



INTEGRATING SOCIETY, ECOLOGY,  
AND THE ECONOMY

# RESPONSIBLE GROWTH FOR THE NEW MILLENNIUM



THE WORLD BANK

## CHAPTER 5

# WATER RESOURCES: MANAGING SCARCITY

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**T**he World Commission on Water has described the “gloomy arithmetic of water” (World Commission on Water 2000). During the past century, while world population tripled, the use of water increased sixfold. Irrigation now accounts for 70 percent of global water withdrawals, industry for 20 percent, and municipal use for 10 percent. The increased use of water has come at high environmental costs. Some rivers no longer reach the sea. Half of the world’s wetlands have disappeared in the past century. A fifth of freshwater fish are endangered or extinct. And many of the most important groundwater aquifers are being mined, with water tables already deep and dropping by meters every year, and some damaged permanently by salinization.

The World Commission on Water estimates that water use will increase by about 50 percent in the next 30 years. An estimated 4 billion people—half of the world’s population—will live under conditions of severe water stress in 2025, with conditions particularly severe in Africa, the Middle East, and South Asia. Compounding the relative scarcity of water is the continuous deterioration in water quality in most developing countries. And it is the poorest countries and poorest people who are most directly affected.

This gloomy arithmetic of water is mirrored in the gloomy arithmetic of costs. Although low-cost, often community-based solutions

can be further tapped, the “easy and cheap” options for mobilizing additional major sources of supply for human needs have mostly been exploited. Many countries are now facing sharply increasing unit costs (often associated with interbasin transfers or desalination).

Population and economic growth, plus greater appreciation of the value of water in ecosystems, means that water demands are growing and shifting. Tensions over water rights are increasing at the level of the village, city, and basin. Some of those disputes are spilling over to international river basins. Shifting patterns of precipitation and runoff associated with climate change compound this gloomy arithmetic. An inability to predict and manage the quantity and quality of water and the impacts of droughts, floods, and climatic variability imposes large costs on many economies in the developing world. If the computer simulations on climate change are correct, those impacts will only heighten in the coming decades.

All countries thus face major challenges in developing the laws, regulations, and institutions to manage water resources in ways that are economically productive, socially acceptable, and environmentally sustainable. Better resource and demand management, therefore, has a high priority. The details have to be tailored to the historical, cultural, environmental, social, economic, and political circumstances of each country.

And all countries face a major challenge in developing and maintaining an appropriate stock of water infrastructure, including dikes, canals, dams, and interbasin transfers. Industrial countries have largely completed their investments in major water infrastructure, but developing countries have not. Europe and North America have developed 75 percent of their potential, whereas Africa has developed only less than 7 percent. Australia and Ethiopia have similar degrees of climatic variability, but Australia has 5,000 cubic meters of water storage capacity per person and Ethiopia 45 cubic meters. The United States and Nepal have roughly equivalent economically exploitable hydropower potential. Installed hydropower capacity in the United States is about 70,000 megawatts—in Nepal it is fewer than 600 megawatts.

Infrastructure-rich industrial countries should focus appropriately on management reforms. Developing countries must simultaneously improve the way they manage water and water services—and invest in priority infrastructure.

## NECESSITY OF WATER MANAGEMENT AND DEVELOPMENT FOR GROWTH AND POVERTY REDUCTION

Effective water resource development and ecological management play a fundamental role in sustainable growth and poverty reduction, through four different mechanisms (table 5.1). First, broad-based water resource interventions (type 1), usually including major infrastructure such as dams and interbasin transfers, provide national, regional, and local benefits from which all people, including the poor, can gain. Second, because it is usually the poor who inhabit degraded landscapes, poverty-targeted water resource interventions designed to improve catchment quality and provide livelihoods for the poor (type 2) are of major importance. Third, broad-based water service interventions (type 3), aimed at improving the performance of utilities, user associations, and irrigation departments, benefit everyone, including the poor. And fourth, poverty-targeted water service interventions (type 4), such as water and sanitation and irrigation services for the unserved poor, play a major role in improving the lives of the poor.

In most developing countries, growth-oriented, poverty-reducing water resource strategies will involve action in all four areas. The corollary is that donors must be available as full-service partners to assist development of integrated and consistent action in all four areas.

