5 Water competition in agriculture

“Among the many things I learnt as a president, was the centrality of water in the social, political and economic affairs of the country, the continent and the world”

Nelson Mandela, World Summit on Sustainable Development, 2002

CHAPTER 5

Water competition in agriculture

An issue with important implications for human development and global poverty reduction is how to manage water resources to meet rising food needs while protecting the access of poor and vulnerable people to the water that sustains their livelihoods

One hundred years ago William Mulholland, the superintendent of the Los Angeles Water Department (LAWD), introduced California to a new concept in state politics: the water grab. Faced with meeting the water demands for a small, fast growing desert town, Mulholland quietly bought up water rights in the Owens Valley, more than 200 miles to the north, built an aqueduct across the blistering Mojave Desert and delivered the water to downtown Los Angeles. Violent protests followed. Owens Valley ranchers attempted to dynamite the aqueduct, and the LAWD responded with a massive show of armed force. The water transfer paved the way for the growth of Los Angeles. Urban users got unlimited supplies of water, and large commercial farmers got irrigation water that made the deserts bloom with cotton and other water-intensive crops. Farmers in the Owens Valley lost out.

Times change—but some things stay the same. These days southern Californians resolve their disputes over water through litigation, rather than dynamite and guns. But the Mulholland episode demonstrates two enduring features of water governance. First, water is power—and when water is in short supply, power relations figure prominently in determining who gets access to water and on what terms. Second, when water shortages intensify, people lacking a voice in allocation decisions tend to be the first in line for adjustments to reduced supplies.

Over the next few decades many developing countries face the prospect of intensified competition for water. Population growth, rising incomes, changing dietary patterns, urbanization and industrial development will increase demand for what is essentially a fixed supply of water. Where river basin systems are already overexploited, this will lead to acute adjustment pressures, even with efficiency gains. Agriculture—the major user of water and the source of food for growing populations—will be a focal point for these pressures. Power and voice will strongly influence how the adjustment process affects the poor.

As concern over scarcity has mounted, the global debate on water resource management has focussed on food security. The question commonly posed is whether the world has enough water to meet the food needs of a growing population. Less attention has been directed towards another issue with equally important implications for human development and global poverty reduction: how to manage water resources to meet rising food needs while protecting the access of poor and vulnerable people to the water that sustains their livelihoods.

This issue has a direct bearing not just on prospects for achieving a wide range of Millennium Development Goals by 2015 but also on the well-being of future generations. The world may be urbanizing, but most poor and malnourished people still live in rural areas and depend on agricultural production for employment, income and food. Water security is vital to their

Land and water are two key assets on which poor people depend for their livelihoods, usually far more than do people who are better off

livelihoods—and to their prospects for escaping poverty. The danger is that fast growing cities and industries seeking more water will extend their hydrological reach into rural areas, reducing the access of poor households to a crucial livelihood resource.

Adjustment to competition is already taking place. In many countries the dominant governance model is a path of least resistance approach, with powerful constituencies in industry, commercial agriculture and municipalities transferring water by stealth from those—including the rural poor—with the weakest political voice. Unequal outcomes in the adjustment to greater competition mirror wider inequalities based on land, wealth, gender and political influence. Governance systems can redress these inequalities but all too often they exacerbate them, just as they did in Owens Valley.

This chapter looks briefly at the links between water and rural livelihoods and at the emerging scenarios for water use that can influence these links. It then focuses on three themes that will have a critical bearing on whether the governance of competition for water supports or undermines efforts to reduce poverty and inequality:

- Competition, rights and the scramble for water.
- Better governance for irrigation systems.
- Greater water productivity for the poor.

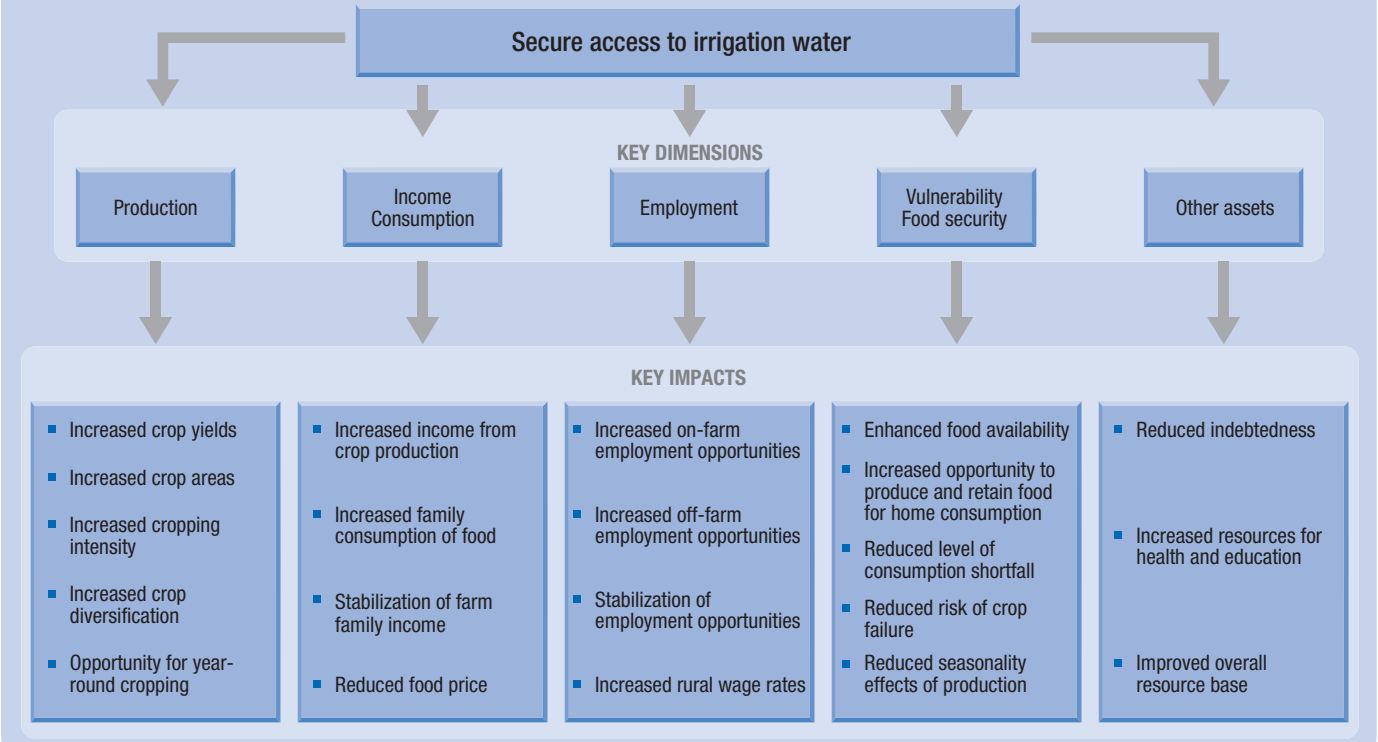
Water and human development—the livelihood links

Poor people in agriculture experience the link between water and human development as a living reality. An Indian finance minister once famously declared that his country's budget was a "gamble on the rains".[1] For millions of small farmers, pastoralists and agricultural labourers the stakes in the gamble are far higher. Variations in rainfall, or disruptions in water supply, can make the difference between adequate nutrition and hunger, health and sickness and—ultimately—life and death.

Water security in agriculture pervades all aspects of human development. Land and water are two key assets on which poor people depend for their livelihoods, usually far more than do people who are better off. Water cannot be considered in isolation from wider capabilities such as health and education, or from access to other productive assets, including land, capital and infrastructure. But water insecurity represents a powerful risk factor for poverty and vulnerability.

Livelihoods comprise the capabilities and assets that people need to make a living and maintain their well-being. In rural areas water plays a crucial role for some obvious reasons. Like land, it is part of the natural capital base that underpins the production systems that sustain livelihoods. Access to a reliable supply of water makes it possible for people to diversify their livelihoods, increase productivity and reduce the risks associated with drought. It enables producers to enter higher value-added areas of production and creates income and employment, and it gives people the security to undertake investments (figure 5.1). The links between rural livelihoods, water and global poverty reduction efforts are immediately apparent. Some three-quarters of all people surviving on less than $1 a day live in rural areas, where their livelihoods are dependent on agriculture. Smallholder farmers and agricultural labourers also account for about two-thirds of the world's 830 million malnourished people. The water security-livelihood nexus helps to explain the widely observed relationship between water and poverty. In Ethiopia distance from a water point is one of the most accurate indicators for vulnerability and poverty.[2]

Figure 5.1 **Access to irrigation water can reduce poverty and vulnerability**



Source: Adapted from Hussain and Hanjra 2003.

The predictability of water supply and the sustainability of water-based ecosystems are crucial dimensions of water security. Predictability helps to explain why access to irrigation is associated with a lower prevalence and reduced severity of poverty. Cross-country research shows that poverty levels are often 20%–30% lower within irrigated systems than in nonirrigated areas.[3] Irrigation provides a range of water security benefits that reduce poverty, from greater food output, higher real incomes and increased employment to lower food prices. However, the strength of the link between irrigation and poverty is conditioned by a wide range of institutional factors, including efficiency and equity in land distribution.

Agriculture under pressure—the emerging scenarios

Future water management in agriculture faces pressure from two directions. On the demand side industrialization, urbanization and changing diets will increase demand for food and the water used in its production. On the supply side the scope for expanding access to irrigation water is limited. It is this imbalance between supply and demand that is driving adjustment pressures.

The future for water management in agriculture will look very different from the past. Consider the recent history of irrigation. Over the past four decades the global area of irrigated land has doubled. Coupled with the increases in productivity that underpinned the green revolution, the expansion of the irrigation frontier enabled agriculture to feed a growing population. In South Asia annual per capita cereal availability increased from 162 kilograms in the mid-1960s to 182 kilograms in the mid-1990s.[4] Production of predominantly irrigated crops—such as rice and wheat—rose by a factor of two to four, with more than two-thirds of the gain coming from yield increases. These massive productivity gains were a key element in improving food security and reducing world hunger. Without the expansion in irrigated area, rural poverty and global food security would look very different today.

Looking to the future, prospects for extending irrigation are limited, while pressures from industry and domestic water users are rising

Contrasts with Sub-Saharan Africa, where productivity gains have barely kept pace with population growth, are instructive.

Looking to the future, prospects for extending irrigation are limited, while pressures from industry and domestic water users are rising. New sources of water for irrigation are increasingly expensive and ecologically damaging to exploit, setting limits on the potential for the type of expansion that marked the decades after 1960. The real cost of new irrigation in countries such as India, Indonesia and Pakistan has more than doubled since 1980.[5] Meanwhile, during the next four decades agriculture in many developing countries will be competing for water in basins where overuse is already resulting in closure or near closure, with water use exceeding minimum recharge levels. Large areas of China, South Asia and the Middle East are now maintaining irrigation through unsustainable mining of groundwater or overextraction from rivers. The groundwater overdraft rate is more than 25% in China and 56% in parts of India.[6] Correcting the overdraft would require cutting groundwater use from 817 billion cubic metres to 753 billion cubic metres, sharply curtailing the water for irrigation in many areas.[7] The groundwater problem now presents a risk to food production in large swathes of the developing world, with attendant risks for rural livelihoods.

