Project Report

Development of Effective Water-Management Institutions

A Regional Study Implemented by the International Water Management Institute

With Financial Support from the Asian Development Bank (RETA 5812)

Final Report, Volume III

Case Studies of Advanced River Basins

30th June 2003

International Water Management Institute

Development of Effective Water-Management Institutions

Regional Study Implemented by the
INTERNATIONAL WATER MANAGEMENT INSTITUTE

With Financial Support from the
ASIAN DEVELOPMENT BANK
(RETA 5812)

Final Report, Volume III

Case Studies of Advanced River Basins

30 June 2003

Contents

Foreword

The Terms of Reference of the Technical Assistance Agreement between the ADB and IWMI finalized in January 1999 for a regional study in Asia stipulated the following specific activities:

i. Development of a conceptual framework for analysis of policies, institutional arrangements, functions and resource mobilization related to agricultural water management in the wider context of integrated water resources management (IWRM).

ii. Case studies in at least two developed countries to identify key elements of successful water-resources management and provide lessons for transfer to the Developing Member Countries (DMCs).

iii. In-depth institutional assessments and performance studies in five participating DMCs to assess the strengths and weaknesses in policies and institutions responsible for agricultural water management, identifying the major issues facing the countries and the opportunities to meet the emerging challenges.

iv. Preparation of action plans and processes in each participating DMC for implementation of institutional, policy, and strategic improvements based on the findings of the in-depth assessments.

v. Support for implementation of action plans for policy and institutional reform in the participating DMCs.

The final reporting material of the overall study comprises four components, which are structured in terms of the four main study outputs expected in the IWMI-ADB Technical Assistance Agreement. The executive summary and the four output components are presented in five volumes of the Final Report:

Volume	I	–	Executive Summary.
Volume	II	–	Conceptual Framework.
Volume	III	–	Case Studies of Advanced River Basins.
Volume	IV	–	Country Studies and Action Plans.
Volume	V	–	Towards Water Sector Reforms.

This Volume (III) presents the reports obtained on three advanced rive-basin case studies selected from Australia, Japan and Indonesia. It also gives a comment on the replicability of some of the key features of these river basins, which have been developed to an advanced stage, and which are managed according to advanced procedures.

While this study was under way, a number of researchers have started to deal with the issue of replicability of best practices found in developed countries. The subject of "the relevance and transferability of developed world experience in water reform to emerging nations of the developing world" was recently highlighted in *Water International* (Volume 24, Number 4, December 1999). In this issue, dedicated to this subject, three papers specifically discussed the transferability of Australian experiences to developing countries. Interestingly, two of these three papers referred to two developing countries covered by this study: China and Sri Lanka. A fourth paper on the Australian experience by Howe and White discussed a case study on integrated-resources planning in the Sydney region, and asserted that the study results would have implications for water-service providers in other countries. Overall, the essence of all the presentations was that the transferability is difficult and can only be of limited success, mainly because of the contextual differences.

A few excerpts from this special issue are given here. Malano, Bryant and Turral in their paper on "Management of Water Resources: Can Australian Experiences be Transferred to Vietnam?" point out that the "major difficulty in sharing experiences is the context-specific nature of water-resources management." The basic hydrologic, political, legal and environmental context is unique and specific for each country and river basin. A similar remark was made by Hu in comparing the Australian and Chinese conditions for implementing integrated catchment management. His conclusion was that the Australian model "cannot be directly used in China because of: 1) difficulty of coordinating authorities at different levels; 2) unclear ownership of resources; 3) small farming scales; and 4) poor education of resource users."

Hunt examined in his paper the potential issues faced by developing country water authorities when subjected to the transposition of developed country water-reform policies, such as "user pays." For example, can the "user pay principle" be transferred to the Solomon Islands? Hunt concluded that such transfer "is not sustainably viable" because of major differences in political structures, national priorities, living standards, cultural traits, technological development, literacy levels, financial and infrastructural growth, and change-management competency. The differences lead to a lack of "contextual fit" between the policy development and the respective policy-application environment.

There was one mild positive note in the paper by Birch and Taylor on "International Mentoring: Application of Australian Experience for Sri Lankan Water Sector Reforms ...." They concluded that "despite some obvious differences between the two countries, Australian experience and approaches are proving useful in technical assistance to current reforms in the Sri Lankan water sector." The most distinct feature in Sri Lanka's proposed reform package is described to be the decision to establish a new apex organization in the water sector. However, the authors themselves have stated: "it remains to be seen if this approach will be successful and if it will lead to the reform of the existing agencies that will continue to play important roles."

John Pigram, the guest editor of this particular issue of *Water International*, raised a different issue: "North-South or South-South?" He suggested that the preferred approach might be a "South-South exchange of knowledge and expertise in water-resources management between developing countries."

With these comments in the backdrop, this Volume III of the Final Report of IWMI's study presents the three advanced basin case-study reports, two of which are from developed countries, Australia and Japan, and the third from a developing country, Indonesia. It is possible that there are broad principles and approaches, as well as some technologies that can be transferred as lessons from developed country river-basin management. Many of these new ideas can be of great value to developing countries, particularly to those who promote effective institutions for integrated water-resources management. There are also examples from developed countries that may not be compatible with developing country situations. The presentation in this volume is to convey this message, and highlight a note of encouragement to look for what is applicable in the given developing context.

D. J. Bandaragoda
Principal Researcher, IWMI, and
Project Leader for the Study

Chapter 1

Introduction

Recent literature on water-resources management presents a considerable amount of information on the advanced nature of river-basin management in developed countries in North America, Europe and the Far East (UNEP 1989). It is generally acknowledged that, in these countries, the institutional arrangements for river-basin management are strong and that they support Integrated Water-Resources Management (IWRM) through modern management methods. With this understanding, the proponents of the study on "Development of Effective Water-Management Institutions" incorporated in their study design the item, "case studies in at least two developed countries to identify key elements of successful water-resources management and provide lessons for transfer to the Developing Member Countries."

Although the Terms of Reference of the Asian Development Bank's (ADB's) TA Agreement referred to this item as "Developed Country Case Studies," during the study inception stage, IWMI and ADB agreed to call the item "Advanced Basin Case Studies." The idea was to gain the flexibility to select a basin with demonstrable management features even if it was not located in a developed country. Also, another important consideration was to select river basins from the Asian region, with features that were compatible with the study objectives. The advanced river-basin case studies were only part of the overall regional study on "Developing Effective Water-Management Institutions in Asia," which had its overall goal to "improve the management of scarce water supplies available for agriculture, within and responsive to a framework for integrated water-resources management in a river basin."

For the purpose of this study, an "advanced" river basin means a river basin which is already developed in terms of appropriate physical infrastructure and effective institutions for IWRM. The intensity of physical infrastructure reflects the degree of human interventions and the modifications effected on the natural water-resources system in the basin. The interventions and modifications of nature, in turn, account for an institutional framework, which encompasses water-management organizations, and underlying rules and regulations related to water acquisition, distribution and use. As the development proceeds, there is a need to establish more and more effective water-management institutions, and it is assumed that an advanced river basin would have a fairly well-established institutional framework.[1]

A few countries have pioneered the establishment of some form of institutional framework for IWRM in a river-basin context. Some others are actively considering new policies and strategies to develop such institutions. The pioneering efforts help others to learn from their early experiences, and to consider whether there are some contextual conditions under which such river-basin institutions are appropriate, and can be useful in improving water productivity. The proposed case studies were meant to analyze institutional arrangements in three selected river basins, and their policy linkages.

Having considered a number of options, IWMI and ADB agreed to select two river basins from developed contexts, the Murray-Darling basin in Australia and the Omonogawa basin in Japan

[1]The document was later published as IWMI Working Paper No. 5 (Bandaragoda 2001).

and a third advanced river basin from a developing country in Asia, the Brantas river basin in Indonesia.

The main purpose of the study on the Murray-Darling basin is to identify the lessons it can provide in terms of its effective institutional arrangements for river-basin management, which provides for mechanisms to coordinate water-management functions in a large geographical area. An interesting aspect of this experience is that it has evolved through an initial focus on the need to coordinate different water uses and alleviate the effects of salinity within the vast area of the river basin. The Omonogawa river basin in Akita, Japan, has been considered a suitable site on the grounds that it closely represents the Asian situation related to agricultural-water management: a) its agricultural-water use is characterized by the smallholder rice cultivation that is common to most of the developing countries in Asia; b) the basin has advanced regulatory and institutional arrangements for IWRM including participatory arrangements for water-resources development, water delivery and distribution. Its Land Improvement Districts would provide useful replicable lessons for voluntary social organization in other countries. The third case study on Brantas illustrates how an effective institutional framework and a single basin organization have been developed and installed to cover multiple uses of water in a large river basin in a developing country. Jasa Tirta, the Brantas river-basin organization, has been involved in preparing the master plans, deciding on priorities and developing infrastructure for multiple uses, and is now required to be an autonomous water-resources management organization for the Brantas basin. This seems typical for the requirements of many developing river-basin situations in Asia.

Once the agreement was reached on the river basins, the advanced basin case studies were undertaken partly through consultancies. The case study of the Murray-Darling river basin in Australia was conducted through a consultancy arrangement with the Commonwealth Scientific and Industrial Research Organization (CSIRO) of Glen Osmond, SA, Australia, whereas, the case study of the Brantas river basin in East Java, Indonesia was through a consultancy arrangement with the Jasa Tirta Public Corporation of Malang, Surabaya, Indonesia. The case study of the Omonogawa river basin in Akita, Japan was conducted through direct involvement of Ian Makin and Tissa Bandaragoda of IWMI, in collaboration with Toru Mase and staff of the Department of Agricultural Engineering, the Agriculture University of Akita Prefecture, Japan. All three case studies were completed in time for their summary reports to be presented at the regional workshop held in Malang during 15–19 January 2001. This volume presents the three summary reports, and an evaluation of the material as lessons for developing countries. The three unabridged case study reports will be published separately.

The following chapters give the reports arising from the three case studies, a commentary on the replicability of developed country experiences in developing countries, and a conclusion.

Chapter 2

Institutional Arrangements in the Murray-Darling River Basin

Darla Hatton MacDonald and Mike Young[2]

Overview of the Basin

Managing water resources in the Murray-Darling basin is a lesson in resolving conflicts across jurisdictional lines. Often, it is assumed that the water resources of the basin are managed by one body, which is not a full picture. Australia is a commonwealth of states and territories and works under a model of cooperative federalism. The Murray-Darling basin is managed in a framework that involves the commonwealth (or federal) government, four states and one territory. The framework involves layers of representative bodies that consist of a Ministerial Council, the Murray-Darling Basin Commission (MDBC), and a series of high-level groups interspersed with community representatives. These layers make up the fora where strategies and policies are set out for sharing the water and managing the serious problems of water quality in the basin. Water is fundamental to Australia's economy and a strong commitment to using water according to its highest and best use has emerged in Australia. As part of a National Competition Policy, Australia has embarked on major reforms, which include expanding water trading and moving to full-cost pricing of the resource.

The two rivers, the Murray and the Darling, which give the basin its name, are hydrologically very different. The Murray river flows out of the mountains in southeast Australia and has a relatively reliable flow, whereas the Darling drains the northern half of the basin and displays the erratic flow patterns of a river in a semiarid area. The two rivers come together quite far downstream, some 250 kilometers from the sea. The Murray-Darling river-basin comprises a large geographical area, approximately one million square kilometers or approximately one-seventh of the landmass of Australia. With a total length of 3,780 kilometers, it is the fourth longest river system in the world. The total area is roughly equivalent to the area of France.

The Murray-Darling river basin contains half the Great Dividing Range and some of Australia's highest mountains. The high catchments provide a significant amount of water to the system. However, much of the basin is flat, with extensive plains or low undulating areas less than 200 meters above sea level. The basin covers 75 percent of the State of New South Wales, 56 percent of the State of Victoria, 15 percent of the State of Queensland, 8 percent of the State of South Australia and the entire Australian Capital Territory (MDMBC 1987). The Murray river system consists of the main course of the Murray river and all its branches, and tributaries entering the Murray river upstream of Albury.

Due to the relatively low rates of runoff in much of the basin, and the existence of a substantial amount of salt of geological origin present in the landscape, salinity is a significant issue in the basin.

---

[2]Dr. Darla Hatton MacDonald is a Resource Economist in the Policy and Economic Research Unit, CSIRO, Australia. Mr. Michael Young is the Director of the Policy and Economic Research Unit, CSIRO, Australia. A longer paper on this topic can be accessed at: www.clw.csiro.au/research/agriculture/economic/publications.html

The Murray-Darling basin has been transformed by the construction of major water weirs, locks and storages on the rivers over the last 100 years. A number of works have been put in place: Dartmouth dam, Hume dam, Yarrawonga weir, Lake Victoria storage, the Menindee lakes storage, the weirs and locks along the Murray river and lower Murrumbidgee, as well as the barrages near the mouth of the Murray river. Further, a major hydroelectric power station, the Snowy river scheme, was constructed over a 25-year period beginning in 1949. The scheme diverts water from the Snowy and Eucumbene rivers and adds about 1,140 giga-liters (million m^3) of water to the Murray and Murrumbidgee valleys making more water available for irrigation. People living in the Snowy catchment are now arguing for some of this water to be returned to them.

The total volume of water-storage capacity in the basin is just less than 35,000 giga-liters. The major storages, especially Dartmouth, Hume, Lake Victoria, and the Menindee lakes and other river regulatory structures have made it possible to store water during wet periods and release it as needed during summer or in droughts.

The basin has been populated for an estimated 40,000 years and there are significant sites where cave paintings and artifacts of aboriginal culture have been found. The basin is also important as a place of recreation and tourism. The Adelaide city with a population of over 1 million people draws an average of 40 percent of its water needs from the Murray system. There are a large number of wetlands throughout the basin some which are considered to be of international significance and listed as Ramsar wetlands. The basin provides the breeding habitats for many species of water birds, fish, invertebrates and plants.

The importance of the basin to Australian agriculture is evident by the fact that 43 percent of the total number of farms in Australia are in the basin, representing 45 percent of the crop area. Within the agriculture sector, crops, pastures and grasses are the largest-value components of agricultural production in the basin, with a gross value of production of A$7.9 billion (Australia Bureau of Statistics) (US$1.00=A$1.54). Irrigation dominates the landscape of the basin. Irrigated crops and pastures in the basin represent 72 percent of Australia's total area of irrigated land. Irrigation is essential for improved dairy, cotton, rice and horticulture, in particular viticulture.[3]

Water Resources in the Basin

One of the more remarkable features of the Murray-Darling basin is the climatic variability. Within the basin, rainfall varies from 1,400 mm/yr. in the highlands to 300 mm/yr. in the northwest (MDMBC 1987). Australia's climate, compounded by the variability of its rainfall, means that virtually all of Australia's river systems are subject to considerable variability of flows from one year to another. According to Brennan and Scoccimarro (1998), annual variations from maximum to minimum flows range from 300:1 to 1,000:1 in Australia. Extremes of 10,000:1 have been reported for the Darling river. The northern "Darling" system is essentially a summer rainfall system, while the southern "Murray" system is essentially a winter rainfall system.

The Murray and Murrumbidgee rivers experience relatively more reliable precipitation and, as a result, streamflow is much more reliable than in other parts of the basin. The largest variability seems to occur with the Darling river and its tributaries where massive floods can occur as well

[3]See Crabb (1997) or http://www.mdbc.gov.au/tour/irrigation.html.

as times when the rivers cease to flow.[4] The Murray-Darling basin has a relatively low mean annual discharge in proportion to runoff and in comparison with other river systems in the world.

Geopolitical Organization of the Basin

The previous section highlighted the unique physical characteristics of the Murray-Darling basin. Due to the geographic size of the basin, it crosses the boundaries of states and one territory. The Murray-Darling river basin is managed by individual states but there are overarching bodies that coordinate many of the efforts of state and territorial governments at the basin level. Australia is a commonwealth of states and territories. Water resources are largely under the jurisdiction of the states and territorial governments. Rather than amending the Constitution, an MDBC has been formed to manage inter-jurisdictional processes and conflicts in an organized manner.

The commonwealth (or federal) government does participate in water and water-resources management through other means such as legislative and executive capacity. In particular, the commonwealth government gives financial assistance to the states and territories under Section 96 of the Commonwealth Constitution (Fisher 2000, 35). However, these financial incentives must not be shown to discriminate between states. This is a form of cooperative federalism where the commonwealth and state governments come to agreements and the commonwealth relies on the states to implement agreements within their respective jurisdictions.

As a result of the constitutional framework, different bodies of legislation and institutional arrangements have evolved in each of the states. To follow the elaborate layers of committees, management groups and other arrangements that are necessary to manage the basin (and other resources in Australia), it is necessary to introduce the key bodies that shape commonwealth, state and territorial government policy on water. The institutional arrangements in the basin are in a process of evolution as the states and territories move towards market-based systems of allocation of resources.

An overarching policy, which affects most sectors of the Australian economy, is the National Competition Policy. Under this policy, the states, territories and the commonwealth are committed to a process of creating a level playingfield for all by facilitating effective competition. The goal of this process is to promote economic efficiency and economic growth. The policies are articulated in what has become known as the Hilmer report on National Competition (Hilmer 1993).

To facilitate these competitive reforms, the commonwealth government has placed funds in a pool to be distributed among states and territories on the basis of progress in implementing reform (each step is known as a tranche). Thus, states and territories have a financial incentive to implement the policy framework. The size of payments promised varies among states. Payments are not large enough to fully finance reform but have been sufficient to ensure that serious steps are taken to implement the required reforms.

Council of Australian Governments

The Council of Australian Governments (COAG) comprises heads of federal (Commonwealth of Australia) and state/territorial governments plus a representative from each local government. Water is one of many sectors that come under the purview of the COAG.

---

[4]Water flow becomes an issue later in the report when we discuss security of water allocations.

The COAG has developed a national policy called the COAG Water Reform Framework for the efficient and sustainable reform of Australia's rural and urban water industries. Many of the states and territories had been moving in these directions prior to the COAG. In developing its framework, the COAG has adopted a position that required a consistent approach to water reform throughout Australia. The key elements of COAG's water reforms are the following:

- All water pricing is to be based on the principles of full cost recovery and cross-subsidies must be made transparent.
- Any future new investment in irrigation schemes, or extensions to existing schemes, are to be undertaken only after appraisal indicates it is economically viable and ecologically sustainable.
- States and territorial governments, through relevant agencies, are to implement comprehensive systems of water allocations or entitlements, which are to be backed by the separation of water property rights from land and include clear specification of entitlements in terms of ownership, volume, reliability, transferability and, if appropriate, quality.
- The formal determination of water-allocation entitlements, including allocations for the environment as a legitimate user of water, is to be undertaken.
- Trading, including cross-border sales of water allocations and entitlements, is to be allowed within the social or physical and ecological constraints of catchments.
- An integrated catchment-management approach to water-resources management is to be adopted.
- Resources management and regulatory roles of governments are to be separated as far as possible from water-service provisions.
- Greater responsibility is to be given to local areas for the management of water resources.
- There should be greater public education about water use and consultation in the implementation of water reforms and appropriate research into technologies of water-use efficiency and related areas.[5]

Each state and territory was given the flexibility to adopt its own approach to implementation depending on its own unique institutional and natural characteristics, but agreed that the full framework would be implemented by the year 2001. A key feature of the COAG framework was the state and territorial agreement to a tranche payment system, where access to very large payments was conditional upon delivery of reform milestones. The tranche payment system was instrumental in achieving the degree of economic reforms that has occurred across the states.

The reform process has not led to universal or even uniform changes in policies and practices across the states and territories. Governments have tended to tackle the reforms that are most easily achieved. In some ways, South Australia was furthest along the track, as the state had already introduced many of the reforms in a single piece of legislation, the Water Resources Act, 1997.

---

[5]*Source:* http://www.affa.gov.au/water-reform/facts2.html.

South Australia has the most comprehensive planning process where catchment boards undertake community consultation as part of the water management plans and this process is made consistent with a State Water Plan. However, South Australia has made only partial progress towards full cost pricing of water because of the state-level commitment to one price for reticulated water throughout the state. Arguably, New South Wales has made the greater strides towards full cost pricing because the state already had a process in place through the Independent Pricing and Regulatory Tribunal (IPART). Musgrave (2000) reports on the transparent public process that IPART uses to navigate through the conflicting interests.[6] Many of these more successful aspects of water reform do not appear to be transferred easily even to other states, as the process of reform is constricted by institutional settings already in place. Generally, in the area of water reform, Queensland has the "longest way to go," which has required the state to undertake an extensive consultation process on water pricing, water trading and the system of water allocation. A new insight beginning to emerge is that states that are slower to implement reforms can learn from others. Those states that were last to implement reforms are now beginning to pass those who were the first movers in the reform process.

The COAG Water Reform process has been further developed by the High-Level Steering Group on Water. This group consisted of the chief executive of each state and territorial and commonwealth department directly responsible for water. The head of the Murray-Darling Basin Ministerial Council (MDBMC) is not represented on the High Level Steering Group on Water HLSGW but its members, with a few exceptions, are members of the commission.[7]

MDBMC

The MDBMC was established in 1985 with amendments to the Murray-Darling Basin Agreement. The MDBMC advises the council of the Australian Governments on appropriate matters relating to the implementation of the framework for water reform. The MDBMC consists of the ministers responsible for land, water and environmental resources in each of the signatory or contracting governments, the Commonwealth, New South Wales, South Australia, Victoria and Queensland, with each government limited to a maximum of three members. Its prime functions are:

a. Generally, to consider and determine major policy issues of common interest to the contracting governments concerning effective planning and management for the equitable, efficient and sustainable use of the water, land and other environmental resources of the Murray-Darling basin.

b. To develop, consider and, where appropriate, authorize measures for the equitable, efficient and sustainable use of such water, land and other environmental resources (Murray-Darling Basin Agreement 1992, Clause 9).

---

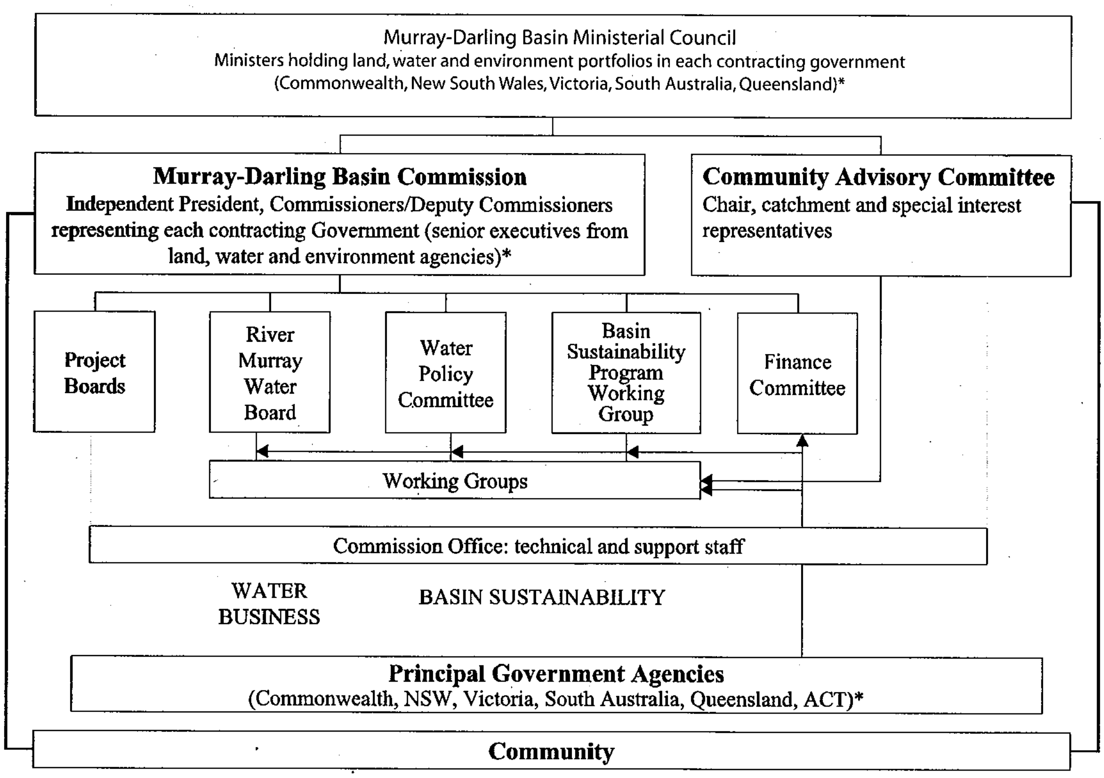
[6]Pricing issues will be described in more detail in the water-pricing section.

