

DIRECTIONS IN DEVELOPMENT

# Toward Sustainable Management of Water Resources

ISMAIL SERAGELDIN





**Toward Sustainable Management  
of Water Resources**

## Directions in Development

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of Water Resources**

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Few issues have a greater impact on our lives and on the life of the planet than the management of our most important natural resource: water. Today we have a new appreciation for the role of water in our lives, our economies, and our ecosystem. Water is our lifeblood. Human beings, like other animals and plants, are made mostly of water. We need water to maintain basic health and sanitation. Some 8 percent of the world's freshwater supplies are used for this purpose. We need adequate supplies of water to feed ourselves. Agriculture accounts for some 63 percent of the world's use of freshwater (about 70 percent in the developing countries), and a third of the world's food crops are produced by irrigated agriculture. We also need water to develop and maintain vibrant economies. Industries use about a fifth of the world's freshwater supplies, often as a vital part of the production process. Factories use water for cooling, processing, and generating steam to run equipment and as a transporting agent. Finally, most animal and plant species depend on freshwater ecosystems, which are also important for maintaining regional weather patterns and even global climate.

### A New Appreciation for Water

Abundant as water may appear to be, we also have a new appreciation for how little freshwater is on the earth. Less than 3 percent of the world's water is freshwater, and most of this is in the ground, ice caps, and glaciers. Lakes and rivers account for only 0.014 percent of all water. Although enough precipitation falls each year on the land surface of the earth to cover the United States to a depth of 15 feet or to fill all lakes, rivers, and reservoirs fifty times over, about two-thirds of this evaporates back into the atmosphere, and more than half of what remains flows unused to the sea. Rainfall is also highly variable; the same area can experience droughts one year and floods the next. Withdrawals and the cost of recovery vary widely, as does the quality of water sources.

Indeed, water is critically scarce in many places. Generally, a country or region will experience periodic water stress when supplies fall below 1,700 cubic meters per person per year. The global average annual supply of renewable freshwater is about 7,400 cubic meters per

**Table 1. Availability of Water, by Region**

Region	Annual internal renewable water resources		Percentage of population living in countries with scarce annual per capita resources	
	Total (thousands of cubic meters)	Per capita (thousands of cubic meters)	Less than 1,000 cubic meters	Between 1,000 and 2,000 cubic meters
	Sub-Saharan Africa	3.8	7.1	8.0
East Asia and the Pacific	9.3	5.3	<1.0	6.0
South Asia	4.9	4.2	0.0	0.0
Eastern Europe and former U.S.S.R.	4.7	11.4	3.0	19.0
Other Europe	2.0	4.6	6.0	15.0
Middle East and North Africa	0.3	1.0	53.0	18.0
Latin America and the Caribbean	10.6	23.9	<1.0	4.0
Canada and the United States	5.4	19.4	0.0	0.0
World	40.9	7.7	4.0	8.0

Source: World Bank 1992.

person per year. However, twenty-two countries have renewable water resources of less than 1,000 cubic meters per person, and eighteen have more than 2,000. By and large Latin America is best endowed, while the Middle East and North Africa is where water is most scarce (table 1). By 2025, as many as fifty-two countries inhabited by some 3 billion people will be plagued by water stress or chronic water scarcity. India, now the world's second most populous country, will experience chronic water shortages nationwide. China will narrowly miss the water stress benchmark. However, in many areas of the country, such as the North China Plain, the demand for water is already outstripping supply.

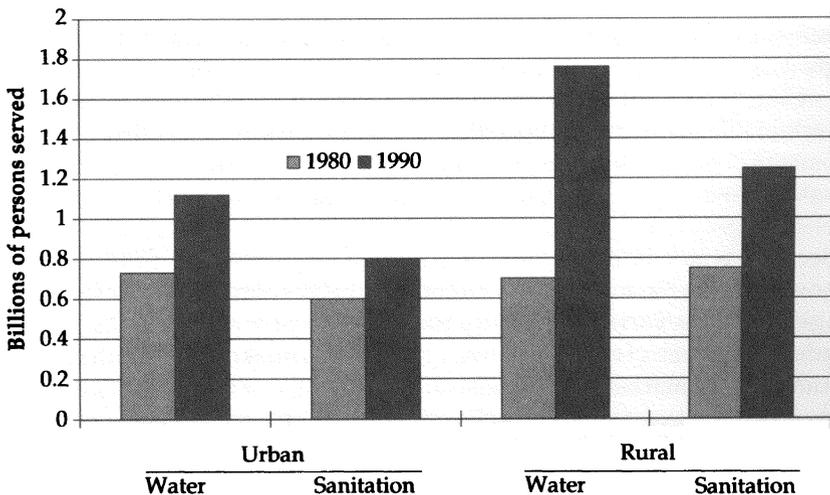
Issues of scarcity have put water at the top of the international political agenda. Agreement on access to water is an important part of the peace accords between Israel and its neighbors. A water treaty has also helped to maintain peace between India and Pakistan. But water politics are not confined to historically conflicted or dry areas. Today, nearly 40 percent of the world's people live in more than 200 river basins that are shared by more than two countries. Even within countries, conflicts over water are often bitter. As populations and demand for limited supplies of water increase, interstate and international frictions over water can be expected to intensify.

## Failure of Current Policies

Although we have a renewed appreciation for the many functions played by water, we are also more aware of our failure to manage the resource properly. During the 1980s major efforts were made to extend water and sanitation throughout the developing countries. However, the majority of poor people are still without safe drinking water and adequate sanitation services; 1 billion people lack an assured supply of good-quality water, and 1.7 billion have no adequate sanitation (figure 1). In urban areas, the number of people without access to sanitation actually increased by about 70 million in the 1980s. The health consequences of such service shortfalls make water a life-and-death issue for millions of people. Water-related diseases account for 8 percent of all illnesses in developing countries, affecting some 2 billion people annually (table 2). It is estimated that 2 million children die from such diseases each year, deaths that could be averted if water supply and sanitation services were adequate.

Beyond the overarching human and equity arguments, economies also suffer because of poor water management and inefficient investment. Debilitating waterborne diseases reduce human productivity, especially in rural areas. Lack of access to water in developing coun-

**Figure 1. Access to Safe Water and Adequate Sanitation in Developing Countries, 1980 and 1990**



Source: Adapted from World Bank 1992.

**Table 2. Effects of Improved Water and Sanitation on Illness**

<i>Disease</i>	<i>Millions of persons affected by illness</i>	<i>Median reduction attributable to improvement (percentage)</i>
Diarrhea	900 <sup>a</sup>	22
Guinea worm	4	76
Roundworm	900	28
Schistosomiasis	200	73

a. Number of episodes a year.

Source: World Bank 1992.

tries takes a different kind of toll: women represent the most potentially productive part of the population in poor countries, yet many of these women spend a good portion of each day walking long distances to collect water for drinking, cooking, and cleaning. Finally, underpricing has resulted in inefficient use and misallocation of water. In both industrial and developing countries, agriculture, which takes the lion's share of available water, is an especially low-value user compared with municipalities and industry. This has serious economic consequences.

We continue to ignore the critical role of water in maintaining the quality of the environment and the link between a healthy environment and a healthy economy. Already half of our coastal wetlands have been drained for infrastructural or agricultural development, and in many places groundwater is seriously at risk from overexploitation and contamination by urban and rural pollutants and the intrusion of saltwater. Sewage and industrial waste pollute rivers on every continent. By some estimates, the amount of water made unusable by pollution is almost as great as the amount actually used in the human economy.

Clearly, current water policies and management practices are not sustainable from any perspective: social, economic, or environmental.