Recent water-use scenario exercises developed by the International Food Policy Research Institute, the International Water Management Institute and the Food and Agriculture Organization tell slightly different stories—but with common themes. Among the core features of the scenario for the next four decades:[8]

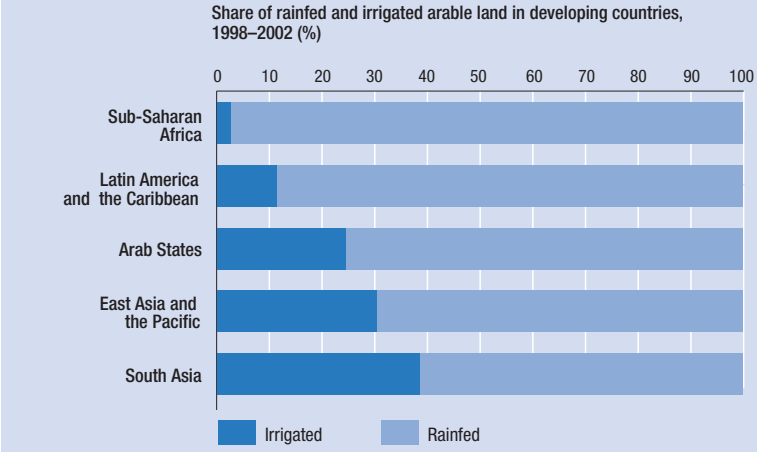
- *Continued population growth and rapid urbanization*. Population will increase by some 80 million people a year over the next three decades, reaching 9 billion by 2050—with almost the entire increase taking place in developing countries. Population growth will go hand in hand with rapid urbanization. In 1960 two-thirds of the world's population lived in rural areas. That share has fallen to half, and by 2050 two-thirds of the world's population will live in cities. Maintaining food supplies will require large productivity gains to ensure that fewer rural producers can meet the demands of a rising urban population.
- *Growing demand for water*. Projected water withdrawals in developing countries will be 27% higher in 2025 than in 1995. Nonirrigation water use will double, while consumption of irrigation water will increase by only 4%. As shown in chapter 4, projected use of water for irrigation will grow far more slowly than for industry, urban centres and livestock.
- *More water-intensive demand but slower expansion in irrigation*. Rising food demand in developing countries will require crop production increases of 1.4% a year on average, increasing to 2.5% for Sub-Saharan Africa. Food demand will become more water-intensive with rising incomes. Meanwhile, the rate of increase in irrigation will slow dramatically. By 2030 irrigation water withdrawals will increase by only 14%. In some regions the water constraint will be far tighter. In Asia water use for irrigation will rise by 1%, compared with 14% for other uses.
- *The imperative to raise productivity*. How will the world meet its growing demand for food? For cereals the Food and Agriculture Organization projects that irrigated yields in developing countries will need to rise by about one-third (to levels higher than in the developed world today), with production increasing by two-thirds. Rainfed agriculture will have to account for 47% of the overall increase in cereals production, highlighting the critical importance of boosting the productivity of "green water" (water absorbed by the soil and transpirated by plants) through enhanced moisture retention and improved tillage practices. Rainfed production is substantial and offers considerable potential. It accounts for about two-thirds of cereals production, yet per hectare yields average only about half the 3.2 metric tons produced in irrigated areas.

These are broad global projections. They do not take into account the distributional factors that shape real food security as distinct from food availability. Nor do they capture large variations between and within regions. But they do point to intensified pressure on already over-

stretched water resources. India, to take just one case, will have 270 million more people living in urban areas in 2025 than in 1995. Many of these people will be employed in water-intensive—and labour-intensive—industries operating in water-stressed parts of the country.

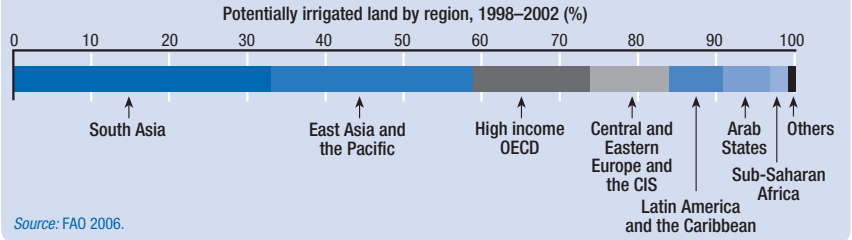
Sub-Saharan Africa faces distinctive challenges. As the developing region most heavily dependent on rainfed agriculture (figure 5.2), green water management will remain the central priority. The region accounts for less than 5% of global irrigation (figure 5.3), and just two countries (Madagascar and South Africa) account for two-thirds of current capacity. Mozambique and Tanzania have developed just 5%–10% of their potential.[9] Increasingly, governments in the region and aid donors see the development of irrigation as a route to higher productivity and greater food security. The Commission for Africa has recommended a doubling of the area under irrigation over the next decade, adding 7 million more hectares by 2010.[10] Progress in this direction could generate important gains for human development: research on rice productivity in Tanzania suggests that irrigation could raise yields by 5% a year. However, outcomes will depend on the distribution of benefits—a governance issue to which we return below.

Figure 5.2 Sub-Saharan Africa has the smallest ratio of irrigated to rainfed agriculture



Source: FAO 2006.

Figure 5.3 Asia accounts for more than half of global irrigated land



Source: FAO 2006.

Immovable objects and irresistible forces

Over the next four decades water governance will be operating in the space between an immovable object and an irresistible force. The immovable object is the ecological limit to water use. The irresistible force is being brought to bear by the mounting demands from industry for water and from urban populations for food. Statistics-based scenarios hide some of the important human development questions raised by the adjustments that will have to take place.

Developed water resources are almost fully used in many countries. With the financial, environmental and political costs associated with developing new water resources rising, competition for water between uses and users is set to increase progressively. In effect, a fixed cake will be divided into unequal slices with some people losing out. Against this backdrop, intersectoral water transfer is likely to become one of the major human development issues of the 21st century. Much of the discussion has concentrated on economic efficiency and technology. Less attention has been directed towards equity and the consequences for vulnerable people living in rural areas, even though these are likely to be profound. As national competition for water intensifies, people with the weakest rights—small farmers and women among them—stand to see their access to water eroded by more powerful constituencies

The consequences of competition are not just theoretical outcomes of a plausible future scenario. They are already evident in the mounting conflict surrounding adjustments to water shortages in many countries. Consider these recent conflicts:[11]

- In India competition for water is escalating in many parts of the country. Chennai, in the state of Tamil Nadu, is a textbook model of a water-short city extending its

Secure rights to water can expand opportunities for poor people to escape poverty, while the absence of secure rights leaves people open to the risk that they will be unable to assert their claims in the face of competition

hydrological reach. It is completing a 230 kilometre pipeline to bring water from the Cauvery River basin—one of the most water-constrained basins in India and the source of a long-running dispute between Tamil Nadu and Karnataka. Competition between users is increasing in intensity. In the Pallakad district of Kerala the abstraction of groundwater by a multinational soft drink company has depleted the aquifer, dried up several wells and caused serious environmental damage.[12] In a repeat episode on the outskirts of Mumbai the same company has provoked protests by farmers against its water abstraction operations to serve the fast growing middle-class mineral water market in the city.[13] Gujarat and Rajasthan have also witnessed repeat bouts of violent conflict over water use.

- In China the government has embarked on a $2.7 billion programme to divert water from irrigated areas in Shanxi and Hebei provinces, encountering significant opposition. All along the Yellow River and across the water-stressed northern plains, authorities are mediating conflicts over water between farmers, municipalities and industry. In July 2000 violent protests followed the announcement of a plan to divert reservoir water from agriculture to industry in Shandong, the last province before the Yellow River reaches the sea.
- In Thailand agricultural producers in the Mae Teng irrigation system are protesting the transfer of water to Chiang Mai, where municipal authorities are struggling to cope with the rising demand of urban and industrial users.
- In Yemen farmers are protesting the transfer of water from agriculture to fast growing urban centres such as Ta'iz and Sana'a.
- In the Pakistan province of Sindh hundreds of "tail-end" irrigation farmers have protested against water shortages and the management of an irrigation system that favours upstream water-intensive crop production. Disputes over access to irrigation canals are increasingly common. In June 2006, 14 people were killed in the Karrum region during village disputes over irrigation channels following a decline in water availability.[14]

While international commentators reflect on the potential for water wars between countries, conflicts such as these within countries are already intensifying at a worrying rate. Violence is becoming increasingly common in many countries, and the potential for conflict will inevitably increase as competition intensifies. Adjustments to the scenarios set out earlier will create winners and losers. Who wins and who loses will be determined not through the simple calculus of supply and demand, but through institutionalized systems of rights and claims that determine entitlements to water. It is the governance of these systems that will ultimately determine human development outcomes (see chapter 6).

Competition, rights and the scramble for water

Entitlements matter in any process of competition, and entitlements are wrapped up with rights. Broadly defined, water rights represent socially accepted and enforceable claims to water. They define the terms allowing for the removal of water from its natural environment, the use of water in a natural source and the management of water flows. As with land, secure rights to water can expand opportunities for poor people to escape poverty. Conversely, the absence of secure rights leaves people open to the risk that they will be unable to assert their claims in the face of competition.

The world's earliest legal statutes recognized the special character of water. Under Roman law in the third century, *aqua profluens* (flowing water) was a common good, neither public nor private, emphasizing equity and societywide ownership. Today, water rights vary widely across countries, often connecting a diverse array of water users. But there are three broad categories of rights common to most societies: *public water rights* held by the state, *common or customary rights* legitimized by norms and traditions and *private property rights* to use or transfer water (through, say, groundwater extraction or irrigation). These overlapping rights have an important bearing on how the claims and entitlements of rival users play out when competition increases.

As the pressure towards intersectoral resource transfer mounts and competition within agriculture grows, systems of rights and claims will become increasingly important. The transfer process for water can happen through administrative fiat, market exchange or other types of negotiation. Which stakeholders are involved in decisions, who receives compensation and who shapes the rules and norms for managing adjustment will inevitably be affected by the nature and extent of water rights and the relative power of different actors.[15]

The limits to private water markets

As competition for water has intensified, some people have argued for the development of markets based on tradable water rights to resolve competition problems. Establishing clear private water property rights, so the argument runs, will allow adjustments to increased competition to take place through the market, with the price mechanism ensuring that water flows to its most productive use. Does this represent a viable model for addressing the social and economic challenges posed by the scenarios outlined earlier?

Private water rights have a long history. In the western United States they were introduced more than a century ago, through legislation covering not just the authority to draw water but also to trade in its use.[16] Today, water trading enables cities like Los Angeles to purchase water from farmers in the Central Valley who hold the private right to irrigation water on their land. In the developing world Chile has the most highly developed system of private and tradable water rights. Introduced in the early 1980s, the system allows farmers to trade the right to draw water with other users (box 5.1).

Private water markets provide a mechanism for rebalancing supply and demand and enhancing efficiency, as measured through market pricing. However, markets do not automatically balance efficiency and equity goals—and market

Box 5.1 Chile—water markets and reform in a high growth economy

Chile is often cited as a success story in incorporating water into wider strategies for sustainable resource management and accelerated economic growth. Market-based mechanisms occupy a central place in public policy. But efficiency and equity have sometimes pulled in different directions.

Tradable water rights were institutionalized under the 1981 National Water Law as part of a sweeping economic liberalization. Private markets developed, and water rights were traded as a commodity. Landowners could trade water for cash. And transfers through water markets helped sustain the rapid growth of water-intensive agricultural products, such as fruits, vegetables and wine, as well as of wood pulp and copper (mined and processed in the Atacama desert).

The reforms increased the scarcity value of water and created incentives for investment in efficiency gains. Sophisticated water management systems in the agro-export sector put Chile in the front rank of efficient water users. Between 1975 and 1992 irrigation efficiency increased by 22%–26%, the equivalent of freeing up an additional 264,000 hectares for crops and saving $400 million for developing new water supplies. Since 1980 water used in the wood pulp sector has fallen by 70%.

Beyond enterprise efficiency, however, the indicators point to a mixed balance sheet. Water scarcity prices did not reflect the costs of environmental damage related to overuse for a familiar reason: environmental externalities are not adequately priced in free markets. And government subsidies promoting forestry exports undermined the price signals from water markets, creating incentives for environmental damage.