[7]A decision to rationalize the number of high-level institutional arrangements in Australia has resulted in the recent transfer of the functions of this group to a new Natural Resources Management Council and its subsidiaries. At the time of writing, it is still too soon to see if this group will conclude that all water and natural-resources management issues can be managed under a single structure or if there is an ongoing need for separate water-focused meetings. In most states, the CEOs responsible for water policy are the same people responsible for natural-resources management.

Being a political forum, the MDBMC has the power to make decisions for the basin as a whole because of the presence of ministers representing each state and territory. Resolutions of the council are arrived at through consensus. This means that decisions taken by the council represent, in theory, a consensus of governmental opinion and policy across the basin at a point in time. However, the MDBMC relies on the states to implement any decisions taken. An overview of the high-level organization of the Murray-Darling basin can be seen in figure 1 and details concerning the MDBC are discussed below.

This organizational chart highlights how the state and commonwealth governments coordinate their efforts to provide a high-level structure that is responsible for the basin. It is interesting to note that within this high-level structure, a place has been made for a community advisory committee, which reports to the MDBMC. The committee serves as a two-way communication channel between the MDBMC and the communities living in the basin. In the last few years, the community advisory committee has considered a number of controversial topics, such as dryland salinity, implementation and monitoring of the cap on water diversions and floodplain management. The committee was able to communicate the issues to the community and provide a "reality-check" concerning the human dimensions of problems. The committee has also been considering issues relating to aboriginal involvement in natural resources management and recognition of cultural heritage in the basin (MBDC 2000). The first two tiers of the structure have been stable for many years, but the third tier of project boards, policy committees, etc., changes regularly. The commission's staffing structure was changed radically in 1999.

Figure 1. Organization of the MDBC.



* Participation of the Australian Capital Territory is via a memorandum of understanding

MDBC

The MDBC is the executive arm of the MDBMC. It also works cooperatively with the states. The MDBC is responsible for managing the Murray river and the Menindee lakes system of the lower Darling river, and advising the MDBMC on matters related to the use of the water, land and other environmental resources of the Murray-Darling basin.

The MDBC comprises an independent president, two commissioners from each contracting government (i.e., the Commonwealth, New South Wales, Victoria, South Australia and Queensland) and a representative of the Australian Capital Territory Government. Each contracting government also has two deputy commissioners. The Australian Capital Territory has one deputy representative. Apart from the president, commissioners are normally chiefs and senior executives of the agencies responsible for management of land, water and environmental resources.

The MDBC is an autonomous organization equally responsible to the governments represented on the MDBMC as well as to the council itself. It is a rather unusual entity in that it is neither a government department nor a statutory body of any individual government.

The MDBC has a couple of key functions that include:

- Advising the MDBMC in relation to the planning, development and management of the basin's natural resources.
- Assisting the council in developing measures for the equitable, efficient and sustainable use of the basin's natural resources.
- Coordinating the implementation of those measures or, where so directed by the council, directly implementing measures.
- Giving effect to any policy or decision of the MDBMC.

The MDBC must balance equity considerations as well as manage and distribute the water resources of the Murray river in accordance with the Murray-Darling Basin Agreement. The MDBC began with a mandate to manage the water quantity that has gradually extended to include water-quality issues and, to a limited extent, related issues on land-resources management. In the late 1980s, it was given a mandate to initiate, support and evaluate integrated natural-resources management across the Murray-Darling basin.

The MDBC must work in cooperation with the contracting governments, committees and community groups to develop and implement policies and programs. As a result, it tends to work on a consensus basis. This cooperative approach reflects the constitutional reality and the importance placed on government-community partnerships that bring to participants and end users the benefit of shared concerns and expertise, and jointly developed and integrated solutions, and avoids duplication of effort.[8]

[8]www.mdbc.gov.au/about/about_mdbc/the_commission.html.

Other Committees Involved in Water Reforms

There are a couple of key ministerial committees[9] that have been charged with putting the policy framework in place in each state and territory in line with COAG reforms. Two groups, the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) and the Australian and New Zealand Environment and Conservation Council (ANZECC), have provided policy directions in relation to water needs for agriculture and the environment. These ministerial committees are supported by Standing Committees of senior officials.

In recent years, ARMCANZ and ANZECC have been fora for government ministers to coordinate efforts. The HLSGW, which consists of departmental heads, provided the ties between government agencies and the policy-setting committees, such as ARMCANZ and ANZECC. There are a number of other committees that involve lower-level government officials where the details concerning how to implement these policies are worked out. The committees have been key in implementing reforms concerning full cost pricing and the creation of the environment for the competitive provision of water. Recently, ARMCANZ, ANZECC, and a number of other committees have been restructured to separate pure agricultural issues from integrated natural-resources-management issues and environmental issues.

Coordination of Various Agencies

Coordination is achieved via a constellation of councils and bodies that often involve the same people. Agreements entered into by the states will necessarily reflect approval by the ministers who sit in the various government cabinets.

The MDBC is also an important point of coordination. Each year, each state develops a 3-year rolling plan that outlines the outcomes to be achieved against basin-sustainability objectives in the management regions. The management regions correspond to the catchments in New South Wales, Victoria and South Australia. A consolidated 3-year rolling investment plan, based on state plans, then provides a summary of the investments being made across the basin. This allows for some evaluation of progress towards sustainability goals.

In Australia, it is recognized that states must work together on resources-management issues. The process works because of the processes embodied within institutions to resolve issues. The constellation of a myriad committees and groups of officials work reasonably well despite the complexity of the arrangements. The key is the continuities created by ministers and their deputies by sitting on various committees. Mutual trust and a culture of cooperation among individual administrators have grown up over the years. Further, in these settings, moral suasion is used as a mechanism to encourage states to act in a manner consistent with the common good.

Characteristically, new agenda issues are approached by setting a vision and then negotiating the detail once a consensus concerning a vision is achieved. A second feature is the complex web of people involved. It is common for many of the commissioners to chair subcommittees, sit on

[9]Under the Australian system of government, ultimate responsibility for policy implementation rests with a minister. To be a minister, one must first be elected to parliament and then selected for a position in the cabinet. Departments are constrained and guided by legislation and are subject to the direction and control of a minister.

the HLSGW and be the head of a natural-resources-management department. These same people also interact through committee processes that involve ministers.

How to Share the Water

In the Murray-Darling river basin of Australia, water is used for passive, environmental and consumptive purposes. Historically, access to the Murray-Darling basin began with a framework that enabled virtually whoever wanted to use water for consumptive purposes to do so. Moreover, most of the infrastructure used to deliver water was paid for by governments and supplied at subsidized prices.

The combination of drought and water quality has become a significant issue for water users throughout the basin. Events such as droughts, algae blooms and increases in salinity provided an impetus for renegotiating how to share the water in the Murray-Darling river basin. Views on the situation are colored by location in the basin. Queensland, New South Wales and Victoria are "upstream states" and South Australia is a "downstream" state.

Priorities among Users

In general, across states, the consumption of water by people and animals takes top priority followed by agriculture. Most water licenses and legislation indicate that water needed for domestic purposes and livestock production is a prior right. That is, people may not interfere with the rights of others to consume water for stock or domestic purposes.

The importance of the environment has been underlined through a number of policy statements that have been issued. However, where in the list of priorities the environment is actually placed is not always well defined in practice. An example is the Corporatization of the Snowy Mountains Hydroelectric Authority, Draft Environmental Impact Statement (EIS) released by the Commonwealth (Department of Industry, Science, and Resources 2000). The EIS outlines how water levels in the Snowy river might be restored through water savings in the Murray-Darling but rather than recommending specific trade-offs between economic and environmental interests, or between competing environmental interests, the EIS has sought to compare and contrast the various advantages and disadvantages for each group of stakeholders of reducing water releases to the Murray-Darling basin in order to provide increased flows in the Snowy river (Department of Industry, Science, and Resources 2000, 2).

This reluctance indicates the difficulties that governments, communities and businesses face in placing the environment in a list of priorities. However, positive steps have been taken as 100 giga-liters have been set aside for the Barwah-Millewa forest. The Barwah section of the forest is a Ramsar wetland indicating that this is a site of international importance (MDBC 1999).

All levels of government have committed themselves to an Inter-Governmental Agreement on the Environment. This agreement commits them to a set of principles designed to ensure that all resources use and development in Australia are ecologically sustainable. Indicative of this change in emphasis, the Government of New South Wales recently reduced most irrigation allocations by 10 percent in the basin so that "allocations" to the environment could be increased. At this stage, however, no formal quantity of water has been allocated to the environment. Some irrigators, however, are of the view that this should occur and that any increase in allocations to the environment should be made only through processes that involve voluntary purchase of environmental flows at full market price.

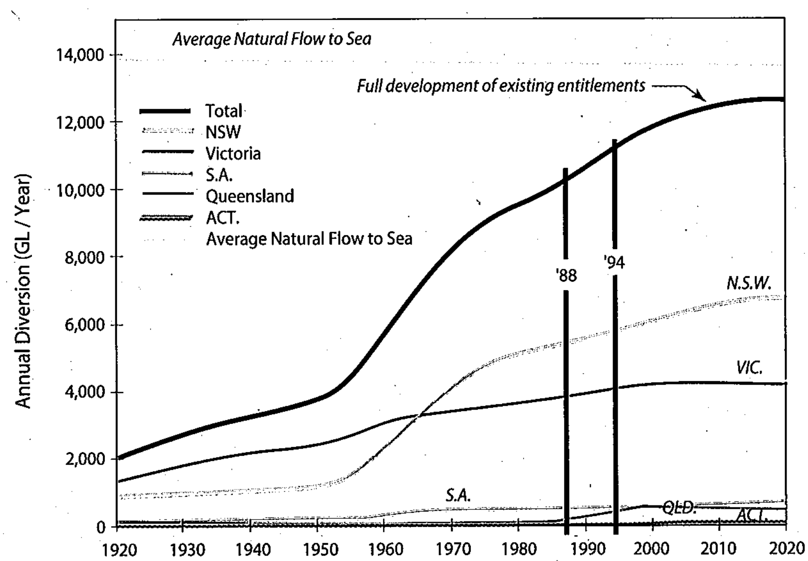
Allocating Water among States

The basis for allocating water across states is largely the product of historical use. New South Wales and Victoria have engaged in intensive agriculture since the turn of the century and the pattern of increasing use can be seen in figure 2. Through the 1980s, the amount of water being used for consumptive purposes began to increase significantly. In 1993, a decision was made by the MDBMC to prepare a water audit that would:

- Establish water use in the basin.
- Describe current level of development.
- Document recent trends.
- Assess the implications of those trends.

The MDBMC was concerned about the health of the basin. Salinity of water was increasing, algal blooms were occurring more frequently and biodiversity appeared to be declining. For the downstream State of South Australia, the situation was thought to be quite serious.

Figure 2. Historical use of the Murray-Darling basin by the states and projections as of 1995 without a cap.



Source: MDBMC 2000.

It was acknowledged by the MDBMC that water usage could not continue to increase within the basin. As a result, an overall cap on water diversions has been introduced, limiting the volume of water to what would have been diverted under the 1993–94 levels of development. The cap is variable depending on climatic conditions; in dry years, less water is diverted based on the water that would have been available given the existing infrastructure.

Perhaps, the most dramatic impact of the cap has been an increase in water trading. The ability to move water to its highest and best use has resulted in significant increases in the price of water. Trade in water has been occurring in Victoria and New South Wales since the early 1980s. Trading became particularly important and widespread with droughts, diminished supplies, the cap on water and, in some areas, decreases in water allocations. The property rights reforms that are underway in the states and territory will further facilitate trade.

Most of the states are putting in place legislation that separates title to land and water and allows licenses to be traded either permanently or temporarily.[10] For example, in South Australia, it is now possible for a person who owns no land to hold a water license as an investment and sell water on an annual basis to any interested party. A system of well-defined property rights is not a requirement for water trading though it certainly facilitates more efficient trade.

Water Trading within and among States

The development of markets for water is well established in some states such as New South Wales and Victoria. In New South Wales, water trading was active and total sales amounted to 11 percent of total entitlements to consumptive users in 1997–98. Much of the trade involves temporary transfers of water. Until the new legislation is passed, land and water licenses are not separate. Permanent transfers would require cancellation of the license of the transferor and the issuing of a new license to the transferee. Temporary trades are essentially "leases" of a license. Moreover, the crops grown in New South Wales do not necessarily require high security water rights. In South Australia, the situation is considerably different, since the irrigation of grapes requires a very secure source of water. Most trades in South Australia are permanent.

In Victoria and the other states, there are significant issues to resolve with respect to third-party impacts. The states have been allowing trade to expand slowly in order to assess the impact on environmental health and water quality. There are also costs associated with allowing water to leave an area. Irrigation schemes and communities are struggling with this issue.

The next step in the water-reform agenda is an interstate water trading pilot project. Under a pilot project, trade in water is permitted in the Mallee region of South Australia, Victoria and New South Wales. The geographic area covered is the Murray river between Nyah and the Barrages at the mouth of the Murray and the licenses from the Darling river, which are supplied from Lock 10, near the junction of the Murray and Darling rivers. The Mallee region was selected for two reasons. First, the same type of agricultural activity, such as irrigated production of fruits, vegetables and grapes for wine, is prevalent in the region. Second, the price per mega-liter of water is relatively uniform throughout the region.

Only high-security entitlement[11] holders engaged in the permanent transfer of water were allowed to participate in trading. In New South Wales, holders of private high-security licenses, in South Australia, holders of water licenses granted under the Water Resources Act of 1997, and

[10]At the time of writing, New South Wales had a new water bill ready that was soon expected to be enacted.

[11] A high-security entitlement is a license for which the water will be provided except in severe drought conditions. A low- or general-security entitlement is a license for available water, which can vary from year to year.

in Victoria, holders of private diversion licenses are allowed to participate in trading. Even within this region, trading may have an impact on water supply as interstate trades can have an effect on other users. If water is coming from a different source, such as another reservoir or another river, then there will be transmission gains and losses along the system. As water moves down the rivers and channels there are more options for storage and, therefore, there is increased security. To reflect these security issues, a set of exchange rates has been developed.

Temporary trading between states, outside the interstate pilot project, was put on hold by the Minister for Natural Resource in Victoria. The difficulty appears to be in the way each state accounts for water use. New South Wales has a system of continuous accounting and Victoria has a "use it or lose it" system. Under this suite of arrangements, a Victorian water user could transfer water to New South Wales, carry it forward to the next season and bring it back without "losing" it. Victoria was worried about this because its allocations are based on the assumption that every year a proportion of the water would be lost. If this feature is abandoned, then all existing allocations may need to be reduced. Temporary interstate trades will not be allowed after February until the next irrigation season.

The pilot project was allowed to operate for 2 years and then the program was independently reviewed by Young et al. (2000). Under the pilot, 9.8 giga-liters of water were traded at a price of approximately A$1,000 per mega-liter though there was considerable variability in the price over the time frame. The evaluation of the pilot project revealed that the ability to trade interstate tended to lead to "unused" water[12] being moved out of New South Wales and Victoria to South Australia to be used for horticulture and viticulture. The ability to trade water has highlighted the need to simplify and streamline the administrative checks and balances, and the need to put in place a system of binding salinity-mitigation obligations.

Issues of Water Quality

One of the major failures of the institutional arrangements is in the area of water quality. With multiple jurisdictions and conflicting interest of resources users, it has been difficult to get jurisdictions to agree that there is a significant problem, let alone agree on solutions. The MDBC was formed initially to deal with the issues of water quality relating to algal blooms, waterlogging, salinization, etc. Salinity is too large a problem to be solved by one government; it requires coordinated interstate action and community cooperation. The central planks of the Murray-Darling Salinity Strategy are:

- Salt-interception schemes.
- Changed operating rules for several lakes with a view to reducing evaporation and, hence, salt concentration.
- A suite of land management policies and programs jointly funded by the states and the commonwealth.

[12]Here by "unused" is meant that it was not used by people who held allocations from where it was transferred. In practice, however, it needs to be recognized that before these transfers occurred the water was left in dams and then allocated to others.

One of the unique features of this strategy is the agreement between the Victorian and New South Wales governments to manage water resources within agreed limits. These states cannot construct or approve any proposal that would increase salinity by 0.1 EC[13] or more in the Murray river at Morgan unless they have access to salinity credits.

Under the salinity credit scheme, the New South Wales and Victorian governments received salinity credits of 15 EC each for their contributions to the costs of the interception schemes. States can earn more credits by financing schemes that reduce the expected salinity load at Morgan. The MDBC maintains a register of works undertaken and the salinity credit and debit impacts. The salinity impact of any proposed irrigation scheme must be offset by acquiring credits in the register. South Australia requires that interstate water be subject to a Zero Impact Assessment. However, the difficulty with all these processes is the difficulty of making the agreements with irrigators binding, especially if the water can be traded again.

Despite the progress that has been made, some analysts such as Quiggin (2001) suggest that the present policies are still unsustainable. Even with the cap on diversions, if all entitlements existing in 1995 were fully developed by 2020, more than 90 percent of the average natural flow to the sea would be diverted. This pattern is unsustainable for the water-dependent ecosystems. This suggests that further steps must be taken to reduce the amount of water being diverted, if important ecological resources are to be preserved and the costs associated with salinity damage to downstream users in Adelaide are to be averted.

Water Pricing

In the 1990s, many of the states were reforming pricing of water for irrigation and water for household consumption (and stock watering in some cases). Basic principles of economics suggest that a resource will be used most efficiently where the competitive market would price the resource. This is usually taken to be the long-run marginal cost (or the incremental cost per unit of water). Water and many other utilities have large fixed or "start-up" costs, which lead to a decreasing cost industry where average and marginal costs decrease with the amount produced (at least over the relevant range). Thus, there is always a tendency for a few firms (often only one in a particular jurisdiction) to supply water. Moreover, pricing at marginal cost in a decreasing cost industry means that average costs are not covered in the long run. In the long run, firms must cover their costs. Further, marginal cost pricing will not allow for covering the costs of future expansion as is sometimes required in water systems.

These economic considerations are in part covered by the key elements of the water-pricing policy of the Council of Australian Governments (COAG). In the case of pricing, the COAG reforms codified many of the policies that had been floating in policy circles at the time. The COAG pricing regime is to be based on the following:

- Consumption-based pricing and full cost-recovery for urban water and rural water supplies.
- The elimination of cross subsidies as far as possible and their exposure where they exist.

[13]EC is a measure of electrical conductivity. 1 EC=1 micro-Siemen per centimeter measured at 25 °C.

- Cost recovery that includes environmental costs (externalities) and the cost of asset consumption as well as taking the cost of capital into account.
- Positive real rates of return on written-down replacement costs of assets.
- Future investment in new schemes or extensions to existing schemes to be undertaken only after appraisal indicates it is economically viable and ecologically sustainable.

On a state-by-state basis, full cost pricing is at various stages of implementation. Cost-recovery pricing is not a straightforward process to implement. Some states and territories are further along this process than others. According to the Progress Report to the COAG, water sold in urban areas is sold on a cost-recovery basis though there is some question whether proper account is being taken of the environmental externalities.

New South Wales established the Government Pricing Tribunal, which evolved into the Independent Pricing and Regulatory Tribunal (IPART). Both entities predate the COAG reforms. IPART reviews information on costs and revenues and determines bulk water prices. IPART considers, for instance, whether the department's costs represent an efficient level of service. Revising the price strategy of a resource is unlikely to be a painless process. The extractive users in New South Wales, particularly the irrigators, mounted a noisy opposition to the potential increases in price. However, the tribunal conducted its review in a very public forum and consulted with interested groups across society. In the end, IPART was able to develop a set of pricing rules accepted for adoption at the national level by the Standing Committee on Agriculture and Resource Management. The rules are currently being used to guide the process of price reform across jurisdictions.

Conflict Resolution

One of the key lessons of the Murray-Darling basin is that institutions can serve as mechanisms to resolve conflicts. When institutions fail to resolve conflicts they must either evolve or be abandoned. As transaction costs among economic agents increase, in this case the various entities operating in the basin, there is an incentive to create institutions to internalize these costs. Challen (2000) points out that the voluntary agreements that the state and commonwealth governments have entered into allow for sharing and accounting for the resources. This results in mechanisms for managing the resources that avoid a situation of open access. As yet, however, the framework does not provide sufficient incentives for states to control resources use so that the activities of users in any particular state are viewed in terms of the impact across the entire basin. When issues become serious, however, the framework does appear to enable governments to negotiate a solution. Illustrative examples of this include the commitment to cap water allocations and, more recently, to try and set valley-by-valley salinity targets.

MDBC

The Murray-Darling Agreement is a prime example of institutional rules designed to manage conflicts. Early conflicts arose between users of the Murray river for irrigation and navigation. However, an agreement between the states of New South Wales, Victoria and South Australia was not reached until after a series of severe droughts raised the cost of noncooperation past the threshold for the three states.

The existence of the River Murray Commission from 1917 to 1985 speaks of the commission's ability to work cooperatively with the states and to coordinate the construction and operation of some of the works on the river. Regulating the flows of the river clearly served the interest of the states (e.g., expansion of agriculture in the basin).

The commission expanded its role over time but was not able to evolve into an institution capable of dealing with basin-wide problems, such as salinity and the declining health of the riverine environment. As states realized they could not resolve these issues within their own jurisdictions and costs would continue to escalate with inaction, there was again the incentive to develop a new institution, the MDBC that, as discussed earlier, has a broad mandate to bring about basin-wide solutions.

Over the last decade or so, the MDBC has become increasingly aware of the need for the benefits of community consultation. To this end, in 1986 it established a Community Advisory Committee that reports directly to the MDBMC. Today, virtually all commission programs involve a large degree of consultation. Most policy reforms are, at least, discussed with the council and explored through transparent media and meeting-based processes. Draft policies and/or strategies are then released and finalized after a period of time.

