Water for food, water for life

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16 River basin development and management

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Overview

In many river basins use of water for human purposes through investments in water infrastructure for urban, industrial, and agricultural growth is approaching or exceeding the amount of renewable water available. Such overcommitment of water resources is caused by a disregard for environmental water requirements, incomplete hydrological knowledge, fuzzy water rights, and politically motivated projects with weak economic rationale *[well established]*. The results are overbuilt river basins and basin closure, the situation where more water is used than is environmentally desirable or, in some cases, than is renewably available. The challenge for water management in agriculture is to do more with less water in river basins that are already stressed and to provide much stricter scrutiny by decisionmakers and civil society of new infrastructure development in relatively open river basins to avoid overcommitment of water resources.

River basins are experiencing multiple constraints. Expanding water supply is constrained by the cost and potential impact of new projects and by the reduction of available renewable freshwater due to contamination, overdraft of aquifers, and climate change, which increases variability and imposes more conservative management of dams. On the demand side, nonagricultural requirements increase, irrigation often expands, and more water needs to be reserved or reallocated to environmental flow regimes *[well established]*.

A first response for escaping this impasse is too often to seek supply-side approaches for capturing more water. In both open and closing basins informed decisions need to be made about whether more infrastructure is needed, where, and of which type. In closing basins further increases in water withdrawals for human purposes will lead to irreversible losses of biodiversity and ecosystems services *[established but incomplete]*. In closed basins interbasin transfers or new dams are often inappropriate responses, exacerbating problems or shifting costs to the donor area. River basin management therefore needs political reforms and a commitment to more open, accountable, and inclusive governance; increased public scrutiny of traditional evaluation tools such as cost-benefit analyses and environmental impact assessments; and enabling policy and political environments that allow negotiated agreements.

With basin closure the interconnectedness of the water cycle, aquatic ecosystems, and water users increases greatly. Local interventions such as tapping more groundwater, lining canals, or using microirrigation often have third-party impacts and unexpected consequences elsewhere in the basin. In closing basins users and managers tend to adapt to scarcity, conserve water, and resort to multiple sources, while local "losses" are reused elsewhere in the basin. Thus the scope for using water more efficiently at the basin level is frequently much smaller than assumed *[established but incomplete]*. Based on a solid hydrological analysis, planners need to gauge whether there is scope for saving water or simply for redistributing it and to make sure that possible third-party impacts are avoided or compensated for.

> Basins should have a three-tiered allocation framework for surface water: a tier for basic human needs and the environment, a tier for productive water for the poor, and a tier for other productive uses

Water policies and interventions need to take into account the social and political aspects of basin interconnectedness and the imbalances they create. The population groups that manage water, make or influence decisions, receive benefits, or bear costs and risk have different levels of access to resources, knowledge, political representation, or courts.

Sustainable river basin management needs water allocation mechanisms based on a comprehensive understanding of hydrological interactions and on recognition of customary rights. To prevent negative impacts on weak constituencies, a good starting point for redesigning water allocation mechanisms is to define environmental water requirements and water entitlements for the poor. Both open and closed river basins should have a three-tiered allocation framework for surface water: a tier for basic human needs and the environment, a tier for productive water for the poor, and a tier for other productive uses. Stakeholders must participate in defining entitlements, which should remain flexible and adaptive, with possible evolution toward a more formal water rights system.

Progress in establishing integrated water resources management strategies has been undermined by such factors as the lack of fit between hydrologic and politico-administrative jurisdictions, conflicts between line agencies and policy fields, as well as erratic financing and lack of hydrological data or technical capacity [well established]. Basins facing complex problems of conflicting societal values and pressure on resources will probably not be well managed by a single body. In such cases institutional arrangements for river basin management should focus on consultation and coordination instead of pursuing an ideal organizational model for river basin management through a centralized river basin organization. Although institutional arrangements should be based on existing organizations, customary practices, and administrative structures, this will often require reshaping the role of traditional hydraulic bureaucracies and seeking political support for more polycentric and collaborative modes of governance.

Many international rivers are the subject of shared agreements, but results have fallen short of expectations because of historical factors, lack of shared hydrological data, and the absence of nonstate actors in negotiations [established but incomplete]. Permanent platforms, data sharing, or the introduction of other issues of common interest in the negotiations may assist in building trust and achieving equitable agreements.

Not all problems can or should be solved at the river basin level. Water quality or flood problems may be more local in scope. Watershed initiatives also signal that local governance is more effective, but how to integrate scattered initiatives within the larger basin remains a crucial question. While river basins are relevant units for planning water resource development, many problems affecting them—and their solution—may well lie beyond the basins themselves. Agricultural policies, free trade agreements, demographic changes, and shifts in ideologies or societal values can all have a bearing on water use and call for dynamic and adaptive river basin management.