Table 5.1 A Typology of Water Interventions

	Broad interventions	Poverty-targeted interventions
Interventions affecting water resources, development, and management	<i>Type 1: Broad nationwide water resource interventions (for example, multipurpose river basin development and aquifer management)</i>	<i>Type 2: Targeted water resource interventions (for example, watershed management in designated areas with poor farmers)</i>
Interventions affecting water service delivery	<i>Type 3: Broad water service delivery reforms (for example, reform of water supply utilities and water-user associations for irrigation management)</i>	<i>Type 4: Targeted water service reforms (for example, rural water supply and sanitation projects)</i>

Source: World Bank 2003.

## MANAGEMENT CHALLENGES

The main management challenge is not a vision of integrated water resource management but a principled (providing guidance on what needs to be done) and pragmatic (understanding that the art of reform is the art of the possible in specific circumstances) approach for improvement.

The Dublin Principles, forged for the 1992 Earth Summit, are widely accepted for sound water management. They state that water resources should be managed holistically and sustainably—ensuring participation and treating the resource as an economic good. Despite agreement on the principles, practice in the richest countries has improved only slowly—and it is still very far from ideal, especially for managing water as an economic good. The gap between principle and practice is wide in developing countries, especially for sound economic management of a scarce resource.

The new focus is on the basic economic principles. Sound water resource management requires that users take into account both the financial costs of supplying services and the costs that their use of water imposes on others (“opportunity costs”).

### Financial Costs

Pricing to cover financial costs is essential for two reasons. First, it provides the user with information on the cost of providing the service, thereby inducing more considerate use than if the service were free. Second, revenues from tariffs are the basis for maintaining existing and building new infrastructure.

Water and water services have traditionally been underpriced, resulting in inefficiency (and an inability to attract new investment) and inequity (because the poor inevitably are excluded). The political economy of pricing is quite different for services (such as urban water supply) that are local and not tradable and for services (such as irrigation water) that are inputs into products traded globally. Market structures are severely distorted, primarily by the more than US\$300 billion a year in subsidies that rich countries provide to their agricultural producers.

In urban water supply, there is a clear movement toward broad application of the “user pays” principle, with positive results in efficiency, accountability, and the ability of utilities to serve the poor. In irrigation, too, there is movement toward modern forms of organization and financing, in which user payments become the centerpiece for transparent, accountable relations between providers and users. As distortions in global agricultural markets are reduced, the impetus for development of normal arrangements in irrigation services will increase.

### Opportunity Costs

The use of water entails more than financial costs. When one person consumes water, other potential users may be denied the opportunity and value of such use. To ensure that water is allocated and used efficiently, countries must have institutional arrangements that ensure that these opportunity costs are taken into account. Here the central challenge is the development of a legal and enforceable system of water rights. Once established, such rights give rise to a series of fundamental and healthy changes:

- First, those that require additional resources (such as growing cities) will frequently be able to meet their needs by acquiring the rights of those that are using water for low-value purposes.
- Second, there are strong incentives for those that use water for low-value purposes to voluntarily give up their rights, making reallocation both politically attractive and practical.
- Third, establishing formal water rights gives rise to strong pressures to improve the data required to manage the resources.
- Fourth, establishing formal water rights reduces the pressures of a “race to the bottom,” because those that have rights have a powerful interest in sustaining the resources.

There is no unanimity on the concept of water rights, for some see it as an unhealthy commodification of a public good. Nor is it simple to introduce rights-based systems for a fugitive resource in administratively weak environments with deep cultural implications. But there has been substantial progress in recent years (in Brazil, Chile, Mexico, and South Africa). And there are local pressures (villagers

who store rainwater in Rajasthan, India) and international pressures (between Mexico and the United States) to define the rights to use an ever-scarcer resource.

Progress in implementing the Dublin Principles takes place one step at a time, heavily conditioned by broader political and economic realities. Needed is a reaffirmation of the Dublin Principles (ecological, institutional, and economic) and a shift in focus to implementation—to developing realistic, sequenced, and patient reform processes adapted to local realities.

Economic principles—such as ensuring that users take financial and resource costs into account when using water—are very important. And the solutions need to be tailored to specific, widely varying natural, cultural, economic, and political circumstances. The art of reform is in picking the low-hanging fruit first, not in making the best the enemy of the good. Architects of good reform recognize that the broader economic and fiscal and governance reforms often trigger reform opportunities in the water sector. They also recognize that reform processes are always political and, thus, that politicians who are willing to lead reform processes must be supported.