Irrigation Schemes

Within the basin, most of the large irrigation schemes were created to deliver water and encourage the expansion of agriculture. The water-reform process, the expansion of water trading, and the cap on diversions have changed the operating environment of these entities. These entities have evolved over time from a means to put irrigation infrastructure in place to become major water managers. One irrigation scheme, Colleambly Irrigation, has been evolving into a natural resources manager at a time when there was a crisis in confidence about the land and water management planning process and the impact that irrigation in New South Wales was having on the environment. The Government of New South Wales was moving to impose costly monitoring and reporting requirements. Colleambly perceived that it did not have time to wait for natural resources outcomes to demonstrate that it was a responsible resources manager. Colleambly chose instead to apply for ISO 9002 and 14001 accreditation.[14] The accreditation process provided a means of resolving conflicts between Colleambly, NGOs and the media about the health of the river environment. The accreditation process proved successful in demonstrating commitment to the environment and a means of differentiating itself in a competitive environment.

Catchment Boards

At the catchment level, people are most closely associated with the environment and the water resources. Throughout the basin, there are catchment boards with differing levels of experience, expertise and power. Most boards engage in public consultation and have varying degrees of community involvement. This is a means of engaging people in the issues and it is also a process of education for most of the interested parties. Through consultation, boards as well as the public

[14]ISO 9002 is an accreditation system where a set of procedures to ensure a certain level of quality are in place. ISO 14001 is an environmental management system based on the same accreditation process.

learn about the state of the catchment and the positions of the various parties with respect to what should be done. South Australia is currently the only state that boards the power to raise levies.[15]

The planning process of water allocation and the consultation process with the community are often cited by catchment managers as a useful process for uniting divergent interests. The chairs of catchment boards, which are unable to navigate through the conflicts, come under pressure to resign or not seek a renewal of their position. The process usually restarts with the appointment of a new chair.

The Courts

Ultimately, the court system in Australia serves as a place where remedies for conflict can be sought. Generally, this is an expensive process for water users, states or territories to engage in. These costs often serve as a means of motivating the different entities to work to solutions through other means.

Conclusions

The Murray-Darling river basin by its physical and geopolitical nature is difficult to manage and is likely always to be a source of conflict due to its economic significance. The lessons from the basin can be summarized largely in terms of how conflicts are managed. The sustainable management of resources has required innovative mechanisms to be put in place that will encourage reform in an environment of cooperative federalism. The system of tranche payments has proven to be a means of encouraging states to move in a consistent manner through water reforms.

In Australia, there is an unspoken philosophy concerning how much room there is concerning adherence to rules. There is generally some tolerance about minor deviations from rules but there is a point of no return where payments are frozen, governments go to the courts seeking remedies and voters lose confidence in their elected officials.

The constellation of myriad committees and groups of officials work reasonably well despite the complexity of the arrangements. The key is the continuities created by ministers and their deputies sitting on various committees. Trust between individuals has grown up over the years. Moreover, in these settings, moral suasion works as a mechanism to encourage states to act in a manner consistent with the common good.

Institutions such as the MDBC and IPART in New South Wales have tended to use open transparent processes. The commission operates to create consensus concerning a common vision or broad principles and negotiates the details later. The commission will use a combination of moral suasion and public shaming to force states to honor commitments to the cap on diversions and salinity targets within the basin. IPART has used the open public setting to prevent interest groups from hijacking the agenda from the goal of full cost pricing.

Australia has done a number of things well in the basin. Capping water usage and establishing a salinity credit system represent major accomplishments. Adherence to these systems, where not all states bear the burden of salinity or benefit from enhanced environmental flows, is going to be the major challenge in the short term. Moving to full cost pricing and expanding water trading have proven to be sources of conflict that are gradually being resolved through the institutions, which appear robust enough to survive the demands of water users in the basin.

---

[15]Until recently, Victoria's boards also raised levies but a recent change in government resulted in the withdrawal of this power.

Chapter 3

Water Resources Management in the Omonogawa Basin, Akita Prefecture, Japan

I. W. Makin, D. J. Bandaragoda, R. Sakthivadivel and N. Aloysius[16]

Omonogawa Basin

Physical Characteristics

The Omonogawa basin is in the Akita Prefecture, about 500 kilometers north of Tokyo, lying between 39–40^0 North and 140–141^0 East with a surface area of approximately 4,952 square kilometers. It is the thirteenth largest basin in Japan. The two main branches of the Omonogawa rise in the central ridge of Honshu with a watershed of up to 2,200 meters above sea level. The mountains and foothills are extensively forested and the dominant land use is forests and homesteads that cover about 85 percent of the catchment. The valley and the flood plains are predominantly covered by paddy lands, but they also contain some homesteads. These include irrigation, drainage and flood-control components, in addition to the improvement of roads and other infrastructure. Existing irrigation and drainage systems have been incorporated into the new LID areas and farmers included in the LID organizations.

Omonogawa is well endowed with water resources. Even in years of severe drought, such as 1994, a considerable volume of water was discharged by the river system. Until the development of flood protection schemes as a component of the Land Improvement projects, reduction of agricultural production occurred more frequently as a result of floods than of droughts, with flooding on six occasions between 1960 and 2000. The extent and severity of flood impacts have been reduced as the LID expanded with the construction of two large flood-control reservoirs in the upper catchments.

Social Characteristics

The population of the Omonogawa basin is about 690,000, with the urban population representing about 70 percent of the total, and a population growth rate of approximately zero. Although agriculture is a more important industry in the north of the Honshu Island than in the more industrialized southern areas, expanding opportunities for other sources of income now means

[16]This study of the Omonogawa basin in the Akita Prefecture, Japan has been funded by the ADB as a component of a Regional Technical Assistance Project, the Five-Country Regional Study on Development of Effective Water Management Institutions. The Omonogawa basin was selected as one of three basins with existing institutional frameworks to provide examples of appropriate management institutions. During the field study, in May 2000, the College of Agriculture, Akita Prefectural University provided extensive logistical support and assistance. Professor Dr. T. Mase was instrumental in identifying and recommending Omonogawa to the study team, organizing the collation of an extensive dataset, and arranging for the study team to meet representatives of the main stakeholders in the basin. Dr. Mase's assistance in translation and interpretation is gratefully acknowledged, as are the contributions to the analysis of the basin and its institutions made by him and his colleagues (Drs. T. Kondoh and H. Jinguji).

that agriculture is a secondary activity. A common problem in agriculture is the difficulty in securing successors for the aging farming population. Agriculture is becoming a less-attractive career for the younger generations due to limited income potential and the greater potential in industry and the public and commercial sectors.

Agricultural Characteristics

Agriculture involves about 51,150 families in the basin. Many farms now constitute a secondary source of income, with other urban and industrial sources being more significant. However agriculture, and particularly rice cultivation, has a strong tradition.

The northerly location of the basin restricts the growing season to the summer months (May to September) and allows only a single crop of rice. The restricted availability of land (typically 1.1 ha per holding), opportunities for off-farm income and the relative abundance of water resources (see section on Water Accounting) make maximizing land productivity important.

Average yields for paddy rice have reached 7 tons/ha with highly mechanized agriculture being the norm. Low temperatures and the short growing season have led to production of rice seedlings in "poly-tunnels." Mechanized cultivation with mechanical transplanting and harvesting is widespread. Other field crops, notably vegetables and fruit orchards, are present in the basin but cover only about 10,000 hectares.

Water Accounting

Omonogawa is well equipped with monitoring stations for both rainfall and river flows. Records for nine river gauging stations (table 1), with records available for the period 1967-1997 were analyzed. The record for the most downstream station, Omonogawa at Tsubaki Gawa, Station Number 20329, was selected as the downstream boundary for water accounting. This station has a catchment area of 4034.9 km^2, about 81.5 percent of the total basin area. Eight rain gauge stations, with over 20 years of records available, were analyzed to obtain basin rainfall estimates, based on weighted averages of three zones within the basin (table 2).

Crop water requirements were estimated for each of the four major land surface covers (table 3) to determine maximum depletion rates by agriculture. Depletion rates for domestic and municipal use were taken as 40.8 million cubic meters (MCM) based on authorized abstraction licenses, population estimates and estimated wastewater return flows.

Annual water accounts for the years 1990–1997 are summarized in table 4. Forests and irrigated agriculture are the largest consumers of water in the Omonogawa river basin. Figures 1 and 2 illustrate the water accounting for this river basin for 1991 and 1994, respectively. The depleted fraction amounts to only about 21 percent of the gross rainfall volume falling on the basin, with a productive fraction of between 4 and 5 percent.

Table 1. Summary of gauging sites in the Omonogawa basin.

Rain-gauge station	Latitude	Longitude	Stream gauge	Catchment area (km^2)
407 Iwami-Sannai	39° 42.3'	140° 17.5'	20329 Tsubakigawa	4,034.9
466 Kakunodata	39° 36.0'	140° 33.6'	20323 Jinguji	3,336.5
476 Tazawa lake	39° 41.8'	140° 44.1'	20317 Omagari Bashi	1,882.1
496 Daisyoji	39° 31.5'	140° 14.3'	20313 Omonogawa Bashi	1,240.0
551 Ohmagari	39° 29.3'	140° 30.0'	20303 Yanagida Bashi	475.6
596 Yokote	39° 19.1'	140° 33.5'	20301 Kawai	145.0
691 Yuzawa	39° 11.1'	140° 28.0'	20321 Nagano	1,088.0
771 Yunotai	38° 57.4'	140° 32.0'	20315 Yokote	216.2
			20306 Mato	255.0

Table 2. Rainfall and streamflow in the Omonogawa basin.

	Annual rainfall		Streamflow at Tsubakigawa gauge station
Year	(mm)	(MCM)	(MCM)
1977	1,716	8,495	7,534
1978	1,606	7,952	6,796
1979	2,260	11,192	9,272
1980	1,884	9,329	7,951
1981	2,209	10,939	8,968
1982	1,754	8,687	7,114
1983	1,679	8,314	7,228
1984	1,630	8,070	8,094
1985	1,741	8,624	7,033
1986	1,654	8,190	7,425
1987	1,909	9,456	8,094
1988	2,887	14,296	6,650
1989	1,610	7,970	5,901
1990	2,049	10,147	8,020
1991	2,069	10,245	8,656
1992	1,665	8,247	6,127
1993	2,010	9,953	8,061
1994	1,478	7,319	6,239
1995	2,250	11,144	9,104
1996	1,682	8,331	7,823
1997	2,008	9,944	7,580

Table 3. Annual consumptive demand for major land covers in the Omonogawa basin.

Month	Crop evapotranspiration (mm)
Paddy	693
OFC	588
Pasture	364
Forest	474

Table 4. Summary of annual water accounts and indicators.

Year	Annual rainfall (MCM)	Depleted water (MCM)	Depleted fraction (DF_{net})	Depleted fraction ($PF_{depleted}$)	Depleted fraction ($PF_{available}$)	Paddy production (kg/m³ET)
1990	10,147	1,968	0.19	0.23	0.04	0.97
1991	10,245	1,968	0.19	0.23	0.05	0.91
1992	8,247	1,968	0.24	0.23	0.05	1.00
1993	9,953	1,967	0.20	0.23	0.05	0.83
1994	7,319	1,911	0.25	0.20	0.04	1.21
1995	11,144	1,967	0.17	0.23	0.04	0.91
1996	8,331	1,967	0.23	0.23	0.05	1.01
1997	9,944	1,968	0.20	0.23	0.04	1.00

A severe drought occurred in 1994. The rainfall analysis indicates this to be the driest year in the available record. This drought triggered the implementation of the Emergency Drought Management Committee. This drought was widespread across Japan. The impact of the drought management regulations is evident in the abstractions at the Naruse and Minase barrages. Abstractions for irrigation were severely curtailed after the 17 July 1994 instigation of the drought committee, with abstractions at Minase of only 74 percent of the authorized seasonal diversion. The estimated productivity of water in paddy cultivation during the 1994 drought reached 1.21 kg/m^3, considerably higher than the already high average productivity achieved in the basin of 0.98 kg/m^3 of consumptive use. (The yield is given in milled rice rather than in paddy.)

The Nana Taki LID is typical of established locally managed irrigation systems in the Omonogawa basin. The system is located on the alluvial fans at the points where the Omonogawa tributary streams enter the valley plain. The LID serves about 1,608 hectares, operating four storage reservoirs (1,128 MCM, 0.75 MCM, .405 MCM and 0.196 MCM), an interbasin transfer tunnel (858 m long with a design discharge of 1 m^3/sec.) and one river headwork. In addition, about 24 groundwater pumps and natural springs are developed for irrigation purposes.

Institutional Structure

Water is an important factor in Japanese society. The importance of rural communities and agriculture is embodied in the regulatory framework that controls water management in the country, the Rivers Act, first promulgated in 1897. This original act, and the Revised 1964 Act specify firstly, the need for regulation of water to be vested in a single agency (Ministry of Construction), and secondly the principle of protecting traditional and existing uses.

The LID system has become recognized as one of the more successful innovations in the region to support user involvement in management of irrigation and water resources schemes. The experience in Japan has some enlightening and useful facts of more general relevance. Farmers in the LIDs are involved in effective water use and wish to increase their income in response to the price signals for agricultural produce. Farmers have a sense of both ownership over the water and belonging to irrigation facilities. The sense of ownership and shared responsibility are essential trends in farmers' self-governance of irrigation and in attaining effective, equitable and sustainable use of water.

However, the LID system has grown out of a long experience in communal management of land and water resources and it should not be forgotten that this experience has included many years of bitter and painful conflicts among farmers concerning water allocation. The prevailing system of water management has been developed gradually by farmers themselves, subsequently being formalized by the Land Improvement Act, promulgated in 1949.

By the early 1960s environmental concerns became evident and Japan focused on the deterioration of the environment and communities. A new Environmental Pollution Control Act was promulgated in 1967, followed by the establishment of the Environmental Agency in 1971. Aggravation of pollution from excessive use of agricultural chemicals led to the issuance of the Agricultural Chemical Control Act in 1970.

In common with many countries, there are many institutions with interests in management of water resources. In Japan, the Ministry of Construction has the predominant role in river basin development and management, a position that has been maintained for over 100 years. However, although the role of the public sector is central to water resources management, farmer groups have a well-established role based on participatory development and management of natural resources for protection of agricultural water resources. In many cases, it is the farmer groups that take the initiative to identify requirements and to specify development objectives. The institutions with defined roles in the management of water resources are summarized in table 5.

The central office of the Ministry of Construction nominally allocates water resources. However, in most cases, allocation is delegated to the local prefecture office as approved by the 1964 Rivers Act (GoJ 1964). Licenses for abstraction of water from the main rivers are issued, without charge, for periods of 10 years. The delegated authority allows the local Prefecture Office of the Ministry of Construction to allocate water resources in tributary streams, subject to maintaining agreed minimum discharges at the confluence with the main river stem. Allocations from the main river stem are made under delegated authority from the Ministry of Construction to the Governor of the Prefecture. These allocations confer rights to extract water to approved maximum rates and for defined periods, and are summarized in table 6.

In Omonogawa, 99 Land Improvement Districts serve about 73,000 hectares of irrigation, drainage and flood control schemes.

Table 5. Summary of institutions with water-management responsibilities.

Organization	Level	Institution
Irrigation Department	National	Construction Department, Ministry of Agriculture, Forestry and Fisheries
	Provincial	Akita Prefecture Agricultural Policy Department
Water Resources Board		Water Resources Development Public Corporation
Environment	National Agency	Nature Conservation Bureau of Environment
	Provincial	Akita Prefecture Department of Life & Environment
Agriculture	Provincial	Akita Prefecture Agricultural Policy Department
Agrarian Services	Provincial	Akita Prefecture Agricultural Policy Department
Agricultural Development	Provincial	Akita Prefecture Agricultural Policy Department
Inland Fisheries	Provincial	Institute of Fisheries and Fisheries Management–Akita Prefecture Agricultural Policy Department
Water User Organizations	National	National Federation of Land Improvement Associations
	Provincial Associations	Akita Prefecture Federation of Land Improvement

Table 6. Summary of allocation of water rights in Omonogawa, 1999.

Sector	Allocation (m^3/s)
Agriculture	143.0
Municipal and domestic	2.27
Industrial	3.40
Total	148.67

In addition to the decentralized authority over water exercised by the various ministries with water-related responsibilities, water users as represented by the Land Improvement Associations also play a significant part in the administration of water. At the Prefecture level, the Federation of LID associations adjudicates water-related disputes among the member associations. The federation and member organizations have played an important role in the development and management of the basin, originally in the development of the major infrastructure over a period of 50–60 years. This was followed by second-stage development of terminal irrigation facilities in the service areas, and included land consolidation to facilitate mechanization of agriculture and improvements to canals, drains and roads. In the third stage, development of sewage and water treatment facilities has been undertaken in collaboration with the municipal authorities.

Although water user rights are protected by licenses (issued by the National Government, Ministry of Construction) during periods of severe drought these rights may have to be overridden in the public interest. Article 53 of the Rivers Act (GoJ 1964)) makes provision for the establishment of Emergency Coordination Committees with representatives from the water-related stakeholder ministries and line agencies. Representatives of the Ministry of Construction head each committee and they have the authority to adjudicate in the event of conflicting demands for limited water. Coordination Committees are established when drought conditions are declared.

For example, in 1994 the Cabinet of the Government of Japan declared a severe drought condition on 15 July, forming a National Coordination Committee drawn from 13 ministries, headed by the National Land Agency. Eight subregional coordination committees were also established with representatives from the relevant branch offices of the ministries. Of the 47 Prefectures 29 were moderately or severely affected by water shortages and implemented emergency coordination committees, referred to as Special Commissions. These committees adopted seven measures to ameliorate the severity of the drought impacts on domestic, industrial and agriculture sectors:

1. Minimum level of power generation was guaranteed.
2. Dead storage water was extracted from reservoirs.
3. Pumping equipment was made available on lease, from municipal authorities, to farmers whose land was out of command due to the drought.
4. New groundwater wells were sunk and existing wells revived.
5. Treated sewage and industrial wastewater was used for agriculture.
6. Desalination plants were established for domestic supplies in the most severely affected coastal cities.
7. Water was imported from Vietnam and Korea for industrial use.

In 1994, the Shikoku Island received less than 40 percent of the mean annual rainfall. As a result, the Kagawa Irrigation Land Improvement District (KILID) in the Kagawa Prefecture worked with the local LIDs to maximize the benefit derived from the sharply reduced inflows (20% of normal flows) to the main distribution system. The LIDs reinstated traditional forms of water distribution, originally superseded following construction of the main intake channel. These earlier distribution systems were based on local irrigation tanks and ponds. Rotation of supply proceeded from upstream to downstream areas, with priority being given to longer-established paddy lands over newly reclaimed land. The Bansui and Hashiri Mizu forms of rotation were used by different LIDs in response to the preferences of their members. In the Hashiri Mizu form of rotation, literally "Running Water," paddy fields are not inundated with ponded water but water is allowed to flow from lot to lot continuously. For Bansui rotation, water is rotated between terminal-area farmer groups, by time in proportion to relative areas served. Terminal areas remote from the source may be abandoned to minimize conveyance losses.

In the Omonogawa basin, abstractions at the Minase and Naruse barrages for the Omonogawa-Suji project were reduced and became more variable than in other years as the impacts of the drought conditions became more evident. However, the drought was less severe in the basin than elsewhere, such as the Shikoku Island, and even in this year significant volumes of water were discharged from the basin.

Environmental Conservation

During the third quarter of the twentieth century the need for the economy to recover from the devastation of the Second World War resulted in the pursuit of shorter-term policies than in earlier times. These policies led to a strong focus on increased agricultural and industrial production and promotion of a strong economy. The pursuit of these goals, almost inevitably, resulted in an increase in the exploitative use of resources to achieve immediate gains.

The period of economic recovery contrasts with established Japanese cultural values that place great value on tradition and ancestral ties. The importance of rural communities and agriculture is embodied in the regulatory framework, the Rivers Act, first promulgated in 1897, which controls water management in the country. This original act and the revised 1964 act specify, first, the need for regulation of water to be vested in a single agency (Ministry of Construction) and, second, the principle of protecting traditional and existing uses.

By the early 1960s, the economic renaissance of Japan became focused on the deterioration of the environment and communities. A new Environmental Pollution Control Act was promulgated in 1967, followed by the establishment of the Environmental Agency in 1971. Aggravation of pollution from excessive use of agricultural chemicals led to the issuance of the Agricultural Chemical Control Act in 1970.

A remarkable consequence of the recognition of existing water use by the 1897 Rivers Act, even after a period of a strong focus on production and consumerism, is the continuation of traditional water allocations to irrigated agriculture. During this study it was reported that in 2000, traditional irrigation water allocations, i.e., those that predate the 1897 Act, still account for about 60 percent of the total agricultural use (table 7).

The existence of a clearly enunciated policy and its implementation over an extended period, coupled with (now largely superceded) protectionist policies, has enabled the preservation of agricultural rural communities in northwest Japan. The protection of traditional values has preserved agricultural communities and extensive forest areas, and has provided the basis for the reinstatement of water quality.

Table 7. Summary of traditional water rights as a percentage of current agricultural water allocations, 2000.

Basis	Current use (%)
Area	50
Volume	60
Number of intakes	80

Water Quality

Individual LID management organizations are responsible for the day-to-day operation, maintenance, and development of the irrigation and drainage systems in the area of operation. These organizations are responsible for the quantitative measurement of water abstractions and also for measurements of the water quality. Consolidated records of water quantity are submitted to the Ministry of Construction each season to demonstrate compliance with approved licenses.

The LID and the municipal authorities monitor the water quality to regulate the quality of return flows from municipal areas to agriculture and vice versa.

The Ministry of Agriculture, Forestry, and Fisheries set the standards of water quality for agriculture. The LID can force municipalities or industrial users to construct and operate water-treatment plants if discharges are not within the approved standards. Standards of municipal water intake are higher than those set for agriculture. The LID has not had many difficulties in ensuring acceptable quality of return flows, although standards for pesticides in water are becoming more stringent and may impinge on agricultural practices in the near future.

The Tamagawa and Naruse branches of Omonogawa receive highly acidic flows that enter the watercourses from subsurface vents. These flows have resulted in the acidification of sections of the river. In the Tamagawa subbasin, amelioration of the impacts has been implemented by addition of $CaCO_3$ through a treatment works near the Tamagawa lake.

Conclusions

In considering the transfer of the Omonogawa river basin institutions to other river basins, the socioeconomic conditions of Japan must be fully considered. There can be little dispute that, even after the recent turmoil in Japanese and other Asian economies, Japan is the most powerful economy in the region. This economic base, combined with a shared sense of traditional values and a moderate climate, creates a special environment that has nurtured the implementation of effective river basin management.

Specifically, since the early 1960s, a general and expanding popular demand to redress the detrimental practices of the previous 10 to 15 years, when the focus was increased production at almost any cost, led to a rapid development of water and environmental regulations. A long history of comprehensive river basin management under the Ministry of Construction, mandated by the 1897 Rivers Act, and the acceptance of rule of law by society in general, have provided the basis for effective management of water resources. The economic resources of Japan, due to its strong international trade, enabled deployment of advanced systems to support the implementation of the basin management philosophy. The widespread acceptance of the rule of law and recognition of the intrinsic value of the natural environment, linked to the perception of cultural value of agriculture and rural societies have enabled the maintenance or restoration of the basin conditions. The economic base of the country has provided the capacity to implement the necessary infrastructure to address the needs to increase flood protection and to provide responsive irrigation systems.

