnik, Gerente, Departamento Agroindustrial, Fundacion Chile, Santiago.
Prof. D. Alejandro Vergara Blanco, Professor of Law, Pontifica Universidad Catolica de Chile, Santiago.
Dr. Guillermo Donoso Hariss, Director, Departamento de Economia Agraria, Pontifica Universidad Catolica de Chile, Santiago.

BRAZIL

- Sr. Luiz Gabriel Azevedo, World Bank Mission, Brasilia.
Mr. Larry D. Simpson, Water Resource Management Consultant, World Bank Mission, Brasilia.
Eng. Laudo Bernardes, Assesor, Gabinete do Ministro, Ministerio do Medio Ambiente, dos Recursos Hidricos e da Amazonia Legal (MMARHAL), Brasilia.
Eng. Fernando A. Rodriguez, Director de Departamento, Secretario de Recursos Hidricos (SRH), MMARHAL, Brasilia.

Sr. Julio Thadeu S. Kettelhut, Geral, Departamento de Gestao de Aguas Federais, SRH, MMARHAL, Brasilia.

Sr. Marcos Eduardo de Freitas Brandao, Consultor, SRH, MMARHAL, Brasilia.

Dr. Henrique Marinho Leite Chaves, SRH/DNOCS/IICA, Instituto Interamericano de Cooperacao para a Agricultura, Brasilia.

Dr. Oscar de Moraes Cordeiro Netto, Professor Adjuncto, Departamento de Engenharia Civil, Universidade de Brasilia, Brasilia.

Prof. Denisard Oliveira Alves, Faculdade de Economia, Universidade de Sao Paulo, Sao Paulo.

Prof. Monica Porte, Presidente, Associacao Brasileira de Recursos Hidricos, Universidade de Sao Paulo Sao Paulo.

Prof. Ruben Porte, Department of Hydraulic and Sanitary Engineering, Universidade de Sao Paulo, Sao Paulo.

Prof. Ivanildo Hespanhol, Department of Hydraulic and Sanitary Engineering, Universidade de Sao Paulo, Sao Paulo.

SPAIN

Prof. Alberto Garrido, Departamento de Economia, Universidad Politecnica de Madrid, Madrid.

Prof. Consuelo Varela Ortega, Departamento de Economia, Universidad Politecnica de Madrid, Madrid.

Prof. Ramon Llamas, Departamento de Geodinamica, Universidad Complutense, Madrid.

Sra. Josefina Maetsu, Director, Ecotech Research and Consulting Ltd., Madrid.

Dr. Josu Mezo, Analistas Socio-Politicas, Gabinete de Estudios, Madrid.

Dr. Jose Alberto Herreras Espino, Presidente, SYNCONSULT, S.L., Madrid.

Sr. Gonzalo Marin Pacheco, Director (Hydraulics), SYNCONSULT, S.L., Madrid.

Sr. Jose Maria Santafe Martinez, Jefe de Area de Planes Y Programas, Ministerio de Medio Ambiente (MMA), Madrid.

Ing. Bernardo Lopez-Camacho y Camacho, Jefe Departamento de Aguas Subterraneas, Canal de Isabel II, Madrid.

Prof. Luis Miguel Albisu, Unidad de Economia y Sociologia Agrarias, Servicio de Investigacion Agraria, Diputacion General de Aragon, Zaragoza.

Prof. D. Antonio Embid Irujo, Departamento de Derecho Publico, Universidad de Zaragoza, Zaragoza.

Prof. Pedro Arrojo Agudo, Departamento de Analisis Economico, Universidad de Zaragoza, Zaragoza.

Sr. Tomas A. Sancho Marco, Presidente, Confederacion Hidrografica del Ebro (CHE), MMA, Zaragoza.

Sr. Manuel Omedas Margeli, Secretario Tecnico de Presidencia, CHE, MMA, Zaragoza.

Sr. Antonio Coch Flotats, Jefe de la Oficina de Planificacion Hidrologia, CHE, MMA, Zaragoza.

MOROCCO

Mr. Mohammed Jellali, Director General, Administration de Hydraulique, Rabat.

Dr. Muhamad Ait Kadi, Director General, AGR, Rabat.

Mr. Ahmed Hajji, Ingenieur en Chef, Directeur de la Planification, Office National de l'Eau Potable, Rabat.

Dr. Jose Maria Pliego Gutierrez, Director General, Sociedad Espanola de Estudios para la Fija a Traves del Estrecho de Gibralter, Madrid, Spain.

Mr. Omar Aloui, Economist, Agro Concept, Rabat.

Dr. Mohamed Larbi Firdawcy, Director of Research, Department of Agriculture, Rabat.

Mr. Chaouni Mohamed, Chief Divisia de la Legislatia d'Eaux, Administration de Hydraulique, Rabat.