## INVESTMENT IN INFRASTRUCTURE

Most developing countries have inadequate stocks of hydraulic infrastructure, such as dikes and dams, and face daunting financial challenges in developing such stocks. They need assistance in developing and maintaining appropriate stocks of well-performing infrastructure. The World Commission on Water estimates that annual investments in water infrastructure need to rise from US\$75 billion today to US\$180 billion by 2030. Attracting private investment will remain very important for many developing countries, but most financing of water infrastructure will continue to come from public sources.

The historical challenge of water resource management has been the reconciliation of human needs for predictable and regular flows of water with the variable patterns of precipitation and streamflow. The challenge is greatest where average flows are especially low and where variability is high.

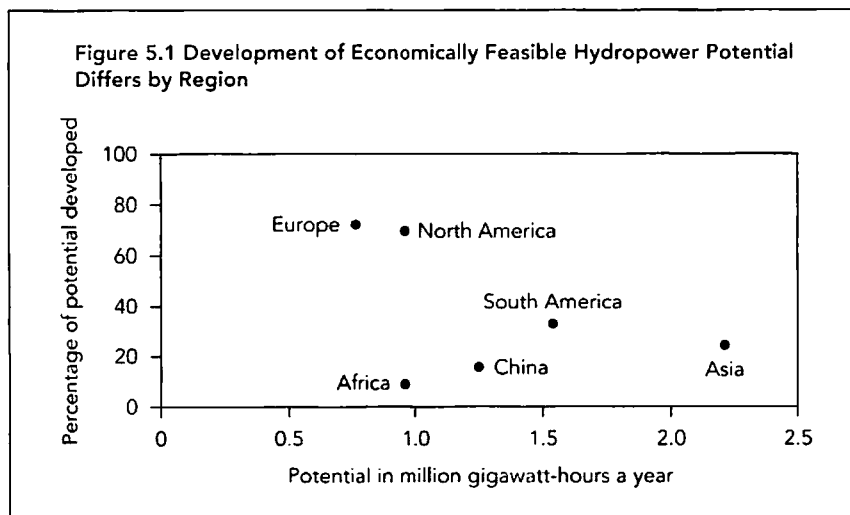
Societies have long developed structural and nonstructural mechanisms for attempting this reconciliation, with two main lessons. First,

infrastructure (dams, levies, and canals) is critical. Second, infrastructure investments need to be complemented by previously neglected nonstructural investments (in watershed management, land-use planning, and information and systems management). The emphasis in infrastructure-rich industrial countries is now heavily and appropriately focused on nonstructural solutions.

### Major Challenges

First, many developing countries have stocks of water infrastructure that are a small fraction of those in climatically similar industrial countries (figure 5.1). Developing countries need to make large investments in infrastructure of all scales, ranging from local rainwater harvesting structures to major infrastructure such as dikes, canals, dams, and interbasin transfer schemes. Those investments need to follow good technical, economic, social, and environmental practices.

Second, they also have to invest simultaneously and heavily in nonstructural management solutions. Most developing countries have understood this need and are now doing so. Such efforts range from the massive efforts at watershed management in the Upper Yangtze



Note: Data for Asia do not include China.  
Source: World Bank 2003.



catchment in China to the development of improved hydrology data in India, to the elimination of water-using invasive alien plants in South Africa.

Third, global climate change accentuates the underlying imbalances between human demands and natural hydrological patterns, making the task of developing an integrated package of structural and nonstructural tools more urgent.

Major hydraulic infrastructure needs to be reconsidered, for four reasons:

- First, there have been improvements in recent decades in the way the social and environmental aspects of dams and other major water infrastructure have been addressed, and developing countries are committed to continuing improvement.
- Second, major water resource projects often form the basis for broad regional development, with significant direct and indirect benefits for the poor (and others). In India, for example, only 26 percent of people living in districts that have benefited from such projects are poor, in contrast to 69 percent in districts that have not so benefited.
- Third, as water scarcity in many countries becomes more acute, the costs of water infrastructure are rising rapidly. Many countries are having to invest in interbasin transfer schemes, with price tags of billions and even tens of billions of U.S. dollars. An analysis of World Bank “repeater” water supply projects shows that the cost of bulk water for the future project is often two to three times greater than that for the previous project.
- Fourth, among the governments of developing countries there is now a broad consensus that, although public funds have been and will remain indispensable, the required water infrastructure cannot be built with public funds alone. The private sector has an important complementary role. The Monterrey Conference on Development Financing highlights a need for the relevant international and regional institutions to increase their support for private foreign investment in infrastructure. Over the past decade, there has been a major change in the role of private financing of infrastructure in developing countries. Starting from a low base in 1990, the private sector has invested up to US\$130 billion a year in infrastructure in developing countries to the year 2000.