Except for a few islands or desert areas all land on the Earth's surface is part of one river basin or another

An introduction to river basins

During much of the 20th century the water needs of growing populations were met through the construction of infrastructure to increase water withdrawals from rivers and aquifers. Water was perceived to be abundant, and impacts on the environment were incremental and little noticed at first. Today, water resources in many river basins are fully or almost fully committed to a variety of human uses, water quality is degraded, river-dependent ecosystems are threatened, and expanding demand for water is leading to intense competition and even at times to strife. In agriculture the challenge for water management is to do more with less water in river basins that are already stressed, while in relatively open river basins judicious assessments of new water infrastructure is needed. Compounding this challenge is the widespread poverty in river basins in developing countries and the pressure this places on the reallocation of water to the poor for productive uses. This chapter reviews the drivers and impacts of river basin development and outlines the challenges facing agricultural water management in closing river basins.

Except for a few islands or desert areas all land on the Earth's surface is part of one river basin or another. River basins are the geographic area contained within the watershed limits of a system of streams and rivers converging toward the same terminus, generally the sea or sometimes an inland water body. Tributary subbasins or basins more limited in size (typically from tens of square kilometers to 1,000 square kilometers) are often called *watersheds* (in American English), while *catchment* is frequently used in British English as a synonym for river basins, *watershed* being more narrowly defined as the line separating two river basins. This chapter is mainly concerned with river basins.

While efforts to control rivers go back many thousands of years, the concept of river basins as units for planning, developing, and managing water emerged in the late 19th and early 20th centuries (Teclaff 1996; Molle 2006). River basin development was boosted by technological changes in dam construction at the beginning of the 20th century. During the second half of the century multipurpose development of river basins focused primarily on the construction of large dams (whose numbers increased from 5,000 in 1950 to 45,000 in 2000, an average of two new large dams each day; WCD 2000) for hydropower generation, flood control, and water storage for irrigation. During the same period irrigated areas doubled from 140 million hectares (ha) to 280 million ha (see chapter 9 on irrigation).

Enthusiastic—and optimistic—large-scale development of river basins yielded unexpected results, however. River systems turned out to be interconnected transfer and transport systems (Newson 1997) carrying not only water, but also sediment, nutrients, contaminants, and biota across space and time. Control of water, estimation of extreme events, and management of annual variability posed many problems unanticipated by engineers. The intricacies of surface water and groundwater interactions led to unexpected impacts and conflicts, while drastic alterations of the natural water regime provoked severe ecological degradation.

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Human interventions in the water cycle have placed many river basins under growing stress. When water resources are increasingly committed, the interconnectedness of the water cycle, aquatic ecosystems, and water users rises greatly. Interventions such as groundwater development, canal lining, drip irrigation, and reforestation generally have unexpected third-party effects elsewhere in the basin. Because users adjust to water scarcity and reuse water in the basin, closing basins tend to have much less "slack" than is often assumed, and the potential for net water savings at the basin level is often overstated. In addition, the social and environmental costs of supply-side approaches to capturing more water, such as interbasin transfers and construction of more dams, are seldom fully identified and in many cases—especially in closing basins—will only exacerbate problems. This double squeeze demands care and judgment in designing solutions and requires decisionmakers to deal with sociohydrological complexity and avoid overcommitment of water resources.

In moving toward sustainable river basin management there is a growing interest in institutional processes that can bring together fragmented water uses and water users into an integrated planning, allocation, and management framework. This has led to the rise of integrated river basin management for reconciling hydrologic and ecosystem complexity, uncoordinated development interventions, and sociopolitical and administrative fragmentation. Despite the orderliness and rationality conveyed by the approach, it is apparent that the diversity of values and interests (water, power asymmetries, and wealth stratification) combined with natural risk and variability defines a framework in which sociopolitical processes engage in a struggle for resources and a constant reordering of the water regime. Thus, the politics of governance are embedded in sociopolitical realities and lie at the heart of river basin development and management.

With mounting pressure on water, allocation takes center stage. The call for clear, secure, and transferable water rights has been made many times, but creating property rights to water that are just, equitable, and feasible (both technically and politically) and account for legal pluralism is never straightforward. That demands sophisticated knowledge of hydrological interactions among surface water, groundwater, and wastewater, with corresponding data management, and respect for prior customary rights to water. As the environment and the poor tend to be short-changed in existing water allocations, the definition of environmental flows and water entitlements for the poor is a good starting point for redesigning water allocation mechanisms.

The next section describes common and emerging problems affecting river basins, how societies have responded, and how users are increasingly interconnected through the hydrological cycle. It also addresses trends in management and governance in more detail.

The following section looks at how effective river basin management can address issues of further water resources development, allocation, conflict resolution, poverty alleviation, and environmental sustainability. It also stresses the limits of basin approaches and draws attention to the links between river basins and their wider economic and sociopolitical environments.