ISRAEL

Prof. Dan Yaron, Department of Agricultural Economics, Hebrew University of Jerusalem, Rehovot.

Prof. Yoav Kishlev, Department of Agricultural Economics, Hebrew University of Jerusalem, Rehovot.

Mr. Saul Arlozorof, Former Deputy Water Commissioner and presently International Consultant, Tel Aviv.

Dr. Elisha Kally, Water Expert, Tel Aviv.

Dr. Joseph Draizin, Director, Planning Department, Water Commission, Tel Aviv.

Mr. Menachem Kantor, Former Water Commissioner, Kibutz Maagan Michael.

SOUTH AFRICA

Mr. Claus Triebel, Deputy Director General (Utilisation), Department of Water Affairs and Forestry (DWAF), Pretoria.

Alan Conley, Director, Information Service, DWAF, Pretoria.

Dr. Gerhard R. Backeberg, Research Manager, Water Research Commission, Pretoria.

Mr. Piet Maritz, Director, Agricultural Engineering, National Department of Agriculture, Pretoria.

Prof. Johann Kirsten, Head, Department of Agricultural Economics, University of Pretoria, Pretoria.

Mr. Dirk J. Pretorius, Remote Sensing Specialist, Institute for Soil, Climate, and Water (ISCW), Agricultural Research Council (ARC), Pretoria.

Mr. Rudolf de Munnik, GIS Specialist, ISCW, ARC, Pretoria.

Mr. Reinhard Kuschke, Agro-meteorology Specialist, ISCW, ARC, Pretoria.

Ms. Robyn Stein, Water Law Expert, Johannesburg.

Mr. Van der Linde, Director of Water Supply, Hermanus, Western Cape.

Mr. Gordon Maclear, Geohydrologist, DWAF, Cape Town, Western Cape.

SRI LANKA

Mr. Ranjith Ratnayake, Director, Water Resources Development, Ministry of Irrigation and Power (MOIP), Colombo.

Mr. L.T. Wijesooriya, Director General of Irrigation, Irrigation Department, Colombo.

Mr. Danasuriya, Additional Director (Institutional Development), Irrigation Management Division, Irrigation Secretariat, MOIP, Colombo.

Mr. Banduratne, Deputy Director, National Planning Department, Colombo.

Mr. Navaratne, Deputy Commissioner, Agrarian Services Department, Colombo.

Dr. Douglas Merrey, International Irrigation Management Institute (IIMI), Colombo.

Dr. Douglas Vermillion, IIMI, Colombo.

Dr. Alfred Birch, Senior Technical Advisor (Asian Development Bank), Sri Lankan Water Resources Secretariate, IIMI, Colombo.

Mr. Terence Abeysekara, Economist, World Bank Mission, Colombo.

Mr. Nikal Fernando, Irrigation Engineer, World Bank Mission, Colombo.

AUSTRALIA

Prof. John J. Pigram, Executive Director, Centre for Water Policy Research (CWPR), University of New England, Armidale.

Mr. Robert French, CWPR, University of New England, Armidale.

Dr. Jonathan Baldry, Department of Economics, University of New England, Armidale.

Ms. Brobwen Jackman, School of Law, University of New England, Armidale.

Prof. Warren Musgrave, Advisor, Premier's Department, Government of New South Wales (GONSW), Sydney.

Mr. Warren Martin, Manager, Water Management Task Force, The Ministry of Land and Water Conservation, GONSW, Sydney.

Mr. Collin Reid, Chief Manager, Water and Transport, Independent Pricing and Regulatory Tribunal, GONSW, Sydney.

Mr. George Bawtree, Manager, Competition and Pricing, Sydney Waters, Sydney.

Ms. Raj Goyal, Manager, Commercial & Economic Services, Sydney Waters, Sydney.

Mr. Kevin Melville, Senior Economist, Sydney Waters, Sydney.

CHINA

Mr. Gu Hao, Director General, Department of Water Administration and Water Resources (DOWAWR), Ministry of Water Resources (MOWR), Beijing.

Mr. Yu Qiyang, Engineer, DOWAWR, MOWR, Beijing.

Prof. Zhang Hai Lun, Advisor, Nanjing Institute of Hydrology and Water Resources (NIHWR), MOWR, Nanjing.

Prof. Jia Ze-Min, Deputy Director, NIHWR, MOWR, Nanjing.

Prof. Liu Heng, Assistant Director, NIHWR, MOWR, Nanjing.

Mr. Xu Zi Kai, Engineer, NIHWR, MOWR, Nanjing.

Ms. Zou Youlan, Operations Officer, World Bank Mission, Beijing.

Mr. Jiang Liping, Water Resources Engineer, World Bank Mission, Beijing.