The Omonogawa basin is not short of water. Only about 20 percent of the mean annual discharge is consumed within the basin. Two large reservoirs perform both flood control and water supply functions. These have ameliorated some of the worst water-related problems in the basin. The area of paddy rice has been reduced over the past 20 years as the impacts of reduced consumption took effect, as the nation became wealthier and reduced subsidies.

Where the quality of the river water has been degraded due to natural inflows from acidic vents, the basin authorities have been able to implement water treatment works to ameliorate the impacts of these flows. Where domestic, industrial or agricultural return flows adversely affect water quality, the effective implementation of the existing regulations provides a mechanism to require the polluting party to treat the effluent. Both municipal and agriculture sectors, and the

LID associations, have the necessary technical skills to confirm the compliance of the other sectors with the appropriate regulations.

The important lessons for other basins are the following:

Administration of a water-surplus basin does require positive management to ensure that drainage and flood-control structures are operated and maintained correctly. Also, even in water surplus basins, during times of drought there needs to be a well-documented and effective system available to manage revision of water allocations to ensure that basin-scale impacts are minimized.

Water-quality issues can be dealt with effectively when the sectors involved are able to monitor and evaluate compliance of the other sectors.

Water-management agencies focused on agricultural water management, such as the LIDs in the Omonogawa basin, have a major role to play in the management of water resources. With appropriate delegated authority and support these agencies can be highly effective.

Chapter 4

Integrated Water Resources Management: Lessons from the Brantas River Basin in Indonesia

Rusfandi Usman[17]

Abstract

The development area of a river basin involves an ecosystem unit, an economic development area, and an administrative unit. Development of the river basin concerns not only the area based on a hydrological boundary, but also the surrounding area. This concept is needed because development of the river basin may affect the surrounding area. Optimum development in the river basin should be followed by developing the surrounding area; otherwise, the optimum tends to decrease.

The Brantas river, in East Java Province, Indonesia, plays a vital role in the economic region, not only for East Java, but also nationwide. The government has created more than 20 projects that have brought great economic benefit to the Brantas river basin, concurrently with national economic development.

The President of the Republic of Indonesia on February 12, 1990, issued Government Regulation No. 5/1990 which established a State-Owned Company, namely Perusahaan Umum (PERUM) Jasa Tirta (PJT I: Jasa Tirta Public Corporation) to address water resources management, and facilitate operation and maintenance (O&M) of finished structures on the Brantas river basin.

The mission of PJT I is to manage the water resources in the Brantas basin so that they can be optimized in order to promote regional development, to accumulate profits and to contribute to the development of the entire nation.

Introduction

Life on earth depends upon water, which maintains and correlates all ecosystems within the planet, continually moving on and in the ground surface. Water characterizes the river resources on which mankind is largely dependent for livelihood. A steady increase in population in both agricultural and industrial activities has refuted the idea that water has always been an unlimited commodity. Excessive use of water resources, as a logical consequence of economic development, has induced a range of national problems. The shortage of clean water supply has become an obstacle for economic development while an increase in waste discharges has polluted natural water bodies. This has worsened with the reduction of forested lands and conversion of agricultural areas to settlements that, in turn, have changed the hydrological cycle remarkably.

---

[17]President Director, Jasa Tirta I Public Corporation, Malang, East Java, Indonesia.

The Brantas River Basin

Indonesia, straddling the equator, is an archipelago with over 17,000 islands, of which about 6,000 are inhabited. It covers an area of 1,940 million km^2. Most of the nation's population of about 220 million (1997) live in the four main islands, Java, Sumatra, Sulawesi and Bali. Although the average population density of Indonesia is currently about 104 per km^2, Java, the most densely populated island, with an area of only 6.9 percent of the country, had a population density of 926 per km^2, or 110 million in1997.

The Brantas river basin in East Java Province has been one of the most productive and advanced granaries in Indonesia, because of ample water resources, tropical climate and fertile soil. This basin holds possibilities for further agricultural development. Industry located in the lower reaches around the Surabaya port is also promising for future growth.

The overall characteristics of the Brantas basin can be summarized as follows. The length of the river is about 320 km, and the catchment area about 12,000 km^2. Average annual rainfall is 2,000 mm, equivalent to a volume of surface water runoff of about 12 billion m^2. The basin's population is about 14 million (1997).

The Brantas river basin development is carried out as an integrated development based on a master plan which is reviewed every 12 years, projecting future socioeconomic conditions and based on the national guideline goals. The plan is based on the philosophy of one river, one plan, one coordinated management. Up to 1998, four master plans have been worked out. Facilities already built are summarized in table 1.

Table 1. Facilities built during the four master plans.

Master Plan	Objectives finished	Structures
Master Plan I (1961)	• Flood control • Irrigatgion • Hydropower development • Water supply (domestic and industrial	• Sutami Dam (1970) • Selorego Dam (1973) • New Legkong Dam (1973) • Porong river improvement (1977) • Lahor Dam (1977)
Master Plan II (1973)	• Irrigation • Flood control • Hydropower development • Water supply (domestic and industrial	• Brantas middle reaches river improvement (1977) • Wlingi Dam (1977) • New Gunungsari Dam (1981) • Bening Dam (1982) • Lodoyo Dam (1983) • Tulungagung Drainage (1987) • Sengguruh Dam (1989)

Figure 1. Water accounting diagram for the Omonogawa river basin (MCM) Japan, 1991.

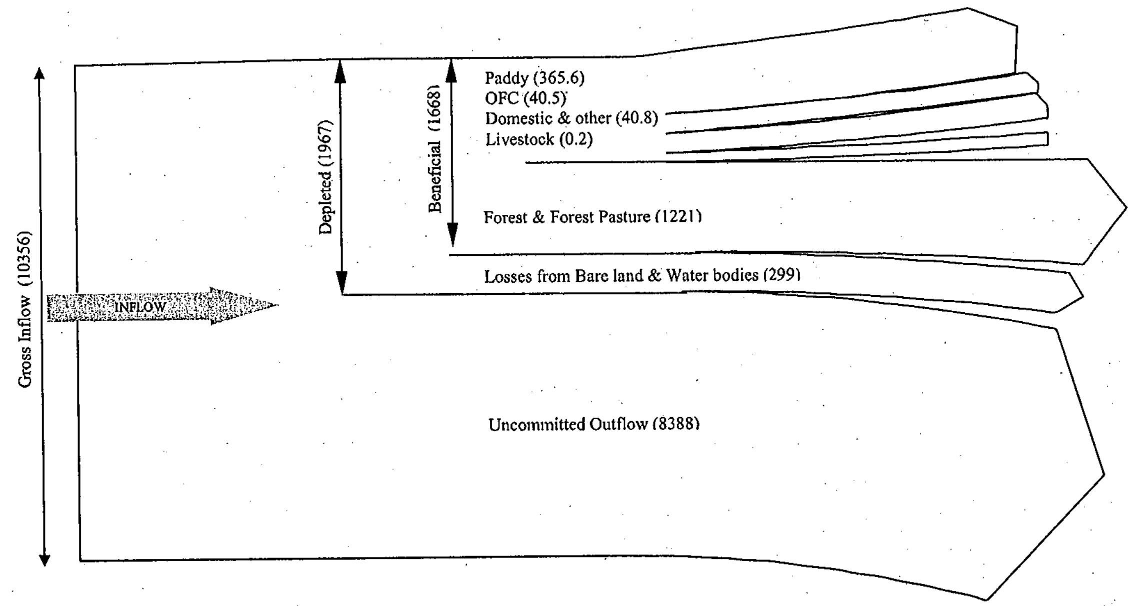
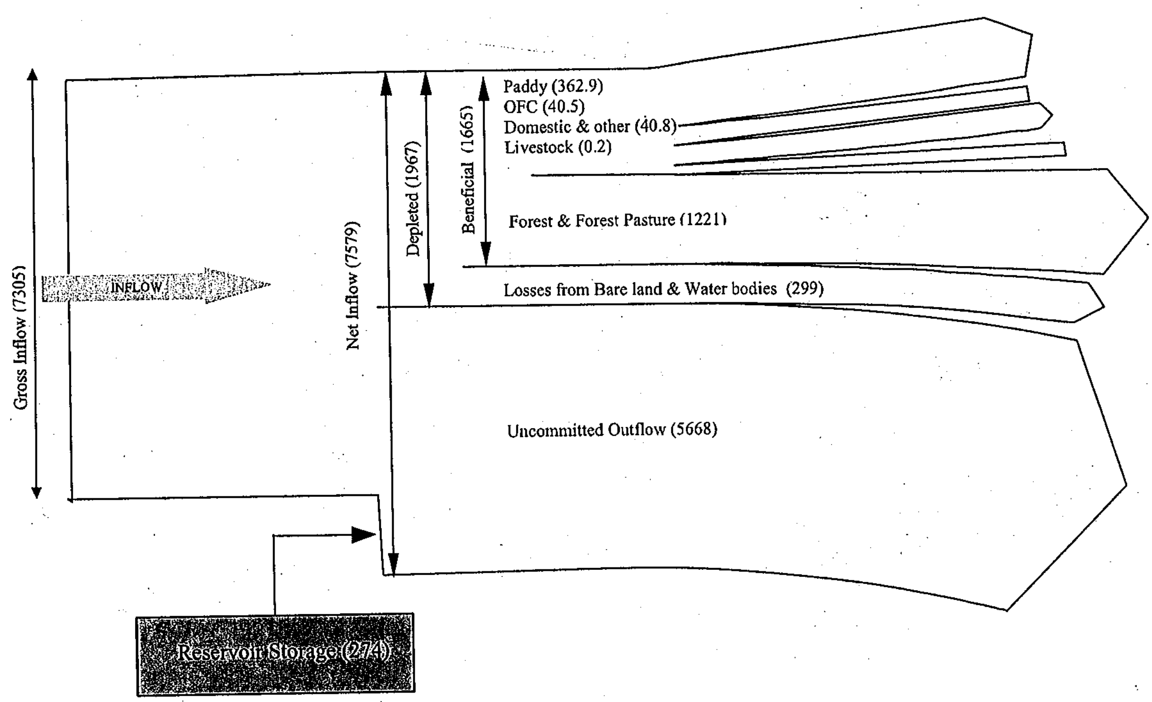


Figure 2. Water accounting diagram for the Omonogawa river basin (MCM) Japan, 1994.



Master Plan	Objectives finished	Structures
Master Plan III (1985)	• Water suppply (domestic and industrial) • Irrigation • Hydropower • Flood control	• Brantas middle reaches rehabilitation (1990) • Tulungagung hydropower (1990) • Jatimlerek rubber dam (1992) • Wlingi dam rehabilitation (1993) • Menturus rubber dam (1993) • Porong river rehabilitation (1993) • Surabaya flood control (1995) • Wonorejo dam (2000)
Master Plan IV (1998)	• Water resources conservation and management	• Integrated watershed management

Benefits of the Development

The benefits achieved due to water resources development in the Brantas basin include the following:

1. Protection against 50-year floods.

2. The 233 MW capacity hydropower plants, producing around 1.0 billion kWh of energy per year.

3. Total area of paddy irrigated from the Brantas river system is around 345,000 hectares. In the dry season irrigated agriculture consumes approximately 80 percent of the available water in the river. Since 1989, East Java has been able to supply more than 30 percent of the national food production.

4. Supply around 300 Mm^2 per year of raw water for drinking and for industries.

5. Freshwater requirement for brackish aquaculture was estimated at 13.5 m^3/s for 11,000 hectares in the Brantas delta, but due to limitations of water, water supply of brackish aquaculture depends on the return flow from irrigation water use.

Post-Construction Problems

After construction, it is necessary to maintain the facilities in order to ensure maximum benefit and reach the planned technical life span. Adequate O&M activities are necessary, but these activities encounter specific problems:

Institutions

To manage the basin, many institutions are concerned, and each has its sectoral responsibility. But coordination among sectors may be difficult in some situations because each sector has previously had its own plan, strategies and objectives.

Management of Water Quantity and Water Quality

Water shortage occurs, if population growth and general economic development lead to an increased water demand (agricultural, domestic and industrial), while due to deteriorating water quality, the available water becomes unsafe for use. Effluent discharges of domestic as well as industrial wastewater have been increasing and, hence, the pollution from wastewater is exceeding the assimilation capacity of the river.

Funding

The investment in new infrastructures and the O&M cost are too huge to be covered by the government budget. It is necessary to increase participation of beneficiaries and the private sector in water resources investment and in the cost of operating and maintaining the infrastructures.

Conflict between Water Users and Water Usage

Water demands of beneficiaries have not been always fulfilled, especially in the dry season. On the other hand, some people use water in inappropriate ways. One of today's issues is that our lifestyles tend to be wasteful of the available water resources. Often, some people use good-quality water for purposes, which actually need only lower-quality water.

Considering the limited amount of water, it is necessary to use available water resources wisely, avoiding conflict, and preserving the environmental capability to get sustainable benefits.

Perum Jasa Tirta (Jasa Tirta Public Corporation)

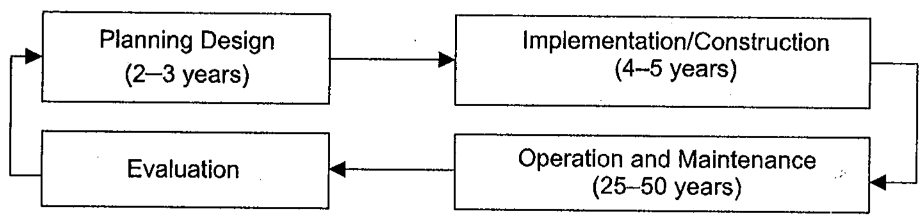
According to the laws and regulations, beneficiaries of water resources facilities are asked to contribute to the O&M of the facilities. Contributions from water users are not collected because projects are not authorized to collect these contributions. It is necessary to transfer the O&M of finished structures to a body that is duly authorized to collect contributions.

In Article 4 of Law No. 11 of 1974 on Water Resources, it is stated that the state's authority to manage water resources may be delegated to central or provincial governmental institutions or to a definite corporate body where the requirements could be stated in Government Regulations.

This is intended to give opportunity for public and private sectors to participate in developing the benefits of water resources.

After about 30 years of development, several river structures have been constructed along the Brantas river. The subsequent activities should be O&M. In the development cycle O&M constitute one of the main tasks for successful achievement of the objectives.

Development Cycle



The Jasa Tirta Public Corporation (PJT I) was established on February 12, 1990, by Government Regulation No. 5/Th 1990. The main objective of establishing the corporation is to manage O&M of the facilities in the Brantas river basin.

The cost for O&M activities will be collected by PJT I from the beneficiaries. For the time being, the main source of funds will be from electricity, drinking water and industries. There is no obligation for farmers to pay water charges, although more than 80 percent of water in the Brantas river is for irrigation purposes. The government is now introducing a pilot project of Irrigation Service Fee in several provinces around Indonesia. The purpose of the pilot project is to show the farmers the importance of adequate budget to support the O&M of irrigation facilities.

Main Tasks and Working Area of PJT I

Main Tasks

Based on Ministry of Public Works Regulation No. 56/PRT/1991, Article 6, the main tasks of PJT I include:

a. Performing O&M of water resources infrastructure.

b. Water supply services.

c. Management of the river basin, including water resources conservation, development and utilization.

d. Rehabilitation of water resources infrastructure.

Working Area

PJT I conducts its activities, such as planning, construction, rehabilitation, O&M, supply, conservation, supervision and control of water resources of 40 rivers in the Brantas basin.

Based on Article 8 clause (2), Government Regulation No. 5 of 1990, the management of other river basins by PJT I would be decided by the President upon the proposal of the Minister.

IWRM in the Brantas River Basin

IWRM is taken to mean the process of formulating and implementing a course of action involving the management of water and related resources for the purposes of achieving optimum allocation of water resources within a catchment area. With the Ministry of Settlement and Regional Development as the lead agency in this effort, this optimization of water utilization is meant to contribute to increase human welfare from improved agricultural, domestic and industrial uses of water.

It is important to understand the need to intensify development efforts in upland areas. This is in response to a clear understanding, from experience with flooding, siltation and other downstream consequences of upstream activities, that a complex of interrelationships links upland and lowland social and ecological systems. There is also a clear sense that the past focus on the lowlands has been at the expense of upland areas, in terms of policy and program attention. The consensus was, therefore, that a more balanced approach to the development of river basins should be adopted for the future.

This attention to social equity relates to another point on which agreement was reached, namely, that answers to problems of river-basin development and water resources management cannot be found solely from a technical standpoint, but must be reached through close attention to social and economic factors affecting the use of natural and human resources. Technical answers to most of the problems faced in the case study basins are already known. This technical knowledge can be made useful, however, only if it is combined with knowledge of social and economic systems to develop viable solutions to problems such as upland soil erosion, low incomes of many rural inhabitants, inefficiency in irrigation and other water applications, and so forth. It was agreed that such social and economic knowledge could only be obtained through active participation of local residents in activities of river-basin development and water resources management. Table 2 shows these activities, which are explained below.

Maintenance of Structures

Maintenance activity is primarily to protect water resources structures (dam, reservoir, weir, check-dam, dike, sluice, conduit, etc.). PJT I implements the following categories of maintenance activities:

1 *Preventive maintenance* in the form of routine periodical maintenance and small repairs to prevent serious damage.

2 *Corrective maintenance* in the form of large-scale repairs, rehabilitation and rectification in order to restore or increase the functions of water resources infrastructure.

3 *Emergency maintenance* is a temporary repair that has to be done soon due to some emergency condition, such as a flood.

Table 2. IWRM (scope of works).

- ❖ Basic concept: one river, one plan, one coordinated management
- ❖ Operated by permanent institution, not by project
- ❖ Professional staff
- ❖ Adequate budget

Maintenance of Structures	Upper Watershed Management	Water Quantity Management	Water Quality Management

• Dam
• River
• Tunnel
• Etc.
	(Coordination among parties concerned)
	• Reforestation
	• Demplot of land use planning
		• Water allocation for beneficiaries
		  • Agriculture
		  • Raw water for drinking water and industry
		  • Electricity
		  • Tourism
		  • Fishery
		  • Transportation
		• Flood management
		  • Telemetering system (real time data)
		  • Reservoir operation rule
			• Source of pollutant
			  • Industry
			  • Domestic
			  • Agriculture
			• Pollution monitoring
			  • Periodical monitoring (daily, weekly, monthly)
			  • Data evaluation
			  • Recommendation (law enforcement)
			• Public awareness
			  • Clean river program guideline
			  • Public campaign
			  • Continuous action

The management of the Brantas river basin needs the participation of beneficiaries. For example, farmers play a role in operating and maintaining the irrigation infrastructure, including paying an irrigation service fee (ISF) while other beneficiaries pay a water abstraction fee. The fees are used to manage the river basin.

The management of the Brantas basin follows the concept of sustainability, meaning maintaining the resources. The concept of sustainability coordinates and integrates the river-basin activities and environment, and is applied to all phases of development, i.e., planning, design, construction and O&M.

Upper Watershed Management

The categories and percentages of land use in the whole basin as of 1990 were: farmland 57 percent, forest 26 percent, homestead area 14 percent, and others 3 percent, respectively. On the other hand, according to the land use map prepared by East Java Province, in the year 2008, farmland will have decreased and forest and homestead areas will have increased, compared with those in 1990, by 10.2 percent and 21.8 percent, respectively.

Sediment yield in the Mt. Kelud basin mainly results from eruption of a volcano, Mt. Kelud. Wlingi dam reservoir, located at the lower reaches of the basin, was damaged by sediment deposition coming from the southern slopes of Mt. Kelud after an eruption in 1990. In order to settle this problem, a sediment bypass channel in the Putih river and *sabo* (sediment retention) works are being constructed. Sabo works in the Konto and Lesti basins are also being rehabilitated or constructed, to trap sediment discharge.

Two dams (Sengguruh and Wlingi), out of six, suffered from sediment caused by volcanic eruptions (Mt. Semeru and Mt. Kelud). To overcome this problem, besides construction of check dams, periodical excavations (dredging) have been done by PJT I in both reservoirs. Reforestation works are also underway, led by PJT I.

Water Quantity Management

A Water Use Right is the right to obtain and use water for a certain necessity. Water use right is stipulated in the Indonesian Basic Constitution of 1945, Law No. 11 of 1974 on Water Resources, and Government Regulation No. 22 of 1982 on Water Resources Management. In principle, water resources are governed by the State and utilized as much as possible for the welfare of the people. Based on this principle, water use prioritization is given in the Governor of East Java Decree No. 316 of 1988 as follows: a) domestic water, b) irrigation, c) plantation, d) fishery, e) industry, f) hydropower, g) flushing, h) swimming pool. In particular, on the principle and basis of water rights, Government Regulation 22 of 1982 on Water Resources Management, Article 2, states that in the water management regulations the principles of public utility, harmony and conservation shall be applied.

Particularly for groundwater, it is stated in Law No. 11 of 1974, Article 5, Paragraph 2, and the Government Regulation 22 of 1982, Article 6, that groundwater sources and hot springs such as power and mineral springs are not under the authority and responsibility of the Minister responsible for water resources, but that they are under the Minister of Mines and Energy. However, this division between surface water and groundwater is considered inappropriate and will be realigned in the reformed policy for water resources development and management.

Licensing

Licenses for water utilization are issued by the Local Government, supported by technical recommendations from PJT I.

Technical recommendation from PJT I is important to ensure the balance in water supply and demand. Water in the Brantas river is used for various purposes. The main consumers are irrigation (80%), raw water for drinking, industries, fishponds, and urban flushing (20%) and electricity (which does not consume the water). Water allocation from PJT I to the users is on a contract basis. Users, except farmers, have to pay a fee to PJT I to cover O&M cost. The tariff is decided by the government after discussion between the PJT I and the users.

Dry-season operation rule

Water management in the Brantas river is coordinated by a body called Panitia Tata Pengaturan Air (East Java Provincial Water Board; EJPWB) headed by the Vice-Governor of East Java Province. The water allocation pattern consists of two kinds of Operation Rule (OR) that are for the dry season (June–November) and the rainy season (December–May).

The procedure of preparing the dry-season OR is as follows. In May, users submit water demands to PJT I. By simulation and weather forecasting, PJT I prepares a draft dry-season OR. At the end of May, the draft OR is discussed in the EJPWB and if all agree, it is then signed by the Vice-Governor. Implementation of the OR is done by PJT I with monitoring in 10-day periods. If there is deviation from predictions, or conflict of interest in the field, some members of EJPWB discuss and review the OR if needed.

Rainy-season operation rule

Preparing the rainy-season OR follows the same procedure as for the dry-season OR. The important issue in the rainy season OR is flood management.

PJT I has prepared a Guideline for Flood Forecasting, Flood Warning and Flood Fighting on the Brantas river. Subjects of this book include critical locations along the river (levees), protection methods, materials and equipment available for flood fighting in warehouses along the river, names, addresses, and telephone numbers of staff involved, hierarchy of information to be submitted, etc.

To monitor rainfall intensity in the basin and discharge along the Brantas river, a telemetering Flood Forecasting and Warning System (FFWS) has been installed, consisting of 26 rainfall stations and 31 water-level stations, covering 12,000 km^2 of catchment area, with the Master Station located on the main office of PJT I. Field data are transferred to the Master Station every 30 minutes in real time. The basic concept of flood control is one river, one plan, one coordinated management.