While the 1981 law enhanced economic efficiency, it was far less successful when measured against the yardstick of equity. The allocation of water rights without limit or restriction predictably gave rise to speculation and water monopolies. And because water rights were linked to land rights in a system marked by highly unequal land distribution, the benefits were skewed against the poor. Research in the Limari Basin shows that water rights have become more concentrated in the hands of large commercial farmers and urban water traders. The poorest third of farmers have seen their share of water rights fall by more than 40% since 1981.

Reforms in 2005 aim at realigning private markets with public interest. Regulatory provisions to restrict speculative activity, dismantle monopolies and strengthen environmental protection are a central part of the new legislative framework for governing water markets.

Source: Rosegrant and Gazmuri S. 1994; Romano and Leporati 2002; Peña, Luraschi and Valenzuela 2004; GWP 2006c.

People's legal rights count for little if the institutions charged with protecting them are inaccessible or unresponsive

efficiency can be compromised by institutional failures to correct market imperfections.

Consider some of the equity issues that have arisen in US water markets. These markets have facilitated adjustments to scarcity and competition (box 5.2). The western United States, in particular, has highly developed rules and institutions governing markets and mediating claims. But equity is not always well served. One study of the distribution of gains and losses from water transfers in Mendota, California, found that the number of farms in water-exporting regions fell by 26% between 1987 and 1992. But the number of small farms fell by 70%, and labour demand fell even more as wholesale produce firms went out of business.[17] While aggregate welfare increased, the losers included a large group of poorer producers.

The US experience also demonstrates the importance of empowerment in using the law as a complement to equality before the law. People's legal rights count for little if the institutions charged with protecting them are inaccessible or unresponsive. This is true even in countries with highly developed rules and norms for the administration of justice. In New Mexico the state engineer's office is required to adjudicate the rights of small water users as well as third-party effects. Even so, small farmers from traditional farmer-managed irrigation systems (*acequias*) have found it difficult to defend their well established rights. Most of them are of Hispanic descent, socially marginalized and seldom fluent in English, the language of litigation. When it comes to implementation, empowerment matters as much as the letter of the law.[18]

Box 5.2 Water trading in the western United States

The western United States is perhaps most widely cited by reformers as a model for efficient trade in water rights. But less attention has been paid to the laws and institutions developed over a long period to govern that model.

Water transfers in the western United States have been facilitated by laws that separate water rights from land rights. It was this separation, admittedly reinforced by a disregard for other legal processes, that enabled William Mulholland to appropriate water in the Owens Valley in the 1920s and transfer it to Los Angeles. Information is critical to the water transfer regime. Extensive state records on the volumes and shares of water associated with individual rights are another feature of western US systems.

Intersectoral transfers are governed by institutional processes that differ from state to state. In Arizona, New Mexico and Utah the state engineer's office is charged with assessing the technical characteristics of all transfers and conducting hearings on third-party effects. Colorado uses water courts to rule on disputes between rival users, resulting in much higher transaction costs for those who propose and those who oppose contested actions. And only "beneficial use" rights are considered, ruling out recourse to public use complaints by people affected through reduced flows or loss of livelihoods as irrigated production falls.

In California some transfers have been conducted through a state "drought water bank" that arranges purchases from individual farmers for transfer to other uses. Most transfers take the form of temporary leases, in part because of the restrictions on water rights but also because most holders do not want to transfer rights permanently. Some municipalities secure additional water in drought years by paying farmers to install water conservation devices or by increasing recharge in wet years, with the city receiving the additional water saved or stored.

Water transfers in the western United States are a highly contested and litigated sphere of politics. What is distinctive about the system, especially when viewed from the perspective of low-income countries seeking to implement policy instruments—such as tradable permits and administrative reallocations—is the depth of institutional rules and norms. And even with these rules and norms equity in water use has been difficult to protect—an outcome that should figure prominently in public policy debate in developing countries.

Source: Meinzen-Dick and Ringler 2006; NNMLS 2000.

The evolution of private water markets in Chile has underlined the complex interaction—and the potential tensions—between efficiency and equity goals. Water efficiency has increased dramatically since the mid-1970s, reflecting the incentives and market signals that have emerged from the trading of water rights. Producers in agriculture and in water-intensive industries such as mining have responded to higher water prices by adopting new technologies, including the drip irrigation systems that have sustained an export boom in high value-added fruits and vegetables.

The development of water markets in Chile has unquestionably enhanced efficiency and helped make possible the sustained growth in high value-added agricultural exports. However, efficiency gains in water management have outpaced the management of equity. During the 1980s and 1990s the absence of effective regulatory structures led to water monopolies, market distortions and highly unequal outcomes. Small farmers were marginalized and unable to capitalize on water rights. Meanwhile, indigenous communities lost water use rights to mining companies able to assert private property claims.

The Water Code Reform adopted by Chile in 2005 marks an attempt to address these problems and fill the regulatory vacuum in water markets. The new legislation limits speculative activity, breaks up water rights monopolies and protects small farmers.[19] Indigenous groups have also mobilized to use the legal system in a bid to reassert their claims. In 2004 the Aymara and Atacemeños indigenous groups in northern Chile secured a historic ruling that customary use establishes a prior claim that overrides subsequent private water rights.[20]

Proposals for transferable water rights have generated an intense debate across the developing world. In Indonesia, Sri Lanka and Thailand such plans have generated concerns that the market power of large producers and industry will strip small farmers of their access to irrigation water. Those concerns are justified. In theory, leasing or selling water rights could offer a source of income for poor farmers—just as it has for farmers in the western United States. But there are asymmetric power relations, inequalities in access to information and disparities in capacity for legal recourse. These problems can be added to the obvious dangers of farmers being forced into "distress sales" of water rights during periods of crisis caused by drought or crop failure, with vulnerable households losing water rights in return for short-term monetary gain.

Ultimately, water rights cannot be considered in isolation from the political and institutional structures that govern them. In that respect water markets are no different from any other market. What is distinctive about water is its pivotal role in the livelihoods of people and the environment of a country. These unique properties point to the need for highly developed systems of rules and institutions to ensure that important public policy objectives of social justice and ecological sustainability are not subordinated to the pursuit of private gain.

For developing countries private property rights in water are unlikely to offer easy solutions for reallocation, especially if equity is a policy goal. Developing the institutions, rules and norms to regulate water markets in the public interest is a complex exercise, as the experience of Chile and the United States shows. In most cases rapid shifts to transferable rights systems are likely to lead to unacceptable social and political consequences in developing countries facing intense competition for water resources. The more feasible option is to gradually develop existing rights and strengthen provisions for the poor.

The water rights agenda—missing equity and empowerment

In recent years reforms based on the integrated water resources management model have brought water rights back to the front of the policy agenda. While reform paths have varied, two clear strands have emerged. In a large group of countries—including Ghana, Indonesia, South Africa, Sri Lanka, Tanzania and Thailand—new legislation has formally declared water to be state property. The aim has been to create a unified legal framework for governments to allocate

It is important that public policy objectives of social justice and ecological sustainability are not subordinated to the pursuit of private gain

Water rights, licences and permits are intended to facilitate adjustment to growing competition, but a highly visible equity gap remains

water rights within the limits of environmental sustainability, treating water resources in an integrated fashion. The second strand involves water withdrawal permits within a formal water economy. In effect, permits and associated licensing arrangements are intended as an alternative or a supplement to pure market pricing, with allocations based on government priorities.

Like water rights, licences and permits are intended to facilitate adjustment to growing competition. However, a highly visible equity gap remains. One notable feature of the approaches that have emerged is the absence of redistributive provisions. In this respect, greater equity has been a far weaker objective in water governance reform than in land tenure rights. An exception is the 1998 South Africa Water Act (box 5.3). It provides a legislative framework for pro-poor redistribution, but outcomes have fallen short of objectives because of the slow pace of land redistribution—a key requirement for poor households to increase their share of water use in agriculture.

The failure to ensure equity has been exacerbated in implementation. Strengthened government controls over water allocation through use permits have gone hand in hand with policies that back urban and industrial claims against agriculture. In the implementation, if not in the design of legislation, the political voices of powerful urban and industrial water users have invariably overridden the claims of rural residents. This tendency has been especially pronounced in countries seeking to balance the competing claims of rural users with high growth industries. Although China has legislated for water rights since 1993, it has managed demand through centralized policy and allocation mechanisms, sometimes without sufficiently compensating farmers.[21] This is especially pronounced in the northern plains, where agricultural water withdrawals have been falling since the mid-1990s while industrial and urban demands have risen sharply.

Another example comes from the Philippines. Manila draws almost all of its water from a single source, the Angat Reservoir, shared with farmers in one of the country's largest irrigation schemes. Both municipal and agricultural users have established rights. But adjustments to shortage are heavily skewed against the interests of farmers because of the political strength of the Metropolitan Waterworks and Sewerage System in Manila. This has made livelihoods more precarious for agricultural producers (box 5.4).

Formal licensing systems aimed at managing reallocation to enhance efficiency while protecting equity often obscure the realities of unequal power relationships. As a rule of thumb, the importance of power in shaping outcomes from legislation is inversely related to regulatory capacity. Weak regulatory capacity increases the scope for exploitation of unequal relationships. In Indonesia water for commercial purposes is governed by formal permits that limit volume. Licences cannot be traded, and water use cannot be supplemented through informal trading. By law, smallholder farmers have priority access to water. In practice, the effectiveness of these provisions depends on the capacity of governance institutions to regulate water abstraction. The textile industry in West Java has

Box 5.3 Water rights and redistribution in South Africa

Unlike most governments, South Africa has explicitly targeted redistribution as a policy goal in integrated water management.

Under apartheid water use was based on the English common law principle linking control and use rights to private property in land. With more than 80% of land in the hands of white farmers, who also controlled irrigation boards, this excluded the majority of rural people from groundwater, springs and dams on private property. The 1998 National Water Act declared water to be a public resource owned by all citizens.

A minimum amount of water for drinking is now guaranteed as a legally enforceable right (see chapter 1). In rural communities individuals have use rights to water for domestic purposes or small-scale gardening without payment or registration. For water for commercial purposes, individuals are required to purchase a licence. The money generated from the licensing system is intended to contribute to the costs of water management. Individuals are granted water use rights for up to 40 years.

Public regulation is intended to set controls on the volume of water used to limit overexploitation. By abolishing "riparian rights" and transferring water to public ownership for allocation through state licensing, the legislation creates a framework for the redistribution of part of the country's natural capital stock. But redistributive outcomes will be conditioned by the redistribution of the other central pillar of natural capital—land.

Source: Perret 2002; Hodgson 2004; Faysse 2004; Muller 2006.

Box 5.4 Overlapping water rights and unequal exchange in the Philippines

Diverse and overlapping water rights can be managed through governance systems that mediate between different claims. The extent to which equity figures in the governance equation is determined by the politics of water management.

The Angat-Maasim River system in the Philippines serves a large irrigation area and the municipal and industrial sectors of Metropolitan Manila—a megacity with a population of more than 10 million and growing at more than 1% a year. Three different agencies hold state-recognized water rights to the reservoirs: the National Irrigation Administration (NIA), the Metropolitan Waterworks and Sewerage System and the National Power Corporation. The NIA stands at the apex of a hierarchy of rights, but the water code has emergency provisions that give priority to domestic users.

In most years there is enough water to meet the needs of all users. During periods of drought and shortage, however, agriculture loses out heavily not just to municipalities but to industry as well. With the 1997 El Niño-related drought agriculture received no water for the dry season crop while industry's allocation fell only marginally. The irrigation system lost 125 metric tons of rice production and associated income, but farmers still had to meet rental payments. Many went into debt or lost their land. Because rights to water are vested in the NIA, rather than in a water user association, farmers were not compensated. The financing capacity of the NIA was compromised by the loss of income from irrigation service fees, weakening its ability to maintain the irrigation system.