Mounting pressure on water

The growing abstraction of water by individual users and state-initiated projects has approached or even exceeded the threshold of renewable water resources in a number of river basins. Water shortages and conflicts have increased accordingly. This trend has been paralleled by a degradation of the quality of both surface water and groundwater through the combined effluents of cities, industries, and agricultural activities.

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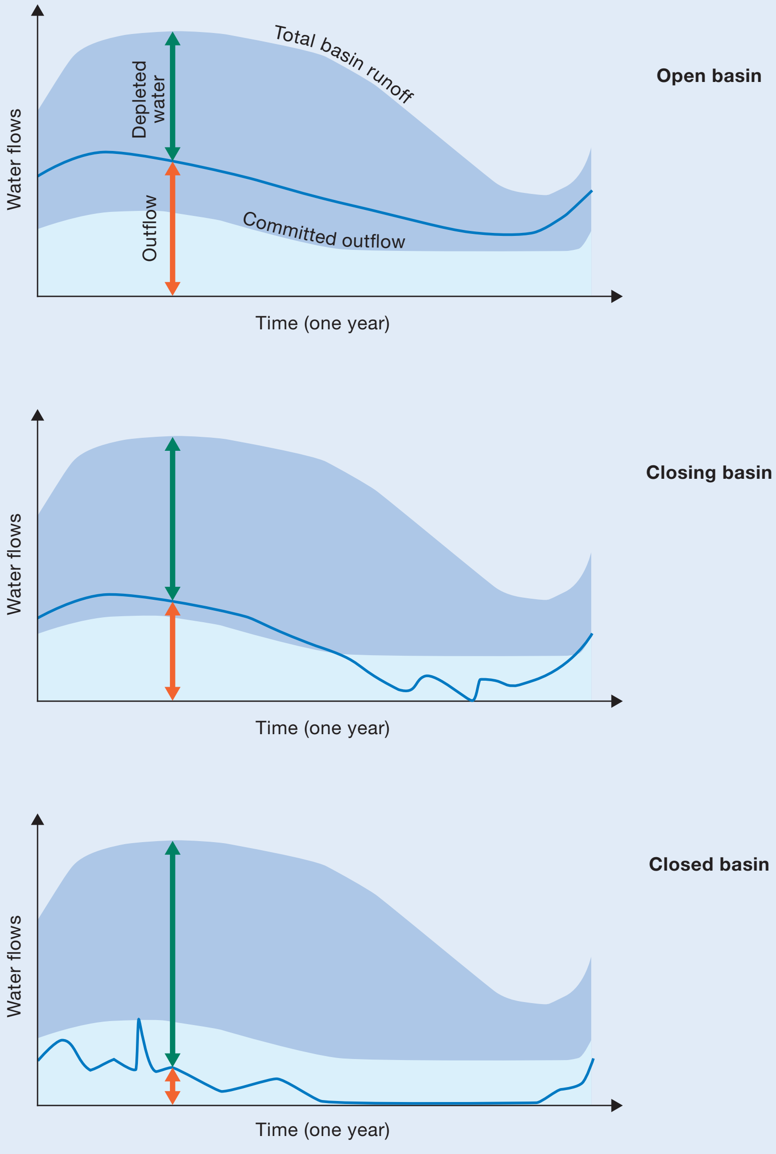
Basin closure and other water challenges

The roots of the resulting crisis lie beyond mere notions of dwindling per capita endowments, and its consequences have been coped with in various ways.

Committed and degraded water resources. As societies develop, water resources within a given basin become increasingly diverted, controlled, and used. Water flowing out of subbasins is often committed to other downstream uses, and outflow to the sea has several often overlooked functions: flushing out sediments (Yellow River in China), diluting polluted water (Chao Phraya River in Thailand), controlling salinity intrusion (many deltas), and sustaining estuarine and coastal ecosystems. When river discharges fall short of meeting such commitments during part of or all of the year, basins (or subbasins) are said to be closing or closed (figure 16.1).[1] In many cases (as in Europe and the Eastern United States) basin closure has been accompanied by severe pollution, as increasing effluent and declining flows have outstripped the dilution capacity of many rivers and led to wider ecosystem degradation.

Many closing basins are typically under stress for one to six months a year. The Yellow River (China) dried up for the first time in 1972, but in 1997 the dry-up lasted 226 days and reached 700 kilometers (km) upstream (Ren and Walker 1998). The Colorado (United States), the Indus (India and Pakistan), the Murray-Darling (Australia) and most rivers in the Middle-East and Central Asia are also severely overcommitted. Even basins in monsoon regions, such as the Chao Phraya River (Thailand) and the Cauvery River (India) experience months of closure, when salinity creeps inland or outflows are zeroed as a result of upstream diversions. River basins that terminate in lakes are not closed if they can replenish and sustain these wetlands, but many basins are situated in arid regions with large diversions and are also closed (for example, the Jordan River and Dead Sea, the Amu Darya and Syr Darya Rivers and Aral Sea, and the Tarim River and Lop Nor Lake).