A closer look shows that levels of private investment have declined dramatically in recent years. Furthermore, only a small proportion of private investment in infrastructure went into water-related infrastructure—about 5 percent into water and sanitation and another 5 percent into hydropower, concentrated in low-risk economies in East Asia and Latin America.

### The Nile Basin

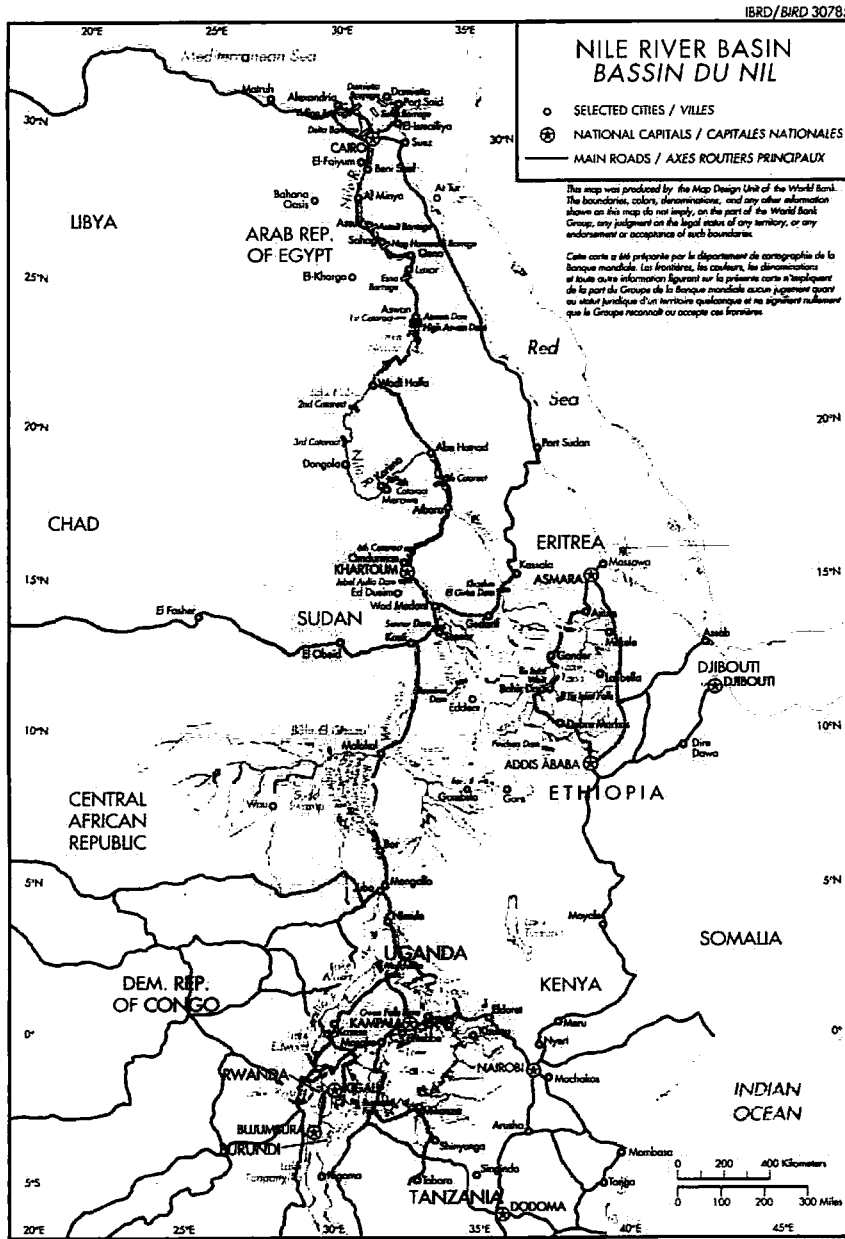
Since 1996, the Africa Water Resources Management Initiative has sought to improve national water resource management through institutional and legal review and reform, emphasizing ownership and stakeholder participation, environmental sustainability, demand management, and cost-efficiency. Often the point of entry for discussions of reform has been a client's request for major investments in infrastructure. Where the perceived investment needs are vast, a review of current practices and options is generally called for.