The limited rights of farmers to water, coupled with the political power of industrial lobbies in Manila, produced an inequitable distribution of adjustment costs.

Source: Meinzen-Dick and Ringler 2006.

circumvented the rules by informally purchasing water rights upstream, leading to a loss of livelihoods for downstream producers (box 5.5).[22]

As these cases suggest, formal rights offer no guarantee of equity in the face of unequal power relations. But the absence of a well defined, properly regulated and enforced rights framework is even less likely to enhance water security and opens the door to institutional "water grabs" based on power.

Groundwater management demonstrates the problem. In many developing countries private groundwater extraction has allowed rural-urban water transfers through unregulated informal markets, with devastating effects in some cases for rural poverty. An example is the irrigation systems of India's Bhavani River, whose waters have been extensively depleted by industries and urban settlements in Coimbatore, Tamil Nadu. Since 1990 water transfers have slashed farm incomes almost in half for those at the tail-end of irrigation systems. Poverty among farm households increased from 3% in 1999/2000 to 15% in 2002/03. Hardest hit have been agricultural labourers who lost employment in irrigation systems: their poverty rates increased from 15% to 34%.[23]

Customary and formal rights—evidence from Sub-Saharan Africa

Formal rights to water will play an important role in shaping outcomes related to the intersectoral transfer of water. At the same time, water use in many countries is governed by a complex interaction between customary rights and formal rights. That interaction has an important bearing not just on water transfers between sectors, but also on the allocation of water rights within agriculture. The development of irrigation potential in Sub-Saharan Africa demonstrates how the interaction between formal and customary water rights can influence human development prospects. Questions over what right is recognized by whom and with reference to what norms and laws play a pivotal role in determining the equity of outcomes.

Competition for irrigation can marginalize the poor—experience in the Sahel

Plans to develop irrigation capacity in Sub-Saharan Africa are gathering pace in many countries. The prize being sought is an increase in productivity and a reduced dependence on the

Box 5.5 Fabrics versus farmers in West Java

Agricultural producers in West Java have strong formal rights to water, reflecting the role of rice farmers in the country's cultural, political and economic development. But formal rights have been eroded in some areas by the competing claims of industrial users.

West Java has been the site of a fast expanding textile industry. Factories have obtained more water through three routes: government-allocated permits to draw on surface and irrigation water or groundwater, negotiations with local farmers to buy or rent land to acquire water use rights and the installation of additional pumps and pipes.

The first of these routes, the permit, is sanctioned by government. The second, purchasing or renting land, is not sanctioned by state law, but is widely accepted in local law as a legitimate means of acquiring water. The third, installing additional pumps and pipes, is sanctioned neither by state law nor by local law, but is possible because of the political power of factory owners.

How has the legislative framework shaped the pattern of winners and losers? Many companies have exploited the gap between state law and local practice to buy or rent land, thereby acquiring water rights. Because factories have purchased land and water rights from producers upstream, these farmers have been compensated, but farmers downstream have lost out from reduced water flows and illegal overpumping by factories. As a consequence of lost production and increased insecurity of supply, many downstream farmers have been forced to sell their land—and those receiving compensation are not those bearing the greatest cost. The upshot: while farmers in Indonesia have the strongest water rights in both local and state law, conflicting regulatory structures and, more important, the greater economic and political power of factory owners mean that they are often ill-equipped to defend those rights.

Source: Kurnia, Avianto and Bruns 2000.

vagaries of rainfall. However, when an asset as precious as irrigation water is introduced into a water-scarce environment, it inevitably become a focus for competing claims. The danger is that the claims of the politically and commercially powerful will take precedence over the claims of the poor and marginalized.

Developments in the Sahel demonstrate the problem. Here, large irrigation systems are comparatively rare, though they are likely to become more common in the future. The development of large systems has often gone hand in hand with the introduction of formal land rights. In one large scheme, the Office du Niger in Mali, customary systems have effectively been replaced by government regulations. Because the public investment cost of developing irrigation facilities is high—direct costs are more than three times as high per hectare in Sub-Saharan Africa as in South Asia[24]—generating high returns has been important. To attract private capital, successive governments in Mali have strengthened tenure security and created private property rights in land. An explicit objective has been to attract investment from large-scale commercial producers. One concern is that smallholders will be disadvantaged. Is this concern justified?

Large-scale producers are not inherently more efficient than small-scale producers in irrigated areas. In fact, there is evidence from several countries that smallholders can be more efficient than large commercial farmers. However, increased market orientation can strongly favour large-scale commercial producers. In 2004, for example, the Malian government decided to sell some 3,000 hectares of land in the Office du Niger to private operators, with less than 10% set aside for smallholders. At the same time some 4,000 eviction orders were served on small farmers accused of not paying water fees. As ever with water, the issues are rooted in local politics. But the Office du Niger, one of the most efficient irrigation systems in Sub-Saharan Africa, now faces the difficult challenge of managing the competing claims of smallholder farmers and politically influential large-scale producers.[25]

Similar problems have emerged in Senegal. The future of smallholder family farming is at the centre of a protracted debate in the country.

Some see the sector as a source of employment, innovation and food security in an environment marked by extreme uncertainty, financial constraints and extensive poverty. Others see a need to modernize agriculture through large-scale capital investment. The government's rural development programme seeks to develop both sectors. But in the Senegal River Valley decentralized rural councils have sought to attract large-scale foreign investors from France and Saudi Arabia, providing access to land and irrigation resources. The resulting competition for water has attracted opposition from farmers claiming customary rights to the land and water, forcing national authorities to intervene.[26]

Customary law can both enhance governance and exacerbate inequalities

Some people view customary law as an obstacle to progress and modernization in agriculture, and others view it as guarantor of equity. Both perceptions suffer from exaggeration. Customary law is often part of a highly sophisticated set of institutions for managing water as a scarce resource. It can also be a driver of inequality.

Evidence drawn from the Senegal River Valley reveals the complexity of the governance issues raised. Advocates of private property rights consider customary law as a route to the "tragedy of the commons". Lacking any formal legal binding on water use, the argument runs, individual users have no incentive to curtail demand, leading to the depletion of shared water resources by overuse. In fact, customary law often involves strict controls on water use, with water rights structured to balance claims based on inheritance, social need and sustainability. Institutional cooperation is common. One study of the Dieler Canal in Senegal found villages cooperating to finance the maintenance of canals and drainage systems and to regulate the amount of water drawn from the feeder lake. These villages are now engaged in dialogue with large-scale agro-industrial enterprises, encouraging irrigation methods that consume less water, such as drip irrigation.[27]

On the other side of the equation, customary law is not inherently more equitable than formal land rights. In many irrigation schemes customary rules that underlie social stratification tend to resurface after the renegotiation of land rights. Customary landholders are often well placed to use their position as chiefs or councillors to skew formal rules to perpetuate their privileged access to land. This has happened in the Senegal River Valley, where decentralization and the introduction of formal land laws enabled the guardians of customary law to foster inequality and social exclusion (box 5.6).

Box 5.6 Customary law and inequality in Senegal

Customary water rights are sometimes seen as inherently more equitable and democratic than formal water rights, with local institutions providing a high level of accountability within traditional structures. But evidence cautions against idealism. In many contexts customary landholders use their position in the community to circumvent formal rules and perpetuate their privileged access to land.

Towards the end of the 1980s Senegal transferred management responsibilities for irrigated lands to local governments. Since then, elected rural councils have assumed responsibility for allocating irrigated plots to user groups, which then allocate plots to individual users.

In the Fleuve Valley on the Senegal River communities are divided by rigid hierarchies that differentiate descendants of slaves and nobles. Both groups operate plots in the Senegal River Valley irrigation scheme. Democratic rural council elections give descendants of slaves the same formal opportunities for office as descendants of nobles—and all villagers are eligible for irrigated land on the basis of distribution criteria linked to family size. But social status figures in the election process. In the rural community of Bokidiawe, a typical example, 30 of 32 elected councillors are of noble origin.

Research shows how the rigid dividing line sometimes drawn between formal and customary arrangements can be illusory. Local landholding elites wear multiple hats, straddling statutory and customary institutions. In Bokidiawe the community leader is at once a village chief, a rural councillor, president of the land user group, member of a political party and a relatively large-scale rice grower.

Local elites often use their position to maintain control over irrigated land. In Senegal customary landholders have been able not only to capture a disproportionately large share of irrigated land, but to allocate and sell irrigated land to powerful outsiders (including politicians, army and government officials, and judges) despite legislation restricting access to irrigated land to local residents. Meanwhile, lower caste farmers have been forced to enter sharecropping arrangements to gain access to irrigated land, paying part of their crop as rent, even though sharecropping on irrigation schemes is illegal.

The Senegal River Valley has wider relevance. Water governance reforms typically emphasize equal access to irrigated plots for all eligible people. But while statutory laws aim to promote equity in access to water and to support greater participation and accountability, the democratic and egalitarian principles that underpin them are often at odds with customary principles that entrench social hierarchies and gender inequalities.

Source: Cotula 2006; Sylla 2006.

Water rights matter because they shape entitlements to water, both in a formal legal sense and through informal processes that empower—or disempower—people

Gender inequalities pervade both formal and informal land rights. Within most customary systems women enjoy well defined use rights but very limited decision-making authority. In Comoe Province of Burkina Faso, men have traditionally controlled the uplands used for growing groundnuts and cotton, while women cultivate rice and enjoy use rights in the lowlands. When a major infrastructure programme was launched in the early 1990s to extend irrigation to the lowlands, design and implementation were guided by traditional male chiefs and a male-biased interpretation of customary law. The outcome: improved lands were allocated to male household heads, productivity declined and gender inequality increased. The programme later corrected this male bias by involving women in land allocation.[28]

Formal rights are not a guaranteed route to equity

While formal property rights linking land and water can offer greater security, they can also conflict with customary rights. In the event of conflict formal rights often take precedence over customary rights.

Evidence of the problem is widespread in areas with pastoral systems of production. Across parts of Sub-Saharan Africa pastoralists have consistently lost out as a result of water shortages, increased pressure on land and the extension of formal land rights. Enclosing a water point, creating an irrigation scheme or attaching a legal title to land can shift the power relationship between sedentary producers and pastoralists, whose entitlements are rooted in weaker (often nonenforceable) customary claims. In northern Uganda, southern Tanzania and northeastern Kenya violent clashes between farmers and pastoralists have become increasingly common. Tensions between private and customary claims are intensifying. In Niger legislation introduced under water governance reforms allows for private water points in pastoral grazing areas. Elsewhere in West Africa, new open access wells constructed by the state have undermined traditional sharing systems. The public wells have been taken over by larger, more powerful herders, including customary chiefs, traders and politicians, reducing access to water for other herders.[29]

Conflicts between formal and informal land rights are sometimes heightened by poor policy design and weak regulatory capacity. Managing the interface between diverse groups of users with different legal claims and interests, but linked by the same water system, is an institutional challenge. In Tanzania the Pangani River Basin has been the site of an ambitious attempt at integrated water resource management. The large majority of water users in the basin are livestock keepers and smallholders farming in wetland areas. Growing population pressure and demands from industry and irrigation have created problems of water scarcity, especially during the dry season. Formal water abstraction rights and fees failed to address these problems, and in many cases made them worse by creating unintentionally perverse incentives for large users to overextract water (box 5.7).

Water rights shape entitlements

Water rights matter because they shape entitlements to water, both in a formal legal sense and through informal processes that empower—or disempower—people. While rights are important for everyone, they matter more for some than for others. Wealthy and powerful people have many ways of protecting their interests, whether through legal or political channels. Lack of secure and enforceable rights pose a much bigger problem for the poor, especially in water. If the access of poor households to a resource as essential as water can be taken away without consultation, compensation or even advance notice, livelihoods become more precarious, and the incentives that people have to invest in improving their lives are severely compromised.