The purpose of establishing a flood forecasting and warning system is to prevent or mitigate damage and to ensure the safety of inhabitants. Flood-fighting activities are performed by flood defense teams. People living near the river are enabled to take necessary actions for flood protection, by giving them flood information with enough time allowance. Information on a coming flood such as scale, arrival time of peak, etc., is to be given to inhabitants well in advance, if occurrence of flood is judged to be inevitable.

Water-quality management

Water-quality control plays an important role for sustaining benefits in the Brantas river and its tributaries.

Legally, PJT I should have active participation in supervising and controlling the Brantas river water quality. The task of PJT I on water-quality control is to support the Central and Provincial Governments. One continuous activity of PJT is water-quality monitoring along the Brantas river at 50 sampling points and 41 sources of industrial pollution. The samples are tested by PJT I's Laboratory. These data can be used by the Local Government of East Java to control polluting activities. By using simulation computer programming, it can also develop a strategic action plan for pollution abatement in short, medium and long terms to achieve the river-water-quality objective.

The main pollutant sources in the Brantas river, based on a study in 1989, are industry, domestic users and agriculture.

To reduce pollutants from industries the Government issued a regulation that all industries have to install wastewater treatment plants. For small industries (home industries), it is difficult to follow the regulation. For some large industries the wastewater treatment plants are not always operated.

More difficult to control is pollution coming from domestic waste. The people use the river water for many purposes. Because of low income and less awareness of environment protection it takes time to educate the people.

Pollution from agriculture is not a significant factor causing deterioration of water quality. Agricultural activity is done during the rainy season when the flow of water in the river is big enough to neutralize pollution.

Clean River Programme

To minimize pollution discharge into the river, the government initiated a program called the Clean River Programme (CRP) in 1989. PJT I and other parties promote the CRP through several activities. Pollution control is carried out by the Environment Pollution Control Committee (KPPLH) which is established by the Governor Decree, and consists of all agencies concerned. In KPPLH there are four Working Teams, for the CRP, Clean Town, Domestic Waste Pollution Control and Industrial Waste Pollution Control; PJT I sits as Vice Coordinator I of the Team for the CRP.

Effluent discharge standards are currently stated in the Governor Decree 136 of 1994; however, this is being updated involving all agencies concerned, coordinated by the Provincial Office of the Environmental Impact Management Agency or BAPEDALDA.

CRP Campaign

Public education is carried out in coordination with the Department of Home Affairs, universities, NGOs and Moslem traditional boarding schools, for the following groups of people: on land and water conservation, to people in villages and students of Moslem traditional boarding schools in the upper reaches; on water pollution control, to industry managers, high-school teachers and students; on mining and land use in the river corridor, to the people and the village officials; on environment protection, to high-school students.

The success of public education programs is usually constrained by economic conditions. Although no specific assessment has been undertaken, the physical condition shows that so far public education has had a good achievement proven by the positive social control given by the public.

Law Enforcement

Law enforcement is focused on large industries. Many large industries do not operate their wastewater treatment plants continuously. Difficulties of law enforcement include poor regulation, poor staff and difficulties of obtaining evidence. On the other hand, maybe, global cooperation is needed between developed and developing countries. Many large industries come from developed countries. What is their role to protect the environment?

After several years of hard work, the people along the Brantas river have now come to the stage of understanding about environment protection, but not yet to do it. Some industries have already applied to the court of justice. More time is needed, before environmental conditions will be completely protected. Public campaigns have to be continued.

Stakeholder Identification and Participation

Water Resources Stakeholders

Stakeholders in water resources can be classified into three main groups:

a. Government as the "owner and regulator" plays the role of controlling and policing water, and exercising public authority. It has the right to a part of the profit gained by the River Basin Management Agency while, on the other hand, it is obliged to contribute its funding for activities towards public safety and welfare.

b. River Basin Management Agency (RBMA) as the "operator" has the concession to manage water and its infrastructures, and develop its management system. It has the right to collect contributions from beneficiaries and receive contributions from the government for public safety and welfare activities. It is also obliged to render prime services, promote public and private participation, give contribution to the owners, and to be accountable in performing tasks to shareholders and stakeholders.

c. Society as the "users" has the right to receive good services and participate in decision-making processes. They are expected to use water efficiently, take part in sustaining the environment, provide financial contributions for water resources management (WRM) and provide constructive social control.

The proportion of population below the poverty line (US$ 800/year) in the Brantas river basin after the economic crisis of 1998 is about 46.3 percent (1,193,075 households out of 2,578,139). Conflict of interest among stakeholders is still manageable, even though during the dry season the available water is not enough to cover water demands of all sectors. The irrigation water user, as the biggest water consumer (almost 80% of manageable water during the dry season), receives only 60 percent–80 percent of their water demand.

Organizing Stakeholders

Stakeholders are organized through the Water Resources Committee (WRC). The Vice-Governor is the Chairman and Provincial WRM Office is the Secretary. The WRC membership consists of high-level provincial officials from relevant sectors, RBMA and representatives of stakeholders, i.e., Electricity State-Owned Company, Municipal Water Supply Corporation, industries (represented by Industry and Trade Provincial Office), farmers (represented by Irrigation Committee), universities, etc. The WRC is supported by some Technical Work Groups for specified fields, such as water conservation, water allocation, pollution control, flood control, sand mining, etc.

The role of the WRC is to assist the Governor in preparing the water resources management plan (policies, strategies, planning and programming) as well as to coordinate all regulatory aspects and to solve technical problems related to implementation of the plan. This WRC is responsible for accommodating various interests, and to govern the water management rules applied throughout the province.

Access to Water for Poorer People

Specific water users (for commercial uses: electricity, municipal water supply, industries, horticultural estate) should have water use permits from the government. Once the permit is issued, the RBMA should secure the water allocation for their utilization. The water users are obliged to pay a water service tax and fee to the government and the RBMA. Based on this permit, the RBMA and the user sign a Water Service Contract, which specifies the rights and obligations of each party.

On the other hand, social uses (irrigation water uses, human daily activities, etc.) and nonspecific water users (municipalities) are not obliged by law to have water use permits. These users are not obliged to contribute a water service tax and fee. Most of the nonlicensed water users are poorer people in urban and rural areas.

In dry seasons when available water is not enough to cover all demands, irrigation users always have reduced water allocations. Irrigation WUAs distribute water among farmers under the guidance of District WRM Offices. The Municipal Water Supply Corporation supplies water for poorer urban people through public water taps (10% of the total distributed water). The RBMA supplies raw water to the sector users at their water intake, based on an agreed allocation pattern.

Through the ongoing national reform of water resources policies, it is intended to develop water use rights for irrigation and maintenance flow in order to have equitable access to water for the poorest people.

Institutional and Policy Issues

Institutional Framework

One objective in the establishment of PJT I was to develop and implement the concept of an institutional framework for WRM, by establishing a permanent, neutral, professional and accountable institution to perform equally the principle of a healthy corporation and general utilization of water resources, based on public, private and community participation.

The main strength is that WRM in the Brantas river basin performed by PJT I is a national pilot project for future WRM institutions in Indonesia. The weaknesses of the implementation of the system in other river basins in Indonesia are:

a. Limited capacity of the society to contribute to WRM cost.

b. Not all of the beneficiaries pay the cost borne for WRM.

c. Price of water does not encourage the private sector to participate in WRM.

d. Less awareness by the people means less social control on water resources issues.

After 10 years of the pilot WRM institution, the government made the decision to implement the management system developed by PJT I in other strategic river basins.

Water Rights

Based on the Indonesian Basic Law, the water right is in the hands of the State. The people have only the water use right. Only specific beneficiaries have permits to use the water and permits to discharge their effluent to the river. For social use (farmers, etc.) and nonspecific beneficiaries (municipal) it is not necessary to have permits. In the near future, water use rights will be implemented for all water users. For the time being, the permit system does not allow tradable permits.

Water Allocation Mechanism

Stakeholders' participation in decision-making processes is conducted in the WRC. In water allocation, for example, the mechanism can be explained as follows:

a. The initial concept of water allocation is prepared by the RBMA with computer simulation based on water demand and water supply projection. The draft water allocation plan is discussed in the Technical Work Group and submitted to the WRC for approval.

b. The water allocation is then conducted by RBMA. If a significant deviation exists, RBMA makes a review and prepares the revised pattern, which will be discussed by the Technical Work Group and submitted to WRC for approval.

Water distribution among sectors is done by the RBMA, while water distribution in irrigation areas is done by WUAs under the guidance of District Water Resources Technical Management Units.

Water Accounting

Land utilization differs in each part of the basin. Most of the arable land is utilized for productive farming (38%) and the rest of is used for forest, settlement and nonagricultural activities. Critical land that is subject to erosion is estimated at 17 percent of the Lesti Catchment and 18 percent of the total Brantas upper reach. Features of the Brantas river basin are shown in tables 3 to 6.

Table 3. Main features of the Brantas river basin.

Main river	Kali Brantas (320 km)		
Geographical coordinates	110° 30' - 112° 55' E and 7° 31' - 8 15' S		
Average temperature	25.5° C		
Relative humidity	82%		
a) Total catchment area	11,800 km² (25% of East Java)		
b) Total reservoir capacity			
• Gross storage (initial/present)	525/297 million m³		
• Effective storage (initial/present)	378/245 million m³		
c) Water availability			
• Average precipitation	2,000 mm/year		
• Runoff coefficient	about 0.50		
• Potential flow	11,800 million m³/y		
d) Water utilization			
• Irrigation	2,400	million³	(79.9%)
• Domestic	225	million³	(7.5%)
• Industry bulk supply	133	million³	(4.4%)
• Maintenance flow	204	million³	(6.8%)
• Fisheries (irrigation return flow)	41	million³	(1.4%)
Total	3,003	million³	(100%)

Table 4. Precipitation in the Brantas river basin, 1995–1999 (mm).

Month	Average	Maximum	Minimum	Season
January	343.83	566.72	181.90	Rainy
February	306.62	554.03	193.25	Rainy
March	297.33	512.51	88.75	Rainy
April	203.00	389.57	49.31	Rainy
May	110.55	324.65	12.14	Dry
June	61.23	224.64	0.11	Dry
July	40.54	271.81	0.00	Dry
August	19.79	96.47	0.00	Dry
September	28.46	152.33	0.00	Dry
October	81.45	353.43	1.65	Dry
November	176.33	393.66	25.12	Rainy
December	278.93	473.35	124.25	Rainy
Total	1,948.06	3,434.26	1,228.05	

Source: PJT I 2000.

Table 5. Population.

Description	Java Island	East Java Province	Brantas river basin
Area (km²)	132,206	47,938	11,800
Population			
1980	91,269,528	29,188,852	11,996,000
1990	107,581,306	32,503,991	13,004,000
1995	114,733,486	33,844,002	13,534,000
2000 (projected	122,811,842	35,570,386	14,224,370
Density (person/km²)	929	742	1,205
Percent to East Jave	125.2	100.0	162.4

Source: Indonesian Statistical Office 2000.

Table 6. Growth of Gross Regional Domestic Product in the Brantas basin (%/year).

Sector	1984-1985	1985-1992	1993-1995	1996-1998
Agriculture	3.1	3.2	0.5	11.6
Industry	4.7	10.7	12.2	15.4
Services	7.3	7.3	7.9	13.5
Gross domestic product	5.5	6.7	7.7	9.8

Sources: Final report of Master Plan IV 1998; Indonesian Statistic Office 1999.

The Gross Regional Domestic Product (GRDP) of the basin amounted to Rp 39,018 billion in 1995 (note: US$1=Rp 2,250 at bank exchange rate during 1995), which was 58.9 percent of the GRDP of East Java and 9.4 percent of Indonesia's Gross Domestic Product (GDP). GRDP per capita of the basin was US$1,269 in 1995, which was 46 percent and 44 percent, respectively higher than the rates for East Java (US$872) and all Indonesia (US$880). After the economic crisis in 1997, the GRDP of the basin was estimated at Rp 45,428 billion in 1998 (US$405). The basin's economic growth was led mainly by the industrial sector after the mid-1980s.

Water Resources Utilization

Sources and uses of water in Surabaya Metropolitan Area (SMA: Gresik, Bangkalan, Mojokerto, Surabaya and Sidoarjo) in 1998, and estimates of future demand, are shown in tables 7 to 9.

Table 7. Sources of water (m^3/second).

Brantas river	47.84
Treated surface water	1.43
Spring/well	0.53
Other surface water	0.12
Total existing supply	49.92

Source: East Java Water Balance Team 1998.

Table 8. Water use in SMA (m^3/second).

	1998	2000	2005	2010	2020
Insudtry	3.96	4.53	11.58	27.30	90.04
Irrigation	41.41	41.41	33.28	29.17	20.58
Domestic	10.69	13.35	19.33	25.74	41.93
River maintenance	7.50	8.64	11.49	14.34	20.00
Total demand	63.56	67.93	75.68	96.55	172.55

Source: East Java Water Balance Team 1998.

Table 9. Overall demand and supply in SMA (m^3/second).

Year	1998	2000	2005	2010	2020
Demand	63.56	67.93	75.68	96.55	172.55
Supply capacity (1998)	49.92	49.92	49.92	49.92	49.92
Deficiency (without action)	(13.64)	(18.01)	(25.76)	(46.63)	(122.63)

Source: East Java Water Balance Team 1998.
Note: The balance does not include brackish water fisheries.

Major Issues and Strategies

Major Issues

Water resources will be the limiting factor in the development of the region. The water demand is estimated to be tripled in the next 20 years while water resources development is already limited. The Wonorejo dam, which will be in operation in 2001, is the last favorable dam site in the basin.

Water quality degradation is a problem especially in the downstream area: Surabaya and Porong rivers. The total pollution load in the basin has increased almost threefold during the last 10 years: 125 tons of BOD/day in 1989 increased to 330 tons of BOD/day in 1998, of which 62 percent is from domestic users and 38 percent from industries.

Watershed degradation promotes erosion and sedimentation. The sediment load in Sutami catchment area is estimated at around 3.2 million m^3/y in 1998, meaning an increase by almost threefold during the last 30 years.

Strategic Plan

The main strategies for addressing these major issues are:

- Promote stakeholders' participation in the decision-making process to get their commitments in the implementation of a WRM plan.

- Public education to promote positive social control from the public.

- Implement economic and other instruments to promote efficient use of water, abate pollution load and develop sources of funds for the WRM budget.

- Develop and implement consistently the Land and Water Conservation Plan.

Projections of future water quantity and water quality under this plan are shown in tables 10 and 11.

Table 10. Water quantity (m^3/second).

Year	1998	2000	2005	2010	2020
Deficiency (without actions)	(13.640)	(18.01)	(25.76)	(46.63)	(122.63)
Action Plan					
• Demand efficiency	6.21	7.10	10.22	18.35	58.51
• Supply efficiency	3.60	3.60	3.20	3.20	2.80
• WR development	-	-	-	-	-
- Wonorejo dam	-	8.02	8.02	8.02	8.02
- Umbulan spring	-	-	4.45	4.45	4.45
- Beng dam*)	-	-	-	9.50	9.50
- Kd. Warak dam	-	-	-	-	3.50
• Final balance	(3.83)	(2.86)	0.13	(3.11)	(34.85)

*Pumping scheme: Brantas river will be pumped to the reservoir during rainy season.
Source: Surabaya Development Programme 1998.

Table 11. Water quality (tons of BOD/day).

Year	1998	2005	2010	2020
Projected load without action	330	395	442	565
Domestic load	205	224	234	257
Industrial load	125	171	208	308
Maintenance flow (m^3/sec)	7.5	7.5	7.5	7.5
Protected load with actions*	330	208	177	118
Domestic load	205	182	151	92
Industrial load	125	26	26	26
Maintenance flow (m^3/sec)	7.5	11.5	14.5	20.0

*The water-quality objective will be achieved in 2020 if targeted pollution load abatement can be realized.
Source: Pollution Control Master Plan 1998.

Financial Aspects

Sources of Funds

In order to achieve sustainable WRM, budget availability for river basin management needs to be secured. This requires that beneficiaries gradually bear costs for river basin management through the application of the principles of users pay, polluters pay, as well as the government obligation (for funding social services and public safety and welfare measures, such as flood control, water pollution control, land and water conservation, and irrigation).

Funds obtained from beneficiaries are used for O&M activities. Investment budget may be obtained from: 1) corporate internal funds, 2) the government budget, 3) local or foreign loans, and 4) other reliable sources (joint ventures, municipal bonds, etc.). The major cost components are indicated in table 12.

Table 12. Components of cost.

Direct costs	Indirect costs
• Operation and maintenance	• Personnel expenses (for Head Office)
• Watershed conservation	• General expenses (for Head Office)
• Personnel expenses (for WSD Offices)	• Travel expenses (for Head Office)
• General expenses (for WSD Offices)	• Depreciation
• Travel expenses (for WSD Offices)	• Marketing expenses
	• HRD expenses
	• Public education cost

Note: WSD Offices: Water Services Division Offices.

Fund-Collection Process

In principle, PJT I should negotiate the fee tariff with the sector users. Then the agreed tariff is proposed by PJT I's Board of Directors to the Ministry of Settlement and Regional Development (MSRD). After getting the recommendation from the Ministry of Finance and the Governor, the Ministry approves the fee tariff.

The fee paid by the users is collected by PJT I in collaboration with Provincial Tax and Retribution Offices which already have a well-established collection system. The non-fee payer (social and nonspecific users) pays to the government in other forms of tax (land and building tax, etc.). The government then gives subsidy to finance activities relating to social services and public safety and welfare.

Methods of Assessment of Water Service Fee

Based on Government Regulation No. 6/1981 the fee should be calculated to cover: 1) O&M; 2) depreciation; 3) interest; and 4) fund for further development. Considering the capability to pay, the fee is calculated only for O&M cost recovery.

The water service fee is calculated by the RBMA based on the following methodology:

a) Listing of all major water resources infrastructures.

b) Identification and calculation of O&M activities of each infrastructure.

c) Distribution of cost among functions for multipurpose facilities (separate or joint cost).

d) Derivation of proportions for allocating O&M cost for each sector user (based on the gross benefits received by sector users).

e) Derivation of O&M costs for respective functions for all facilities.

f) Derivation of amounts of power generation (kWh/year) for electricity and water used (m^3/year) by other sector users (municipal water supply, industries).

g) Calculation of water service fee for each sector user to recover O&M costs.

It is very difficult for the RBMA to make a tariff agreement. There is no guideline issued by the government in calculating fees. Through the ongoing National Reform of Water Resources Policies, it is intended to issue a government regulation on the guideline for calculating the water service fee and the wastewater discharge fee.

Budget Approval Process

a) Four months before the following fiscal year, the Board of Directors prepares the next Yearly Corporate Budget and Work Plan, based on the O&M work plans proposed by each Water Services Division, by considering the recommendation of RBWRC and PWRC.

b) Before submitting the Yearly Corporate Budget and Work Plan to the MSRD and Minister of Finance, it is discussed and approved in principle by the Supervisory Board. The Board of Directors and Supervisory Board hold several meetings to discuss both the technical and financial matters.

c) Approval of the Yearly Corporate Budget and Work Plan is obtained from the Minister of Finance after recommendation from the MSRD.

Effects of the Financing System

During the last 10 years, the tariff level of water service fee has increased as shown in table 13. The progressive tariff and increasing tariff level stimulate the application of recycling technologies for major industrial water users, such as sugarcane factories. For the time being, it is difficult to have equity and adequate access for poor people. The Government Obligation Principle cannot be implemented due to the government's budget limitation. Equitable access to water could be improved after the implementation of water use rights for irrigation and for environment (maintenance flow) and commitment of the government in realizing the Government Obligation Principle.

Table 13. Tariff level (in Rp).

Water Users	Units	1990	2000
Electricity State Owned Company	Rp/kWh	6.00	13.61
Municipal Water Supply Corporation	Rp/m³	16.00	35.00
Industries	Rp/m³	16.00	52.00*

*Basic tariff level for progressive tariff system.
Note: In mid-2000, US$0.0115 = Rupiah 1.00 at nominal exchange rates.

Present Condition of PJT I

The following is a summary of the main features of PJT I at present.

Beneficiaries' Contribution for O&M

Beneficiaries' contribution in 1999 reached Rp 27 billion (US$ 4 million). Even though this does not cover normal O&M budget requirements, it leads to these results:

- Increasing regional revenue as the result of orderliness in water allocation and tariff determination in the Brantas river basin.
- Cost burden from government budget allocation for the Brantas river basin could be minimized and allocated for other basins.

Improvement of Water Resources Infrastructural Functions

Improvement of O&M has resulted in improved functioning of water resources infrastructure, which directly contributes to management improvement.

Company Performance in 1991–1999

The company's audit up to the fiscal year 1999 is considered excellent, proving satisfactory results from application of the cost-recovery principle.

Public/Private and Community Participation in WRM

Water resources management operated by PJT I makes it possible for public as well as private sectors to participate in water resources development and management in the basin.

ISO 9001 Certification

Certification of ISO 9001 for Design, Operation and Maintenance of Water Resources Infrastructures in the Brantas river basin issued by SGS International Certification Services has proven the quality of professional water resources management practices by PJT I.

Conclusion

General View of the Corporation

- The Brantas river basin has been a valuable natural resource for many years. It was essential for food production; to support national economic development, water is considered as a strategic commodity.
- The development of the Brantas river basin has been carried out since 1961 as an integrated development through a series of Master Plans with the basic concept of one river, one plan, one coordinated management. The benefits of development include flood control, food production, drinking water, industrial water and electricity production.
- In order to overcome the post-construction problems, the Government of Indonesia established the state-owned corporation PJT I on May 12, 1990.
- The management of water resources in the Brantas river basin is carried out as an integrated management operated by PJT I. The scope of activities of PJT I includes water-quantity management, water-quality management and maintenance of water resources infrastructure. PJT I has implemented Quality Assurance System ISO-9001, issued by Yarsley International Certification Services Limited, London, No. Q.9755 on May 12, 1997.
- To operate these activities, PJT I collaborates with related agencies, such as East Java Provincial Water Resources Committee (Panitia Tata Pengaturan Air) for water allocation the Commission for Environmental Pollution Control and Abatement (KPPLH) for pollution control.
- The funding for O&M of water resources in the Brantas river basin mainly comes from the contributions of beneficiaries: State Electric Power Company, Regional Drinking Water Supply Company and Industries.
- In the future, PJT I will be extended to cover other rivers in Indonesia.

Management Problems

- The formula to compute the unit water rate is not established yet. This is needed, from the point of view that water revenue should be reliable and stable for the long-term sustainability of the corporation.
- The O&M contribution from beneficiaries excludes depreciation. In the future it may be necessary to establish a water rate formula including depreciation and other factors.
- Up to now, farmers do not pay O&M contribution. Most of the irrigation water users still keep the old perception that the charge for water used is included in the tax they pay.

- Due to lack of awareness, water taken by the farmers is not efficiently utilized. Some farmers take more water than their actual needs. As a result, farmers downstream face water-shortage problems in the dry season.

- River water quality has seriously deteriorated throughout the Brantas river. The reason is untreated wastewater, from industry, domestic users, agriculture and livestock breeding, which has been drained into the river.

- At present, the upstream area of the basin is considerably devastated and existing reservoirs have suffered from sedimentation.

