Asia’s Irrigation Management in Transition: A Paradigm Shift Faces High Transaction Costs

K. William Easter

Many water management problems have arisen in past Asian irrigation projects. They have been characterized as a vicious cycle involving the lack of maintenance, poor irrigation service, low rates of fee collection, inadequate institutional arrangements, and lack of user participation. This article argues that we have generally agreed on a strategy to address these problems and asks whether or not the strategy is being implemented effectively. A review of the irrigation record of six countries in Asia (including India and China) shows that they have implemented several of the key irrigation management reforms but that high transaction costs have delayed reform.

Irrigation has been, and continues to be, an important engine to increase food production in Asia, but for surface water, irrigation has been accompanied by a wide range of water management and environmental problems (Bromley; World Bank, 1996a, 1998). Some have described these management problems as a vicious cycle caused by lack of maintenance, poor irrigation service, low rates of fee collection, inadequate institutional arrangements, and lack of user participation (Easter and Welsch; World Bank, 1998). Others point to structural rigidities in the hydraulic infrastructure, excessive government involvement at all stages, unrealistic national food security policies, and overemphasis on water supply expansion as the root causes. Yet it is quite clear that the nature of the problem varies with the type of irrigation and level of technology (table 1). For example, fewer water distribution problems arise with private development of groundwater, but with improved pumping technology and small farm size, farmers irrigating with groundwater are increasingly imposing externalities on neighbors who

K. William Easter is a professor and director of the Center for International Food and Agricultural Policy in the Department of Applied Economics at the University of Minnesota.
Table 1. Classification of irrigation systems

<table>
<thead>
<tr>
<th>Class of Resource</th>
<th>Type of Irrigation</th>
<th>Seriousness of Stock Externalities*</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Renewable resources</td>
<td>Groundwater with pumping</td>
<td>Minor and localized</td>
</tr>
<tr>
<td>A. Without critical zone</td>
<td>rate ≤ recharge rate</td>
<td>Run-of-the-river systems (diversions or pumping)</td>
</tr>
<tr>
<td>1. Current use does not affect future flows</td>
<td>Groundwater with pumping rates &gt; recharge rates</td>
<td>Moderate and localized</td>
</tr>
<tr>
<td>a. Downstream effects unimportant</td>
<td>Surface system with limited storage</td>
<td>Serious when supply is small relative to demand and where enforceable water rights do not exist (unidirectional externality)</td>
</tr>
<tr>
<td>b. Downstream effects important</td>
<td>Surface system with substantial storage</td>
<td>Same as above</td>
</tr>
<tr>
<td>2. Current use does affect future flow</td>
<td>Groundwater with recharge</td>
<td>Very serious</td>
</tr>
<tr>
<td>a. No losses from storage</td>
<td>but subject to aquifer compaction or saltwater intrusion</td>
<td></td>
</tr>
<tr>
<td>B. With critical zone</td>
<td>Groundwater without recharge</td>
<td>Very serious particularly if pumping cost is low and demand is high</td>
</tr>
</tbody>
</table>

*There can be serious externalities in the delivery system of most surface water systems. This is basically the problem that those at the head of the canal impose externalities on all the farmers below them on the canal. They also have limited incentive to help maintain the canal.

use wells for irrigation or domestic purposes. These problems can be very serious if recharge rates are significantly lower than pumping rates, as appears to be the case in areas such as the North China Plain and the Punjab in India (Barker and van Koppen). In such cases, past traditions or laws that attach groundwater rights to land ownership lead to overexploitation of the resource.

This article reviews the water and irrigation management experienced in six Asian countries, four of which rank one to four in terms of area irrigated in.
Asia (China, India, Pakistan, and Indonesia). All six countries have had extensive outside assistance from the World Bank and other international agencies to develop and improve their water and irrigation resources. Moreover, irrigation has been an important part of their past development strategies. The review considers five key water management reforms and attempts to determine what the six countries have done since the mid-1980s to reform their irrigation management. Reforms in other countries are also used to illustrate different approaches and constraints that have raised the transaction costs of reform. One of the key questions is whether transaction costs have blocked or delayed individual reforms.

Reform Strategy and Transaction Costs

Numerous organizations and institutions have been created to try to address water management problems. For example, the International Water Management Institute (IWMI) was created originally to improve irrigation management, whereas the International Network on Participatory Irrigation Management focused on user participation and promotion of water user organizations (WUAs). Consequently, water management problems are fairly well understood, and there is a general consensus concerning the strategy to reform water and irrigation management, as reflected in the World Bank’s water policy paper (World Bank, 1993). However, work is still needed to design innovative ways to establish and allocate water rights, particularly for groundwater. Furthermore, there is much less agreement concerning what needs to be done to actually modernize irrigation systems. Burt and Styles argue that many irrigation systems are not designed correctly so that they are easy to operate. Thus many modernization efforts have failed.