Stronger rights and enforcement mechanisms can help vulnerable producers resist the encroachments of large industry, commercial agriculture and urban users. But water rights can be a double-edged sword. The formalization of rights may also expand opportunities for those who are wealthier, more powerful and better connected, marginalizing those lacking the capacity, the confidence or the political connections to

Box 5.7 Winners and losers from water policy reform on the Pangani River in Tanzania

Water policy reform in Tanzania highlights the unintended consequences of introducing new water rights into systems of customary regulation.

Over the past decade the Tanzanian government, with international support, has put in place new administrative rights systems to improve basin-level management and enhance cost-recovery for service provision. The Upper Ruaha catchment area on the Pangani River has been a centre for reform. The majority of water users there are small-scale irrigators and livestock keepers who have traditionally managed water resources through customary arrangements without state support. Competition has increased with large irrigation upstream and rising demands from urban users.

Since the reforms introduced in the mid-1990s Tanzania has devolved authority to water user associations and introduced fees. Water user groups now have to pay a minimum flat rate fee with a view to conserving water and mobilizing revenues. The fees—averaging $35–$40 for individuals and groups—are applied to all users of surface and groundwater.

Having to pay for a previously free resource has caused extreme hardship for small-scale farmers and livestock producers. Perversely, the collection costs for revenue administration have exceeded revenue flows, defeating one of the stated purposes. Another perverse result is that a reform process designed to conserve water has instead encouraged overuse. Large-scale irrigation users have accepted the new fee structure, but they view paying the formal charge as an entitlement to use water without any limit, regardless of seasonal flows. Large producers have been expanding irrigated land area, citing payment of the water fee as justification. Overuse by upstream irrigators, previously restricted by customary rules, has increased shortages among downstream users during the dry season. Imbalances in political voice have made the problem worse: not a single water user association had been established in the downstream plains by 2003, six years after the reforms were instituted. Thus the administrative reform has also created more serious equity problems.

Fees for water use make sense for large-scale users, urban providers and industry but small-scale users managing their own water systems should be exempted. Similarly, acquisition of formal water rights should not be treated as a licence to unrestricted use: volumetric and proportional controls are needed to align supply with demand. Under a poverty-focused planning framework, volumetric and proportional allocations to large-scale modern users should take into account the needs of vulnerable small-scale users.

Source: Van Koppen and others 2004; Lankford and Mwaruvanda 2005.

act on their rights. As a group, customary rights holders may lack legal standing. An obvious danger is that narrow interpretations of water rights, based on formal state laws, will exclude groups such as women, pastoralists and smallholders.

Individual or group water rights are an important instrument for human development. The absence of secure rights can expose already vulnerable people to higher levels of risk and uncertainty, increasing their vulnerability to poverty. Much depends on local context and institutions. But one of the broad lessons is that for water rights to be meaningful for the poor, rights have to be linked to wider strategies for empowerment and equity. These strategies include legislative provisions that enshrine the rights of the marginalized and legal processes that are open to the poor.

Better governance in irrigation systems

Across much of the developing world irrigation systems will bear the brunt of increased competition from other users. That is especially the case in Asia, where irrigation is losing its privileged position as first among equals in claiming water. One challenge is how to manage transfers from agriculture to nonagricultural users. While the quantities involved may appear small when measured against water volume used in agriculture, diversion can have a profound impact on livelihoods. At the same time irrigation systems themselves will become

As irrigation systems come under pressure to produce more with less water, there is a danger that unequal rights and entitlements will widen inequalities

the locus of growing competition, as producers seek to maintain access to an increasingly scarce resource.

As irrigation systems come under pressure to produce more with less water, there is a danger that unequal rights and entitlements will widen inequalities. That outcome would have important implications for human development. Access to irrigation is associated with lower poverty levels. Even so, some one-third of people living in irrigation systems are below the income poverty line because of inequitable benefit sharing and poor performance.

Does the enhanced efficiency needed in irrigation systems to raise water productivity automatically conflict with equity objectives? Best evidence suggests that there are no inherent efficiency-equity tradeoffs. Indeed, greater equity is one of the requirements in many countries for improving basin-level efficiency. Others are increased investment, the reform of centralized top-down planning and the development of more accountable service provision.

Reducing the risk of poverty

Irrigation systems reduce the risk of poverty—but some reduce the risk more than others. Reasons vary, but the distribution of land and differences in governance are recurrent themes.

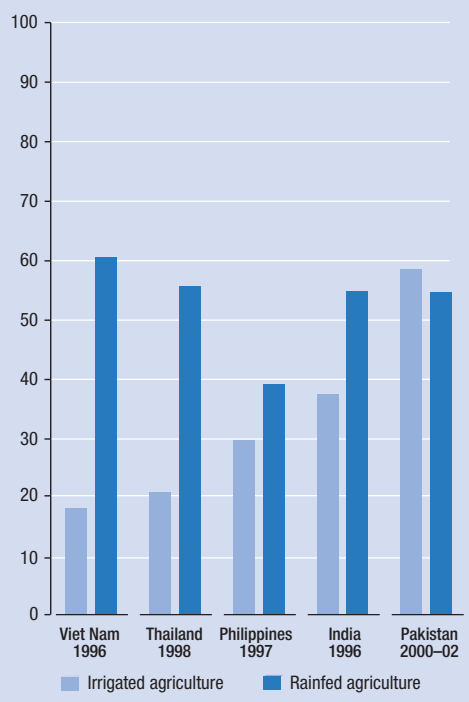
Poverty, inequality and inefficiency

Cross-country comparisons between South and East Asia demonstrate the relationship between poverty and inequality, and efficiency. The prevalence of poverty in irrigation systems in (relatively equal) Viet Nam, for example, is far lower than in (far more unequal) Pakistan and India. Indeed, Pakistan has the distinction of being one of the few countries in which poverty levels have been found to be as high inside the irrigation networks as outside (figure 5.4).

Within irrigation systems unequal access to water is a corollary of unequal access to land. In Pakistan the largest 2.5% of farms (more than 50 hectares) account for 34% of cultivated land while the smallest 55% of farms (less than 5 hectares) account for 12%.[30] Because water allocation in irrigation systems is based on size of landholding, larger farms get the most water. This matters for the efficiency of water use because cropping intensity and productivity are inversely related to farm size: small farmers get more output per hectare and more crop per drop. Comparative research on different irrigation systems has found productivity per hectare to range from $230–$690 in South Asia to $665–$1,660 in East Asia. Measured on this indicator China, with relatively equitable land distribution, is the most efficient irrigator and Pakistan the least efficient (figure 5.5). [31]

Higher productivity is the link from irrigation to lower poverty through increased incomes and, in many cases, greater opportunities for employment. By one estimate Pakistan could reduce the prevalence of poverty within its irrigation systems by 20% if it were to increase its income per hectare to China's levels.[32] Such an outcome would be good for the poor and good for the country because of the benefits for growth—but it would require a commitment to land redistribution and the development of marketing and input support systems.

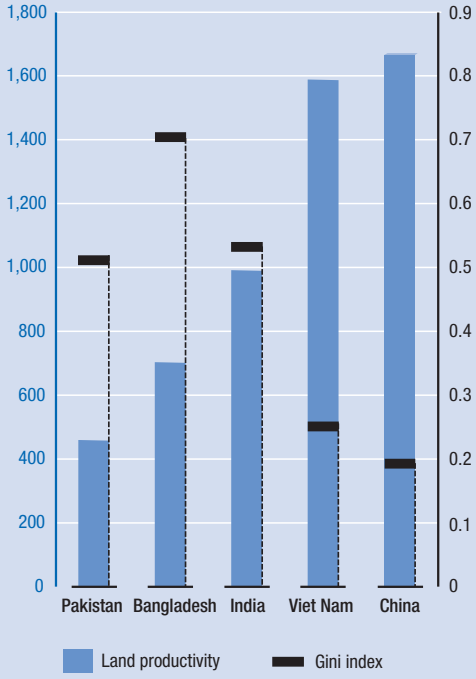
Figure 5.4 Irrigation is linked to lower poverty in many developing countries



Note: Data refer to selected sites in each country.

Source: Hussain and Hanjra 2003.

Figure 5.5 Agricultural productivity and equity are often closely related



Note: Data refer to selected sites in each country.

Source: Hussain 2005.

Tail-end disadvantage

Water scarcity is not the main cause of poverty in most irrigation systems. The underlying problem is the rules, institutions and power relationships governing access to water. Where a producer is located on an irrigation system determines the availability and reliability of water flows.

Tail-end farmers, away from the head or middle of canals, suffer a twin disadvantage: less water and more uncertainty. Farmers between the head and the middle of an irrigation canal get an abundant—often overabundant—supply of water, while those at the tail get too little (figure 5.6). In India and Pakistan it is typical for tail-end producers to receive less than a third of the water of farmers at the head of the canal.

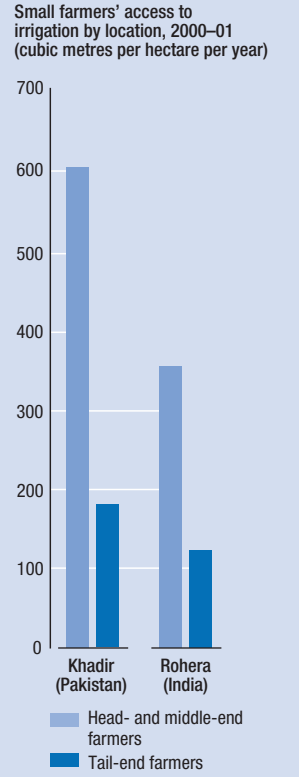
Such inequalities erode the potential human development benefits of irrigation. Low water flows restrict the scope for adopting new varieties of seeds and new technologies to boost productivity and thus contribute to higher levels of poverty among tail-end irrigators (figure 5.7). Uncertainty and fluctuations associated with water supply increase household vulnerability and risk and create disincentives for investment. Once again, irrigation modelling has found that the reallocation from head-end to tail-end users in Pakistan can generate win-win outcomes—production and incomes at the tail can be increased with little impact at the head. Thus there is considerable scope for improving overall system productivity and enhancing efficiency.[33]

So why do governments not seize opportunities for such win-win outcomes? The answer lies in politics, not economics. Relative power, not comparative efficiency, governs water allocation systems in many countries. Rich farmers with political power can influence the timing and volume of water releases by manipulating canal managers. Meanwhile, unaccountable and sometimes corrupt governance systems harm the poor by favouring people with political connections and money for bribes. Research on an irrigation system in the Punjab in Pakistan found that a few large farmers were illegally appropriating large amounts of water from nine outlets, receiving benefits of $55 per hectare per year, while downstream losses of some $7 per hectare per year were spread across a large group of producers served by 40 outlets.[34] Small farmers at the tail-end cited their inability to afford legal costs and the corruption of local legal systems as the major barriers to contesting the illegal appropriation—a problem documented in the *Pakistan National Human Development Report 2004* and found throughout much of Asia.[35]

Financing with equity

The financing of irrigation systems raises central questions of efficiency and equity. The underfinancing of irrigation infrastructure leads to the rapid erosion of canals and drainage systems, with associated costs for efficiency and the environment. Central Asia presents an extreme case of the human development problems linked to the poor governance of large-scale irrigation systems (box 5.8). But the problem is far broader.

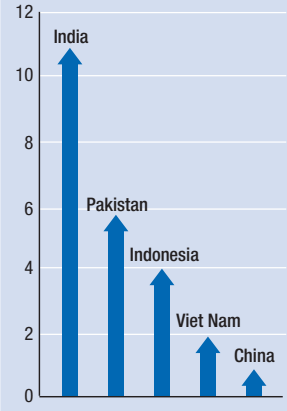
Figure 5.6 Heads you win, tails you lose on quantity...



Note: Data refer to selected sites in each country.