Chapter 5

Issues in Transposing Successful River-Basin Management Institutions in the Developing World[18]

Abstract

Many developed countries such as the USA, France and Australia have evolved highly advanced and resilient institutional regimes for Integrated River Basin Management (IRBM); but this has taken decades or even centuries of gradual change to evolve. An issue which has held great appeal to policymakers, donors and social researchers is: might it be possible for the developing countries of today to do an "institutional leapfrog," as it were, to quickly approach a stage at which developed-country basin institutions find themselves today. This paper reviews the difficulties that developing countries might face in making such a leapfrog because of the vast and fundamental differences in four realities that matter in their institutional evolution: hydrological and climatic, demographic, socioeconomic, and the reality of the way their water sectors are organized. The paper suggests that basin institutions in the developed world have successfully resolved problems of pollution, sectoral allocation, etc., that are not uppermost in the priorities of many developing country policymakers and people; and the problems that are uppermost to them, such as groundwater overexploitation, using irrigation to promote the livelihoods and food security of the poor have either remained unresolved in the developed world, or are rendered irrelevant by their evolutionary process. There is thus the problem of "contextual fit." This does not mean that the experience of river basin management in the developed world is irrelevant; it does mean that uncritical imposition of developed-country institutional models in developing-country river-basin contexts may prove dysfunctional or even counterproductive.

Backdrop

Management becomes important as a productive resource becomes scarce; and there is hardly a situation in which this is truer than in the case of the water resource. For a long time now, water policies of many emerging nations have been focused on developing the resource; and optimizing was directed at the efficiency of water infrastructure rather than water itself. As water has become increasingly scarce, optimizing is now being increasingly directed to improving the productivity of water itself. Increasingly, the river basin is emerging as the unit of management of land, water and other natural resources in an integrated fashion. Many developed countries such as the USA, France and Australia have evolved highly advanced and resilient institutional regimes for IRBM; but this has taken centuries in Europe and decades in the USA—of gradual change to evolve. An issue which has held great appeal to policymakers and social researchers is this:

[18]This chapter is based on an analysis made by Tushaar Shah, Ian Makin and R. Sakthivadivel, Principal Researchers of IWMI, covering the river basin reports of this study, as well as a few other river basin studies conducted by IWMI.

Is it necessary that developing countries in Asia and Africa should take all that long in crafting such institutional regimes? Or might it be possible for them to do an "institutional leapfrog," as it were, to a stage at which developed country basin institutions are today?

A textbook case of institutional reform for IRBM in recent times has been the Murray-Darling basin in Australia, where sweeping changes have been made and enforced since 1990. And transferring the lessons of success in IRBM—from Murray-Darling to Mahaweli, and Mississippi to Mekong—has emerged as a growth industry.

This paper attempts a broad-brush approach to understanding the material differences in the contexts of the developed-country river basins, from where institutional models emerge, and the developing-country river-basin context in which these are applied. The idea is not to undermine the significance of the lessons from success but to emphasize the need for sagacity and critical analysis in assessing what will work and what will not, given the differences in the context. The phrase "institutional change" is used to describe how communities, the government and society change recurrent patterns of behavior and interactions in coping with water scarcity and its socio-ecological ill-effects. It involves understanding laws and rule-making, roles, policies and institutional arrangements at different levels. The overarching premise is that the effectiveness of a pattern of institutional development is determined by at least four realities of a river basin: hydrogeological reality, demographic reality, socioeconomic reality, and the organization of the water sector. By implication, institutional arrangements that have proved effective with one set of these realities may require major adaptation before they become appropriate to the needs of a river-basin context defined by an alternative set of these realities.

Integrated River Basin Management is a powerful idiom, and will increasingly dominate natural resources management discussion in the developed as well as the developing world. In its broadest sense, a basin or catchment is visualized as:

> "an inter-connected machine or system which transforms natural inputs of solar energy, atmospheric precipitation, nutrients and other environmental factors, along with man-made inputs of labor, capital, materials and energy, into output products such as food, fiber, timber, building materials, fuels, minerals, natural vegetation and wildlife, recreational and aesthetic amenities, buildings and development sites, as well as water in desirable quality and quantity" (Burton 1986, cited in Hu 1999, 324).

River-basin management, as a notion, goes far beyond traditional land and water management and

> "includes significant parts of land-use planning, agricultural policy and erosion control, environment management and other policy areas. It covers all human activities that use or affect fresh water systems. To put it briefly, RBM is the management of water systems as part of the broader natural environment and in relation to their socioeconomic environment" (Mostert et al. 1999, 3).

Institutional discussions on IRBM have tended invariably—and probably erroneously—to gravitate around three models of strategic organizations for managing river basins:

- The hydrological model, in which a river basin organization/authority, cutting across administrative boundaries, takes overall charge of water resource management.
- The administrative model, prevailing in many developing countries, in which water management is the responsibility of territorial organizations unrelated to hydrological boundaries.
- Coordinating mechanisms superimposed on the administrative organizations to achieve basin management goals.

Each has advantages and disadvantages: the hydrological model effectively deals with upstream-downstream issues that the administrative organization is generally unable to deal with; however, hydrological organizations tend typically to focus on water and overlook land management issues. River Basin Commissions, as a hybrid, might combine the advantages of both but, at least in the developing country context, they often command little authority, and are therefore confined to the lowest-common-denominator solutions (Mostert et al. 1999). In many developing countries today, institutional reform for RBM is confined almost wholly to the creation of the basin-level organization—the implicit assumption being that mere formation of the appropriate organization will result in IRBM, an assumption whose validity has been repeatedly refuted.

In the developed world, the discussion has been much broader and has veered around initiatives in four aspects of natural resources governance:

a) Some mechanism for basin level negotiation and coordination fortified with adequate authority and resources, and a broad mandate considered appropriate to the basin's context.

b) Legal and regulatory reform.

c) Redesigning economic instruments of policy (transfer prices, taxes, subsidies) in harmony with national policy goals.

d) Redesign of economic institutions (including utilities, service providers, property rights; water markets, irrigation management transfer to user organizations).

Countries like the USA have achieved, over long periods, high levels of integration even without a central basin organization (see, for example, Svendsen 2000).

Applying the Lessons of the Murray-Darling to the Developing World

The Murray-Darling river system, as a recent case of accelerated institutional reform, has appropriately emerged as a model of institutional structure for IRBM. The basin encompasses over 75 percent of the State of New South Wales, 56 percent of the State of Victoria, all of the Australian Capital Territory, and small parts of Queensland and South Australia, a vast region of the southeastern parts of the continent. Already, several case studies of the Murray-Darling are available; and it is not our intention to review these. In brief, the institutional innovations of the Murray-Darling basin management regime include:

a) The Murray-Darling Ministerial Council as the top-level policymaking and coordinating mechanism; the Murray-Darling Basin Commission as the operating organization; and several Catchment Management Agencies that are responsible for day-to-day management of water.

b) A system of permits for diversions that encompasses all uses except the water needed for domestic use, livestock production, and irrigation of up to 2 hectares, which are recognized as a prior right (Hatton MacDonald and Young 2000, 10), and exempted from the legal as well as the permit system.

c) An effective cap on water diversions at 1993–94 levels of development to ensure adequate environmental supplies, accompanied by a system of volumetric licensing to users that raises the scope for large-scale water trade across states and sectors.

d) Consumption-based, full-cost-recovery pricing (Hatton MacDonald and Young 2000, 14).

e) A system of "salinity credits" that permits trade in salinity.

f) Explicit mechanisms for water allocation for environmental needs.

g) A legal regime that separates water rights from land rights.

h) Privatization of service providers such as Murray Irrigation Ltd. and Victoria's Rural Water Corporation (Malano et al. 1999).

The Murray-Darling RBM regime clearly represents a highly evolved form of institutional arrangement and effectively addresses all major problems that a mature river basin would face. As alluded to earlier, exploring whether developed-country basin institutions—particularly, the Murray-Darling experience—can be replicated in a developing-country context has fascinated many researchers in recent years. An entire issue of *Water International* (vol. 24, no 4, 1999) was devoted to it in 1999.

The results of these investigations have not been very encouraging. For example, Hu explored the applicability of Murray-Darling experience in the Chinese context and concluded negatively because of a) the difficulty of coordinating authorities at different levels; b) unclear ownership of resources; c) small farming scales; and a) poor education of resource users (Hu 1999, 323).

In a similar vein, Malano et al. (1999, 313) ask: "Can Australian experiences be transferred to Vietnam?" Their conclusion is less emphatic than Hu's, but all their evidence suggests that it will be long before Vietnam becomes really ready for the Murray-Darling prescription; and that "context, hydrological and socioeconomic, defines the detail and balance that is required." The new water law of Vietnam contains provisions to adopt an integrated river basin approach. The World Bank and the ADB have apparently held up funding to Vietnam until it forms the National Water Council to implement it. The Ministry of Agriculture and Rural Development, which is at present in charge of water, does not relish the responsibility of IRBM. The progress in stakeholder participation, another Murray-Darling prescription, has been slow to say the least. Farmers view irrigation provision as a government responsibility; even so, irrigation charges in Vietnam are high by Asian standards. Yet, presumably under donor pressure, the government tried to eliminate irrigation subsidies, but this was followed by massive popular unrest in 1998, whereupon, the government had to restore the subsidies.

Can the Australian success in enforcing the "user pays" principle be transferred to the Solomon Islands? Hunt explored this issue in a recent study and concluded that such transfer "is not sustainably viable" on account of huge differences in political structures, national priorities, living standards, cultural traits, technological development, literacy levels, financial and infrastructural growth, and change-management competency. All these differences result in the absence of what Hunt calls a "contextual fit" between the policy development and the respective policy application environment (Hunt 1999, 302).

"If there is any conclusion that springs from a comparative study of river systems, it is that no two are the same" (Gilbert White cited in Jacobs 1999). Each river basin must differ from any other in a thousand respects; but that does not mean that lessons of success in one are of no value to another; it does mean though that uncritical "copycat" replication of successful institutional models—either by enthusiastic national governments or at the behest of enthusiastic donors—is a sure formula for failure. The history of institutional reform in developing-country water sectors is dotted with failures of such copycat reform.

Integrated river basin management (IRBM) is not a new idea, even in developing countries. India tried to transpose the TVA (Tennessee Valley Authority) model tried in the USA by constituting the Damodar Valley Authority, which was a resounding failure. Catchment management committees were established in China way back in the 1950s in some of the major river basins such as the Yangtse and Yellow rivers to plan and exploit water resources, generate electricity, mitigate flood damage, and provide facilities for navigation (Hu 1999: 327). But all these institutions shed their broad agenda and ended up focusing on irrigation, the purpose that was most central to their domains in those times.

In Sri Lanka, a Water Resources Board was established as early as 1964 to promote integrated water resources planning, river basin and trans-basin development and to tackle water pollution; however, the Board never worked on its broad mandate and instead, took to hydrological investigations and drilling tube wells.[19] Such examples can be multiplied easily; the point is: in learning useful lessons from success cases for making meaningful reform in developing countries, it is important to understand critical differences between the two worlds that have material significance for what will work and what will not. We pose that, in understanding the applicability of institutional innovations, it is critical to take into account four types of material differences between the developed- and developing-country realities:

a) Hydrology and climate.

b) Demographics.

c) Socioeconomics.

d) Organization of the water sector.

We briefly outline these material differences in the following sections.

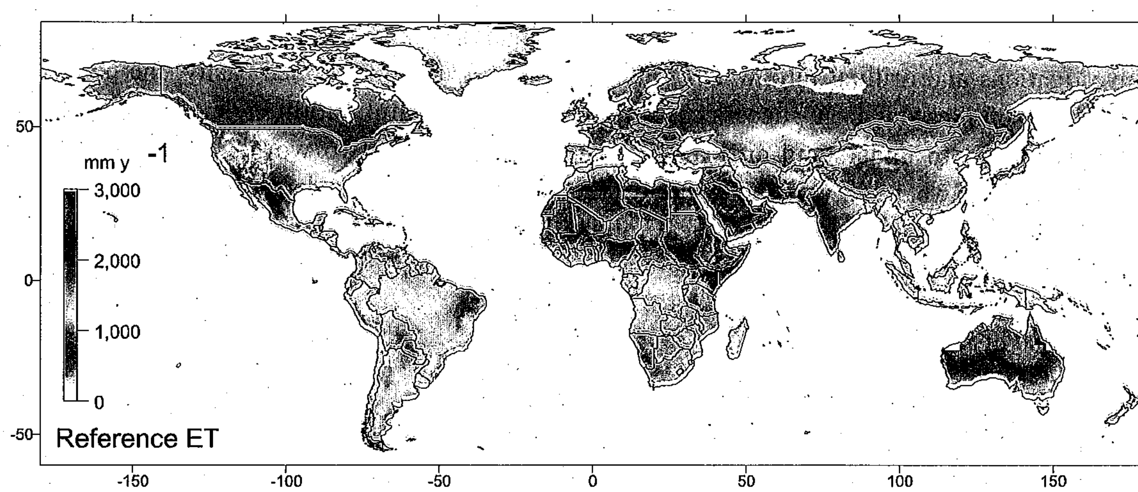
[19]Another round of reform has just begun in Sri Lanka. In 1990, a draft law made provision for bulk water allocation and included the establishment of a National Water Resources Council to do what the Water Resources Board could not; but the draft law could be submitted to the Parliament only in 1995 for lack of consensus in the cabinet as well as amongst the myriad agencies dealing with water (Birch and Taylor 1999, 331).

Hydrology of the Developing World

Historically, agriculture advanced early in arid climates such as those of Egypt and Iraq; but industrial development began early in the temperate and humid climates of Europe, North America and Japan. Some arid areas where significant wealth creation and accumulation have occurred—as in West Asia—are typically rich in mineral and oil resources. Today, however, the bulk of the developing world, where rainfall tends to be low and water scarcity is a major emerging constraint to progress is in the arid or semiarid[20] parts of the world. Figures 1 and 2, showing the global distributions of mean annual rainfall and potential evapotranspiration, help illustrate some major climatic differences between developed countries (mostly in the temperate latitudes) and developing countries (mostly in the tropical and subtropical regions).

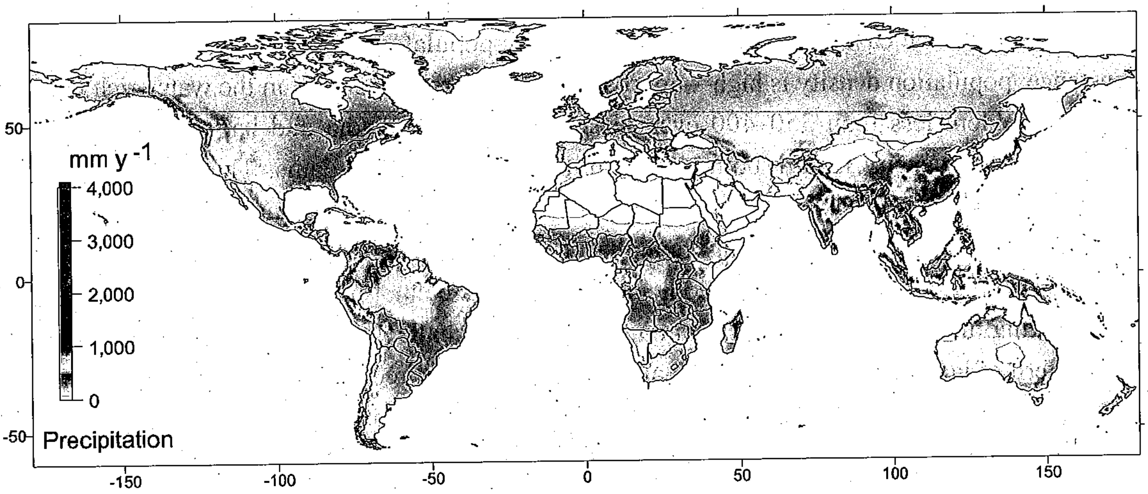
Sutcliffe (1995) pointed out that developing countries also happen to be concentrated in parts of the world with more extreme climates when compared to the regions occupied by today's developed countries. Figure 1 illustrates the variation in annual rainfall. India, for example, receives almost all its annual rainfall in less than 100 hours of torrential downpours from June to October; and its challenge is to save enough of it from evapotranspiration to last from October until April–May, the months that mark the period of highest water stress. Botswana receives all of its 350–500 mm rainfall during November–March, the period which also coincides with the highest evaporation, resulting in little or no runoff (Sutcliffe 1995, 69).

Figure 1. Global distribution of mean annual rainfall.



[20]Referring to regions like India and West Africa, which are humid for a small part of the year but arid during the rest of the year.

Figure 2. Global distribution of mean annual potential evapotranspiration.



Humid areas typically have higher stream densities than are found in the arid and semiarid areas, which means that, ceteris paribus, a higher proportion of precipitation in the arid and semiarid areas runs off in sheet flow before forming into streams, and is thereby subject to higher ET (evapotranspiration) losses (figure 2). Other things also are not quite the same; the developing world—especially, South Asia and much of Africa—around the tropics has higher mean temperatures for more of the year than the developed world. And, for equivalent levels of precipitation, runoff and the need for irrigation tends to be greater in arid and semiarid areas than in humid areas (Sutcliffe 1995, 64).

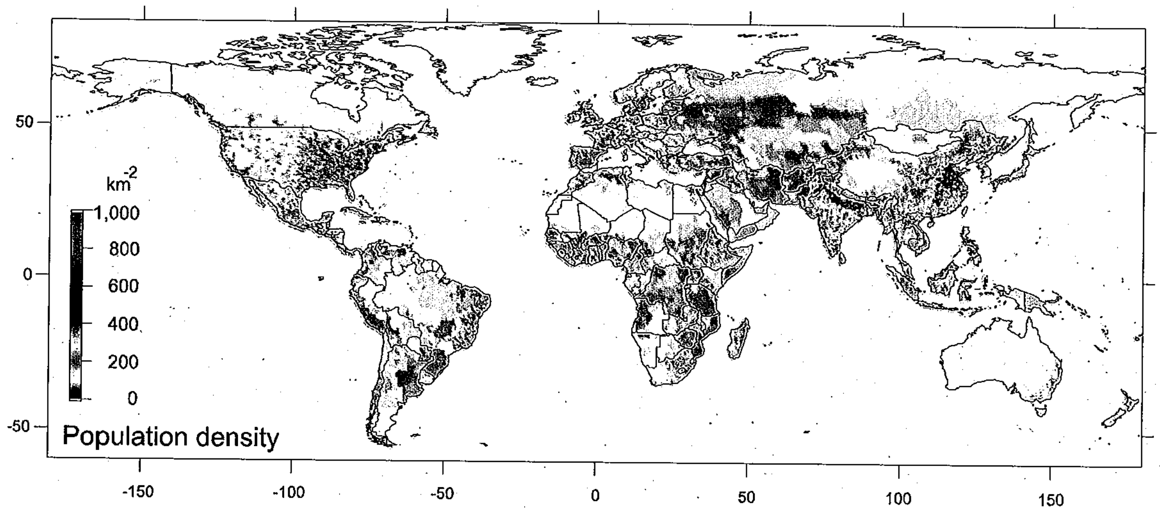
The climate and hydrological conditions, combined with demography (discussed in the following section), explain why decentralized institutions for water management have historically evolved in many parts of the developing world. The profusion of small tanks in India's southern peninsula and Sri Lanka can be viewed as the response of communities in the catchment areas to stake their claim on their rainfall. Even today, one collective maintenance task carried out by many south Indian tank communities before the start of the monsoon is cleaning and deepening of the channels that feed rainwater runoff to their tanks. Village people here recognize that if they do not capture runoff in artificial streams, most of it will be lost before it reaches their tanks.

Demographics

Many parts of the developed world have extreme climates too; however, over time, population and urbanization in these parts have tended to concentrate in wet areas or on downstream reaches of rivers near coastal areas, where water can be supplied through large-scale diversion structures. As figure 3 shows, except in Europe, most of the developed countries have low population densities throughout, with urban agglomerations near the coasts and rural population along rivers or irrigation systems. Here, the competition is for large accumulated bodies of "diverted water." Since catchment areas have relatively sparse populations, the downstream water-harvesting structures have large catchment areas that are virtually free from competition.

But this is not the case in some of the most densely populated regions of the world. In India, for instance, population density is high—approaching 600 persons per km^2 in the water-rich Ganga basin; and seldom less than 350–400 even in semiarid western India and hard-rock peninsular India. Population density is high both upstream and downstream of dams. The same is true for much of China; the North China plains have much less water than South China; but their population density is around the same. One might argue that the cause of intensive groundwater development in South Asia and China is that most people in these regions cannot be downstream of large dams; and by sinking tube wells people upstream are, in a sense, challenging the basic inequity inherent in the pattern of large irrigation projects that usurp the rainfall precipitation of populous upstream catchment areas to bequeath it to a small number of canal irrigators.

Figure 3. Global distribution of population density.



All these factors have had implications for the kind of water institutions that have evolved historically in the developed and developing world. For example, the system of rights based on riparian doctrine and on the doctrine of prior appropriation is alien to the cultures of many developing countries because the largest majority, by far, depend upon rainfall and local water-harvesting and storage structures. Riparian rights or prior allocation become operative only along the streams and rivers, where the bulk of the irrigators and water users tend to be concentrated in countries like the USA or Australia. But these make no sense, for example, for some 20 million persons pumping groundwater in South Asia; or the communities that use over 300,000 tanks in South India or 7 million ponds in China.

Because large proportions of the population in the developing world depend upon rain and on local storage, the people's notions of ownership and rights relate more easily to precipitation than to large-scale public diversions. Egypt gets less than 10 percent of its water from rainfall; yet Egyptians consider the rainwater to be truly their own. In Asia, where population densities are commonly as high in the catchment areas of the basin, as along the stream and river channels, the implicit primacy of the right of communities over precipitation rather than over diversions is for example widely accepted. Indeed, in recent years, a popular slogan in western India has been "rain on your roof, stays in your house; rain on your field stays in your field; and rain in your village stays in your village." In the Western countries, upstream-downstream conflicts are important because most water users think of users upstream as their rivals. In the World Water Forum that met at The Hague in March 2000, the slogan that the Delhi-based Centre for Science and Environment popularized was "Everyone Lives Downstream," which is eminently sensible if all or a majority of people in a basin depend for their water needs directly upon rainfall.

The IRBM discussion talks very little of the enormous amount of work on farming in the semiarid tropics, done by national and international centers such as ICRISAT.[21] As the Global Water Partnership (2000, 25) notes: "Most water management, including the literature on IWRM, tends to focus on the "blue water,"[22] thus neglecting rain and soil-water management. Management of "green water" flows holds significant potential for water savings." This is because there is little real "dryland farming" of the Indian and West African variety in the developed world; but making the best use of soil moisture is a critical issue in many African and Asian countries. Europe, Canada, New Zealand and USA do have rain-fed farming; but this is not quite the same as dry farming in western Rajasthan or sub-Saharan Africa; in many of these countries, favorable rainfall and climatic conditions result in favorable soil-moisture regimes that make irrigation unnecessary for growing good crops.

The conventional notion of irrigation is one of controlled supply of water to meet the full scientific requirements of plants precisely when needed. But the irrigation that is most widely practiced in South Asia and amongst smallholder farmers in Africa is supplemental irrigation designed to increase the productivity of "green water." Green water is the precipitation used directly for crop production and thus "lost" in evaporation; "blue water" pumped out from wells is as important in South Asia and North China as the part that flows into rivers and canal systems.[23] This is quite unlike the situation in many developed country river basins. In these the bulk of economic water demands have been met from development of "blue" surface water and where, with the closure of these basins, the focus of basin management is on raising the productivity of blue surface water, largely without regard to green water.