Requirements for Reform

The reform strategy for water and irrigation management involves the following five key elements:

1. Strengthen the legal and institutional framework for managing water resources and promoting user participation.
2. Develop better economic incentive systems, including improved water pricing, water markets, and financially autonomous water management units, so that users internalize the economic value of water, and management units internalize costs of water provision.
3. Fully account for the environmental impacts of water use when designing, constructing, and managing irrigation systems, including the external impacts that are created within an irrigation system by return flows and fluctuations in water releases from reservoirs (figure 1). This involves taking a basinwide approach to water management, including both surface water and groundwater, and improving watershed management capabilities.
4. Improve delivery of agricultural technical assistance in irrigation areas so that it complements irrigation improvements. This will require close cooperation between the irrigation and agriculture ministries.
5. Improve water investment decisions by considering the full range of benefits and costs that are created by water development. Investments to improve irrigation systems must have significant user input and use appropriate infrastructure and technology.
The key question is how to implement the strategy outlined above when not all stakeholders gain from the proposed changes. The big losers are likely to be overstuffed departments of irrigation and water supply agencies. Farmers at the head of irrigation canals also stand to lose because they generally ignore external costs they impose on downstream farmers (Bromley).

**Lowering Reform Costs**

It has not been easy to initiate major water reforms. Briscoe suggests some rules for reform, noting that the most important rule is that reform should not take place until “there is a powerful articulated need for reform” (p. 153). This articulated need may be part of a country’s effort to privatize public-sector activities, as happened in Chile, or as a country’s response to severe water shortages, such as those facing the Middle East. He also argues that there must be a clear way to involve stakeholders in reform discussions and to address their fears about possible changes in an effective and understandable manner. He goes on to say that one should start with the relatively easy problems first and be sensitive and innovative in adapting general principles to different institutional and environmental situations. Finally, he emphasizes that there is no silver bullet or panacea, and we should not waste our energy in trying to find the “perfect solution” (Briscoe).

As one might expect, in most cases, the process of reform has been slow. It has been difficult to move water agencies away from their supply-based approach to solving water problems. This is understandable given the supply-side orientation of past water management policies in most countries. Furthermore, policies involving demand management are difficult to enforce and are unpopular with many water users.
Transaction Costs and Implementation

Most of the implementation rules suggested by Briscoe for water reform involve ways to lower transaction costs of reform. The rules for reform focus on reducing transaction costs of changing government policy, but they do not really address the problem of how to reduce the expenses of organizing and participating in specific water management reforms (Gordon). Examples of transaction costs include search and information costs, bargaining and decision costs, and monitoring and enforcement costs (Dahlman). Some other tasks that may be added to the transition costs of implementing water reform include design of regulations for allocating water, development of application procedures to register water-use rights, review of applications for water-use rights, and conducting hearings concerning disputes over water allocation (Stiglitz).

Oates (1986) and Williamson (1985, 1993) argue that transaction costs increase as the diversity and number of parties involved increase. This suggests that reforming large irrigation systems in Asia may be difficult and involve high transaction costs. Williamson uses the minimization of transaction costs as the explanation for important changes in economic organization. The same idea can be applied to institutional and organizational changes that minimize transaction costs of improving water management. Thus one of the key questions is whether there have been institutional or organizational changes or innovations that will reduce transaction costs and facilitate the reform of water management. To answer these and other questions, one can look at the experience of countries that have reformed their water sector, such as Chile and Australia. For example, improvements in irrigation infrastructure that make it more flexible have reduced the transaction costs of improving water management (Easter et al., 1998). Infrastructure rigidity (inability to change water allocations over time) is one of the characteristics of most very large irrigation systems and is a constraint to changing water management.

It also appears that efforts to reform the water sector have benefited from reforms elsewhere in the economy. A number of countries that had already started economic reforms found that they were also able to make dramatic changes in their water institutions (Chile, Australia, Mexico, and South Africa, for example). The synergy between reforms elsewhere in the economy and those in the water sector seem to reduce the transaction costs of changing water institutions. This may be thought of as scale economies in institutional change (Saleth and Dinar). Furthermore, Saleth and Dinar found that water sector performance was dependent on an integrated legal treatment of water, the existence of an independent body for water pricing, a balance in functional specialization, a legal foundation for private participation, and a serious budget constraint. Their work illustrates the critical importance of institutional arrangements that lower transaction costs of user participation in integrated water management and provide a shield against political pressures targeted at water pricing decisions.

Reform of Irrigation Management (Success or Failure?)

There are good signs that for a number of countries in Asia the need for reform in the water sector is clearly recognized both within the country and among international development agencies such as the World Bank. Thus it seems that we
have, at least, met Briscoe’s first requirement. The question is whether countries have been very good at taking his advice to reduce transaction costs by taking the relatively easy problems first and building momentum for reform. Part of the problem is sorting out priorities and deciding on a sequence of actions to improve irrigation management. For example, should project rehabilitation and improvement of infrastructure precede the turning over of management to water users, and is ownership of the system an important component of an effective turnover? In addition, what changes, if any, have they made in their irrigation management policy? Have they done anything to facilitate the adoption of the five strategic reforms listed above?