Closure and scarcity can also occur in subbasins or small catchments, while the wider basin remains open. The Greater Ruaha Basin in Tanzania is a classic example of a subbasin under stress that contributes to a river (the Rufiji) that is fed by many other tributaries figure **16.1** **Closing and closed basins—rivers under stress**



with still abundant flow. The Yamuna River at Delhi is dry part of the year, but the basin reopens further downstream. Likewise, the need to ensure water quality standards in the whole basin has led managers in the United Kingdom and France, for example, to define minimum flows at several nodal points of the river network to avoid local or tributary closure.

The definition of closure depends on the definition of the flow that is committed to flushing, diluting, and sustaining ecosystems. This definition is controversial but challenges the idea that any water in excess of human requirements is "lost," often expressed in declarations by engineers (or politicians) that not a single drop of water should be lost to the sea. The opposite position argues that all the river flow is necessary to sustain ecosystems, as they are intricately attuned to the natural flow regime. In many cases the flood regime is indeed part of ecosystem functioning and crucial for inland fisheries and can be considered as part of the fraction of water "used" (for example, the Rufiji floodplain, the inland Niger Delta, the lower Mekong, the Senegal Valley). Thus defining acceptable, if not optimal, environmental flows is a critical issue. One useful definition is "water that is purposefully left in or released into an aquatic ecosystem to maintain it in a condition that will support its direct and indirect use values" (Brown and King 2002, p. 1; see below and chapter 6 on ecosystems).

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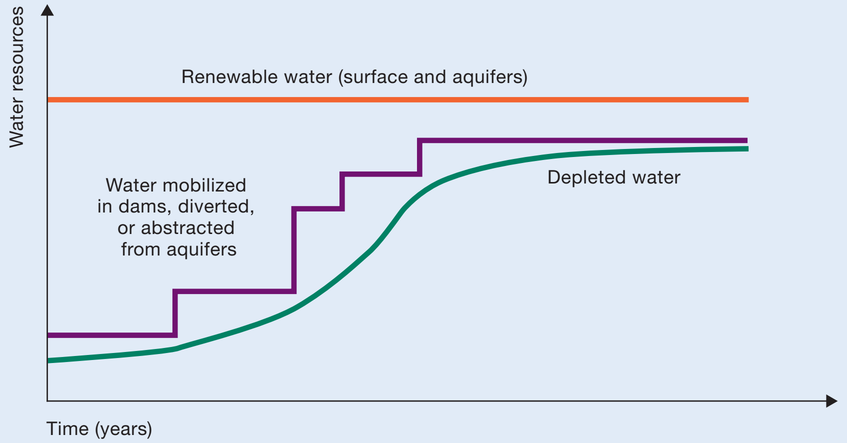
While problems and conflicts tend to increase with basin closure, challenges also arise in open basins. Flood damage, aquifer depletion, and pollution (for example, effluents from mines in southern Africa or diffuse agricultural pollution in Europe) occur widely and in all types of basins. These problems can be local or confined to one part of the basin without relevance for the entire river basin (Moench and others 2003). Situations of poverty due to lack of infrastructure (economic water scarcity) or exclusion (social or political water scarcity) are also common: villagers along the São Francisco River (Brazil), around Lake Victoria (Uganda), or in many parts of Africa suffer from deprivation although they live alongside plentiful waters.

Basin closure can be sketched schematically, as in figure 16.2,[2] which shows how over the years the development of facilities to abstract surface water and groundwater allows human water use to approach the total annual renewable water resources in the basin.[3] The fraction of water that can be stored or pumped under existing economic and technological constraints is generally under the total annual renewable resource when, for example, a large part of floods cannot be controlled and flows to the sea. But it may be higher in some cases when dams can capture all or most of the runoff and aquifers are overexploited. The Lerma-Chapala Basin (Mexico) is a telling example of a closed basin, with water depletion exceeding annual renewable water by 9% on average, even without including environmental flows, because of overabstraction of groundwater and excessive surface water withdrawals (Wester, Scott, and Burton 2005).

The apparent linearity and inexorability of basin closure give this process a "natural" gloss. Just as Malthusian thinking associates high population density with the specter of famines, many analysts associate declining per capita water endowments with environmental degradation, food insecurity, and wars (Starr 1991; Klare 2001). Such an approach overlooks both the political dimension of poverty and deprivation and the scope figure **16.2** | **Development of water resources can lead to basin closure**



Source: Adapted from Molden and others 2005.

for change. Just as local adaptability and global innovations have helped food production catch up with needs through intensification, so societies may respond to water challenges in many ways.