Africa has great needs for investments in water infrastructure. The share of the population with access to potable water is lower than that in any other region. The variability in rainfall is roughly three times that in temperate regions, but many African countries have per capita water storage (in reservoirs) in orders of magnitude less than industrial countries have. And countries have low levels of capacity to manage water resources as well as low levels of infrastructure investment, both of which must be addressed for either to be truly effective.

Complicating matters. Africa has more international rivers than any other continent. Tensions over the control of Nile waters are long-standing obstacles to growth and development in the region. Conflict prevention and cooperative water resource management are therefore central development challenges for the 10 countries sharing the Nile River.

The Nile Basin Initiative has a strategic action program guided by a shared vision to achieve sustainable socio-economic development through the equitable use of the Nile Basin water resources. The program includes a basinwide shared vision program of technical assistance projects designed to lay the foundation for cooperative action and two subbasin investment programs that will promote poverty reduction, economic growth, and better environmental management. Although the initiative's overarching goals are conflict prevention,

poverty reduction, and environmental management—not simply the construction of major water infrastructure—the initiative’s shared projects will deliver its most apparent and immediate development effects.



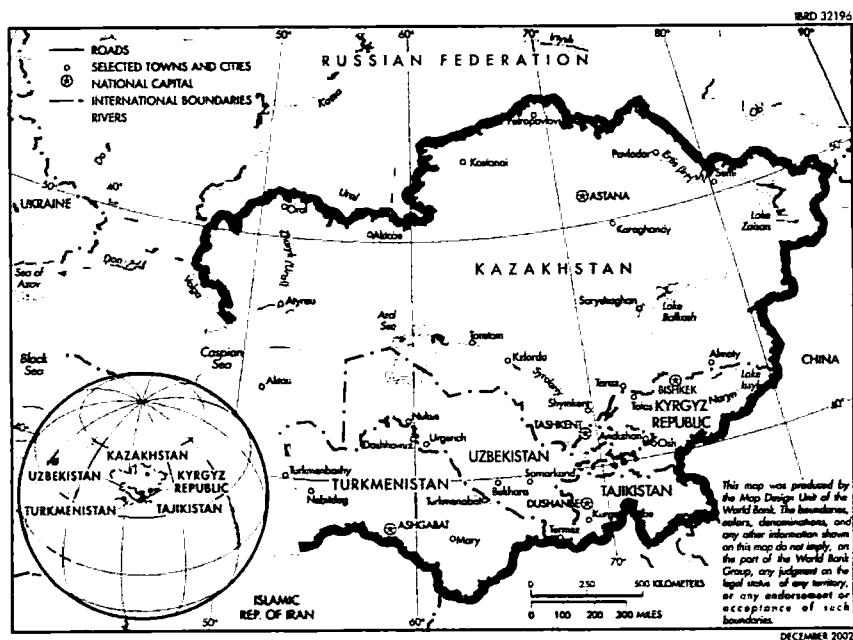
Map of the Nile River Basin.

The Nile Basin Initiative is led by the Council of Ministers of Water Affairs of the Nile Basin States and is supported by a small secretariat based in Entebbe, Uganda.

Some projects of the Nile Basin Initiative might find financing without significant donor involvement. But it is unlikely that all countries would be able to obtain funding, and the disparities in access to financing could increase tensions in the region. Moreover, the involvement of donor partners could increase the likelihood of best environmental and social practice.

### Central Asia

The countries of Central Asia face water scarcity. Two rivers, the Amu Darya and Syr Darya, serve as the principal sources of water, especially for the downstream countries of Uzbekistan, Turkmenistan, and (southern) Kazakhstan, which have desert climates. Irrigation has been practiced in Central Asia for millennia, but the irrigated area almost doubled between 1950 and 1980, diverting large amounts of water from the rivers and reducing the water flow into the Aral Sea by about 80 percent.



Map of Central Asia.

About 35 million people depend in one way or another on irrigated agriculture. But the effects of irrigation on the Aral Sea, whose surface area has declined by more than 50 percent over the past 40 years, have meant economic losses for the 3.5 million people living near the sea—from declining fisheries, loss of wetlands, and the health effects of blowing salt and highly saline shallow groundwater.