Uniformly high population density, combined with unhelpful climate and hydrology, has a profound impact on the objectives of water management in developing-country river basins. In recent years, IWMI's water accounting work (Molden and Sakthivadivel 1999, 58–60) has made much contribution to understanding water productivity in the basin context.[24] Although IWMI's

[21]International Crop Research Institute for the Semiarid Tropics.

[22]"Blue water" is water existing in bodies such as rivers or lakes, or pumped from aquifers. "Green water" is soil water extracted and transpired by plants.

[23]This distinction between "green" and "blue"-water is extremely important for developing countries in the semiarid tropics. Terrestrial ecosystems are "green-water"-dependent; aquatic ecosystems are "blue-water"-dependent (GWP 2000, 24).

focus has been on productivity of water in agriculture, the framework can be easily generalized to develop a notion of basin-level water productivity in terms of a social welfare function for all stakeholders in a river basin constituting a basin community. Under this broad conception.

Basin welfare productivity of water = Basin welfare/Available water

Water productivity understood thus could be enhanced by

a) Enhancing productivity in each use.

b) Constantly reallocating water amongst alternative uses—irrigation, domestic, industrial, and environmental—so that the marginal contribution to overall welfare by water allocated to all uses remains equal.

Using the IWMI water accounting framework, this welfare productivity measure can be written in several alternative ways to highlight the importance of different water use strategies.[25] For highlighting the difference between the developed and developing world, a useful way to write the welfare productivity ratio is:

Basin welfare/Available water =Basin welfare/Diversions) * Diversions/Available water)

In relatively water-abundant humid regions, with low population density in the catchment areas and dense human settlements near the coasts and along rivers, river-basin management seeks to maximize basin welfare productivity by increasing Basin welfare/Diversions). Allocation of diverted water amongst alternative uses is a crucial function in basin-level water management in such conditions. Here, reservoirs have large free catchments; and ET in catchment areas is often not high; therefore, the need for active human intervention to maximize Diversions/available water) is not great.

In water-scarce tropical countries with high population density everywhere, as in South Asia and China, maximizing basin welfare involves working on both the components. Increasing the productivity of diverted water is certainly important; but equally important is the need to maximize the proportion of precipitation and inflows into a basin that can be diverted before they are lost to non-beneficial depletion.

It is against this backdrop that we need to consider the growing mass movement for rainwater harvesting and groundwater recharge in western India (Shah 2000). The region has amongst the highest wind speeds encountered anywhere in the world; it has high mean temperatures for 9 months; rainfall varies between 300–800 mm/year; and population density is 300–500 per km^2 in the catchment areas as well as in the downstream areas. The greatest challenge for rural communities is surviving the annual pre-monsoonal drought in April and May, which is made infinitely more daunting by regular failure of monsoonal rains. During the pre-monsoonal months,

---

[24]Standard definitions used in IWMI water accounting work (Molden and Sakthivadivel 1999) are: Gross inflow: total amount of water flowing into a domain from precipitation, surface and subsurface sources; Net inflow: gross inflow +change in storage; Depletion: use or removal of water from a domain that renders it unavailable for or unsuitable for further use; Beneficial depletion: depletion that generates welfare; Process depletion: depletion in private economic uses; Non-process depletion: depletion in non-private, socially valued uses; Non-beneficial depletion: depletion that generates no economic or non-economic, private or social benefit; Committed water: outflow committed to other or downstream uses; Uncommitted outflow: outflows by default which are not used to create any value, private or social; Available water: net inflow–committed outflow-non-utilizable uncommitted outflow. Non-depletive uses: uses that create value without resulting in depletion.

[25]For example, by writing Basin welfare/available water = (Basin welfare/total depletion) *(total depletion/ total diversion) *(total diversion/water available), we can signify alternative routes to water productivity.

leave alone growing crops, ensuring adequate drinking water for humans and cattle is the great challenge, especially in the catchment areas of river basins. While government investment programs concentrated on building large reservoirs downstream to support irrigation and municipal water supplies to towns, the problems of the people living in the catchment areas remained unaddressed.

Disenchanted with government and public systems, NGOs and communities began to find their own solutions. The past decade has witnessed a massive popular awakening as the result of the efforts of NGOs like Tarun Bharat Sangh, Pradan, and of religious organizations such as the Swadhyaya Pariwar. This has taken the form of rainwater conservation and groundwater recharge work on a scale that governments or public agencies would not be able to manage. The basic motivation that has been driving the movement is to ensure availability of domestic water supply for two months before the monsoon and for one or two crop-saving waterings from wells; and there are indications that the movement may well meet this challenge.

Government agencies and scientists (hydrologists in particular) have been dubious about this mass movement, their argument being that rainwater harvesting structures upstream merely transfer water; these reduce the input into the reservoirs downstream, thereby reducing their productivity. But this argument does not resonate with the communities, especially in the upstream areas, which fail to see why they cannot meet their basic water domestic needs instead of feeding reservoirs to irrigate relatively small areas of paddy or cotton. In defense of this popular movement, the Delhi-based Centre for Science and Environment has asked: what does India need more—Irrigation or Drought-proofing? In reply, it has suggested that by a total rethink on "appropriate" river-basin management, India can trade drought-proofing over vast areas by sacrificing irrigation of small areas.

It has also adduced evidence to show that diverting rainwater in a large number of small water-harvesting structures in a catchment captures and stores more of the scarce precipitation, closer to the communities in these parts of the world, than having a large reservoir downstream (Agarwal 2000).[26] This is because water collected over larger watersheds will have to flow over a larger area before it is collected and a large part will be lost in small puddles and depressions, as soil moisture and evaporation. Much before irrigated crop production, semiarid India needs drinking water for its dispersed rural population during the nine months without rainfall. Many Indian observers think that the answer is not piped water supply schemes but decentralized rainwater harvesting. Agarwal's Centre for Science and Environment has estimated the average area needed per village to capture sufficient water to meet every household's drinking and cooking water requirement in the various regions with varying climate, precipitation and demographic conditions. The average for India as a whole was all of 1.14 ha/village in a normal year and 2.28 ha/village in a drought year!

[26]For instance, Agarwal (2000,9) cites evidence from the Negev desert in Israel to show that 3,000 micro-catchments of 0.1 hectare capture 5 times more water than a single catchment of 300 hectares, and this multiple increases in a drought period. He also cites results by Michael Evanari, an Israeli scientist that show that "While a 1 ha watershed in the Negev yielded as much as 95 m^3 of water/ha/year, a 345-ha watershed yielded only 24 m^3/ha/year. In other words, as much as 75 percent of the water that could be collected was lost. This loss was even higher in a drought year." Agarwal cites Evenari: "...during drought years with less than 50 mm of rainfall, watersheds larger than 50 ha will not produce any appreciable water yield while small natural watersheds will yield 20–40 m^3/ha, and micro-catchments (< 0.1 ha) as much as 80–100 m^3/ha."

Organization of the Water Sector

Developed-country water sectors which have evolved over decades of public intervention tend to be highly organized and formalized with the bulk of the water delivered—and most of the users served—by "service providers" in the organized sector. In low-income countries, a vast majority of water users—the poorest ones—get their water directly from rain and from local private or community storage without any significant mediation from public agencies or organized service providers. The notion of water service providers is alien to a majority of rural South Asians and Africans. As a society evolves and its economy as well as water sector mature, the bulk of the water delivered to ultimate users is produced, developed, planned, allocated—in general, managed—by formal organizations, businesses or utilities. In Israel, for example, 70 percent of the water supply in the country is managed by Mekorot, a state-owned water company that operates the National Water Carrier—the pipeline system that moves water from Lake Galilee to the Negev desert, and is in urban water retail, desalination and sewerage treatment businesses (Saleth and Dinar 2000, 185). When the bulk of the users and uses are served through the formal sector, resource governance becomes feasible, even simple. If a basin management regime wants to increase the water price to domestic users by 5 percent, or make a law intended to change the way business is done, it can do so with the confidence that it will stick. But this is not true when the bulk of the water users and uses are served by an informal sector where "service providers" are not even registered.

In comparing the Australian success with containing agricultural pollution of water with the Chinese situation, Hu (1999, 327) laments that the small number of large Australian farmers are served by a range of local organizations—such as sugar, rice, cattle associations—which serve as vehicles not only for new knowledge and technical advice but also for implementing new rules and laws; but in China, "given the small scale of farming units and the large number of farmers, it is difficult to control chemical and pesticide application, removal of vegetation, erosion and water resource exploitation." In South Africa, over 90 percent of water is managed by formal organizations, including the Water Boards, but 90 percent of rural people, the black irrigators in former homelands are almost wholly in the informal sector, far out of the reach of the public systems.

Ignoring the scale and complexity of dealing with the informal water sectors in the developing world can lead to misleading analysis. In the perspective of Saleth and Dinar (2000, 186), for example, the institutional reform challenge in South Africa "lies in translating the provision of its water law and water policy without creating much uncertainty among private investors." In our view, these are easily done; the real challenge the Government of South Africa is struggling with is of reaching the reform to the black communities in the former homelands, who operate in the informal water sector. And hard as the government is trying, this is not proving to be easy. About the process of Catchment Management Agency (CMA) formation in Olifants, South Africa, Merrey (2000, 9) writes:

"... rural communities were unaware of the provisions of the new water law and the CMA process, despite the efforts to inform people and offer them opportunities to express their views. Small-scale farmers had not heard about the CMA.... But the Irrigation Boards providing water to large commercial farmers were participating actively in the process..."

Small numbers of large stakeholders are easy to work with; the ball game changes fundamentally once we have to deal with a huge number of small stakeholders.

One way the informal sector can be "formalized" is through grassroots user organizations; and the global Irrigation Management Transfer (IMT) initiatives to organize irrigators into WUAs is partly motivated by the need to bring them into the formal sector. But in this too, small numbers of large users in the developed world have an advantage over large numbers of small users in the developing world. All manner of user associations form spontaneously in countries like the USA and Australia. These institutional models are constantly being tried out in developing countries but, here, these generally break down when faced with large numbers of small stakeholders who face such diverse constraints in their livelihood systems that they are at best apathetic towards each of them.

Thus, for example, irrigation management transfer to Water User Associations has unambiguously succeeded in the USA, New Zealand, Colombia, Turkey and Mexico, all situations of medium to large commercial or export farmers who run their farms as wealth-creating enterprises. In contrast, nowhere in low-income Asia, barring a few "islands of excellence," including the much-researched Philippines, has IMT held out the promise of long-term sustainability. White commercial farmers in South Africa took to Irrigation Boards like ducks to water; in African smallholder black irrigation schemes, there seems little chance that IMT will take off at all unless it is preceded by a wide-ranging intervention to make smallholder farming itself viable (see, e.g., Shah et al. 2000).

One standard refrain of institutional discussions in the water sector is get water law and get it "right." It is often the case, however, that the problem is not passing a law but in enforcing it in a society with a large number of tiny stakeholders operating in the informal sector with little or no linkage with meso- and macro-level resource governance structures. This is why many governments in Asia readily pass Acts but spend years before converting these into laws.

There are also cases of countries which have passed laws, and these have come totally unstuck. Sri Lanka has been debating a water law—which has "all the right ingredients" (Saleth and Dinar 2000)—since the early 1980s but is yet to enact it. This is presumably because it is difficult to figure how to make all the "right ingredients"—water permit systems, full-cost pricing, water courts, explicit water policy statement—actually work in ways that make significant difference to the management of water resources in a country where 50–70 percent of the rural people acquire their water not through water supply service utilities/companies but straight from nature or from local storage in small community tanks.

India adopted a water policy in 1987; but nothing changed as a consequence; and it is now working on a new one. Many Indian states have likewise been debating groundwater laws for 30 years; a dozen or so drafts are in circulation; the legislative assembly of Gujarat, the state with most severe groundwater overdraft problems, passed a bill as far back as in 1974; but the Chief Minister refused to make it into a law. And his reasons were convincing: first, he was unable to see how the law could be effectively enforced on a million small private pumpers scattered throughout a huge countryside; second, he was certain that it would become one more instrument of rent-seeking for the local bureaucracy (Shah 1993).

"Get the price right" is another old prescription to make water an economic good. Now that water scarcity in many parts of the world is real, it would be naive to question the value of pricing, not so much for revenue collection but to signal the scarcity value of water to users. There can be no serious debate on whether the view of water as a "scarce but free" resource is tenable in today's context. The real issue is making the price of water stick in a situation where a majority of users are in the informal sector and do not go to anyone except the rain-gods for getting their water.

Even in canal irrigation systems in South Asia, which are in the formal sector, many political leaders and senior administrators would become open to volumetric pricing of water to promote efficient use, if only the logistics of doing so were simple and cost-effective, what with the large number of small irrigators in the commands of Asian systems. After all, paying high prices for high quality irrigation service is common for millions of resource-poor buyers of pump irrigation in India, Pakistan, Bangladesh, and Nepal; but most people would avoid paying the full-cost-price if not paying were an option, as is the case in many developing country water sectors.

That high transaction cost of monitoring water use and collecting water charge is the central issue in water pricing, rather than the politicians' propensity towards giving away largesse, will soon be evident in South Africa, where the new pricing policy will be easy to enforce on large commercial farmers, for whom the transaction cost of monitoring and collection will be low, rather than areas of black irrigation, which represent the developing-country picture in general, dominated as these are by large numbers of small users.

Developed-country institutions have not solved the problem of serving or regulating large numbers of small users particularly well; indeed, they have not yet found satisfactory ways of dealing with moderate numbers of large users. In New South Wales, Queensland and Victoria, the existing law confers on every occupier of land the right to take and use water for domestic consumptive purposes, watering stock, irrigating home gardens and noncommercial crops on a maximum of 2 hectares (Hatton MacDonald and Young 2000, 24). If this exemption were applied to India, it would cover over 80 percent of all land and over 90 percent of all people; and in South Africa, it would cover 90 percent of all users though only 10 percent of land and water. In South Asia, South-East Asia and North China, groundwater is the most valuable and threatened resource; protecting groundwater from overdevelopment is probably among the top three priorities in this region; yet doing so is proving to be a challenge precisely because groundwater is in the informal sector.

In the question of how best to deal with South Asia's 20 million tube-well owners in the informal sector, the experiences of Murray-Darling or Mississippi do not have many practical lessons to offer. Even in "highly evolved" river basins, sustainable management of groundwater is at best problematic, and at worst, as hopeless as in India and Pakistan. Murray-Darling has tried groundwater regulation but it is not certain if it has worked. Access to groundwater in New South Wales is regulated by licenses under the Water Administration Act of 1986; however,

> "over much of New South Wales, undeveloped licenses were not cancelled. In retrospect, this has proved an administrative disaster as, in a number of areas, the total volume of licenses issued is well in excess of estimated sustained yield" (Hatton MacDonald and Young 2000, 23).

In California's Central Valley, groundwater overexploitation is a 60-year-old problem; yet in his case study of basin management, Svendsen (2000) concludes that "groundwater is the most lightly planned and regulated segment of the state's water resources. There is little control over abstractions and, on average, the state is in a serious overdraft situation."

Even in middle-income countries, where major institutional reforms have been initiated in recent years, groundwater overexploitation has defied solution. Spain, one of the European countries that suffer agricultural overexploitation of groundwater, has instituted sweeping reforms that will affect surface water but have little to do with groundwater (Saleth and Dinar 2000). Mexico's aquifers too are amongst the most overdeveloped; IWMI researchers based in Guanajuato state, one of Mexico's agriculturally dynamic regions, found water tables in 10 aquifers they studied declining at average annual rates of 1.79–3.3 m/year during recent years (Wester et al. 1999, 9). An institutional solution is being tried here; the establishment of Aquifer Management Councils called COTAS (Consejos Técnicos de Aguas) in Mexico as part of its water reforms and under the new Mexican water law is a notable development. IWMI researchers in Guanajuato are, however, skeptical: "...several factors bode ill for their (COTAS') future effectiveness in arresting groundwater depletion..."

Finally, for top echelons of national decision makers, it is always easy to take hard decisions, which do not affect a large proportion of a nation's population in a seriously adverse manner. Political leaders and water-sector leaders in emerging economies constantly face pressures to be myopic and adopt postures that are at odds with the ideal of IRBM. The most powerful and compelling pressures emerge from their own internal social realities. In low-income agrarian societies like in South Asia and much of Africa, food security and poverty alleviation will continue to remain prime concerns for decades to come.

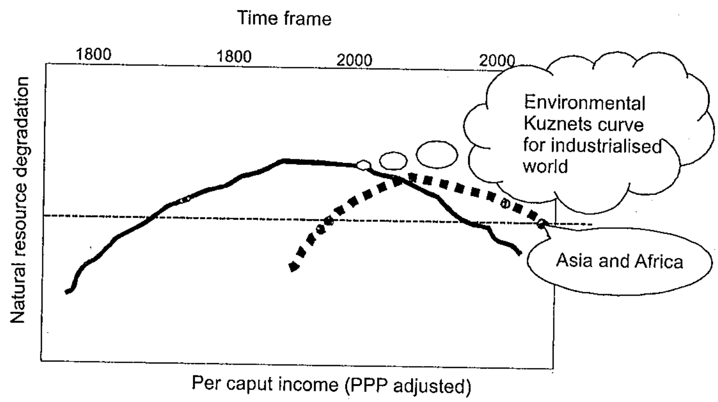
When several poor states—such as India, Nepal, and Bangladesh in the Ganga-Meghana-Brahmaputra basin, or the Central Asian states in the Aral Sea—are involved in a basin, coordinating mechanisms tend to operate at suboptimal levels because national leaders are under pressure to maximize their national interests. It has been argued that the Aral Sea crisis is the outcome of the compelling need of the political leaders in the Central Asian states to ensure food security as well as water-intensive cotton cultivation for export, both at once; and a major move to reverse the desiccation of the Aral Sea, the Amu Darya and the Syr Darya, will have to wait until something changes the dominant perception of the political leadership in Turkmenistan and Uzbekistan that cessation of cotton monoculture will have politically and socially destabilizing consequences.

Stage of Socioeconomic Development

What factors might influence the pace of institutional change in developing-country water sectors? Saleth and Dinar (2000) suggest that as water scarcity intensifies, opportunity costs imposed by missing or malfunctioning institutions will increase and transaction costs of institutional change will decline, which together will determine the pace of institutional change in developing countries. A competing hypothesis is offered by the application of the Kuznets' curve to natural resources management by societies. Recently, there have been attempts to fit an environmental Kuznets' curve to deforestation using cross-country data (Bhattarai and Hammig 2000).

The environmental Kuznets curve (ECC) poses an inverted U relationship between economic growth and environmental degradation (figure 4). The core hypothesis is that, as economies grow, they use natural resources as a factor of wealth creation; but as per capita real income grows, demand for environmental amenity grows and there is greater demand and support for environmental protection.

Figure 4. Relationship between level of economic growth and natural resource degradation.



Although the empirical results of some of this econometric work are far from conclusive, intuitively, it seems compelling to suppose that the income elasticity of demand for environmental amenity is lower at low per capita incomes (as in Bangladesh and Burkina Faso) than at high per capita incomes; and therefore, highly evolved economies of the Western world would have greater demand, capacity and collective will to fix the environmental problems from natural resources mismanagement than low-income emerging economies. In many Western countries, where per capita income growth to present levels took 200 years or more, the ECC-effect too took centuries to work out. Historical evidence suggests deforestation in Europe was at its peak at the time of the Industrial Revolution; and the area under forests began to increase long after economic prosperity ensued (Bhattarai and Hammig 2000).

Much the same relationship seems to hold in the case of water resources management, too. Countries with highly developed water institutions are also those which have evolved industrially. In contrast, it is difficult to find a low-income agrarian society, which has highly developed water institutions. Interestingly, some sketchy evidence suggests that the period of decline followed by upswing gets telescoped in economies like Japan and Taiwan that have grown their industrial output and employment rapidly over a relatively short period.

In table 1, we present the data set for 57 countries organized around their per capita water and arable land availability. The figures alongside the country names are their respective per capita CO_2 emissions, which constitute one of the best corelates of GDP per capita as well as Human Development Index. Mean per capita availability of water and arable land along with CO_2 emission is used to divide the countries into eight categories.

Countries in categories B1, C1 and D1 are poor in water and/or arable land resources; but these are rapidly becoming post-agrarian societies where pressure on water and land from irrigated farming will rapidly ease. The social and economic costs of fixing water mismanagement in these countries already are, or will soon be, within acceptable limits.

It is notable that A1 represents the category of countries from which most models of effective water institutions emerge, and these are offered to countries in the D2 category which have the least water, land and CO_2 emissions. Countries in A1 are amongst the best endowed with both water and land; as a result, despite being highly industrialized (as indicated by their high CO_2

Table 1. Natural resource availability and economic growth.

	Per cap water> mean (10,460m³); Countries with high and low CO_2 emissions/capita				Per cap water> mean (10,460m³); Countries with high and low CO_2 emissions/capita			
	A1		A2		B1		B2	
Per cap arable land> mean (0.37 ha)	Australia	4.61	Argentina	1.01	Denmark	2.95	Sudan	0.1
	Canada	3.73	Brazil	0.46	Greece	2.09	Syria	0.83
	USA	5.37	-	-	Kazakhastan	2.89	Zambia	0.08
	New Zealand	2.18	-	-	Libya	2.18	Turkey	0.78
	Hungary	1.59	-	-	Spain	1.6	Afghanistan	0.02
	C1		C2		D1		D2	
Per cap arable land> mean (0.37 ha)	Malaysia	1.58	Cambodia	0.01	Switzerland	1.68	Zimbabwe	0.45
	Sweden	1.67	Chile	0.92	South Africa	2.1	Tanzania	0.02
	Vietnam	1.77	Indonesia	0.33	Singapore	5.32	Sri Lanka	0.11
			Laos	0.02	Saudi Arabia	3.88	Senegal	0.11
			Mexico	1.02	Oman	1.85	Philippines	0.25
					Japan	2.53	Peru	0.3
					Italy	1.92	Pakistan	0.18
					N. Korea	2.46	Nepal	0.02
					S. Korea	3.07	Kenya	0.07
					Israel	2.5	India	0.29
					Belgium	2.86	Ethopia	0.02
					France	1.69	Egypt	0.42
							China	0.74
							Botswana	0.37
							Bangladesh	0.05
							Iraq	1.21
							Iran	1.15
							Syria	0.83

Source: Engelman Robert et al. 2000.

emissions), these still have large, wealth-creating agriculture and agroindustries sectors that absorb a very small proportion of their populations.

In the D2 category, poor land and water resources endowments combine with high population pressure; but ironically, their most critical problem is their low CO_2 emission. Industrial growth, urbanization and transfer of people from agricultural to off-farm livelihoods seem the only way pressure on land and water will ease. Many of these countries will, over the coming decades, more likely take the Kuznets' curve route that Japan and Taiwan have taken than the one that Australia and USA have taken.

In Taiwan, where rapid industrial growth and urbanization have resulted in 40 percent decline in irrigated areas over recent decades, the popular outlook towards water management issues has undergone fundamental transformation. Over 90 percent of Taiwan's irrigators have become part-time farmers, and income from industrial employment far outweighs agricultural incomes; there have been major increases in demand for environmental amenity and in the touristic value of former irrigation structures; all these have resulted in substantial private initiatives and investments in improving water quality and aquatic ecology. Taiwan has amongst the highest population densities we find anywhere in the world; yet its water institutions will soon approach those in high-income western countries rather than those in low-income Asian countries, which share high population density with Taiwan.