Drivers of basin closure. Basin closure is by definition a human-induced process: a host of driving forces work to produce developed and often overbuilt basins. Overdevelopment of river basins is a common phenomenon that goes beyond the mere continuation of supply-oriented strategies accompanied by disregard for demand-management strategies and the environment. It includes the development of infrastructure with a potential demand for water that outstrips basin resources and ecosystem resilience. Unpacking the logic that drives the overbuilding of basins is essential because of its major impact on water management and allocation.

Development of river basins in the second half of the 20th century unfolded under the banner of integrated, or unified, river basin development, out of enthusiasm for large-scale undertakings as epitomized by the creation of the Tennessee Valley Authority (TVA) after the Great Depression. The vision of integrated development was confined mainly to constructing infrastructure that would serve multiple purposes, in general hydropower generation, flood control, navigation, irrigation, and urban water supply. Newly independent nations, with priorities of food security, rural poverty alleviation, regional unification, and nation building through iconic large-scale projects, embraced this vision. The modernist belief in the potential of technology transfer to trigger development in the developing world, the concept of development projects as strategic assets in the cold war (Ekbladh 2002; Barker and Molle 2004), strong financial interests from the development industry (Saha and Barrows 1981), and the specter of hunger in a world undergoing spectacular population growth contributed to fueling large investments in dams, flood protection, and irrigation infrastructure (see chapters 2 on trends and 9 on irrigation for more detail).

While these influences explain the initial emphasis on infrastructure development, they do not necessarily explain why it continued to the point of provoking basin closure. The first investments in a river basin are generally made in areas with a favorable combination of soils and water resources. Typically large alluvial plains and deltas are developed first, accentuating their natural advantage for crop production. But state investment at a national level is a highly politicized process. Regions with little irrigation infrastructure generally lag behind, exhibit higher rates of poverty, fuel migration to cities, and build up their claim to a share of investment, arguing that they have been discriminated against and that the river that traverses their land is also "theirs." This leads to further development plans in subregions with sometimes only marginal land and to tapping resources that are partly appropriated by downstream users. Equity, in terms of spreading benefits, is promoted at the cost of basic economic principles.

Several factors make this possible: the fuzziness of water rights, the supply-driven logic of development banks, the malleability of cost-benefit analyses, and the overriding political nature of decisions taken before feasibility studies start (McCully 1996; WCD 2000; box 16.1). The complexity of river basins as ecosystems has also made it difficult to identify externalities, so projects are allowed to go ahead because externalities are not fully factored into decisionmaking (WCD 2000). In some cases competition between regions, states, or countries within the same basin generates a race for water appropriation that results in uncoordinated investments and overdeveloped water-use infrastructures, as can be seen in the Cauvery and Krishna River Basins in India (Weber 2005).

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Basin closure is accelerated and compounded by unchecked disposal of waste and contaminants into river systems that outstrips the dilution capacity of streams and renders water unfit for further use. Ignoring social, health, and environmental externalities enhances private gains and the competitiveness of firms, but it decreases water availability. Who can pollute and to what extent are questions of political economy and are therefore human-defined rather than the result of inexorable mounting pressure on resources.

Coping with the water squeeze. As basin water resources are committed, challenges posed by water quality and scarcity arise. Societies respond to basin closure in many ways, at both the individual and community level and the state level. While the emphasis is often on the coping strategies of the state or technocratic elites (Turton and Ohlsson 1999), the multileveled responses of society are often overlooked. In particular, local adjustments by individual users or groups of individuals and by local managers and officials are insufficiently recognized. These uncoordinated adjustments frequently contradict measures taken at the macro level or even make them irrelevant.

A first category of responses consists of augmenting the supply from existing sources (foremost, increasing the quantity of controlled water), as well as tapping additional sources. Typically, this is done by constructing new dams or sinking more tubewells and by diverting water from neighboring basins, desalinizing seawater, artificially recharging groundwater, and seeding clouds. At the local level farmers may tap shallow or deep aqui-

box 16.1 **Overbuilding river basins: you've got your irrigation scheme, now what about my scheme?**

Irrigation in the Chao Phraya River Basin in Thailand started with small valley floors in the upper watersheds but developed on a large scale only in the first half of the 20th century, with the progressive reclamation of the delta. In the 1950s the Chao Phraya Dam was constructed in Chai Nat Province to divert water through major distributors east and west of the river. In the 1960s and early 1970s two major dams were constructed on two of the four major tributaries (Ping and Nan Rivers), gradually allowing the development of dry season irrigation on half of the delta on average. The provinces located between these dams and the delta naturally claimed parts of the benefits of the water flowing at their feet and feasibility studies for the Phitsanulok project, conceived to irrigate 217,000 ha on the lower Nan River, started in the late 1970s.