The countries of Central Asia face a unique set of challenges in developing and maintaining an appropriate stock of water infrastructure. For the most part, the problem is that there is more infrastructure than can be maintained. In irrigated areas, the World Bank has thus worked with borrowers in applying immediate “Band-aids” to critical infrastructure and also on developing medium-term strategies for “triage”—to determine which infrastructure (both supply and drainage) can and should be maintained and which abandoned.

Recent analysis suggests that rehabilitating infrastructure, along with managing demand, could reduce crop water requirements by more than 30 percent. It also shows that most serviced areas can be irrigated economically, even if users pay the operation and maintenance costs for water and drainage infrastructure. But water prices can be increased only when water delivery is reliable and when farmers can receive a fair market price for what they produce. Agriculture is now effectively taxed, with price and trade restrictions on several important commodities. So the key is to see water pricing reforms as part of a larger package of institutional reforms and infrastructure investments, with attention to sequencing, prioritization, and mechanisms for effecting transitions.

Urban water and sanitation utilities also face unique infrastructure challenges, inherited from the former Soviet Union. Domestic water supplies were heavily subsidized, and per capita use was extraordinarily high (typically about 400 liters per capita a day) and wasteful. As a result, both water supply and wastewater treatment plants were often overbuilt. As water use (and sewage production) has fallen to about 100 liters per capita a day, large overcapacity in treatment has emerged, and major pieces of infrastructure need to be mothballed or even abandoned.

For dams, the primary challenge is again to maintain the existing stock at a safe and serviceable level. Another challenge is monitoring and disseminating data on river flows, precipitation, and temperature.

With the decline in public funding in the past decade, hydrometeorological equipment has become outmoded and data systems are no longer reliable. Existing data series suggest that Central Asia will be affected by climate change, with temperatures, precipitation, and net evapotranspiration rising and extreme weather events becoming more frequent.

So the challenges of managing and developing water resources in Central Asia are daunting, and the solutions do not lie in the water sector alone. Instead, progress, as slow and difficult as it will be, will require concerted, integrated action across a wide range of areas—water-related sectors but also social sectors, governance, and macro-economic and fiscal policy.

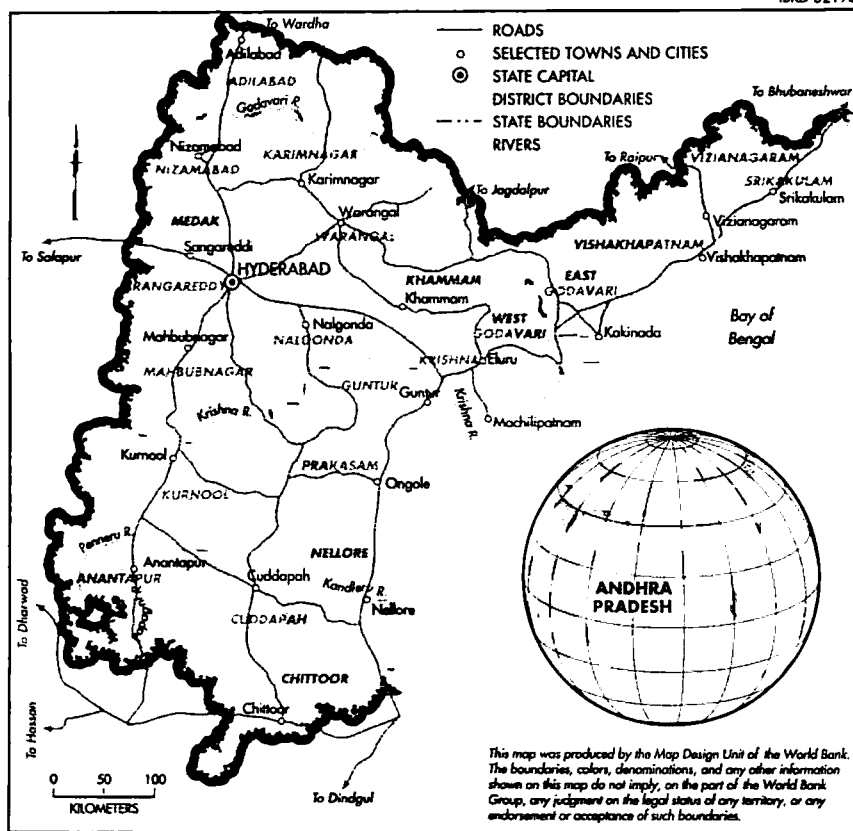
### **India: Andhra Pradesh**

Investments in managing and developing water resources have done much to promote development, food security, and poverty reduction in India. They have led to an enormous increase in the production of food and food grains, benefiting the many poor people who are net food purchasers. They have helped reduce poverty, to the point that poverty rates in irrigated districts are only about a third of those in districts that are not irrigated. And they have had large multiplier effects in the economy.