An irrigation portfolio review showed that East and South Asia together accounted for 56% of all irrigation projects and 63% of all irrigation commitments by the World Bank. The review found that the main shift of the World Bank’s lending program over the 10-year period 1986–1995 was a move away from the development of new irrigable lands toward the completion and improvement of existing irrigation schemes. Multicomponent area-specific projects were replaced by sector-wide irrigation programs that were national or regional in scope. Many of these projects emphasize low-cost infrastructural improvements and repairs. These changes have brought about an increase in complexity of the World Bank’s irrigation program due to the large number of geographically dispersed sub-projects, the increased number of local institutions involved, and institutional and policy reforms. This new approach reflects the World Bank’s implementation of its recently adopted Water Resources Management Policy (World Bank, 1996a). The increased complexity has raised the transaction costs of implementing irrigation projects, but it also should raise their potential to become sustainable.

**Institutional Framework and User Participation**

One clear emphasis by international agencies, such as the World Bank, has been to push for decentralized water management with strong user participation. So far results have been encouraging. For example, performance data from 18 irrigation systems from around the world show that user-managed systems outperformed those with agency management. Agency-managed systems in India and Pakistan consistently have the lowest performance across several different performance measures. Only the agency-managed system from Morocco was competitive with the user-managed systems (Molden et al.). In his study of more than 65 farmer-managed and agency-managed irrigation systems in Nepal, Lam found that the farmer-managed systems clearly outperformed the agency-managed ones in terms of physical condition, water delivery, and productivity.

Still, it is not obvious what approach or approaches work best for decentralizing management and increasing the role of users in irrigation management. One approach is to pursue gradual reform. Another has been the “big bang” approach, where reform is done within a short period, e.g., 1 year. The strength of a gradual approach is that it provides time for users to adjust and collaborate in crafting new institutional arrangements (Lam). The advantage of the “big bang” approach is that there is much less time for resistance to develop before the transfer of responsibilities occurs. The state of Andhra Pradesh in India decided to take the latter approach (much like Mexico and Turkey) after experiencing a continued
Table 2. Water users associations, number and area served, by country

<table>
<thead>
<tr>
<th>Project and Country</th>
<th>Scope of WUAs</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China (Hubei)</td>
<td>18</td>
<td>6,000–7,000*</td>
</tr>
<tr>
<td>Philippines</td>
<td>1,500–1,600</td>
<td>400,000–440,000</td>
</tr>
<tr>
<td>Nepal</td>
<td>731</td>
<td>20,000</td>
</tr>
<tr>
<td>India (Andra Pradesh)</td>
<td>10,292</td>
<td>3,700,000</td>
</tr>
<tr>
<td>Indonesia</td>
<td>n.a.</td>
<td>160,000†</td>
</tr>
<tr>
<td>Pakistan</td>
<td>n.a.</td>
<td>886,000‡</td>
</tr>
</tbody>
</table>

Note: n.a.—not available.

*This refers to only the one project in Hubei.
†The size of the irrigated area turned over to WUAs to operate and maintain.
‡The size of area where WUAs were established to improve water courses.

A drop in irrigation performance, as illustrated by a decline of over 9% in irrigated area between 1991 and 1994. So far progress has been good, with over 10,000 WUAs covering 3.7 million hectares being created statewide for all surface water systems by June 1997 (table 2). They also launched a statewide training program for WUAs, nongovernmental organizations (NGOs), and government staff and have given WUAs a much larger responsibility for irrigation service fee collections (Oblitas).

In contrast, India’s state of Orissa took a somewhat slower approach to establishing WUAs (World Bank, 1995a). Orissa tried to overcome resistance to decentralization and user participation by allocating $70 million to system improvement and farmer participation and turnover. The primary emphasis is on transfer of O&M responsibilities from the Department of Water Resources (DOWR) to WUAs for the distributaries and minor canals. The WUAs will be registered societies and manage areas of 300 to 600 hectares. Farmer participation is to be closely integrated with physical improvements. WUAs and DOWR will have written contracts to guarantee farmers a supply of water from the main system. Turnover of 15,519 hectares of pilot areas was to be completed in 1998.

In Hunan China, the government, with World Bank assistance, not only has emphasized user participation but also has legalized WUAs so that they can buy water and contract for construction of infrastructure (World Bank, 1995b). At Tieshan Reservoir in Hunan, the government has created a financially autonomous water authority that is extending irrigation to 28,000 hectares and is selling water for irrigation, hydropower, and urban uses. In Hubei, 18 WUAs have been established (two of these on their own), and they appear to be willing to put up 60% or more of the construction costs (based on discussion with Richard Reidinger). This is typical of what is generally happening in other irrigated areas of China, where village irrigation management groups have been formed to manage village-level irrigation (Johnson et al.). These groups generally are financially and managerially autonomous from the government.
A mixed record emerges with respect to increased user participation in World Bank projects completed in Nepal and Indonesia. Their success is limited partly by difficulties involved with turning over government systems to water users. Not only do irrigation staff resist the shift, but in some cases users want the government to continue to provide O&M and pay the costs. In the Indonesian project area, about 160,000 hectares have been turned over to WUAs. Yet with only 35% of the WUAs in Indonesia active, it is not clear how serious the government is about turning over more projects to farmers. Nepal, on the other hand, reports success in establishing 731 WUAs out of 770 targeted. Higher-order water-user committees and coordinating committees have been formed at the tertiary and secondary canal levels. A water-user central coordinating committee is being formed to represent farmers at the project level. What seems to be lagging is the Nepalese government’s interest in transferring projects to farmers.