### Four Principal Failures

Because water is considered a strategic resource and public good, governments have always assumed central responsibility for its management. The variable quantity and quality of water and the highly interdependent character of water activities make it difficult to use unregulated markets to deliver water efficiently or to allocate it among sectors. However, although reliance on market forces alone is not possible or even desirable, government mismanagement of water is the greatest cause of serious misallocation and waste. There are four principal and related problems in the way governments have managed their water resources.

- Water management is fragmented among sectors and institutions, with little regard for conflicts or complementarities among social, economic, and environmental objectives. There are multiple agencies for different uses—for example, irrigation, municipal water supply, power, and transportation—and intersectoral interactions within an interdependent system are usually ignored. Issues of water quantity and quality and concerns about health and the environment are treated separately, as is the management of surface water and groundwater. In many countries where individual states and provinces have jurisdiction over water in their territory, the same water source will be developed without considering the impact on other states. Similarly, domestic, industrial, and commercial supplies often are provided by local governments that are not coordinated with provincial or national water departments (box 1). The result often is excessive and unproductive investments, with different agencies developing the same water source for different uses.

- There is a heavy dependence on centralized administration to develop, operate, and maintain water systems. The number of public employees working in water utilities in countries is a symptom of the problem: inefficient countries typically have 10 to 20 employees per 1,000 water connections compared with 2 to 3 employees per 1,000 connections in efficient utilities. The agencies charged with water management are severely overextended and have limited technical capacity to provide quality services. There is little stakeholder or private sector involvement in water activities. Users are rarely consulted or otherwise involved in planning and managing water resources. The result has been unreliable projects that produce services that do not meet consumers' needs and for which they are unwilling to pay.

- Most countries do not treat water as an economic good. Low-value users are allowed to consume large quantities of water without paying for it, forcing high-value users to incur steep costs in securing water from long distances. The result is waste and depletion and less than fully productive investments. For example, in 1990, it was estimated that reallocating water from two agricultural areas to metropolitan San Francisco and Los Angeles would, over a period of ten years, yield some \$2 billion in net benefits.

It is far easier politically to develop new water supplies than to charge constituents for water. The result is that investments are made in water infrastructure that are not economically or environmentally sustainable. Farmers, for example, have few incentives to refrain from growing water-intensive crops or to conserve water because they often pay little or nothing for their water. Water prices are so low in some dry areas that it is often profitable for farmers to grow corn for animal feed. Water is also underpriced in most towns and cities, providing users with little incentive to conserve. A recent review of World

### **Box 1. Fragmented Water Management: Examples from South India**

Water resources have been overdeveloped in a number of countries primarily due to fragmented decisionmaking. One example is the Chittar River in South India, whose highly variable flows have traditionally been diverted at many points into small reservoirs (tanks) and then used to irrigate the main rice crop following monsoon rains. Diversion channels are large to accommodate flows during floods. Thus, when a storage dam was constructed, the uppermost channel was able to absorb essentially all the regulated flow. The upper tanks now tend to remain full throughout the year, concentrating benefits and increasing evaporation losses. The more extensive lower areas have largely reverted to uncertain rainfed cultivation. Constructing the storage dam without adequately considering downstream users and the storage capacity already in the basin is a good example of how developing an individual project in isolation can cause significant economic losses.

Uncoordinated, multiple jurisdictions can also be problematic. The Amaravati River is a tributary of the Cauvery, which is the most disputed major river in India. Without a Cauvery agreement, Karnataka (the upstream riparian state) has steadily developed massive irrigation schemes, depriving the delta (Tamil Nadu's rice bowl) of its accustomed supplies. Moreover, Tamil Nadu has been developing the Amaravati. Releases are made from the Amaravati Dam for the traditional areas, but these areas are far downstream, and substituting regulated flows for flood flows has encouraged the development of private pumps along the riverbank. New electric connections have now been banned, but little can be done to control illegal connections or diesel pumps, and little water now reaches the lowest command areas, let alone the Cauvery. Finally, new storage dams are being constructed on tributaries both in Kerala and Tamil Nadu, further depriving not only the old lands but also the new lands and the pump areas of water.

*Source: World Bank 1993a.*

Bank-financed municipal water supply projects found that the price charged for water covered only about 35 percent of the average cost of supplying the resource. Irrigation charges are almost always far less.

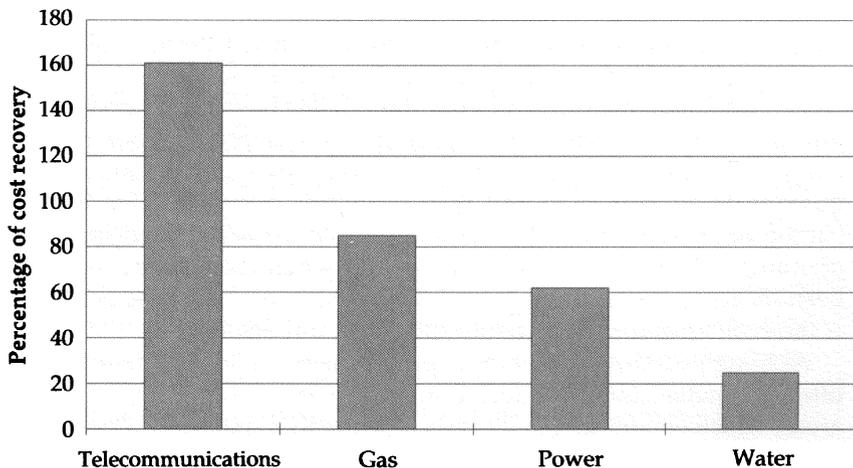
The absence of financial discipline has an especially negative impact on the incentives and accountability of public authorities to provide high-quality services, especially to the poor. Of all the infrastructure sectors, water has the least cost recovery (figure 2), making this sector more dependent on public budget transfers. Contrary to conventional wisdom, lack of pricing or underpricing of water has a disproportionately negative effect on the poor, yielding a vicious cycle of unreliable service, low willingness to pay, and further decline in ca-

capacity to provide services (box 2). Poor people do not have access to water services, and the services they do receive are often far more expensive than what everyone else pays. In fact, in most cities of the developing world, people who do not have access to water pay ten times more for it than people who have taps in their homes.

- Finally, current water resources management neglects linking the quality of water to health, the environment, and economic development. Environmental degradation of water resources causes human suffering and burdens future generations with the costs of remedial actions. Economies also suffer directly from pollution and misuse of water. In Poland, for example, three-quarters of the river water is too contaminated even for industrial use. Agricultural output and productivity are also declining because of environmental degradation resulting from poor drainage and irrigation practices. In India, a country that depends on irrigation for most of its food, more than 4 million hectares of once-productive land have been abandoned because of waterlogging and salinization. Today, 10 to 15 percent of the world's irrigated land is affected by waterlogging.

Many public investment projects have adversely affected the quality of water and contributed to the degradation of aquatic ecosystems. In part, this has resulted because piecemeal evaluations of water resource projects have often overlooked the cumulative environmental degradation caused by several projects and because the interactions within the ecosystem have not been adequately considered. The misuse of land, particularly in agriculture, forestry, and mining, has re-

**Figure 2. Degree of Cost Recovery in Infrastructure Sectors**



Source: World Bank 1994b.

**Box 2. What Do the Poor Pay for Water?**

Several studies show that the urban poor pay high prices for water supplies and spend a high proportion of their income on water. For example, in Port-au-Prince, Haiti, the poorest households sometimes spend 20 percent of their income on water; in Onitsha, Nigeria, the poor pay an estimated 18 percent of their income on water during the dry season compared with upper-income households, who pay 2 to 3 percent; and in Addis Ababa, Ethiopia, and in Ukunda, Kenya, the urban poor spend up to 9 percent of their income on water. In Jakarta, Indonesia, of the 7.9 million inhabitants, only 14 percent of households receive water directly from the municipal system. Another 32 percent buy water from street vendors, who charge about \$1.50 to \$5.20 per cubic meter, depending on their distance from the public tap. In some cases, households purchasing from vendors pay as much as twenty-five to fifty times more per unit of water than households connected to the municipal system. This phenomenon is also found in Karachi, Pakistan; Port-au-Prince; Jakarta; Nouakchott, Mauritania; Dacca, Bangladesh; Tegucigalpa, Honduras; and Onitsha.