Source: Bhattarai, Sakthivadivel and Hussain 2002.

Figure 5.7 ...and poverty is higher among tail-end farmers



Note: Data refer to selected sites in each country.

Source: Hussain 2005.

Box 5.8 Irrigation and water management in Central Asia

Central Asia is blessed with abundant freshwater flowing down from glaciers in the Hindu Kush mountains. The region also has one of the world's most expansive irrigation systems—a legacy of a Soviet modernization model that often pushed irrigation development to generate short-term agricultural revenues at the cost of the environment. The system's collapse is now holding back human development and reinforcing poverty.

With an arid climate across much of the region, irrigation water is indispensable for agriculture—and agriculture is the mainstay of national economies and livelihoods across central Asia. Irrigated agriculture accounts for more than a quarter of GDP in Tajikistan and Turkmenistan and more than a third in Kyrgyzstan and Uzbekistan. Some 22 million livelihoods depend on irrigation. The regional inheritance from Soviet planners includes a large number of dams, canals and pumping stations, most of them on transboundary river systems. Another inheritance is the Aral Sea environmental disaster, caused by the diversion of river systems for cotton irrigation (chapter 6).

Poor management and deteriorating drainage infrastructure have led to extensive water-logging and salinization, especially in downstream states. In the Amu Darya and Syr Darya River Basins in Uzbekistan and Kazakhstan salinization has increased by more than 50% in a decade. Rising groundwater, one of the drivers of salinization, now poses a huge threat to agriculture.

The water scarcity in much of the region owes less to availability than to infrastructure decay. Measured per hectare, water use in Central Asian irrigation systems is 30% higher than in Egypt and Pakistan—themselves not the most efficient water users. Evaporation, siltation of canals and leaks from piped channels mean that less than 40% of the water diverted from rivers reaches the field. Breakdowns of pumping stations used to lift water over elevations of several hundred metres have been another source of scarcity. Inefficiency generates very large losses: Central Asian countries lose an estimated $1.7 billion annually to irrigation mismanagement.

Tajikistan illustrates the scale of the problem. Since 1991 more than a fifth of the country's irrigated land has ceased to receive water, leading to a loss of 4% of GNI by one estimate. Two-thirds of the country's 445 pumping stations are out of operation, reducing flows by 40%. And water losses through the irrigation infrastructure are increasing from already high levels. The collapse in infrastructure has gone hand in hand with a decline in public investment. Financing for the sector in 2002 was reported at a tenth of that in 1991.

Solutions are not easy. Irrigation management in the Soviet era was highly centralized in Moscow. In the post-Soviet era some governments went to the other extreme, transferring authority to private water user associations. The lack of financing for the maintenance of the wider infrastructure, inability to afford rising electricity charges for pumping and constraints on the mobilization of local financing led to the collapse of many of these associations.

Weak regional cooperation has been another problem. Rural livelihoods across the region are linked through shared river systems. The giant Karhsi pumping cascade lifts water from the Amu Darya to irrigate 400,000 hectares of agricultural land on the steppes of southern Uzbekistan. Six of the seven pumping stations are in Turkmenistan. Differences between Turkmen and Uzbek authorities have meant underinvesting in the pumping system and shelving international aid plans to support its modernization.

Enhanced cooperation in the region and beyond is vital to recovery (see chapter 6). Downstream users such as Kazakhstan and Uzbekistan depend critically on the volume and timing of releases from upstream Kyrgyzstan. Kyrgyz authorities are exploring options for expanding hydropower generation, which would further reduce downstream flows. The costs of noncooperation will be very high: financing water self-reliance through new dams in Kazakhstan and Uzbekistan is a high-cost option. The economic benefits of cooperation are substantial, but cooperation is underdeveloped.

Central Asia's water interdependence extends to other neighbours. Failure to manage this interdependence will exacerbate water shortages in agriculture. Countries in the region depend on rivers that rise in Afghanistan, China and Russia and flow through shared river systems. For example, the Irtysh and Ili Rivers originate in China and flow into Kazakhstan. As water scarcity mounts in China, authorities have announced plans to divert water from these rivers into Xinjiang Province. If Afghanistan expands irrigation in its part of the Amu Darya Basin, it will influence flows into Tajikistan, Turkmenistan and Uzbekistan. These cases demonstrate the very real implications of water interdependence and the equally real dangers of failing to develop cooperative governance systems.

Source: UNDP 2003a, 2005a.

In South Asia the dominant model of irrigation infrastructure provision has been aptly described as "build-neglect-rebuild".[36] By an international yardstick replacement and maintenance of irrigation infrastructure require annual spending of about 3% of the value of the capital stock. In the Punjab in Pakistan actual spending is less than one-tenth of this benchmark. Financing for irrigation maintenance in India is greater but still less than half the minimum. Chronic underinvestment in system maintenance has led to widespread problems of siltation, soil-salinization, water-logging and reduced flows in both countries.[37]

Financing for irrigation systems often reinforces the inefficiency-inequity cycle. In South Asia irrigation charges are typically very low by comparison with those in East Asia, both

Table 5.1 **Irrigation charges and value of production for selected irrigation schemes in Asia**

Country	Average water charge ($ per hectare)	Average water charge as share of gross value of production (%)
Pakistan	7.4 [4.6–10.6]	2.5 [1.7–3.9]
India	10 [10]	2.8 [1.6–4.3]
China	46.5 [26–67]	3.6 [1.8–5.1]
Viet Nam	59.5 [58–61]	5.5 [4.6–6.3]

Note: Data refer to the average of selected sites in each country, with the range shown in brackets.

Source: Adapted from Hussain and Wijerathna 2004a.

in absolute terms and as a share of the value of production (table 5.1). These low charges are sometimes defended on the grounds that they are good for food security and for poverty reduction. This overlooks some serious equity problems.

How and where governments spend for irrigation are also important for equity in access to irrigation. In Latin America water is one of the assets driving extreme disparities in rural areas—and government spending sometimes widens them. The Majes project in southern Peru, to take one example, required public investment of about $1.2 billion to capture and collect water from the Colca Valley to irrigate the desert lowlands. The project irrigates about 15,000 hectares of land for 3,000 producers—at a capital investment of $400,000 per beneficiary. An evaluation by the Economic Commission for Latin America estimated that less than 1% of the public investment benefits would be realized in the upper basin, a centre of indigenous poverty in Peru. This is an extreme example of a wider pattern. In Ecuador peasants make up 60% of the rural population but receive only 13% of the benefits from state spending on irrigation. At the other end of the rural social divide, fewer than 5% of rural irrigators have more than 50% of the water rights concessions.[38]

Charging for water

Irrigation charges are typically levied as a flat rate assessed on cropped area, so that tail-end farmers pay the same even though they get less—and less reliable—water than head-end and middle users. Moreover, poor small farmers pay more per hectare since they tend to crop a larger share of their land, with tail-end farmers also paying more, because the unreliability of irrigation water forces them to invest in groundwater extraction (some nine times more expensive than canal irrigation). Just as high-income urban consumers pay less for their domestic water than people in slums (see chapter 2), some of South Asia's poorest farmers pay more for their irrigation water than their countries' largest landowners. In China and Viet Nam charges are higher overall than in South Asia—but water is more equitably and reliably distributed across the system, enabling poor producers to finance payments through higher productivity.[39]

There are no blueprints for ensuring equity in the financing of irrigation infrastructure. The capital costs of building irrigation systems are far too high for producers to bear. That is why governments since the time of the ancient Egyptians through the Mughals to the US administrations of the 1920s and 1930s have financed capital costs out of general tax revenue. Finance for maintaining and operating systems, however, should be borne principally by users, with pricing differentiated by the ability to pay and the service provided.

This is broadly what happens in East Asia and in better performing irrigation systems worldwide—such as those in Egypt, Morocco and Turkey—and what does not happen in South Asia, where government subsidies weigh far more heavily. In Pakistan less than half the operation and maintenance costs of irrigation spending are recovered, and most of the benefits are captured by large-scale producers. In India about 13% of the population has access to irrigation. Within this group the richest one-third of farmers receive 73% of the subsidy.[40] Meanwhile, low rates of cost-recovery often lead to poor service, especially at the tail-end of irrigation canals. Low rates of cost-recovery also lead to high inequity.

Collecting revenues

Cost-recovery cannot be considered in isolation—it is part of a wider system of

Governments since the time of the ancient Egyptians have financed the capital costs of irrigation infrastructure out of general tax revenue

Reforms have often been more about giving water users a voice than about empowering them with rights

governance for service delivery. One of the most influential institutional changes in governance in recent years has been the introduction of participatory irrigation management and the development of water user associations. In the best cases—as in Indonesia, Mexico and Turkey—institutional reforms have transferred management to irrigation users, with marked increases in revenue collection, maintenance spending and irrigation returns. The lesson: where producers have more authority and responsibility for water management, transparency can improve pricing, cost-recovery and performance.[41]

But giving producers more authority, to be financially sustainable and bring tangible benefits to farmers, requires a combination of financial and institutional empowerment that turns on its head the top-down governance models that have dominated irrigation management. The transformation of the model underpinning state agencies—from supply and control to supporting and developing local management capacity—requires deep institutional reform, a task often more easily said than done.

Similarly, transferring management responsibility to farmers will be successful only where agriculture can be profitable. Returns to irrigation investment are the product not just of irrigation governance but of marketing infrastructure, agricultural extension services and access to information, credit and other productive resources. One of the problems documented across Sub-Saharan Africa is that transfers of irrigation management have often shifted liabilities for system maintenance without addressing market, transport and input provision problems that constrain income generation.[42] In Madagascar the transfer of a dilapidated irrigation infrastructure from regional public sector agencies to water users in the 1980s with no government budget support led to the system's collapse.[43]

Such outcomes are not inevitable. Under the right conditions, water user associations can enable members to participate in designing cost-recovery systems, improving collections and ensuring that the fees collected benefit the systems locally. The accountability of providers is critical. In Sindh, Pakistan, farmers unwilling to pay for irrigation stress that the reason is not the affordability of the water but corruption in management and the failure to provide good water service.

Empowerment—the missing link

Sustainable and equitable financing is one requirement for adjustment with equity in irrigation systems. Empowerment is another. Under the emerging consensus on integrated water resources management, decentralization and devolution of authority to water user associations are seen as fast-track routes to empowerment. But empowerment is more complex than administrative reform.

Decentralization has been a core theme in water governance reforms for more than a decade. In some cases reforms have been partial and incomplete, with a primary emphasis on boosting cost-recovery and reducing pressure on government budgets. In others they have yielded noticeable benefits by improving the responsiveness of irrigation bureaucracies to water users. Decentralization can create new patterns of incentives that make service providers more accountable. Service contracts, auditing and independent water tribunals have been among the mechanisms used to promote accountability of both providers and users.

In Indonesia, following reforms in 2001, water user associations were given full control over the financial administration of irrigation facilities, including setting budgets and prices. Elected association representatives now participate in district irrigation bodies and higher level river basin councils. A more striking example of devolution is in Andhra Pradesh, where the water governance system has been transformed through the 1997 Farmer Irrigation Act (box 5.9).[44]

Having a right to be heard is not the same as having the power to influence decisions. One problem with the governance model for irrigation has been its partial approach to empowerment. Reforms have often been more about giving water users a voice than about empowering them with rights. Decentralization and the devolution of authority to the local level may en-

Box 5.9 Devolution of water governance in Andhra Pradesh

Devolution in water governance has often meant transferring responsibility without financial capacity. The Indian state of Andhra Pradesh provides a striking exception.

The 1997 Farmer Irrigation Act followed intense political debate and consultation among national bodies, state agencies, farmer groups and village associations. More than 10,000 water user associations were created through state-level elections.