The Philippines’ effort to establish WUAs and turn over small communal irrigation systems is one of the oldest in the region. The National Irrigation Administration (NIA) used institutional organizers to establish WUAs or to strengthen traditional organizations to take over and manage the small-scale systems (Subramanian et al.). Although farmers like the WUA-managed systems, they have not increased rice yields (Korten and Sy). NIA also has encouraged establishment of WUAs in the national irrigation system. However, for most of the large government-financed irrigation projects, turnover has been slow. Many water users feel that WUAs are just an extension of NIA and are not very responsive to users. Recent appraisals suggest that almost 40% of WUAs may not be active.

Pakistan has made limited progress in its efforts to sustain active WUAs. A number of factors have caused WUAs to become inactive. Most WUAs were formed originally as a prerequisite for government assistance in watercourse improvement. However, once improvements were completed, WUAs became inactive, since they were not given any authority beyond improving watercourses (World Bank, 1996b). A majority became inactive within 2 years of watercourse improvement and reverted to informal alliances. Many areas are dominated by a few farmers with large holdings, and they generally have not encouraged WUAs. Large landowners may see them as a potential source of countervailing power. WUAs also may not be promoted or even assisted by local irrigation agency officials for the same reason. Many irrigation agency staff see WUAs as possibly eliminating their jobs. Turkey removed this obstacle with a policy that protected the jobs of O&M engineers. This contributed to high staff morale and reduced transaction costs of irrigation turnover to local management (INPIM).

Most projects that attempt to establish WUAs have a training component, while a few start with pilot projects. Both the training and pilot projects should help reduce the transaction costs of establishing and maintaining WUAs (Easter and Welsch). Training can help sustain active WUAs by providing them with up-to-date information on effective management strategies and on new irrigation and agricultural technology. Training is also needed within the irrigation agency because decentralization and user management require agency staff to make a basic cultural change. Staff need to feel responsible to farmers and embrace the idea that water deliveries are a service to users (Burt and Styles).
Where irrigation systems are going to be turned over to WUAs or government-designed rehabilitation of infrastructure is planned (which farmers are expected to finance), then negotiation with farmers is critical. Here, training as well as models for effective negotiation strategies should be made available. Again, innovation may be needed to develop procedures that will be effective in a particular system. The focus should be on making the process open, with clear lines of responsibility established. The idea is to develop effective negotiating procedures that keep transaction costs low for turnover or rehabilitation. Hopefully, the transaction costs of establishing WUAs and turning over government irrigation systems to WUAs should fall over time as we learn which methods work best. However, some systems may be very difficult to turn over, either because farmers have become too dependent on government subsidies or because the project is poorly designed and difficult to manage (Burt and Styles).

Many of the projects reviewed emphasized the need to improve irrigation administration. Yet few recommended legal changes to facilitate development of institutional arrangements and foster better rationalization and coordination of user and agency management activities, except to legalize WUAs. This latter change is an important step in improving the standing of WUAs. It will allow WUAs to contract with government agencies and other entities for specific types of services, e.g., a given quantity of water or a set delivery schedule. Additionally, China enacted a water law in 1988 that made it possible for states to introduce water extraction permit systems, develop sanctions against water-use violations at the local level, and institute procedures for mediating water disputes. The law makes it possible to establish measurable water rights that would facilitate allocation of water between sectors through buying and selling. “However, implementation of the new law has been slow. By 1993 only 11 provinces or autonomous regions had passed regulations for the law” (Johnson et al.).

More attention is needed to develop improved ways to define water rights or water-use rights and to establish clear agency and user responsibilities. This will be important in clarifying for farmers what they will receive in terms of water deliveries and in reducing the transaction costs of water allocation. Where water markets are to be formally introduced, the definition of water rights will be critical for reducing the transaction costs of market exchanges (Easter et al., 1998). Once farmers have well-established water rights, the dynamics of water management change. It now becomes the responsibility of the water management unit to effectively deliver water to farmers or WUAs.

**Economic Incentives and Cost Recovery**

Concern regarding low water prices and the lack of incentives for efficient water use have been issues for many years. One approach has been to argue that on-farm or household efficiency in irrigation or water use is not important and that only basin efficiency is important. In other words, water that is lost by runoff or percolation will be used downstream by other water users in the form of return flows. In some irrigation systems, the return flow can constitute 50% or more of the water withdrawn. Others argue that farmers cannot afford to pay the full costs of water because they have very low incomes or that the value of water has been capitalized into land values. Still others point out that farmers should not have
to pay for government’s mistakes in building unprofitable projects to increase food production and lower food prices.\textsuperscript{1} Further, there are problems involved in measuring the actual amount of water each farmer receives in many of the large Asian irrigation systems that serve tens of thousands of farmers. Consequently, there has been no general consensus concerning how irrigation water should be priced in these large Asian systems.