*Source:* World Bank 1993a.

sulted not only in the sedimentation of waterways and water pollution but also in poverty, as lands fail and families are forced to relocate, often to overcrowded cities. Because many irrigation projects lack drainage components, they have caused waterlogging and concentrated large quantities of salts. Moreover, when water is diverted upstream for irrigation and other uses, downstream areas that support sensitive water-dependent ecosystems, including wetlands, become less able to fulfill their valuable functions, such as filtering pollutants and supporting biodiversity. Important river fisheries have been eliminated by such diversions, and important deltas have been impaired by low flows. Some development projects have deprived poor people, particularly the rural poor, of access to water of adequate quality and quantity to sustain them and their economic activities. This has occurred when traditional riverine communities have not participated in planning and implementing projects and when their needs have not been incorporated in them. An extreme example of all these problems is the ecological disaster surrounding the Aral Sea (box 3).

Although funding for water supply projects receives attention, too often adequate sanitation does not. New water is brought into urban areas, which creates large amounts of untreated, polluted wastewater that is often then used by the urban poor. This not only perpetuates disease but also creates larger environmental problems downriver, especially when sanitation projects include only the collection of sew-

**Box 3. The Aral Sea: Lessons from an Ecological Disaster**

The Aral Sea is dying. Because so much water has been diverted, particularly for irrigation, the volume of the sea has been reduced by two-thirds. The sea's surface has been sharply diminished, the water in the sea and in surrounding aquifers has become increasingly saline, and the water supplies and health of almost 50 million people in the Aral Sea Basin are threatened. Vast areas of salty flatlands have been exposed as the sea has receded, and salt from these areas is being blown across the plains onto neighboring cropland and pastures, causing ecological damage. The frost-free period in the delta of the Amu Darya River, which feeds the Aral Sea, has fallen to less than 180 days, below the minimum required for growing cotton, the region's main cash crop. The changes have killed a substantial fishing industry, and the variety of fauna in the region has declined drastically. If current trends continue unchecked, the sea will eventually shrink to a saline lake one-sixth of its 1960 size.

This ecological disaster is the consequence of excessive extraction of water for irrigation from the Amu Darya and Syr Darya Rivers, which feed the Aral Sea. Total river runoff into the sea fell from an average 55 cubic kilometers a year in the 1950s to zero in the early 1980s. The irrigation schemes have been a mixed blessing. Soils have been poisoned with salt, overwatering has turned pastureland into bogs, water supplies have become polluted by pesticides and fertilizer residues, and the deteriorating quality of drinking water and sanitation is taking a heavy toll on human health. Although it is easy to see how the problem of the Aral Sea might have been avoided, solutions are difficult to implement. A combination of better technical management and charging for water or allocating it to the most valuable uses could prompt shifts in cropping patterns and make more water available to industry and households.

But the changes needed are vast, and there is little room for maneuver. The Central Asian republics (excluding Kazakhstan) are poor: their incomes are 65 percent of the average in the former U.S.S.R. The regional population of 35 million is growing rapidly, at 2.7 percent a year, and infant mortality is high. The states have become dependent on a specialized, but unsustainable, pattern of agriculture. Irrigated production of cotton, fruit, and vegetables accounts for the bulk of export earnings.

Any rapid reduction in the use of irrigation water will reduce living standards further unless these economies receive assistance to help them diversify away from irrigated agriculture. Meanwhile, salinization and dust storms erode the existing land under irrigation.

This is one of the starkest examples of the need to combine development with sound environmental policy.

*Source:* World Bank 1992.

age without adequate treatment. In developing countries, high economic costs are associated with the practice of boiling water as well as with the treatment of diseases, such as the Hepatitis A outbreak in Shanghai. In 1991, polluted water from Amman's poor sewage works and industrial effluents severely damaged 6,000 hectares of land downriver used for irrigated vegetable crops. And in Peru, the first ten weeks of a cholera epidemic caused \$1 billion in losses from agricultural exports and tourism—more than three times the amount the nation invested in water supply and sanitation during the 1980s.

In Colombia, cleaning up the Bogotá River would cost an estimated \$1.4 billion. In Shanghai, the cost of moving intakes upstream, because of pollution, is \$300 million, while in Lima, upstream pollution of the Rimac River has increased treatment costs by 30 percent.

Generally, there is a tendency to expand water supply, without adequate attention to sewer or sanitation, which cannot handle the increased wastewater created by the expansion. Without more attention to the removal and treatment of sewage, diseases will continue to spread among the poor, and the economic and environmental deterioration will persist. Improved low-cost and more appropriate technologies are now available to mitigate the high costs of conventional sewerage and sewage disposal systems.

### New Stresses Require a New Approach

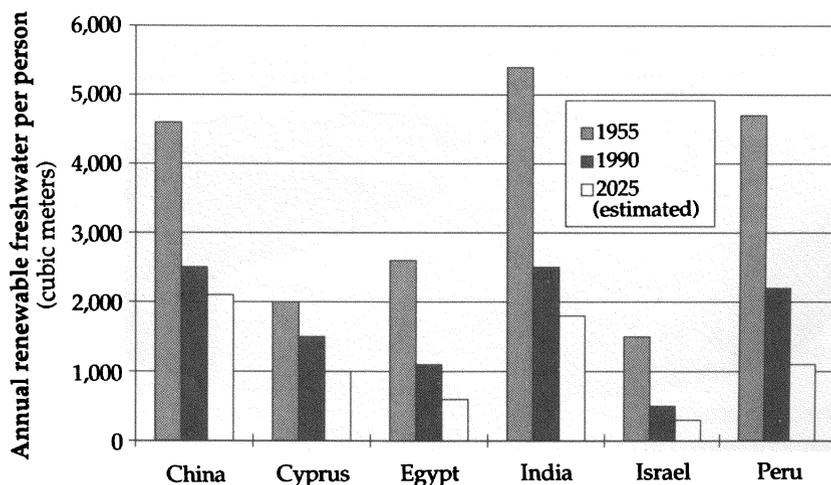
Current water management practices and policies have resulted in stark and terrible failures. But the problems we witness today are only an indication of what may lie ahead. Current trends in the growth of population, urbanization, industrialization, and income will not allow us to continue current practices without crippling our health and our economies as well as causing irrevocable damage to the environment.

Some 90 million people are added to the planet each year, the equivalent of the population of Mexico. For all of them, water will be an absolute necessity. Per capita water supplies worldwide are already a third lower now than they were twenty-five years ago due to the 1.8 billion people added since then. During the next thirty years, world population is projected to increase to at least 8 billion and probably more, resulting in an increase in the demand for water of more than 650 percent. Although there are wide differences among countries, they will all experience a reduction of available resources as populations increase (figure 3). Twenty-six countries, with a combined population of almost 250 million, can already be considered water-scarce. Many of these countries have high population growth rates. In Africa, there are now eleven water-scarce countries, and at the turn of the century, four more countries are expected to be added to the list. By 2000, 300 million Africans will live in water-scarce countries, about

one-third of the projected population. In the Middle East, nine out of fourteen countries are already facing water-scarce situations, and populations in many countries of the region are expected to double in less than thirty years.