The project was initiated in 1982 and funded by the World Bank. Because water was already committed to downstream uses in the dry season, most of the scheme was supposed to grow only one crop (securing existing rainfed crops) and cropping intensity was targeted at 121%. Since only a quarter of the project would be economically justified based on existing efficiencies, ad hoc hypotheses on expected "improvement of practices and facilities" were made. In the 1980s similar development took place on the lower Ping River, downstream of the second dam.

Currently, not only do these schemes in the middle basin claim an equitable share of dry season stocks but they sometimes receive more than the delta (proportionally to area). The combined abstraction of water by these projects and by pumping schemes established independently by the Department of Energy Development and Promotion amounted to 38% of dam releases during the dry season of 1998. In an internal report consultants to the World Bank admitted that the basin was "overbuilt." Other developments also took place in the upper part of the basin, although on a reduced scale. Finally, recurring water shortages and farmer unrest are used as a basis for justifying more supply augmentation projects, including diversions from the Salween and Mekong Basins.

Source: Molle and others 2001.

fers or invest in local storage facilities (such as farm ponds, which store excess irrigation flows or rainfall). They also develop conjunctive uses of water, using water from drains, rivers, and ponds and pumping water from irrigation canals when the water level is too low to allow for gravity inflow to their plot. At the macro level importing food is an indirect way to increase water supply into the country, a transaction often referred to as use of virtual water because the water comes embedded in the imported food (Allan 2003).

A second category of responses relates to conservation, or improving the efficiency of use of already controlled water resources without increasing supply. Line agencies or resource managers may implement structural measures, such as lining canals, controlling leakage in pipe systems, and treating wastewater for reuse. They may also resort to such nonstructural measures as improving dam or canal management (so that nonbeneficial releases are reduced) and establishing rotations or other arrangements for higher supply reliability. The state may also elicit water savings through policies (volumetric water pricing, quotas) or through innovations derived from research (plot-level water management, improved varieties and cultivation techniques).

Farmers and groups of farmers may actually conserve water at the local level as well. They may shift calendars or raise bunds around rice fields (to make better use of direct rainfall or canal water when available), adopt better cultivation techniques (such as mulching, deficit irrigation, the alternate wet-dry water regime in rice farming, shortening of furrows, and improved leveling), choose crop varieties with a shorter cycle, or invest in water-saving technologies, such as microirrigation. Improved management also requires managerial and institutional change, and often better infrastructure. Better collective management of scarcity also results from closer monitoring of flows, involvement of users, participatory planning, stricter rotations and scheduling, and definition of entitlements.

A third strategy consists of reallocating water from one user to another, either within the same sector (for example, within or between irrigation schemes) or across sectors. This reallocation may be justified by a concern for raising water productivity, but the objective may also be to enhance food security, redress inequities, or restore natural river flows. Reallocation can occur within the farm (when a farmer chooses to direct limited water resources to the crops that give a higher return per unit of water), between farmers (typical short-term transactions), or at the irrigation system level. Bribery, water theft, and tampering with hydraulic infrastructure are also ways to reallocate water and augment individual supply. At the basin level managers may reallocate water according to a given priority system. Within the agriculture sector water can be shifted from one area to another according to comparative advantages in water productivity (typically, areas with orchards or aquaculture).

Water allocation issues brought by basin closure make politics, governance, and the distribution of power central issues