Ministries of finance and the World Bank have fought an uphill battle in their efforts to raise the price of water and increase the incentives for efficient water use. Yet today there is substantial agreement that farmers in projects designed primarily to increase production and farm income should, in most cases, pay at least the O&M cost of irrigation and contribute something toward capital cost.\textsuperscript{2} To achieve this goal, a number of new and innovative approaches are being tried. For example, the financially autonomous water authority at the Tieshan Reservoir in China changed WUAs’ incentives for efficient water use. Since WUAs now must purchase water, they have a strong incentive to conserve water. In the pilot area in Hubei, WUAs have reduced water use by 30\% per hectare. The water authority also has an incentive to conserve water so that it can increase its sales.

The 1985 National Regulations on Water Fees in China encouraged the widespread development of a tripartite system of financing O&M.

This included a fixed area fee (based on the area irrigated by a farmer), a volumetric fee (based on an estimate of the amount of water diverted into a farmer’s field), and an annual labor contribution for system maintenance.\textemdash While the introduction of volumetric fee assessment is spreading, it is not universal, since measurement is frequently difficult and costly [Johnson et al.].

Even with these changes in fees, a gap is still likely to exist between irrigation fees and actual costs.

To bridge the gap between the limited revenue which could be raised from fees and the amount needed for O&M and to boost salaries and facilities for irrigation workers, the government introduced the concept of diversified sideline enterprises into the irrigation sector. Irrigation districts were encouraged to develop sideline enterprises to raise additional revenue from the profits of businesses to cross-subsidize the costs of irrigation management. Such enterprises developed gradually during the late 1980s and early 1990s, beginning first with underutilized assets such as reservoirs (for sale of water outside the district, fisheries, recreation, tourism) and reservoir bunds and reserved lands (for tea, orange and tree plantations). Later, sideline enterprises spread to all sorts of businesses, from bottling and food processing to restaurants, construction contracting, bicycle repair shops, petrol stations, production of shirt collars, and so on. Although income from sideline enterprises is growing, generally, it provides only a small percentage of the total resources invested in irrigation [Johnson et al.].

The corporate structure of the NIA in the Philippines has helped improve the management of national systems. It has increased its service fee collection to over 65\% and continued to reduce staff. The turnover of irrigation systems is helping reduce costs, and if service is improved, then fee rates and collections can be increased. At current levels, water fees are no more than 5\% of gross returns in pump irrigation systems and 5\% to 15\% of the incremental increase in production of national irrigation systems when compared with rainfed production.
In Andhra Pradesh, India, after major efforts to improve irrigation and establish WUAs, water charges were tripled in April 1997 so that they would cover 75% of O&M needs (previous rates would only cover 25% of O&M). Collection rates from farmers have been slightly under 70%, which means that total collections cover only 50% of O&M needs. The objective is to have the systems cover all their O&M costs.

As part of the effort to improve irrigation and reinvest water charges, the government in Andhra Pradesh released over $27 million to WUAs for maintenance rehabilitation on tertiary systems. By the middle of 1998, over $33 million in maintenance rehabilitation work had been completed, mostly by WUAs. These rapid improvements were based on earlier successful pilot projects that had increased the equatability of water distribution and expanded the irrigated area by 25% (Oblitas).

An important water association incentive is to have WUAs legally established and responsible for water management and contracting decisions. Without legal standing and management responsibilities, it will be difficult for WUAs to offer their members better water delivery. Without improved service, it will be difficult to convince farmers that they should pay their water charges. Thus legalization of WUAs and turnover of systems should complement cost-recovery objectives and reduce the transaction costs of collecting service fees.

Projects in China, Nepal, and India all emphasized the legalizing of WUAs, whereas Indonesia emphasized turnover of small public schemes. In China’s Yangtze Basin project, farmers appear to be quite willing to share irrigation improvement costs. Involving farmers at an early stage helped reduce costs by 30% in one case and increased the area irrigated by 17% in another. In many districts covered by the Indonesia project there appears to be general acceptance of the idea that a service fee should be paid for provision of irrigation water and that WUAs should be responsible for its collection. This helped increase collection rates to about 79% in the service area of 467,300 hectares by 1995, but drought and the financial crisis in the second half of the 1990s may have changed this picture (table 3). Nepal’s record also shows improvement, but fee collections are still not covering O&M costs. In the turnover area, about 50% of the service fees have been collected after being at much lower levels before the turnover. As Frederiksen and Vissia point out, it may take time for farmers to adjust and for

<table>
<thead>
<tr>
<th></th>
<th>Percentage of Fees Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philippines</td>
<td>65</td>
</tr>
<tr>
<td>Andra Pradesh, India</td>
<td>70</td>
</tr>
<tr>
<td>Nepal (20,000-ha project)</td>
<td>50</td>
</tr>
<tr>
<td>Indonesia (467,300-ha project)</td>
<td>79</td>
</tr>
<tr>
<td>Pakistan</td>
<td>68–100*</td>
</tr>
</tbody>
</table>

*This is the percentage of cost recovery and not the percentage of assessed fees collected.
WUAs to put procedures in place to ensure payment of fees by their members. Orissa has made a strong commitment to reach 100% O&M cost recovery by the year 2000. It is too early to judge success, but good progress is being made in three pilot projects, although collections are behind schedule elsewhere.