Population pressure will increase the demand for food. Some 40 percent of the world's food supply already comes from irrigated land. Since 1950, irrigated area has grown more than 2 percent a year, a key factor in allowing food production to keep pace with the growth in food demand. Half of the growth in food supply in the past thirty years has come from the expansion of irrigated agriculture, and an estimated half to two-thirds of the increment in food production in the future will have to come from irrigated land. However, it is becoming increasingly difficult to sustain the expansion of irrigation. The investments with the lowest cost and highest benefit have already been made (see below). There are also serious environmental concerns about irrigation projects and the dams that serve them. Salinity and water-logging may now take as much old land out of irrigation as is added through new development. The overexploitation of groundwater is another serious problem. Given the share of water going to agriculture, many countries are under pressure to reallocate water from irrigation to other uses. All these factors suggest that the increased demand for food will have to be met by increasing cropping intensities

**Figure 3. Growing Demand for Water in Selected Countries, 1955–2025**



Source: Engelman and LeRoy 1993.

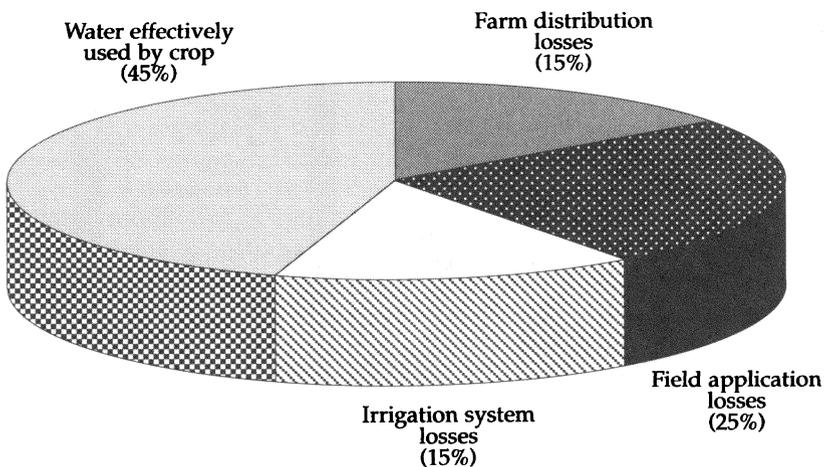
and achieving higher yields using less water. Currently only 45 percent of irrigation water is actually used by the crop (figure 4).

Rapid urbanization and industrialization will substantially increase pressures on the supply and quality of water. Between 1950 and 1990, the number of cities with populations of more than 1 million nearly quadrupled from 78 to 290. They are expected to more than double and exceed 600 by 2025 (figure 5). In the next few years, fully half the world's population will live in cities. By 2025, 90 percent of population growth will have taken place in urban areas, increasing the demand for water of suitable quality for domestic, municipal, and industrial use and for treatment of waste.

Today in the industrial world, industry uses more than 40 percent of total water withdrawals; the comparable figure in developing countries is less than 10 percent. This figure can be expected to grow significantly. Greater industrial use will also lead to more water quality problems, especially if there are no clear and enforceable rules for controlling pollution. Income growth will also put pressure on household water use, as people who are well off use more water than those who are not.

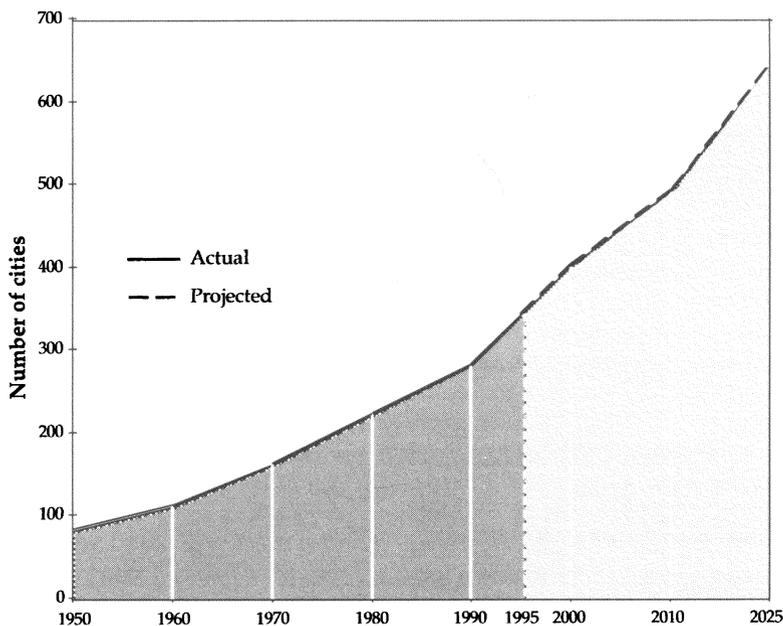
The pressure on water resources does not come only from the demand side. Even with measures to contain the growth of demand in agriculture and to improve the efficiency of existing systems, new water supplies will be needed, especially in urban areas. However, the lowest-cost, most reliable, and least environmentally damaging sources

**Figure 4. Average Losses of Irrigation Water**



Source: FAO 1994b.

**Figure 5. Projected Growth in the Number of Cities with More Than 1 Million Inhabitants, 1950–2025**



Source: World Bank data.

of water have already been developed in many countries. As a result, the financial and environmental costs of tapping new water supplies are increasing dramatically, and they will rise even further when adequate facilities, especially in drainage and sanitation, are included as essential parts of investments.

Beijing must already consider drawing water from a source that is more than 1,000 kilometers away, while Mexico City may be forced to build schemes to pump water over a height of 2,000 meters.

- In Mexico City, water is being pumped over an elevation of 1,000 meters into the Valley of Mexico from the Cutzamala River. The average incremental cost of \$0.82 per cubic meter is about 55 percent greater than the cost of water from the Valley of Mexico aquifer. Use of the aquifer has been restricted as a result of the falling water tables and water quality problems.
- In Amman, Jordan, the water supply system was, for the most part, based on groundwater. The average incremental cost was estimated at \$0.41 per cubic meter. But constant shortages of groundwater resulted in the increased use of surface water, which raised the incremental cost to \$1.33 per cubic meter.

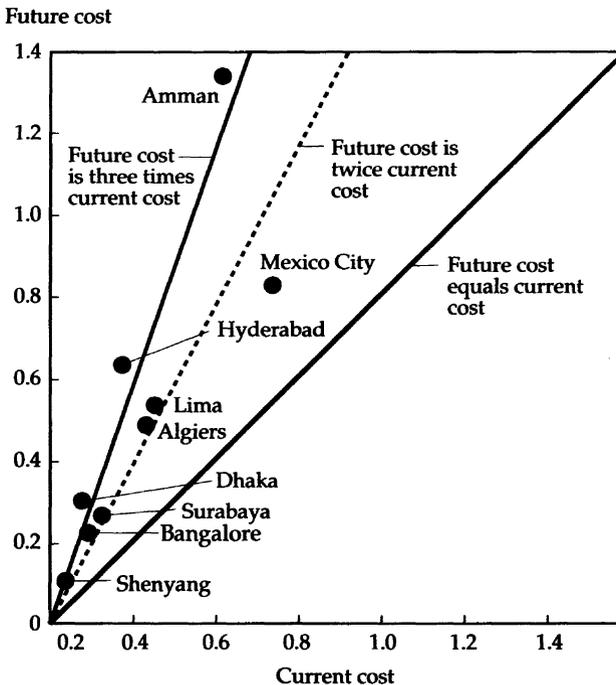
- In Shenyang, China, the cost of new water supplies will increase from \$0.04 to \$0.11 per cubic meter from 1988 to 2000 due to problems with the quality of the current source of water. The groundwater from the Hun Valley Alluvium is not suitable for use as potable water. As a consequence, water will have to be conveyed by gravity from a source that is 51 kilometers away.