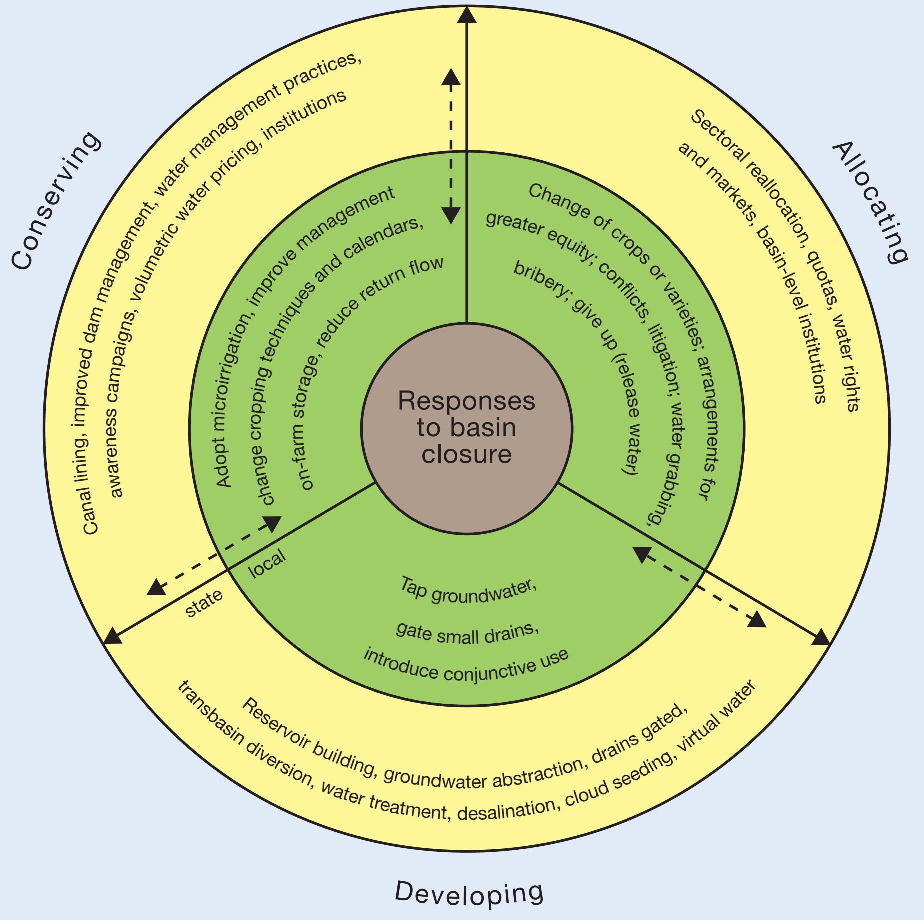
The rationale for intersectoral transfers is generally economic: cities are accorded priority to water for domestic uses and industries, where the economic return to 1 cubic meter of water is much higher than elsewhere and political power is concentrated. Agricultural uses can cope with a higher variability in supply and tend to receive the remaining water in the basin (this residual part also regularly happens to be the largest). Unfortunately, agriculture also often responds by further displacing nature. Reallocation is sometimes decided bureaucratically, but the definition of a new pattern of access to resources often stirs opposition and conflicts. This is why water allocation issues brought by basin closure make politics, governance, and the distribution of power central issues (see discussion of allocation issues later in this chapter).

Conservation and allocation responses are often pooled together as *demand management,* which can be typified as "doing better with what we have," as opposed to supply augmentation strategies (Winpenny 1994).

These three categories of responses to water scarcity can be further identified by level of actors—local and global or state level (figure 16.3)—as a way to stress that actors are not passive and respond individually and collectively to growing water scarcity, just as agrarian systems respond to changes in the relative scarcity of other production factors. This has been shown by case studies such as Zilberman and others (1992) for California, Loeve and others (2003) for China, and Molle (2004) for Thailand. State-driven responses are only a part of the transformation, although officials tend to see rural areas as static and malleable through public interventions (infrastructures or otherwise; Long and van der Ploeg 1989; Scott 1998). They overlook the constant endogenous adjustment of rural households and communities, as well as of line managers, to changing conditions. Because of such manifold adjustments and the gradual tapping of the water that remains available, water-short basins tend to have much less "slack" than is often supposed, and the potential for demand management is thus often overstated (Seckler 1996).

Typically, the first responses to water problems are capital-intensive solutions and augmentation of supply. When options for augmentation get scarcer or more costly, the emphasis is likely to shift to improved management and conservation. Once gains in efficiency have been realized, reallocation to higher value or other uses may appear necessary. These three responses do not always occur in this sequence, and when the fraction of water that is effectively consumed approaches the available supply, the three strategies are resorted to in tandem because none can solve the problem alone (Molle 2003).

figure **16.3** **Three types of responses to water scarcity and the level of actors involved**



Source: Molle 2003.

Which responses are selected depends on the interests of the various stakeholders, the distribution of power and agency in the basin, and other factors, including the nature of state-citizenry relations (governance), and whether the agrarian transition has been smooth (defining the relative weight of rural interests). Responses are also often encouraged or forced by shock events (extreme floods, droughts, pollution), mediated by competing discourses, and shaped by dominant ideologies. Mass media and infrastructure-oriented government departments often call for supply-based solutions, while environmentalists and fiscal conservatives call for demand management. Science is often mobilized to legitimize particular agendas, but the quality of the science and the scientific basis of assumptions brought to bear are highly variable. The project nature of water resource development tends to involve consultancy rather than peer-reviewed scientific expertise, with attendant biases and conflicts of interest.

Basin closure brings about increasing interdependence of users and ecosystems that are dependant on the hydrological cycle

Interconnectedness and complexity in river basins

Basin closure brings about increasing interdependence of users and ecosystems that are dependant on the hydrological cycle. The literature identifies four interlinked manifestations of this interconnectedness: spatial and hydrological interplay, sociopolitical dimensions, ecological interactions, and wider complexity derived from interactions with the outside world.