Pakistan provides an illustration of the relationship between service-fee collections and net returns from irrigation improvement. A watercourse improvement project was initiated in four provinces. In Balochistan and the Northwest Frontier Province, cost recovery was 100%, and economic rates of return were 31% to 32%. In contrast, in the Punjab, where cost recovery was 68%, the economic rate of return was only 19%. In between these three provinces was the Sindh, with a cost recovery of 80% and a rate of return of 27%.

Thus the levels and size of service-fee collections depend on a number of factors, including the amount of benefits generated by irrigation, the WUAs’ role in management, and the quality of service provided. Still, for numerous large government systems, new institutional or organizational arrangements along with infrastructure improvements will be necessary before individual farmers can pay according to the amount of water received. Given current technology, measuring water delivery at less than the 1-hectare level is quite expensive. Effective monitoring and enforcement costs are also high for government at this level. This means that high transaction costs are hindering water pricing reform in a number of large irrigation systems. Yet most government-managed systems could arrange for WUAs to become the point of water delivery and fee collection.

Environmental Improvements and Externalities
(a Basin Approach)

There is an attempt in several projects to take a basin-wide approach to water use and to try to internalize externalities created by water development and to consider tradeoffs in water use between different sectors (see table 1). The water resource consolidation project in Orissa, India, puts a major emphasis on developing a comprehensive framework for their water resource decisions. The state water plan and individual basin plans are to be the cornerstones of future water development in the state. Four basin plans (encompassing 70% of the state’s surface area) have been completed; the remainder will be finished by 2001. Although this component is a small part of the project’s total cost, it builds on India’s long-term interest in river basin planning and could provide a basis for reallocating water during times of scarcity (GOI).

Indonesia tried to establish an effective system of river basin planning in two pilot basins. They were particularly concerned about agency coordination in their water development and management efforts. To date, however, progress has been quite modest, and agency coordination and pollution problems continue to plague Indonesia’s water resources because they do not seem to use the basin approach in their water management decision making.

Even when a basin approach is not taken, organizations such as the World Bank require environmental assessments of proposed water projects. This has helped eliminate some of the most egregious environmental impacts of new irrigation projects. For example, the World Bank–supported water planning effort in Bangladesh contains an important component for environmental assessment
along with extensive stakeholder participation in the environmental assessment. In addition, the World Bank's water policy highlights the need to include drainage as a component in irrigation projects as well as investment in environmental restoration and protection, including watershed protection.

Yet drainage and environmental restoration or protection generally are not included as an important component of irrigation projects in most developing countries. There are several exceptions to this, including provisions for drainage facilities to respond to salinity and water logging problems. In many government-supported tubewell irrigation projects in Pakistan, reductions in salinity and water logging have been important benefits. Furthermore, private wells in Pakistan and India have reduced water logging even more than government wells because there are many more private wells (Berkoff).

China's irrigation projects in the Yangtze Basin have included drainage and environmental restoration as a component. Shelter-forest networks for farmland in China also have been introduced. These are designed to increase forest coverage of farmland by 25% to 30%, mainly in shelterbelts around fields and along canals.

Resettlement components in irrigation projects, or the lack thereof, can have an impact on the environment around an irrigation project. There are numerous examples of upper watershed erosion created, in part, by families displaced by reservoirs (Briones). Both the Orissa and Yangtze irrigation projects include a significant component for resettlement. Resettlement can prevent environmental damage by giving displaced people improved opportunities. Those who are resettled are less likely to move into areas with low agricultural potential and high susceptibility to environmental damage (upper watersheds) (Easter et al., 1991). The same can be argued for small-scale farmers in general. The benefits from improved irrigation should help prevent them from trying to expand their land area by moving into areas with fragile environments. Still, resettlement is difficult for both India and China because of high population densities and the lack of land for new settlement.

Although environmental protection and comprehensive planning do appear in several projects, most fall short in this regard. The whole idea of comprehensive watershed management and protection seems to be missing in most of the irrigation projects reviewed. In some cases, watershed management and protection are included in separate projects. This, however, can raise the transaction costs of coordination among those responsible for forestry and watershed management and those responsible for irrigation. Indonesia's coordination problems in the water sector illustrate this point.