These kinds of investments are expected to make the average cost of most new projects two to three times that of existing investments (figure 6).

Proper management of international watercourses will also present an increasingly important challenge as water becomes more scarce. Downstream countries are beginning to recognize their vulnerability. The problem is that fragmented planning and development of transboundary rivers, lakes, and coastal basins remain the

**Figure 6. Current Cost and Projected Future Costs of Supplying Water to Urban Areas**

(1988 dollars per cubic meter of water)



*Note:* Cost excludes treatment and distribution. Current cost refers to cost at the time data were gathered. Future cost is a projection of cost under a new water development project.  
*Source:* World Bank 1992.

rule rather than the exception. There are also no clear and enforceable international laws governing the resolution of disputes. And, although more than 300 treaties have been signed by countries to deal with specific concerns about international water resources and more than 2,000 treaties have provisions related to water, countries have not devoted funding to manage surface and subsurface water jointly, scientific data are not freely shared, and the requisite spirit of cooperation is often lacking. The results are economic losses in downstream countries that are greater than the potential benefits to countries upstream, further environmental degradation, and continued conflict.

### A Framework for Improving the Management of Water Resources

An old Chinese proverb says, "If we do not act now, we will surely end up where we are headed." The challenges are daunting. Fortunately, the successes and failures of the past two or three decades point us to another path. The overarching lessons of experience are that water management must be based on much sounder policies, greater economic incentives for achieving efficiencies and for providing water services to the poor, and far more effective institutional arrangements than currently exist.

These lessons are reflected in a global consensus—endorsed at the United Nations Conference on the Environment and Development (UNCED) in Rio de Janeiro and elaborated in subsequent international gatherings—to move away from an emphasis on developing new water supplies toward a focus on comprehensive management, economic behavior, policies to overcome market and government failures, incentives to provide users with better services, and technologies to increase the efficiency of water use. This new focus on demand stresses integrated water management based on the perception of water not just as a basic human need, but also as an integral part of the ecosystem, a natural resource, and a social and economic good. The new approach calls for policies that are formulated in the context of a comprehensive analytical framework that takes into account the interdependencies among sectors and protects aquatic ecosystems. Incentives for financial accountability and improved performance should be created through greater use of pricing, decentralization of administration and services, financial autonomy, user participation, and private sector involvement. Furthermore, consistent rules and regulations and coordination among agencies responsible for water services should be established to ensure policy cohesion and public support.

### *A Comprehensive, Cross-Sectoral Approach*

The cornerstone of the new approach is that water policies and investments should be consistent with a long-term vision for development—whether that vision emphasizes food security, health improvement, or environmental protection. This requires the very highest levels of government to articulate a national water strategy.

The strategy should be based on an accurate assessment of a country's water resources. It also should ensure the sustainability of the water environment for multiple uses. Because policies, investments, and regulations in one part of a river basin or in one sector affect activities throughout the basin, the strategy must incorporate a comprehensive framework for water resources management that recognizes the interactions among various elements of a river basin's ecosystem (which is a reasonably self-contained hydrological system) and allows cross-sectoral and environmental considerations to be incorporated in the design of policies and investments. World Bank (1993a, p. 41) describes the formulation of the strategy as a process that should:

include a realistic forecast of the demand for water, based on projected population growth and economic development, and a consideration of options for managing demand and supply, taking into account existing investments and those likely to occur in the private sector . . . ; spell out priorities for providing water services; establish policies on water rights, water pricing and cost recovery, public investment, and the role of the private sector in water development; institute measures for environmental protection and restoration . . . ; [and] facilitate the consideration of relationships between the ecosystem and socioeconomic activities in river basins.

The structures for coordinating effective comprehensive water management will be difficult but necessary to establish. Most countries have a multiplicity of public agencies and commissions with overlapping responsibilities for managing water resources, and decisions are fragmented. Institutional arrangements, such as river basin organizations or coordinating committees, need to be developed that encourage water-related agencies to coordinate and establish mutually agreed priorities for investment, regulation, and allocations and to ensure that policy, planning, and regulatory functions are separated from operational functions at each level of government. At the national level, these coordinating bodies could be set up in ministries of planning or finance. Wherever they are located, it is important that they have adequate authority to review water activities and enforce consistency with national strategies. Australia's experience with the Murray River shows one way to

organize the different arms of government around a river basin (box 4).

The key, however, will be to extend this type of participatory governance to cover an entire region's water resources. This will require representative bodies and devolution of authority, as well as the maintenance of national standards for water quality. This model is inspired by the German experience, which highlighted the importance of several principles: user participation, economic incentives and pricing,

#### **Box 4. The Murray-Darling Basin Authority**

The Murray River Commission was formed in 1914 with the signing of the Murray River Agreement. The administrative body included commissioners from New South Wales, South Australia, Victoria, and the Commonwealth. The primary task was to build the structures necessary to ensure adequate supplies and the economical use and development of the water resources of the Murray River.

In 1982, monitoring of water quality was added to the tasks of the commission. It was recognized that the successful management of the basin's river systems was related to land use. Amendments to the agreement in 1984 enhanced the environmental responsibilities of the commission, reflecting rising concerns by the communities about the salinity problems in the basin, the need for a comprehensive approach to river management, and the need for management of the natural resources of the basin to include input from all the governments. This understanding led to the formation of the Murray-Darling Ministerial Council and Commission with a charter to plan and coordinate natural resources management programs throughout the basin.

The Murray-Darling Ministerial Council and Commission, which met for the first time in 1985, comprises state and federal ministers for land, water, and environment. The council sets policy and defines broad directions for managing natural resources in the basin. Its primary task is to promote and coordinate effective planning and management for the equitable, efficient, and sustainable use of the land, water, and environmental resources of the Murray-Darling Basin.

The executive arm of the Murray-Darling Basin Commission is the Ministerial Council, which advises the commission on environmental management issues. The commission includes two commissioners from each of the governments. Its primary task is to manage and distribute equitably and efficiently the water resources of the Murray River. Its technical responsibilities include managing the river; monitoring water quality; maintaining the flow and quality of water for domestic use, stock, and irrigation; and managing land resources, nature conservation, and community relations.

*Source: Murray-Darling Basin Commission 1993.*

and decentralization of management (box 5). Outstanding examples of the application of these ideas can also be seen in the French experience (box 6). To resolve international water resource issues, many countries have contributed to the establishment of independent, impartial interstate basin organizations that have the authority to decide on mutually exclusive proposals and conflicting claims for water rights. Other countries have relied on interstate agreements.

### *Appropriate Incentives*

Better performance by providers of water services and more efficient use of water by beneficiaries can improve allocation of water among

#### **Box 5. Germany's Ruhrverband**

In Germany, different communities working together in associations play a special role in efficiently managing their water resources. An example of such an association is the Ruhrverband, the Ruhr Basin Water Association. It was established in 1913 to deal with the massive pollution problem of the Ruhr, a tributary of the Rhine River, that resulted from exceedingly heavy industrial and residential development. The Ruhrverband is a self-governing public entity that has managed water in the basin for more than eighty years based on three principles.

- *User participation.* There are 985 users and polluters of the basin's water resources, including communities, districts, and industrial firms, that are associates of the Ruhrverband. The Assembly of Associates (or Water Parliament) is the highest decisionmaking body in the Ruhrverband and is responsible for establishing the budget, which is about \$400 million annually, and standards.
- *Economic incentives and pricing.* The Ruhrverband finances many investments through economic mechanisms, such as water use fees and charges for pollution or wastewater discharges.
- *Decentralization of management activities.* The Ruhrverband is also responsible for the "trunk infrastructure," encompassing the design, construction, and operation of reservoirs and wastewater treatment facilities, while the communities are responsible for the "feeder infrastructure," encompassing the distribution of water and collection of wastewater.