The Andhra Pradesh Irrigation Department was decentralized to provide technical support to water user associations, each empowered with decision-making authority to develop and implement service plans, enforce rules and determine spending on maintenance. Financial control and responsibility for cost-recovery were transferred to the associations, which can engage service providers and manage contracts. More than 90% of fees collected are retained locally. The better service provision financed by the fees has resulted in voluntary decisions by many farmers to increase cost-recovery, reversing the past cycle of underfinancing and deteriorating infrastructure.

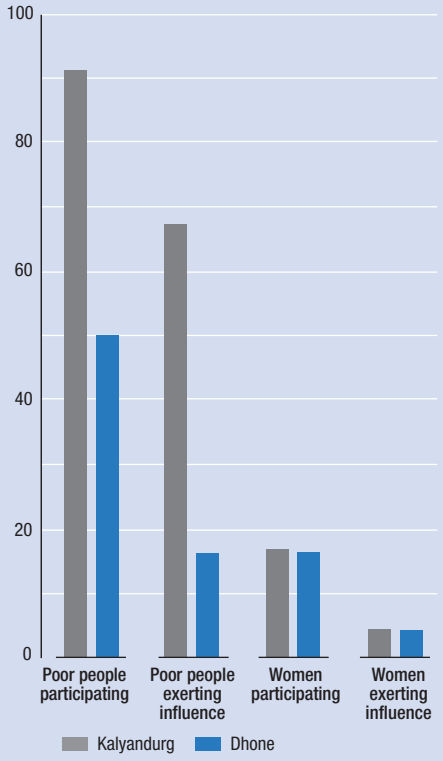
High-profile public audits conducted jointly by water user associations and the irrigation department review political participation within the associations as well as water development issues. Devolution has meant a real shift in the balance of power between water users and government irrigation providers, with providers now far more responsive and accountable to local communities.

But not all community members have an equal say in how priorities are defined. Village-level research has identified large variations in formal participation—and even larger variations in how poor people and women exert their influence. An audit of 102 villages in two representative subdistricts—Dhone and Kalyandurg—found large discrepancies in participation in village meetings on water (see figure). In Kalyandurg, where a nongovernmental organization had been working with farmers for 25 years, poor people felt that they had an influence on decisions affecting them in two-thirds of the villages covered. In Dhone participation and influence scores were far lower, with only 16% of villages registering active influence for the poor (see figure).

Devolution performed far less well in addressing the concerns of women: in only 4%–5% of the villages did women believe that they could influence decisions in village meetings. As the audit concludes: "Women, and particularly poor women, rarely participate in meetings…. Despite impressive advances towards empowerment…women still do not participate effectively in community decision-making."

Managing water—some people have a greater voice than others

Influence and participation in water user associations by the poor and women in two subdistricts in Andhra Pradesh, 2000 (% of villages)



Source: Rao and others 2003.

Source: Rao and others 2003; Vermillion 2005; Sivamohan and Scott 2005.

hance political participation and accountability. Whether that reduces inequality depends on whether disparities in access to land, water and power are addressed.

Old habits die hard…

Decentralizing water governance in irrigation is not an automatic route to enhanced equity, even where policy has an overtly redistributive

Gender inequalities in irrigation are deeply entrenched as a result of formal and informal rules that mute women's voices

design. In South Africa the 1998 water legislation institutionalized the participation of small-scale water users in what had previously been whites-only irrigation boards. Water user associations are now legally obliged to include small-scale users, including farm workers, market gardening groups and farm tenants. While the presence of small-scale users in management structures has given a greater voice to marginalized groups, old power relationships have proven highly resilient. Large-scale commercial farmers still dominate decision-making. Moreover, small-scale users often receive far less water than they are entitled to. Research in the Western Cape and other irrigation districts has found that some small-scale farmers use less than half of their entitlements. The weak political organization of small-scale users and their inability to enforce claims to land appear to be the main causes.[45]

South Africa's experience shows that old inequalities and governance habits die hard. The same is true for corruption. One of the aims of decentralization has been to establish more accountable and transparent governance structures. But progress has been mixed. Surveys of farmers on the Hakra irrigation scheme in the Punjab in Pakistan are instructive. More than half those interviewed felt that efficiency had improved with decentralization and that water theft was less prevalent. But few farmers said that bribery was not a problem, a quarter felt that office holders favoured friends and relatives, and half reported "no change" in benefits for small and poor farmers. These are signs that decentralization is not an automatic route to resolving problems of corruption and poor governance.[46]

…and so do gender inequalities

Tensions between decentralization and equity are also apparent at the household level. Gender inequalities in irrigation are deeply entrenched as a result of formal and informal rules that mute women's voices. In many countries women have use rights to irrigation water but highly restricted rights of control. Control rights are often linked to wider property rights, which are highly unequal between men and women. Lacking rights to land, millions of women in South Asia and Sub-Saharan Africa are denied formal membership rights to participate in water user association meetings. Meanwhile, in many traditional communal irrigation systems people earn the right to use water by working on maintenance. However, cultural norms often preclude women from engaging in this activity. And even when they do, water rights do not automatically follow, as research from Kenya and Nepal documents.[47]

Public meetings on irrigation are often a male domain. Women are sometimes excluded from participation by labour demands in other areas or by a lack of confidence in speaking or a reticence about making demands. One study of women's participation in irrigated agriculture projects in Ecuador cites a woman's summary of the realities of informal gender inequality: "Meetings [of the irrigation association] are on Friday nights. At that time, after cooking for my husband and the kids, I still have a lot of work to do around the house.... Even if I go to the meeting it's only to hear what the men have to say. Men are the ones who talk and discuss".[48] In Andhra Pradesh decentralization may have empowered male water users in their relations with government agencies, but it has done little to give women a voice in management (see box 5.9).

Overcoming these gender barriers is difficult. Women are important stakeholders in food production in irrigated and nonirrigated settings: they produce an estimated two-thirds of the food in most developing countries. But low participation by women in water user associations is a systemic problem not easily amenable to resolution through decentralizing or devolving authority to water user associations. The driving force for change has to come from below. Nongovernmental organizations in Bangladesh, India and Kenya have worked with village groups to increase women's involvement, but the cultural barriers to participation remain high.

Failure to systematically empower and consult women is not just bad for social justice and equity. It is also bad for efficiency: as producers, women have skills and knowledge vital to water management. Recognizing this, some coun-

tries have undertaken bold measures to break down cultural barriers. Legislation in Uganda requires that all political and administrative agencies from the national cabinet down to village water user associations include at least 30% female representation.[49] Affirmative action may not remove cultural barriers—but it does challenge their legitimacy.

Getting more crop per drop, rather than more water to the fields, is becoming the central concern in public policy debates

Greater water productivity for the poor

For much of the past hundred years water shortages in agriculture have been countered by dams and large-scale irrigation works. In the years ahead the focus will shift decisively to demand management. Getting more crop per drop, rather than more water to the fields, is becoming the central concern in public policy debates.

Increasing the productivity of water is one obvious response to water scarcity. One powerful impetus for productivity gains will come through the market. As water becomes more scarce, prices will rise. Other things being equal, this might be expected to create incentives for investment in the development and deployment of new technologies for reducing water use. However, capacity to undertake these investments and to benefit from new technology is not equally distributed. Smallholder farmers lacking assets, tail-end irrigation producers and women are all likely to be bypassed by new technologies unless institutions and policies are put in place to avoid this outcome.

This section looks briefly at the important place occupied by water harvesting and micro-irrigation with new technologies in developing pro-poor options for water governance. Both offer benefits for water security and put water—and water storage—closer to people. They provide households with an asset that can raise productivity and reduce risk, in the same way that large dams and reservoirs can at the national level. Similarly, new pro-poor technologies offer a twin benefit. By substituting labour inputs and small amounts of capital investment for land and water, they can raise productivity and incomes.

Water harvesting and micro-irrigation

Water management is still often seen principally as a subject for large-scale projects and programmes. But small-scale water management can make smallholder agriculture more productive and less risky, with important benefits for human development. The technologies and approaches are well known. The challenge is to develop public policies that emphasize partnerships between communities and government agencies.

Water harvesting

Water harvesting experience shows how community-led initiatives can be scaled up through partnerships. Small reservoirs and rainwater harvesting structures provide an infrastructure framework that, when combined with appropriate land management practices, can increase water availability for the poor and boost the local efficiency and productivity of water use. That framework can enhance water security in rainfed areas, bringing food security and the potential for diversification into small-scale market production.

Rainwater harvesting is one of the oldest recorded hydrological activities. It was used 8,000 years ago in the first human settlements in South Asia and 4,000 years ago in Greece and Palestine. South Asia has a rich history of water harvesting, from the complex integrated

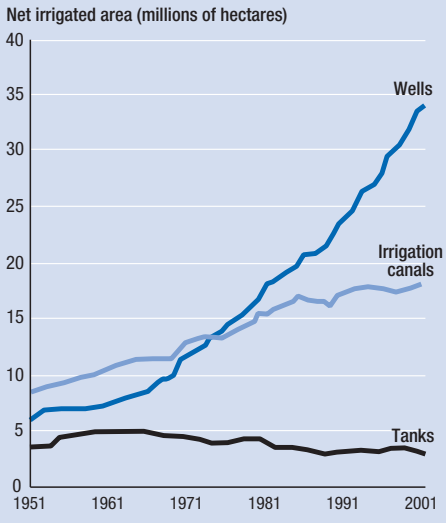
In the modern irrigation era rainwater harvesting structures have been in forced retreat

tank systems developed by the Vijayanagar kings of South India in the 14th century to the thousands of simple village ponds that support a range of local productive and domestic activities today. Across Sub-Saharan Africa too there are diverse traditional water harvesting practices, many involving the direct transfer of rainwater to recharge soil moisture. More than half of Tanzania's rice production is grown under harvesting systems built and managed by farmers. In West Africa harvesting rehabilitates land and captures nutrients washed away by the rain.[50]

In the modern irrigation era, however, rainwater harvesting structures have been in forced retreat. In India the rise of canal irrigation and, more recently, the groundwater revolution have led to systematic neglect of traditional systems (figure 5.8). Since the 1980s the number of tanks, ponds and other surface water bodies has fallen by almost a third, significantly reducing local groundwater recharge capacities—a major concern given the uptake of tubewell technology.[51]

As the groundwater crisis has deepened, state and national government bodies are revising priorities and seeking a new balance. In Gujarat, one of the epicentres of the groundwater crisis, the state government has supported community initiatives to create more than 10,000 check dams (small dams that impound excess water during monsoons and help force the water into the ground) to support irrigation and recharge groundwater. More than 40% of the investment has come from local communities in labour, material and finance. Within three years, every $1 invested has generated $1.50. Village research in Maharashtra suggests the potential for even higher economic returns over the longer term.[52]

Figure 5.8 **Water harvesting in retreat in India**



Source: India 2001.

Extending check dams across all of India's rainfed farming areas would raise the value of the monsoon crop from $36 billion a year to $180 billion, for an initial investment of $7 billion. Of course, this is a cost-benefit estimate that provides no insight into the huge governance challenges that such a programme might entail. But given the very high poverty rate in rainfed areas, it is difficult to envisage another investment with more potential to enhance human development and extend the benefits of India's economic success into rural areas.[53]

Comparisons of the relative efficiency of large- and small-scale water harvesting systems are difficult—and usually unhelpful. The two activities are complementary and should not be seen as substitutes. However, the efficiency claims offered in favour of large-scale infrastructure are sometimes overstated. Intercepting and collecting rainfall where it falls, rather than transporting it through irrigation channels, increases green water moisture in the soil, helps to replenish groundwater and provides a reserve for people to draw on as supplemental irrigation during dry periods. While some small water harvesting structures carry high unit costs relative to large reservoirs, they also offer potential efficiency gains. Recent studies in India, Arizona in the United States and the Negev Desert in Israel show that small dams retain more water per hectare than large reservoirs.[54]

Water harvesting does not make large dams obsolete. In India large-scale infrastructure has 10 times the storage capacity of small tanks—and small reservoirs depend on highly variable rainfall in their own catchments.[55] As chapter 4 argued, the large versus small debate

is fast becoming anachronistic. Even so, small systems maximize the productivity of locally available water and help with groundwater recharge. They begin to address problems locally, relieving the pressure on large, central systems.