The Kuznets' curve hypothesis looks at the relationship only from the angle of demand for environmental amenity. But there is also the supply side to it; much larger volume and quality of resources are applied to natural resources management in high-income countries than in low-income countries. Consider the budget of the water departments: California State Department of Water Resources has 2,000 employees, mostly professionals, who operate an annual budget of US$1 billion (Svendsen 2000). The Gujarat Department of Water Resources probably employs as many engineers but operates a budget of less than US$10 million. The upshot of this discussion is that, over a decadal timeframe, economic growth is probably both the cause as well as response to the problem of natural resources mismanagement; and, if the experience of Japan and Taiwan is any guide, the period over which the interaction between the two plays out need not run into centuries as it did in the case of Europe, but it can be telescoped from centuries to decades.

Conclusion

In this paper, we have made an attempt to explore why efforts to transfer the institutional models of river-basin management from developed countries to developing ones have not met with desired success. The contexts in which reforms are tried in developing countries are vastly different—in their hydrologic and climatic conditions, in their demographics, in their socioeconomic conditions as well as in the way their water sectors are currently organized—from the context of the countries in which the models first succeeded. Successful institutional reforms in the water sector worldwide have tended to have common overarching patterns. They have focused largely on management of surface water bodies; they have aimed at improving the productivity of publicly diverted large water bodies; they have largely ignored groundwater and have not had to contend with dominant informal water sectors; they have centrally been about "blue water" productivity and have largely ignored "green water."

The problems that successful institutional models have resolved—water quality, wetlands, sediment buildup in the upper parts of the river, maintaining navigation use, dealing with occasional floods—are often not of paramount interest in the developing- country contexts. And the problems that developing countries find critical and insurmountable have either remained unresolved in developed-country river basins, such as groundwater overexploitation, or are rendered irrelevant by their evolutionary process, as in using irrigation as a means to provide poor people with livelihoods and food security. This does not by any means imply that developed-country experience has no lessons to offer to the developing world; drawing such a conclusion would be naive in the extreme. What it does mean, however, is that imposing institutional models uncritically in vastly different socioecological contexts can be dysfunctional and even counterproductive.

What it also means is that we need to take a broader view of institutional change. An extraordinary aspect of the institutional discussion in the global water sector is how very narrowly it has focused on things that governments can do: make laws, set up regulatory organizations, turn over irrigation systems and specify property rights. A recent review of institutional changes in the global water sector in 11 countries by Saleth and Dinar (2000), for example, treats water law, water policy and water administration, as the three pillars of institutional analysis. This makes water purely the government's business, quite contrary to the slogan popularized by the World Water Council to make "Water Everyone's Business!" If institutional change is about how societies adapt to new demands, its study has to deal with more than what just the governments do; people, businesses, exchange institutions, civil society institutions, religions and movements—all these must be covered in the ambit of institutional analysis (see, e.g. Mestre 1997 cited in Merrey 2000:5).

Which elements of the Murray-Darling experience can be sensibly applied in which developing-country context is certainly an important and interesting analytical enterprise; but equally, or even more, important is the need to listen to voices from the grassroots. If people living, for example in the Deduru Oya basin in Sri Lanka, are facing water scarcity, they are sure going to begin to do something about it; likewise, if the Government of South Africa withdraws from the management of smallholder irrigation schemes in the Olifants basin, the smallholders will soon respond in some way. What institutional reform makes best sense in Deduru Oya or Olifants should best emerge from understanding the respective realities of these basins; a broad understanding of what has worked elsewhere including in the developed world might offer a good backdrop to the design of institutional interventions. But it might be unrealistic to expect much more; copycat institutional reform would be outright disastrous.

In understanding how societies adapt their institutions to changing demands, Nobel Laureate Oliver Williamson (1999) suggests the criticality of four levels of social analysis as outlined in figure 5. The top level is referred to as the social embededness level where customs, traditions, mores and religion are located. Institutions at this level change very slowly because of the spontaneous origin of these practices in which "deliberative choice of a calculative kind is minimally implicated." At the second level—where the institutional environment of a society is involved—evolutionary processes play a big role; but opportunities for design present themselves through formal rules, constitutions, laws and property rights; the challenge here is getting the rules of the game right. The definition and enforcement of property rights and contract laws are critical features here. Also critical is understanding how things actually work—"warts and all"—in some settings, but not in others.

However, it is one thing to get the rules of the game (institutional environment) right; it is quite another to get the play of the game (enforcement of contracts/property rights) right, which leads to the third level of institutional analysis: transaction costs of enforcement of contracts and property rights, and the governance structures through which this is done. Governance—through markets, hybrids, firms and bureaus—is an effort to craft order, thereby to mitigate conflict and realize mutual gains; and good governance structures craft order by reshaping incentives, which leads to the fourth level of social analysis—getting the incentives right.

Discussion of water policy and institutions in the developing-country context has focused a great deal on levels 2, 3 and 4 and little on level 1; more, it has tended to underplay the interactions between levels. Many populous developing countries will feel a lot wiser about IRBM if we learn more about how level 1 operates in their respective contexts and how the interaction between 2 and 3, and 3 and 4 can work better. How to create property rights that affect users' behavior is more important than exhortations that clear property rights be created; understanding how to enforce a groundwater law meaningfully on 20 million private pumpers scattered throughout the South Asian countryside is more helpful than pushing a groundwater law; how to monitor water use and collect canal irrigation charges cost-effectively is more in order than discussing whether irrigation subsidies should be eliminated.

Figure 5. Four levels of institutional change that explain how societies adapt to new demands.

	LEVEL	FREQUENCY	PURPOSE
L1	EMBEDDEDNESS: INFORMAL INSTITUTIONS, CUSTOMS, TRADITIONS, NORMS, RELIGION	100-1,000 YEARS	NONCALCULATIVE SPONTANEOUS
L2	INSTITUTIONAL ENVIRONMENT: FORMAL RULES OF THE GAME-PROPERTY RIGHTS, POLITY, JUDICIARY BUREAUCRACY	10-100 YEARS	GET THE INSTITUTIONAL ENVIRONMENT RIGHT
L3	GOVERNANCE: PLAY OF THE GAME-ESP CONTRACT ENFORCEMENT; STRUCTURES WITH TRANSACTIONS	1-10 YEARS	GET THE GOVERNANCE STRUCTURE RIGHT
L4	RESOURCE ALLOCATION AND EMPLOYMENT: INCENTIVE CONTINUOUS ALIGNMENT		GET THE PRICES RIGHT

l1 = SOCIAL THEORY
l2 = ECONOMICS OF PROPERTY RIGHTS AND POSITIVE POLITICAL THEORY
l3 = TRANSACTION COST ECONOMICS
l4 = NEO-CLASSICAL ECONOMICS/PRINCIPAL-AGENT THEORY

Source: Oliver E. Willamson. 1999. The New Institutional Economics: Taking Stock/Looking Ahead, Business and Public Policy Working Paper BPP-76 University of California, Berkeley.

Chapter 6

Conclusions: Best Practices and Some Lessons

While the three cases of Murray-Darling, Omonogawa and Brantas offer examples of many positive features of improved IWRM, it is unlikely that all of them can be easily replicated in developing-country river basins. One strong reason for this difficulty is that the institutional conditions supporting river basin management in the three advanced cases may not be available or applicable in the same strength and spirit in the case of developing countries. The conceptual basis of the study has been that the basin management institutional framework is fashioned and shaped by the overall social, economic and political environment of the country in which the river basin is situated (explained in chapter 2 of the Final Report, Volume I). The developed and developing countries differ, in varying degrees, in their social, economic and political environments. The differences also extend to hydrologic and climatic conditions, and demographics, as well as in the way natural resources management is currently organized (Tushaar et al., chap. 5). Therefore, for this reason alone, the improved institutional framework in a developed context may not be readily replicable in a developing country situation.

No two of the three selected advanced basins are similar. They are all different in many ways, supporting the statement by Gilbert White (1999) that, "if there is any conclusion that springs from a comparative study of river systems, it is that no two are the same." Each of them however, seems to provide some useful hints, guidelines or lessons on river basin management, which the developing country water management planners can gainfully adapt, or adopt, in their search for effective institutions for proper IWRM.

The Murray-Darling river basin is a very peculiar case. Two hydrologically different tributaries form the overall basin. The Murray that flows through the mountains in South East Australia, with a relatively reliable flow, joins the Darling that drains through the semiarid northern part of the basin with an erratic flow. Covering approximately a million square kilometers, equivalent to one-seventh of the landmass of Australia, the basin has many complexities, including a remarkable climatic variability, and a considerable interstate sociopolitical differentiation. These complexities have resulted in an equally complex institutional framework.

The impressive list of innovative institutional mechanisms given in chapter 5, suggests that the Murray-Darling river basin management system might have taken a long period of time to evolve in order to address so many problems. The issue is whether any institutionally weak developing-country situation could "leapfrog" into this mature status in a short time. Imposing institutional models uncritically in vastly different socio-ecological contexts can be in fact dysfunctional, and even counterproductive.

However, the Murray-Darling case study highlights some positive elements of river basin management. One major lesson it presents is the successful way of managing conflicts. Because of the complexity of the system, its physical and geopolitical nature, and its economic significance, the Murray-Darling basin is a ready source of conflicts. The plethora of organizational mechanisms and the rules to guide them are all well established, and as accepted institutions, they not only help in resolving conflicts, but also encourage continuing reform. The conflict resolution strategies exist in an environment of "cooperative federalism." Essentially, the federating units in Australia cooperate among themselves, rather than having to cooperate with, or respond to, a central authority. This essential feature pervades most other social units as well. For example, each State or Territory enjoys the flexibility of adopting its own implementation strategies within an agreed framework of policy.

Internal mechanisms within the basin system are first used to resolve conflicts. It is only rarely, and when internal mechanisms have failed, that the courts are used for this purpose. To consider conflict resolution as the most significant feature of the success of the Murray-Darling institutional framework is appealing to emerging river basin management arrangements in developing countries. From transboundary basins to those located within a single political unit, a common problem in water resources management is the constant need to sort out various conflicts. For a developing country with such constraints, the Murray-Darling institutional framework for conflict resolution offers some useful guidelines. The primary reason for the long existence of the Murray River Commission (1917-1985) was its role as the instrument through which the competing States negotiated and reached agreements for water allocation, and resolved any conflicts arising from them. As this instrument was insufficient to resolve basin-wide problems related to salinity and other environmental issues, it was expanded to its present form of the Murray-Darling Basin Commission. This gradual expansion as the needs arise is another useful guide to developing countries, which often try, erroneously, to achieve the most sophisticated form of institutional arrangement by copying what exists elsewhere in the developed world.

Another important lesson that can be drawn from the Murray-Darling case is the value of a well-balanced politico-administrative and civil society collaboration. The Ministers and their Deputies take an active part in various committees across the multilayer institutional framework, and in fact they provide the continuity in policy adoption across these myriad organizations. The stakeholders actively participate in various levels of organizational mechanisms. The system of decision making and implementation is transparent. In most developing countries, these are achievable goals, but a combination of factors, all related to political expediency in one way or another, circumvents them. The political commitment is only up to the extent of seeking authoritative influence over the management affairs, rather than in productive participation. Most officials also yield to this pattern of patronage. The stakeholders are primarily motivated, and organized, according to political alliances, and play their roles in a political game, rather than in terms of objective requirements of natural resources management within the river basin.

Some of these developing-country sociopolitical problems would encourage the actors concerned to look at developed-country management criteria with some degree of doubt and skepticism. Particularly, two of the Murray-Darling practices, namely, water pricing and water trading, would therefore be subject to strong political debate, even surpassing their inherent objectivity. The long tradition of free-enterprise and market economics and friendly State-Federal relationships in Australia would favor concepts such as full cost recovery water pricing, and interstate, intergroup and individual water-trading, and "user pays" approach, whereas the developing countries which have not fully embraced these political ideologies will treat these concepts with caution. Here, the lesson would be to test such ideas with a broad spectrum of stakeholders and adopt them only with unstinted support from them. Adopting the items which are less controversial initially, and proceed slowly to test the contextual validity of other more difficult propositions, is a strategy that can be gainfully used in some developing countries.

Turning to the other developed country case on the Omonogawa river basin in Japan, one clear lesson is that a formal river basin organization is not an essential feature of successful river basin management. The Omonogawa river basin, in all respects, is almost fully developed in terms of physical infrastructure and agricultural enterprises. The Akita Prefecture is the overall administrative and regulative authority for minor rivers in the basin and the function of basin development. However, the Central Government of Japan exerts a substantial policy influence over river basin management. The Ministry of Land, Infrastructure and Transport, through its local offices administers a very strong legal framework based on River Law and its Regulations. This regulatory function covers the issuance and renewal of water rights, coordination of water use at times of droughts, and such other overall functions as flood forecasting, flood warning and integrated planning. Although there is no single exclusive river basin organization for the Omonogawa, the Central and Prefectural government arrangements have effectively accounted for basin-wide planning and water allocation requirements. Stakeholder involvement is through the system of "Land Improvement Districts" (LIDs), a traditional form of local participation. Some LIDs in the basin have reached a very mature status, and like large cooperatives elsewhere, LIDs function with elected members and appointed managers and staff. Another positive feature in the Omonogawa basin management is its strong bias towards environmental protection. Catchment management arrangements go far beyond the recent enthusiasm on watershed development and management, and are related to ancient traditions in the region. Another positive feature was the database management. Most of the data required for water accounting and economic analyses are readily available (though all in Japanese language) in at least two main places: the Prefecture Office and the LID Office. This information base is established as a spinoff from the regular monitoring programs, which in themselves are exemplary.

Overall, the modern management styles and technologies are embedded to local tradition, a pleasant feature of the Omonogawa case, from which the developing countries could draw useful lessons. Going beyond the traditional land and water management practices, river basin management in Japan has included modern aspects such as land-use planning, agricultural techniques, river training, erosion control, and environment management, covering all human activities that use water. Omonogawa is illustrative of the text book definition of river basin management: "the management of water systems as part of the broader natural environment and in relation to their socioeconomic environment" (Mostert et al. 1999).

The Brantas experience is a widely published bright spot in developing-country river basin management. The donors and the government have successfully installed an integrated river basin management system in Brantas, and successfully showcased its virtues. An objective analysis of the case suggests that persistent efforts can establish a good management system in a developing context, if the donors and recipients both agree on a common program of development, provided also that the medium-term investment is considerably high.

The Brantas development in Indonesia, in many ways, is similar to the Mahaweli river basin development in Sri Lanka. Donor inputs were heavy, political commitment was high, and the development program was well planned. In either case, stakeholder involvement in the planning stage, and even in the implementation stage, was rather sketchy. Efforts in mobilizing grassroots involvement are accelerated towards the maintenance stage, when the stakeholder participation in O&M costs is really needed. The positive aspect is that a large area has been developed, benefiting a sizeable population in terms of agricultural development and a potential for nonfarm employment through rural industries. In terms of institutional development, the Brantas organization, known as Jasa Tirta (Water Service), like the Mahaweli Authority of Sri Lanka, is a very robust management organization relative to other government organizational arrangements. The required procedures and rule systems are in place, and are supported by government policies, national laws and district bylaws. At present, it is a very effective institutional framework for river basin management. Until recently, it has been receiving foreign aid and, therefore, the stage has not been reached yet to put this organization into a real test of self-sufficiency in terms of river basin management.

The lessons the Brantas offer include its series of Master Plans, the way they have been progressively implemented, and the comprehensive nature of the management structure. Brantas also offers to the developing world, a model that would closely define the concept of IWRM in its currently known form.

A common remark that can be made to cover all the three cases is that the replicability of these experiences in their own countries needs to be assessed before promoting their implications internationally. The Murray-Darling experience has no precedent in Australia, as its significance and complexity cannot be matched by any other single river basin in the country. However, the contribution it has made to enhance and update the national policies and laws would provide for a wider coverage of the Murray-Darling principles elsewhere in the country. In the Omonogawa case, since there is no specific river basin organization or a specific set of institutions associated with it, the general policies and principles would govern the management of other river basins in Japan. However, generally, both Murray-Darling and Omonogawa institutional arrangements have not fully solved all water management problems in these countries. Concludng a paper on "Transposing of Water Policies from Developed to Developing Countries: the Case of User Pays," Chris Hunt (1999, 304) says: "As a final comment in terms of the transposability of water policies, it would seem to be hypocritical of developed countries to fast-track developing countries, given the slow development approach still applied to water services in developed countries today."

In terms of institutional development, the story in the Brantas is different. Having benefited from rapid donor-driven institutional development, the best practices in the Brantas have not been able to satisfactorily replicate an effective river basin management system in any of the other numerous river basins in Indonesia. Most probably, the resource intensity that saw the Brantas developed into what it is today is difficult to repeat. Another equally compelling reason would be the slow process of absorption of related national and district-level policies and laws, so that the basis still does not exist to initiate the replication of good positive aspects of the Brantas. However, Brantas is an appealing story of institutional development for river basin management, which is likely to be replicated in Indonesia, once the new laws and policies (again mostly donor-driven) gain root.

In conclusion, the best practices observed in the entire three cases offer some important lessons to developing countries, which are on their way to establish river basin management institutions. The practices, however, cannot be easily and gainfully replicated in developing country contexts.

Bibliography

Abernethy, C. L. ed. 2001. *Intersectoral management of river basins.* Colombo, Sri Lanka: International Water Management Institute.

Agarwal, Anil. 2000. *Drought? Try capturing the rain.* Delhi: Centre for Science and Environment.

Bandaragoda, D. J. 2001. *A framework for institutional analysis for integrated water resource management in a river basin context.* IWMI Working Paper No. 5. Colombo: International Water Management Institute.

Bhattarai, M.; M. Hammig. 2000. Institutions and the environmental Kuznets Curve for deforestation: A cross-country analysis for Latin America, Africa and Asia. *World Development.* (Forthcoming).

Birch, Alfred; Paul Taylor. 1999. International mentoring: Application of Australian experience for Sri Lankan water sector reforms under Technical Assistance of the Asian Development Bank. *Water International* 24 (4): 329–340.

Brennan, D.; M. Scoccimaro. 1998. Issues in defining property rights to improve Australian water markets. *The Australian Journal of Agricultural and Resource Economics* 43: 69–89.

Challen, R. 2000. *Institutions, transaction costs and environmental policy: Institutional reform for water resources.* Edward Elgar.

Crabb, P. 1997. *Murray-Darling basin resources.* Australia: Murray-Darling Basin Commission.

Department of Industry, Science, and Resources. 2000. *Corporatisation of the Snowy mountains hydro-electric authority, draft environmental impact statement, summary and conclusions.* Commonwealth of Australia.

Engelman, R.; Richard P. Cincotta; Bonnie Dye; Tom Gardner-Outlaw; Jennifer Wisenewski. 2000. *People in the balance: Population and natural resources at the turn of the millennium.* Washington, D.C.: Population Action International.

Fisher, D. E. 2000. *Water law.* LBC Information Services.

Global Water Partnership. 2000. *Integrated water resources management.* Stockholm: Technical Advisory Committee of GWP.

GoJ (Government of Japan). 1964. *Rivers Act.*

Hatton MacDonald, Darla; Mike Young. 2000. *A case study of the Murray-Darling Basin: Draft preliminary report.* Sydney: CSIRO, prepared under commission for International Water Management Institute.

Hilmer, Frederick G. 1993. *National competition policy.* Independent Committee of Inquiry into Competition Policy in Australia.

Hu, Xiandeng. 1999. Integrated catchment management in China: Application of the Australian experience. *Water International* 24 (4): 323–328.

Hunt, Chris. 1999. Transposing of water policies from developed to developing countries: The case of user pays. *Water International* 24 (4): 293–306.

Jacobs, Jeffery. W. 1999. Comparing river basin development experiences in the Mississippi and the Mekong. *Water International* 24 (3). September.

Malano, Hector; Michael Bryant; H Turral. 1999. Management of water resources: Can Australian experiences be transferred to Vietnam? *Water International* 24 (4): 307–315, December.

Marsden, Jacob. 1999. *Water trading development and monitoring: Final report. 20 May 1999.*

MDBC (Murray-Darling Basin Commission). 1999. *Murray-Darling Basin Commission annual report 1998-99.*

MDBMC (Murray-Darling Basin Ministerial Council). 1987. *Murray-Darling environmental resources study.* Sydney: State Pollution Control Commission, Sydney, for the Murray-Darling Basin Ministerial Council, Canberra.

MDBMC. 1996. *Setting the cap: Report of the independent audit group, executive summary.*

MDBMC. 2000. Review of the operation of the cap: Draft overview report of the Cap Project Board. March 2000.

Merrey, Douglas. 2000. Creating institutional arrangements for managing water-scarce river basins: emerging research results. Paper presented at the session on 'Enough Water for All', at the Global Dialogue on the Role of the Village in 21st Century: Crops, Jobs, Livelihoods, August 15–17, 2000, Hanover, Germany.

Mostert, E.; E. van Beek; N.W.M. Bouman; E. Hey; H.H.G. Savenije; W.A.H. Thissen. 1999. *River basin management and planning.* Keynote paper for International Workshop on River Basin Management, The Hague, 27–29 October, 1999.

Musgrave, W. 2000. The political economy of water price reform in Australia. In *The political economy of water pricing reforms*, ed. Ariel Dinar. Oxford University Press

Quiggin, J. 2001. Environmental economics and the Murray-Darling river system. *The Australian Journal of Agricultural and Resource Economics* 45:67–94.

Saleth, Maria; A. Dinar. 2000. Institutional changes in global water sector: Trends, patterns and implications. *Water Policy* 2: 175–199.

Shah, Tushaar. 1993. *Water markets and irrigation development: Political economy and practical policy.* Bombay: Oxford University Press.

Shah, Tushaar; B. van Koppen; Douglas Merrey; Marna de Lange; M. Samad. 2000. Institutional alternatives in African smallholder agriculture: Lessons from international experience in irrigation management transfer. Paper presented at National Policy Workshop on Irrigation Management Transfer and Rehabilitation of Smallholder Irrigation Schemes. June 21, 2000 at Hazy View, Mpumalanga, South Africa.

Shah, Tushaar; Ian Makin; R. Sakthivadivel. 2001. Limits to leapfrogging: Issues in transposing successful river basin management institutions in the developing world. In *Intersectoral management of river basins*, ed. C. L. Abernethy. Colombo, Sri Lanka: International Water Management Institute.

Sutcliffe, J. V. 1995. Hydrology in the developing world. In *Time and the river: Essays by eminent hydrologists*, ed. G.W. Kite. Saskatoon, Canada: Water Resources Publications

Svendsen, Mark. 2000. Basin management in a mature closed basin: The case of California's Central Valley. In *Intersectoral management of river basins*, ed. C. L. Abernethy. IWMI, Colombo, Sri Lanka and DSE, Feldafing, Germany.

UNEP (United Nations Environment Programme). 1989. Sustainable water development and management: A synthesis. *Water Resources Development* 5(4): 225–251.

Williamson, Oliver E. 1999. *The new institutional economics: Taking stock/looking ahead.* Business and Public Policy Working paper BPP-76. Berkeley: University of California.

Young, M.; Hatton MacDonald, D.; Stringer, R.; Bjornlund, H. 2000. *Inter-state water trading: A two year review.* CSIRO Land & Water.