This model has been duplicated in twelve industrial regions of the state of North Rhine-Westphalia and served as the model on which the French River Basin agency was based in 1964.

*Source:* Briscoe 1995.

### Box 6. France's "Model" System

The French system of water resources management, adopted after many years of study and debate, includes many excellent features that could serve as models to help industrial and developing countries as they look for the best way to put a comprehensive approach into action. There are several key elements.

- *Well-defined laws and regulations.* The Water Acts of 1964 and 1992 are the foundation of the French system. The earlier law establishes specific quality objectives and regulations for pollution control, while the later act is designed in part to meet stricter European directives on water management.
- *Hydrographic basin management.* The system is organized around six major hydrographic basins, with appropriate national policy oversight. These correspond to the country's four main catchment areas and to two areas of dense population and intense industrial activity.
- *Comprehensive management, decentralization, and participation.* Each of the six basins has a basin committee and a corresponding executing agency, a water board. The basin committee, also known as a "water parliament" because of its representation and powers, reflects regional—rather than central government—control and is designed to promote the role and responsibility of different interest groups in the basin. The water boards, while executing the committee's directives, are also responsible to the central government for certain technical matters (such as upholding national standards). Water and sewerage services are provided by either public or private firms (increasingly through competitive bidding) and are chosen by communities.
- *Cost recovery and incentives.* The companies and entities operating water services deliver a portion of the charges they collect to the basin agencies. In addition, a "pollution fee" (a penalty) is collected by the basin agency. Most of these revenues are reinjected into the system to provide technical assistance and to help the public or private sector ensure that water is safe and purified.
- *Supporting research.* About 14 percent of the water boards' expenditures in 1992–96 are budgeted for research and development.

Source: World Bank 1993a.

different users and achieve greater conservation. Performance and efficiency can be enhanced through proper incentives, the most important of which are based on price. Ideally, water should be priced at its opportunity cost: its value in the best alternative use. Adjustments to achieve compatible prices among urban and agricultural uses, reflecting the opportunity cost of water, should guide allocations within a

comprehensive framework that considers national objectives and the preferences of water users.

Many countries are shifting from regarding water as a free resource to understanding its economic value and its growing scarcity, and they are changing policies to emphasize proper pricing. For example, after the city of Bogor in Indonesia increased fees for water by 30 percent, the consumption of water declined by a similar rate, and expensive investments in new supplies were postponed (see p. 23). Similarly, some eighteen months after Guinea turned over responsibility for supplying urban areas with water to a private supplier, the fee collection rate had increased from 15 to 70 percent, and services had improved significantly. Market principles also work on the farm. Even farmers who are very poor are often willing to pay for good-quality services that raise and stabilize their income. In Bangladesh, it is not uncommon for farmers to agree to pay 25 percent of their dry-season, irrigated rice crop to the owners of nearby tubewells who supply their water. And studies of farmer-owned and -managed irrigation systems in Nepal show that farmers contribute large amounts of cash and labor to pay the annual costs of operation and maintenance.

Although there are many successful examples of the introduction of some level of increased pricing, the extent of underpricing—in both agricultural and urban use—usually makes it politically infeasible to immediately adopt water charges that are equal to the opportunity cost of the resource. Indeed, most countries are just starting to charge to cover the cost of services. This, at least, is allowing countries to ensure the financial autonomy of their water service agencies and the sustainability of their operations and is reducing, but not eliminating, the misuse of water resources. The problems of pricing are most pronounced in agriculture, because it is difficult in very large systems to measure the volume of water each farmer receives. Here, alternative mechanisms can be tried, such as cost recovery through user groups (based on water delivered to an entire village or water user association) and approaches that rely on indirect measurement of water use, such as estimating the amount of water deliveries based on the number of hectares irrigated and varying the per hectare water charges by the crop grown, the number of irrigation periods in a season, or the length of irrigation time. Another problem with opportunity cost pricing in agriculture is political: farmers lose an economic rent they perceive to be an acquired right. In this situation, farmers might be encouraged to trade their water in water markets. Thus far, water trading is common within a sector but has been prevalent between sectors only in the western United States and Chile.

The formal buying and selling of water use rights in Chile require legal sanction and registration. Although the law defines water use

rights as a volume of flow per unit of time (for example 24 liters per second), in practice rights are a share of stream flows, since variability renders the volumetric/time specification impractical. Use rights are required for groundwater exploitation; these rights prohibit the user from making other withdrawals within the area specified in the right. A system is in place for challenging the granting of water rights and for resolving disputes related to them (box 7).

Fees and fiscal incentives can also significantly influence water conservation and encourage firms and individual users to adopt water-saving technologies, including reuse systems.

### **Box 7. Water Markets in Chile**

Chile's National Water Code of 1981 established a system of water rights that are transferable and independent of land use and ownership. Water rights are defined as permanent (from unexhausted sources) or contingent (from surplus water) and as consumptive or nonconsumptive. Rights can be obtained by petitioning the government, or they can be established by right based on historical use; they can also, of course, be purchased from the owner. In practice, the second of these methods is the most common, because the government's 1966 expropriation of all water rights necessitated the establishment or reestablishment of those rights since the National Water Code was passed.

The most frequent transaction in Chile's water markets is the "renting" of water between neighboring farmers with different water requirements (Gazmuri 1992). This can also be termed a "spot market," in which the owners sell a portion of their water, usually over a brief period (perhaps even hours), sometimes without fulfilling formal, legal requirements. Although the volume of sales may not be metered, the buyer and seller have good information on the amount exchanged. Compensation may be in kind or in some other form of nonmonetary benefit.

Prices for water rights are left to the buyers and sellers. In a draft study covering more than 700 shares of water in four river valleys in Chile, Hearne and Easter (1995) found that, for both intra- and intersectoral transactions, "market transfer of water use rights does produce substantial economic gains-from-trade" in the two valleys where transactions were numerous. In the Limari Valley, for instance, shares traded at an average of about \$9,000 (which is roughly equivalent to \$0.20 per cubic meter). The net value of the exchange (that is, the value of water in the new use minus the value of water in the previous use) is estimated to be about \$6,000 per share (or about \$0.13 per cubic meter).

*Source:* Le Moigne, Dinar, and Giltner 1995.

- In the United States, industrial water use in 1980 stood at 45 billion gallons per day. By 1990, it had declined 33 percent to 30 billion gallons per day, largely as a result of the tightening of controls on effluents and the imposition of effluent charges over this period.
- In a study of industrial plants in São Paulo, Brazil, water use in manufacturing dropped between 42 and 62 percent, depending on the industry, from 1980 to 1982, after effluent charges were introduced.
- Consumption of water in the former German Democratic Republic dropped from 400 to 120 liters per capita per day, or 70 percent, between 1989 and 1994, primarily as a result of cost-based pricing.

Such incentives also make it easier for farmers to switch to less water-intensive crops and to reduce practices that cause groundwater pollution (some 20 to 30 percent of irrigation water in the world and some 50 percent of new water sources now come from groundwater, most of it from shallow aquifers).

Although municipal water supply accounts for far less water than irrigation, it is a highly concentrated demand and is growing rapidly. In their efforts to limit the need for increased water supplies, many municipalities have employed demand management programs.