In Andhra Pradesh, the challenge is to assist the state in its efforts to improve the management and development of its water resources. An emerging global software center, Andhra Pradesh has made good advances in collecting data but lags behind in interpreting and using those data for decisionmaking. The challenge includes developing a legal, regulatory, and institutional basis for making reallocation of water more flexible and voluntary. It thus calls for careful attention to the sensitive issue of users' water rights. It also means developing an approach to incorporating ecological requirements (for example, water releases into estuaries to sustain mangrove swamps and fisheries).

Those elements are key to an integrated river basin approach to water management, a central principle in the Indian National Water Policy and in the water policy of most Indian states. That approach fits well with the SMART (Simple Moral Accountable Responsive Transparent) philosophy of the government of Andhra Pradesh. But

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Map of Andhra Pradesh.

improving water resource management and development is a task that will take decades of persistence to complete, as well as a sequenced, prioritized program of actions tailored to the political realities as they evolve.

Many of the infrastructure challenges in India relate to the need to use existing infrastructure more effectively and to ensure the environmental and financial sustainability of that infrastructure. That said, challenges remain that relate to the development of new resources, as in Andhra Pradesh. The waters of one of the state's two major rivers (the Krishna) are fully developed, but the other major river (the Godavari) has lots of water. The problem is an elevation separation of about 300 meters from the place where the water is available to the place where there is land and a major demand for water (with

entitlement issues going back to preindependence and with water scarcity contributing to security issues).

A simple economic analysis tells the state that developing those water resources for irrigation and hydropower is not the best use of limited financial resources. But the political and security imperatives are great. So although the state has decided not to build major dams (because of forest submersion and resettlement issues), it will probably proceed with some form of lift irrigation from the Godavari River.

A package of high-priority, well-justified (but not narrowly justified) investments would include modernization of major irrigation systems and some new investments, including possibly a phased, piloted lift scheme for the Godavari. Needed for that scheme is a strong emphasis on a carefully sequenced and prioritized program of institutional reforms, efficiency enhancements, and resource management measures both within the principal sectors (irrigation, water utilities) and for overall water resource management.

Andhra Pradesh shows that

- Water resource infrastructure can provide the basis for sustainable economic growth and poverty reduction and can even play an important part in improving relations among riparian countries.
- Water resource development must be accompanied by management reforms.
- Reforms are difficult and can be undertaken only when there is demonstrated local political leadership.
- When there is such leadership, the international community can bring new ideas to the table and invest in ways that make the reforms durable.
- Reforms are neither simple nor achieved in a day. The art of reform is defining a sequenced and prioritized set of reform actions and ensuring an appropriate incentive system for political leaders who take the risks inherent in reform.

## CONCLUSIONS

The examples show that donor activities in water resources in any country should be the product of the water resource challenges in the country, the approach taken by the government, and the overall



framework governing the relationship. Some broad themes are likely to play out in different contexts.

For water resource management, it is important to pay explicit attention to

- The wide variation in the underlying challenges—natural, economic, political, and social—and the wide variety of starting points. Those factors define the appropriate ambition and pace of reform.
- The need to move away from slogans based on principles and focus directly on issues of political economy. That means close attention to prioritizing and sequencing reform actions, taking advantage of windows of opportunity opened by economic and political reforms, understanding that the best should not become the enemy of the good, and operating with patience and persistence.
- The need to see water resource reforms through an expansive lens, going well beyond hydrology to the political, social, and cultural underpinnings.

For water infrastructure development, the following points are important:

- Most developing countries need to invest substantially in water infrastructure.
- The appropriate approach is not the old one of development first, management later, or the equally unbalanced management first, development later. What is required instead is a mix of investments in management *and* development.
- Donors must find more effective ways of becoming engaged if they are to have a seat at the table and serve as full-service advisory and investment partners to developing countries.

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