Small-scale irrigation

Raising productivity on large irrigation systems by improving maintenance and empowering water users is one response to the emerging water use scenarios outlined earlier. Expansion of the irrigation frontier through micro-level irrigation investments is also important, especially in rainfed areas.

Consider the case of Ethiopia, a water-abundant country. At the head of the Nile it covers 12 river basins and has a per capita water availability of 1,644 cubic metres—a relatively large volume. But because of large spatial and temporal variations in rainfall, farmers can produce only one crop a year. Frequent dry spells and droughts give rise to high vulnerability and poverty, with the well-being of rural populations tied to rainfall. The main problem is predictability rather than availability.

Irrigation offers a way to reduce the risk and vulnerability associated with unpredictability. Up to 2.7 million hectares of land in Ethiopia have irrigation potential, but fewer than 300,000 hectares are developed.[56] Meanwhile, the country has one of the lowest rates of artificial reservoir storage capacity in the world, less than 50 cubic metres per capita in total. Irrigation development could address the problem, but finance is a major constraint. Limited infrastructure means that Ethiopia, like most countries in Sub-Saharan Africa, faces far higher costs per hectare in large-scale irrigation schemes than does South Asia. But research by the International Water Management Institute has demonstrated the potential for expanding small-scale irrigation. Combined with low-cost drip irrigation technologies, it is estimated that with small-scale irrigation infrastructure Ethiopia could double yields over the next 10–15 years at per hectare and per capita costs lower than those required for formal irrigation investments.[57]

Low-technology solutions with high human development returns

As water scarcity constraints have tightened, industry has responded with new technologies—some accessible to poor farmers

As water scarcity constraints have tightened, industry has responded with new technologies. From Southern California to Israel and to the Murray-Darling Basin in Australia commercial producers have been pursuing more crop per drop through sophisticated, often computerized, drip irrigation systems that deliver optimal amounts of water to crops at the optimal time. Today, innovation is creating conditions in which smaller, poorer farmers can join the technological revolution in water management. Seizing the opportunity that this creates for human development will require public policies to overcome poverty-related obstacles.

Micro-level irrigation is at the cutting edge of emerging water management technologies. It has enormous potential. Drip technologies use less water than surface irrigation, deliver it directly to the crop and reduce salinization and water-logging. Unequal distribution of these technologies explains some of the marked differences in water-output rates worldwide. In France sprinklers and drips are used on 90% of irrigated area, compared with 1%–3% in China and India.[58]

Until recently, micro-irrigation technology markets were geared towards large capital-intensive producers. That picture has changed, with technologies becoming cheaper and more widely available. Drip irrigation technologies accessible to poor farmers have taken different forms. Cheap, small-scale bucket-and-drip kits have been developed for vegetable cultivation on household plots. An international nongovernmental organization, International Development Enterprises, has played a catalytic role in breaking down cost barriers to access. One model uses off-the-shelf cloth filters and plastic containers to replace sensitive metallic emitters, reducing the costs of irrigation to $250 a hectare. Field results in Andhra Pradesh, in India, and Nepal show that the area under cultivation has doubled with the same amount of water.[59]

Research by the International Water Management Institute in Kenya and Nepal points to higher productivity, with every $1 invested

Incentives for developing and disbursing new technologies for increasing water productivity have been inadequately developed

generating $2 after subtracting all other costs except labour. In India low-cost micro-irrigation kits—known as Pepsee kits—have been developed and extensively taken up by farmers in semi-arid areas of Madhya Pradesh and Maharashtra, raising yields and increasing the area under cultivation. Studies show that drip techniques cut water use by 30%–60% and boost yields by 5%–50%.[60] Farmers in Burkina Faso, Kenya and Sudan claim threefold to fourfold yield increases using drip irrigation and hand-watering from water-harvesting tanks.[61]

Another innovation is the treadle pump. This cheap and affordable technology ($12–$30) draws water from groundwater sources close to the surface to irrigate up to 0.5 hectares. It has been widely adopted in Bangladesh and eastern India, where groundwater tables are very high. More than 1 million pumps are now being used in Asia, and adopted pump technologies are spreading rapidly across Sub-Saharan Africa.[62] Production costs in Sub-Saharan Africa, at $50–$150 per unit, are still higher than in South Asia, but with documented annual returns to investment of 130%–850% when combined with market-oriented production, their potential for poverty alleviation is great.[63]

Combining micro-irrigation and new technology has the potential to distribute the benefits of irrigation far more widely. It also holds out the promise of facilitating the entry of small farmers into higher value-added markets, both domestic and export. Realizing this promise will require public investment to support the spread of new irrigation technologies and—more important—build marketing infrastructure in more marginal areas. But many countries will first need to review current approaches to agricultural growth. While many governments extol the virtues of smallholder farming, most concentrate scarce public investment on relatively large-scale, capital-intensive commercial farming areas. That approach may be bad for long-run growth and for poverty reduction.

The untapped potential for scaling up is considerable. Micro-irrigation may be expanding rapidly, but it still covers only about 1% of the world's irrigated area. While outcomes vary with location and technology, on-farm water productivity generally doubles with drip irrigation. Working on observed returns to current investment, it has been estimated that the adoption of new technologies by 100 million smallholder farmers could generate net benefits of $100 billion or more.[64] This is one-quarter higher than current aid. Perhaps more important, the returns would be captured directly by communities with a high concentration of poverty. Including the multiplier effects of increased demand, investment and employment, total net benefits could rise threefold, increasing annual incomes by up to $500 for those living on less than $1 a day.[65]

So why are investments in micro-irrigation not taking place on a larger scale? Demand and supply factors come into play. In Jordan volumetric water metering helped to expand drip irrigation rapidly. Farmers were given a strong market incentive to adopt the new technology. But irrigation systems in Jordan are dominated by large producers growing high value-added crops. Extending volumetric metering to hundreds of millions of small-scale farmers in Asia using groundwater and surface irrigation, many of them producing low value-added crops for home consumption, would pose formidable difficulties.

Incentives for developing and disbursing new technologies have been inadequately developed. Responsive market-based supply systems present the most efficient source of outreach to smallholder producers. But governments could do far more to promote research, support social marketing and develop the extension systems that could help markets reach poor people. Rethinking subsidies would help. Instead of providing incentives for groundwater mining through electricity subsidies, governments could offer targeted support for water conservation through micro-irrigation. This is what has happened under the National Water Conservation Programme in Tunisia, where producers can apply for grants structured to reflect farm size and the type of technology adopted.[66]

The way ahead

Governments should look beyond the scarcity equation to wider human development issues, giving equity and empowerment more prominence

As concern over global water supply and food availability increases, governments should look beyond the scarcity equation to wider human development issues. Giving equity and empowerment more prominence in the governance framework is a starting point.

There are three main requirements for addressing the challenge. The first is to prepare a transparent national strategy setting out how water resources will be allocated in the years ahead, to provide predictability. The second is to integrate that framework into national poverty reduction planning exercises, such as the Poverty Reduction Strategy Paper, to ensure that water policy is aligned with wider human development goals. The third is to recognize the rights to water of poor households with customary entitlements and to enforce rights provision by creating institutions that empower the poor. Protecting and extending the water rights of women farmers should be a central priority in all countries.

Irrigation poses special challenges. Devolution with empowerment provides the framework for reform. Recognizing the rights of women in irrigation systems and promoting meaningful female participation in management are vital for translating the rhetoric of empowerment into practical outcomes. At the same time, financing has to be placed on a footing that facilitates, rather than hinders, mutually reinforcing equity and efficiency gains. Sustainable and equitable cost-recovery to finance the operation and maintenance of irrigation systems is important. This has to start with transparent decisions on what costs should be recovered from whom, taking into account the ability to pay. Applying tiered block systems of payment, with low rates for a basic quantity and higher rates linked to volume of use or area is one option. As the International Commission on Irrigation and Drainage has argued, the key principles for cost-recovery are really the same as the principles for irrigation management: transparency, empowerment, sustainability and economic incentives for good practice.

Institutional and legal reforms to empower rural water users are a first step. The initial challenge is to develop legal systems that clarify and strengthen existing rights rather than to introduce sweeping tradable private property rights. This would provide a basis for the development of equitable transfer mechanisms. Such mechanisms, used voluntarily and with provisions for compensation, are better for enhancing water security than arbitrary administrative transfers or imperfect markets. Recognizing customary rights by empowering local institutions is also part of the process. But customary law should not override recourse to formal legal processes to defend such principles as gender equity and nondiscrimination.

Current approaches to irrigation development often neglect opportunities to enhance water security through mutually reinforcing reforms towards efficiency and equity. Putting in place efficient systems of cost-recovery linked to the benefits from irrigation systems would help to rationalize use and to finance maintenance.

Almost all countries recognize the public goods element in irrigation provision. That is why construction and capital costs are heavily subsidized. But these subsidies create a responsibility to ensure that the benefits are spread as widely as possible. In far too many cases this does not happen. For countries where unequal land ownership compromises the efficiency and equity benefits of irrigation, mechanisms for redistribution have to be part of the reform strategy. More widely, irrigation rules can require equitable water shares for the poor and equitable pricing. Policies targeted to the poor can help, such as allocating water on preferential terms at the tail end of irrigation systems, where poverty prevalence is high.

Pro-poor policies will not produce optimal outcomes where poor people are disempowered. Devolving authority and financial capacity to

Empowerment requires challenging the norms and power structures that entrench disadvantage based on gender and wealth

water user associations can change the power balance between users and government agencies, creating more responsive and more accountable governance structures. But empowering poor people and women within water user associations is more challenging. Affirmative action can help. So can the clarification of water use rights and entitlements. Ultimately, however, empowerment requires challenging the norms and power structures that entrench disadvantage based on gender and wealth. Explicitly targeting female farmers in water development and giving women a voice in management is essential for the social and economic success of irrigation programmes.

Public spending on irrigation and water management in many countries has fallen below levels needed to maintain infrastructure. Current national spending on irrigation financing is estimated at $30–$35 billion but is on a steep downward trend.[67] The same trend applies to development assistance. Although international statistics are unreliable, lending for irrigation and drainage by multilateral agencies fell from about $3 billion annually in the mid-1980s to about $2 billion in the mid-1990s, with no recovery since then.[68] In view of the growing pressure on water systems and the threats of global climate change, it is important to reverse this trend. Private finance and public spending by governments will have to provide the primary impetus. But aid also has a role. The World Bank estimates that donor support over the next 20 years will need to double, to around $4 billion annually.[69]

Sub-Saharan Africa should be a priority for donor support. As part of a wider set of measures to support agriculture and rural development, the Commission for Africa has proposed that Africa double the area under irrigation by 2010, with emphasis on small-scale provision. This would cost about $2 billion a year, with donors covering half the costs.[70]

As governments develop water management strategies for dealing with scarcity, it is important that pro-poor technologies and other interventions figure prominently. In technology the focus for governments should not be on production but on social marketing, support for microfinance and public investments in infrastructure needed to support uptake. Micro-irrigation technology and strategies for developing markets should be an integral part of all rural development and national poverty reduction strategies.

The time to abandon the age-old dichotomy between large-scale and small-scale approaches is long overdue. In South Asia and parts of East Asia small-scale water harvesting is a vital part of the response to local groundwater crises. More widely, scaled-up programmes in this area have the potential to improve water security by increasing availability and by bringing water closer to people. Small-scale water harvesting should be a central part of water management from the local to the national level—and an element in wider efforts to empower the poor.