- The city of Bogor, Indonesia, was faced with high investment costs of developing additional water supplies. The municipal authorities decided to cut substantially the water consumption of domestic and commercial consumers. Water fees were increased initially by approximately 30 percent, resulting in an average decrease in consumption of 29 percent. This action was followed by a campaign to reduce water use further, particularly among consumers with monthly consumption of more than 100 cubic meters. Consumers were given advice, as well as the necessary devices, to reduce consumption. Three months after the campaign started, average monthly water use had decreased another 29 percent.
- In an effort to cut water use per capita by one-sixth, Mexico City replaced 350,000 toilets with smaller 6-liter models. This has saved enough water to meet the household needs of 250,000 residents.
- A new pricing system in Beijing links charges to the amount of water used. New administrative regulations set quotas on consumption and authorize fines for excessive use.
- The use of water-saving devices, leak detection and repair, and more efficient irrigation in its parks helped Jerusalem to reduce its use of water per capita by 14 percent from 1989 to 1991.
- A water conservation program in Waterloo, Canada, included higher prices, education, and the distribution of water-saving devices. Vol-

unteers distributed water conservation kits to nearly 50,000 homes. Water use per capita declined nearly 10 percent.

Proper pricing of water is necessary, but not sufficient, to ensure efficient allocation and improved services. The failure to collect and recover costs is a constraint in pricing regimes almost everywhere, especially in the developing world. What is also required is an accompanying set of incentives that encourage accountability for cost recovery and improved services. Experience demonstrates that decentralized service delivery can break the vicious cycle whereby service declines with collections, making consumers less willing to pay. Countries have achieved better-quality service at lower cost by decentralizing the responsibility for delivering water service to local governments and transferring some functions to the private sector, financially autonomous entities, and community organizations such as water user associations. Decentralization, especially in retail distribution of water, makes it easier to ensure financial autonomy and to involve the private sector and water users in water management. Smaller, locally managed institutions, whether public or private, have more effective authority to charge and collect fees and more freedom to manage without political interference. The move toward greater reliance on financially autonomous entities, private firms, and water user associations to cover costs should open up new sources of financing for investment, especially where central government transfers are no longer possible. Because they are likely to achieve higher levels of cost recovery than government agencies, autonomous firms and user associations will be in a good position to borrow investment capital from local and international markets.

Decentralized water management is not possible without institutional reforms that are sensitive to traditional practices and local realities and are responsive to the new structures. The case of Mexico's water user associations is instructive. Millions of hectares of irrigated land have been transferred to farmer management through water user associations (box 8).

Farmers' contributions to operations and maintenance have changed dramatically since the transfer process was implemented, mainly due to user management and a sense of "ownership" of the system. This experience highlights the importance of the following key ingredients of the transfer program: strong government commitment and policy support, establishment of strong legal and institutional frameworks, adjustments to new roles by both farmers and the government irrigation agency, substantial increase in farmers' contributions to operations and maintenance, and on-farm capital improvements, training, and communications programs.

Legislation is needed to establish the legal basis for private firms and water user associations. The rights to water need to be clearly

### **Box 8. Decentralization in Mexican Irrigation**

The Mexican economic crisis of the 1980s stimulated a wide variety of reforms in Mexican agriculture. Among the most significant institutional reforms was the program to decentralize the irrigation sector and to transfer management responsibility for irrigation operations from the public sector to organizations of water users at the level of the irrigation district. By the end of 1994, full or partial management responsibility for fifty-five irrigation districts with a command area of about 2.5 million hectares had been transferred to water user organizations (WUO). The reform program has attracted the attention of irrigation officials from other developing countries interested in enhancing the role of WUOs in the management of irrigation systems in their countries.

The Mexican program centers on developing a public-private partnership with new roles for the users and the National Water Commission—Comisión Nacional del Agua (CNA)—the government agency concerned with water management in the country. In the past, the government built, operated, and managed 3 million hectares of large, surface irrigation schemes organized into eighty irrigation districts. With the reform program, the management of these schemes is being handed over to WUOs, known as Asociaciones Civiles, that manage irrigation subsystems, or *módulos*, varying in command area from 5,000 to 20,000 hectares. These WUOs are responsible for operating and maintaining secondary irrigation and drainage systems. Elected leaders negotiate water management and rehabilitation needs with the CNA's managers at the district level. Where possible, the WUOs form a user organization at the level of the irrigation district to operate and maintain the main irrigation system.

A number of countrywide policy and legal changes have been made to support these reforms. A new National Water Law—*Ley de Aguas Nacionales*—has been promulgated. CNA and the WUOs have signed a concession agreement that specifies the mutual roles and responsibilities of the agency and the water users. A training and communications program has facilitated the process of transfer. Internally, the WUOs have a system of charging for irrigation services and of mobilizing resources for operations and maintenance. To supplement the management transfer program, the government has launched an on-farm development initiative to enhance farm-level productivity and water conservation as well as a program to register and assign water rights to users.

*Source:* Gorriz, Subramanian, and Simas 1995.

defined, with special emphasis placed on the interests of the poor. Establishing the framework for action by nongovernmental entities and individuals is especially important. Effective regulatory systems are prerequisites where social concerns, environmental externalities,

and a tendency toward natural monopoly in water services are prevalent. Nevertheless, private sector involvement in various aspects of water supply and sanitation usually leads to significant gains in productivity and efficiency.

Until relatively recently, private sector participation in water supply was limited. However, in the past few years, interest in private sector participation has burgeoned, and various innovative forms have emerged. The most common forms are lease contracts and concessions, usually secured through competitive bidding. In concession contracts, facilities are leased to the private operator, who contributes investment capital and who operates and maintains the facilities for a period of twenty to thirty years. Such arrangements are common in Côte d'Ivoire, France, Guinea, Macao, Portugal, and Spain and were recently adopted in Argentina. Many countries in Eastern Europe and Latin America are contemplating similar approaches. Early in Chile's reform of water service delivery, the public water company in Santiago began using private contractors to read meters, maintain pipes, and handle billing. This raised staff productivity to the highest level among water and sanitation companies in Latin America. For sewerage systems—even in countries, such as France, with a long history of private sector participation—concession contracts are relatively rare. The predominant form of private involvement in sewerage systems is public investment coupled with a lease contract, typically for ten years. In irrigation, private sector participation has had notable successes in the sale, operation, and maintenance of tubewells, especially in Bangladesh, India, and Pakistan.

Participation of stakeholders is also necessary for a successful incentive system. Prescribing and encouraging the participation of individuals and institutions that would be affected by decisions about water resources management produces a number of benefits. Stakeholder participation in formulating and designing of water projects has helped to incorporate local knowledge and circumstances, leading to better design and lower costs, as demonstrated in the Orangi scheme in Karachi, Pakistan (box 9). In many countries, users are involved in the ongoing management of water systems, considerably reducing the financial and managerial burdens on government.

Participation has encouraged greater cost sharing and better maintenance, promoted equity, built local capacity, and enhanced transparency, accountability, and institutional performance. Participation also generates a sense of ownership for projects, which helps to build the social and political cohesion that is necessary for long-term development planning. The participation of women has been found to be especially important (box 10). Women are the principal

**Box 9. The Orangi Pilot Sanitation Project**

The Orangi Pilot Sanitation Project in Karachi, Pakistan, is a good example of success in providing services through stakeholder empowerment and financial autonomy and, in the words of its architect, liberating people from the demobilizing myths of government promises. There, the task was to provide services that the government had not been able to provide by reducing costs so that sanitation systems could be developed and operated by the community. By eliminating corruption and providing labor and management by community members, the project is providing in-house latrines and street sewers for some 600,000 people at a capital cost of less than \$100 per household. There are two lessons from the Orangi experience: trust the people and put them in command, and then give the residents the support they need.

*Source:* Hasan 1986.

managers of domestic water, and in rural areas they can spend up to six hours a day collecting it. Equity, efficiency, and effectiveness all demand greater attention to gender issues in water policies, programs, and projects.