**Coordination between Agriculture and Irrigation?**

Along with the high transaction costs of coordination with forestry agencies, there has been a continued failure of irrigation and agricultural agencies to coordinate their activities, as highlighted in several projects. Most new or expanded irrigation projects need technical, agriculture, and marketing services provided by agricultural extension agents and by an expanded private sector. Without adequate supplies of inputs and reasonable market outlets for increased production, irrigated output is not likely to increase as rapidly as estimated because of downward pressure on product prices and limited input supplies.
Many World Bank appraisal reports list the need to reduce the transaction costs of coordination between agriculture and irrigation agencies. In fact, a number of irrigation projects included a component to improve agricultural support services. In other cases, support services have been included in separate projects. The Pakistan On-Farm Water Management Project included an irrigation agronomy team as a component to improve agricultural production. This was not very successful in providing technical assistance. Therefore, the World Bank recommended strong linkages with provincial agricultural extension departments as a better means to increase future agricultural production.

The coordination problem is related to both the lack of private-sector development and the long-standing competition between the ministry of irrigation and ministry of agriculture. One only has to look at the history of U.S. surface irrigation development to see agency competition among the Bureau of Reclamation, the Department of Agriculture, and the Army Corps of Engineers. What helped the United States is that the extension service and research component were not dominated by the Department of Agriculture, as it is in most developing countries. The State Land Grant Universities were quite willing to work closely with whatever agency financed the irrigation. Equally important was the active private sector, which supplied the inputs, transportation, and market outlets. Most developing countries do not have a strong, independent research and extension service, and for many Asian countries, government policy has seriously retarded private sector development.

**Investment Decisions (Infrastructure)**

As part of a strategy to improve irrigation while reducing capital expenditures and negative environmental impacts, a much larger share of the World Bank’s irrigation program is going into project rehabilitation, completion, and improvement rather than for new projects. Nonetheless, capital investments in project rehabilitation, completion, and improvement account for a large share of direct costs. Rehabilitation cost ranges from $140 to $440 per hectare, whereas the cost of project completion and improvement ranges from $650 to $1,570 per hectare (table 4). All three investments are much less expensive than new medium- to

<table>
<thead>
<tr>
<th>Country</th>
<th>Project Cost/ha (US$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. India (rehabilitation)</td>
<td>260–550</td>
</tr>
<tr>
<td>(completion)</td>
<td>650</td>
</tr>
<tr>
<td>2. China (rehabilitation)</td>
<td>140–440</td>
</tr>
<tr>
<td>(completion)</td>
<td>1,230–1,290</td>
</tr>
<tr>
<td>3. Philippines (repairs)</td>
<td>210</td>
</tr>
<tr>
<td>4. Indonesia (special maintenance)</td>
<td>160–180</td>
</tr>
<tr>
<td>5. Nepal (improvement)</td>
<td>740–1,570</td>
</tr>
</tbody>
</table>
large-scale projects, which cost, at minimum, $4,000 to $6,000 per hectare, but the return from these investments will depend on their impact on output and benefits. For example, in the improvement project in Nepal, cropping intensity increased from 134% to 169%, whereas for the repair project in the Philippines, cropping intensity only increased from 134% to 140%. A full benefit-cost analysis, therefore, could show that net returns are quite similar, even though costs are quite different.

It is also not clear whether or not these investments are adequate to fund the design and control changes necessary for effective management reform and decentralization. Burt and Styles, in their review of irrigation modernization efforts in 16 projects in developing countries, found that hardware improvements were almost always required. They point out that without some key design and hardware changes, active WUAs will be difficult to sustain. They argue that most design changes are relatively simple and must be integrated with operational and management changes. Even so, they find that insufficient attention has been given to the technical details of how water moves and is controlled throughout an irrigation project in terms of both hardware and operations. They make it clear that these design changes can significantly reduce the transaction costs of managing and delivering water.

Other important questions needing resolution concern investments in water projects, including (as pointed out earlier) the sequence of project rehabilitation and institutional development. If rehabilitation occurs before turnover of the system, then users must be involved in designing the rehabilitation, particularly if they are expected to repay costs and provide future O&M. The involvement of farmers in the planning and design of the irrigation project in Yantze, discussed earlier, is a good example. It is also clear that user involvement is critical for crafting effective institutional arrangements that reduce the transaction costs of water management and are a necessary complement to design and hardware investments (Lam).

Another key issue is whether or not to rehabilitate projects such as those in former centrally planned economies in central Asia, where the benefits will never cover the rehabilitation costs. Based on strictly economic criteria, they should not be rehabilitated. Yet, in these transition economies that do not need more migrants moving to their cities, it poses a real dilemma, as it does in other developing economies with large rural populations and overcrowded cities. Irrigated agriculture can provide a place of employment for many families and keep them from crowding into the cities.

A fourth issue involves a country’s capabilities and interest in placing dollar values on the environmental impacts of water projects. Clearly, this should be done for a complete economic analysis, but examples of such analyses in developing countries are still limited (Tubper; Easter et al., 1991). To some extent, the environmental component of studies can be funded by international agencies. However, with projects funded internally, developing countries have limited incentive to include information on negative environmental impacts. China’s Three Gorges Project is a good example of environmental and resettlement concerns being somewhat discounted. Pressure from environmental groups can help to get governments to consider environmental impacts, but the biggest factor
may be future economic growth, particularly if negative externalities are primarily internal to the country. As incomes rise, demand for environmental services eventually should increase.