### *Environment and Health*

Changes in water management that put greater reliance on the private sector, autonomous utilities, and user participation promise to improve considerably a country's ability to protect the quality of its water and land and to promote the health of its citizens. Cities, industries, and small municipalities can be encouraged to reduce their discharges of wastewater by applying surcharges to water supply fees (on the basis of volume and pollution load of industrial effluents) and other market-like approaches, such as tradable pollution discharge permits. With community participation and organization to collect user charges, smaller towns may also find it cost-effective to treat effluents. Strengthened institutional capacities in urban areas would help to increase monitoring capabilities and compliance. In smaller towns, community scrutiny would play an important role in enforcement.

In the countryside, forcing land users to bear the true costs of poor water and land management through regulatory policies can reduce soil erosion, groundwater contamination, salinity, waterlogging, and flood runoff. Market incentives can also encourage more environmentally friendly practices. Water pricing can reduce water use and associated water and land degradation. Proper pric-

### Box 10. Gender and Water Allocation

As the economic value of water increases due to water shortages from bad management, urbanization, and overall scarcity, the economic return to investing in domestic water supplies will be undervalued because they are located in the traditionally invisible domestic arena. If the returns to investment in domestic water were properly measured, the optimal allocation of water might look very different.

The costs of insufficient quantity or quality of water for domestic uses will likely be borne disproportionately by women and children due to their predominance in the domestic sphere. These costs include:

- *Longer times for water collection.* Because women and children are the primary water collectors, longer collection times mean that women have less time for agricultural production, less control over income, and less time for child care.
- *Less water for drinking, bathing, washing, and sanitation.* Research by the International Food Policy Research Institute has shown that in some circumstances these nonfood inputs into nutrition are more important than food in avoiding malnutrition.
- *Loss of income from water-intensive activities undertaken by women.* Domestic water supplies are used in many small-scale food processing or craft activities and gardens, which are important sources of income, especially for poor households.
- *Poor water quality for domestic use.* Water is contaminated as a result of intensive farm and industrial use.
- *Increased incidence of disease.* Malaria due to standing water, diarrheal diseases due to contamination, or other effects of bad water management affect women disproportionately, because women have to shoulder health expenses and time burdens for caring for the ill.

In allocating water rights, it is important to ensure that women's needs are also met. This involves:

- *Acknowledging customary rights.* This includes recognizing use and ownership rights to various sources, for various purposes.
- *Protecting water rights and providing adequate compensation for water losses.* For example, mechanized pumps for irrigation and industrial uses are draining aquifers in many areas, and no attention is being paid to how this affects the use of open wells and hand pumps that supply water for domestic use.
- *Ensuring women's participation in decisionmaking bodies.* If water allocation is left in the hands of public agencies, they must meet the needs of women as well as men. If rights and management responsibilities are transferred to local user groups, they should be structured to include women.

*Source:* Unpublished note by the International Food Policy Research Institute (Washington, D.C.).

ing of water and electricity can control excessive withdrawals from aquifers. Eliminating crop subsidies for water-intensive crops can also conserve water. Environmentally sustainable management of groundwater and water-dependent ecosystems will require the active involvement of stakeholders in managing and investing in the protection and restoration of local resources. This means that governments must review their legal systems and provide users with certain and predictable land tenure.

Every water-related project should consider the environmental aspects of the activities planned. Using environmental assessments early in the project cycle and ensuring that stakeholders and local nongovernmental organizations participate actively in the process should help to define measures to reduce a project's adverse impact on the ecosystem, avoid conflicts, minimize confrontation, generate alternatives, and promote the sustainable development of water resources. As for the potentially devastating impact of large water projects on people, the Bank has stated unequivocally that, "Public sector water investments should ensure that adversely affected people, especially indigenous people, receive culturally acceptable social and economic benefits as well as access to water as part of any allocation process in a river basin. Resettlement should be avoided or minimized; if it is necessary, former incomes and living standards should be restored or improved" (World Bank 1993a, p. 62).

## Conclusion

The World Bank, with assistance from organizations in the United Nations, and after intensive consultation with its borrowers and with international and developing-country nongovernmental organizations, has adopted a new policy for water resources management that takes a comprehensive approach, emphasizing economic behavior, the overcoming of market and policy failures, more efficient use of water, and greater protection of the environment (box 11). It is working actively with its developing-country partners to encourage implementation of these objectives. In Brazil, the Bank is financing water quality and pollution control projects that create basin authorities and institutional, legal, and regulatory frameworks that facilitate cross-sectoral and cross-governmental coordination, while delegating many responsibilities to municipalities. In Bangladesh, the Bank has supported the creation of an enabling environment that allows the private sector to take responsibility for selling and maintaining low-lift pumps and shallow tubewells. The number of tubewells has grown substantially, with a subsequent increase in market activity for water. In Pakistan, the Bank is helping to develop a delivery mechanism whereby rural communities will provide, operate, and maintain the service themselves. And in

### **Box 11. How the World Bank Promotes a Comprehensive Framework**

As described in its policy paper *Water Resources Management* (1993a), the Bank is giving priority to countries with significant water management problems. It is encouraging and helping countries to develop a systematic framework for incorporating cross-sectoral and ecosystem interdependencies into the formulation of policies, regulations, and public investment plans that are appropriate to the particular country's situation. The framework fosters transparent decisions and emphasizes demand management. It is designed so that the options for public water management in a river basin or watershed can be evaluated and compared within a national water strategy and the various economic, social, and environmental objectives that countries adopt. It also enables coherent public investment plans to be formulated at the national and basin level and consistent policies and regulations to be developed across sectors. This allows individual projects to be simplified, thus enhancing their likelihood of success. To facilitate the introduction of such a framework, the Bank is ready to support capacity building by enhancing analytical capabilities, adopting participatory techniques, and strengthening data bases, as well as by conducting water resource assessments and promoting needed institutional changes.

In its operations, the Bank is promoting the creation and strengthening of hydrologic, hydrogeologic, water quality, and environmental data bases for both surface water and groundwater. It encourages the development and use of adequate data bases regarding the various elements of the water system. This information is an important input into a country's national water strategy and environmental action plan. To facilitate the collection of data, the Bank supports the use of modern technologies for hydrologic and environmental monitoring and for surveys and data processing, taking into account the relation between the costs and benefits of more detailed information. Since improved information systems are a key input for comprehensive water management, the Bank is helping countries to develop systems that effectively use the data to monitor current changes in water supply and demand, thereby improving decisionmaking.

Mexico, the Bank is supporting the transfer of almost 2.5 million hectares of irrigated agriculture to water user associations that will be responsible for operating and maintaining canals and distributing water.

As these examples demonstrate, efforts to implement a new approach are feasible. The financial requirements, however, will be substantial. For water supply and sanitation and irrigation and power, these are estimated to be \$600 billion to \$800 billion during the next

decade. The World Bank will continue its extensive support for water resources. The Bank has already lent \$40 billion for water-related investments in the last thirty years. During the next ten years, it will lend an additional \$35 billion to \$40 billion. This will represent about half of all external agency funding for water. Developing countries must finance the balance, but they will not be able to do so from central budgets alone. Part of the capital will have to come from water users. Therefore, as recommended in the new demand-side approach to water management, emphasis on cost recovery and private sector involvement will be crucial.

After decades of waste, pollution, and inability to provide basic water services to the poor, we must fundamentally change the way we think about and manage water. The lessons of collective experience demonstrate that we must make a decisive break from past policies to embrace a new approach that is comprehensive, market-oriented, participatory, and environmentally sustainable. This approach is consistent with the consensus that has emerged around Agenda 21, adopted at UNCED in 1992. Implementation of the new approach will require difficult decisions on the part of all of us. But one fundamental point is clear: we have no choice. At stake are our health, our economies, and the life of the planet itself.

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