**Concluding Comments**

Projects reviewed in Asia show that the emphasis in irrigation management appears to be changing from a top-down centralized approach to one where users are more effectively involved in project management. The strong focus on user participation is quite significant. Here we need to keep in mind that user participation is not necessarily the goal of irrigation but one means of improving the effectiveness of irrigation projects. The key is to give users more control and responsibility for management. Management can be by users or by engineers hired by users. *The important change is that managers must be responsible to users and not to the irrigation agency.* Abel highlighted this as a key aspect of the success of Taiwan’s irrigation over 20 years ago, as does Lam in his recent analysis of irrigation governance in Nepal.

In areas where it is difficult to organize farmers due to conflict within the community or high levels of noncooperation (free-riding), a commercial operation may be more effective. Some areas in China have evolved unique ways of managing former communal irrigation projects through “private” management, many of which have sideline enterprises that cross-subsidize the cost of irrigation management. Other Asian countries should consider the benefits of adopting such a model in some areas.

In terms of the second component of the reform strategy (service-fee collection), fees have been raised and collections increased. However, the only case where major changes in price incentives for efficient water use have been implemented is in China. Here, setting up a water authority to sell water has changed the incentives for efficient water use. Yet, even in this case, incentives probably have not reached beyond the WUAs to individual farmers. This will not happen until either farmers are charged for the quantity of water they receive or water markets are created based on the amount of water delivered or the amount of time one receives water. Given the small size of farms in Asia, institutional innovation and improved infrastructure will be necessary to reduce the transaction costs of charging individual farmers based on the amount of water they actually receive. Here, turnover of water systems to WUAs may be key.

Third, future projects will need to take a basin-wide approach that includes watershed protection and conjunctive use of surface water and groundwater. Currently, most projects fall short in this respect. As part of the basin-wide approach, projects will have to consider watershed and environmental impacts as well as drainage needs. The lack of drainage and failure to consider the recycling potential of surface irrigation projects have created serious problems in parts of Pakistan, India, and China. *A better future strategy is to use basinwide planning as a means to bring watershed and environmental protection and conjunctive water use concerns into the decision-making process right from the start.* This will be particularly important as water scarcity increases and tradeoffs must be made concerning water use in different sectors.
Fourth, given the current record of poor coordination between many irrigation and agricultural ministries, a strengthened private sector may be the best hope for provision of agricultural services. Still there will be a need for research and technical assistance beyond what the private sector has an incentive to provide. How one addresses this problem will vary among countries, but governments have an important role to play in supporting agricultural research that the private sector does not provide.

Fifth, deciding whether to invest in irrigation infrastructure is much more complicated than just choosing whether to “build or not build.” Should emphasis be on project completion and expansion, or should it be on rehabilitation and repairs? For projects being rehabilitated, should they be restored to their original condition, or should new design concepts be introduced? These investment decisions must be made based both on their technical and economic soundness and on institutional arrangements developed to reduce the transaction costs of coordinating agency and user water management activities.

Although it does appear that the reform strategy is now being accepted in some key countries of Asia, the question remains whether reform will be fully implemented and what future modifications may be needed. As was pointed out in the beginning, there are some important stakeholders who are likely to raise the transaction costs of increasing irrigation fees and decentralizing management. They want to protect their economic rents and treat water as their “public good.” In addition, lack of coordination between irrigation and agricultural agencies continues to pose problems in many projects. There are also design and infrastructure constraints that will have to be addressed before some reforms can be implemented and sustained. Finally, the findings are tempered by limitations in the data set that are from selected projects and not a sample of projects. Most of the data used also were collected by government agencies and may tend to provide an overly positive picture. Still these data limitations should not change the study’s basic findings. A paradigm shift has occurred in how irrigation management is approached in Asia, but high transaction costs have slowed the rate of reform.

Acknowledgments

I would like to thank Ariel Dinar, John Briscoe, Richard Reidinger, Randolph Barker, Douglas Merrey, Jan Pruntel, Jean-Pierre Villanet, Maria Saleth, Herve Plusquellec, and three anonymous reviewers for their very constructive comments on earlier drafts.

Endnotes

1 Many times farmers cannot or do not pay their fees because the project is poorly designed or badly managed or both. In some cases where O&M costs exceed any benefits farmers receive for irrigation, it may be best to abandon the projects and let farmers keep their fees.

2 Because of the weak financial position of many developing countries, if farmers do not pay their fees, the projects are not likely to be sustainable. This assumes that the farmer payments are used effectively to operate and maintain the projects. Where there is little connection between the fees paid and the O&M, as is the case in much of India, then the justification for higher fees is weaker. There also can be problems when more than one agency is collecting fees from farmers. It may be difficult for farmers to see how their fees are being used.
References