Hydrological interconnectedness within river basins. The typology of responses presented above misses a very crucial point in the functioning of river basins: the temporal and spatial interconnectedness across scales in both hydrologic and governance terms. While each of the strategies described as local can be associated with a clear objective, things get blurred when looking at the broader picture. For example, increasing supply locally through farm ponds, groundwater use, water harvesting, or small tanks may be tantamount to capturing water that would have been used downstream. Overall, there is little or no increase of controlled water but a mere spatial redistribution of the resource. Likewise, while transbasin diversions and even cloud-seeding can be considered supply augmentation from a narrow local point of view, they can be viewed as spatial redistribution (or reallocation) from a wider scale. Interventions by the state and adjustments by local actors are also interrelated. For example, subsidies for the adoption of microirrigation will foster local conservation by farmers, while farmers' development of groundwater use will elicit interventions or policies at the national level. (This is symbolized in figure 16.3 by the arrows that link the two layers.)

These examples show that the measures taken at the two levels schematized in figure 16.3—local and state—are not purely additive. Nor should they be treated as noise. Rather, the relationship between micro- and macro-processes lies at the heart of river basin management. Because the closure of river basins results in a growing interdependence of the users within the basin, many interactions must be clearly identified and analyzed, to avoid misconceived policies and faulty decisions. Thus it is important to analyze how rainfall is partitioned between green water (evaporated or stored in the soil) and blue water (flowing), how the paths of the different surface and underground flows are interrelated, and how any local intervention that modifies the quantity, quality, or timing of one of these flows affects the whole system. There are numerous examples of such interactions that need to be properly comprehended:

- *Win-win or win-lose?* Efficiency in water use is most commonly understood at the user or canal level. Return flows are generally called "losses," although they are often reused downstream. Thus reducing losses may merely reduce the water available to downstream users. Canal lining projects frequently reduce groundwater recharge, affecting those who use these sources. The lining of the Upper Ganga (India) and All-American Canals (United States), which were designed to achieve water savings and redistribute them to urban use, are good examples of "paper savings" (box 16.2), which amount to a mere reallocation of resources across space and categories of users. An individual user (or a system) who becomes more efficient may compound the overconsumption of water resources and deprive downstream users.

> Well intentioned water conservation measures are frequently tantamount to reallocation or reappropriation of water—recognized or not, the transfers often amount to robbing Peter to pay Paul

- *Microirrigation can make things worse.* Microirrigation technologies are invariably held as the conservation measure par excellence. However, such technologies often result in better control of irrigation doses and an increase in the amount of water depleted by crop transpiration (Burt, Howes, and Mutziger 2001). In countries where land is not the limiting factor, farmers will generally use the water saved through reduced application to increase their irrigated area (see Feuillette 2001 for Tunisia; García-Mollá 2000 for Spain; Moench and others 2003 for India). In both cases, local water depletion is increased, return flows available to downstream users are reduced, and expected water savings at the basin level do not occur. However, when water returning to the system is degraded in quality, is costly to abstract, or flows to a sink, conservation may be real.
- *Groundwater is not an additional renewable source of water.* Hydrological interconnectedness is often hard to comprehend: contamination is invisible, solid transport is cumulative, and groundwater flows are hidden. A widespread misconception is that aquifers are additional water waiting to be tapped. Although hydrogeological situations are varied and complex, water that infiltrates into the ground generally returns to the surface (through springs or as baseflow to rivers) or to the sea (Sophocleous 2002). Aquifers are large assets as underground reservoirs, providing a buffer during droughts, but the amount of water withdrawn from them generally corresponds to an equivalent reduction in the amount stocked or restituted to the river system. A typical case (for example, in India, Iran, or the United States) is that of rivers that normally receive a net positive inflow from adjacent aquifers and that—because of a dramatic drop in the water level of aquifers—end up recharging them instead. Notions of safe yields are fuzzy and often used to justify mismanagement (see chapter 10 on groundwater).
- *Forests and the "sponge myth."* The runoff collected by rivers is by and large the leftover from rain after evapotranspiration of cultivated crops, natural vegetation, and water bodies. Surface water resources are therefore linked to land use and management, and closing basins become more susceptible and vulnerable to changes in land cover. Common wisdom often links perceived declining river flows, as well as floods, to

box 16.2 | Win-win or win-lose? The Imperial Valley deal

The Los Angeles–San Diego urban area is a well known water-thirsty region that relies on interbasin transfers, particularly diversion from the Colorado River. Celebrated as a win-win agreement between the Southern California Metropolitan Water Authority (MWA) and the Imperial Irrigation District (IID), this 1998 agreement is a good example of a conservation intervention that amounts to reallocation.

Under the agreement MWA would fund the lining of the All-American Canal, which diverts water from the Colorado River to the district, in exchange for a usufructory right to an estimated 100 million cubic meters a year conserved through this intervention (CGER 1992). In fact, the so-called savings are detrimental to the recharge and quality of the aquifer that is tapped by Mexican farmers on the other side of the border in the Mexicali Valley (Cortez-Lara and García-Acevedo 2000). Of the total 100 million cubic meters a year to be saved, 30 million cubic meters a year are currently captured by the La Mesa drain (which has been excavated to control the level of the aquifer), while 70 million cubic meters a year recharge the aquifer. The aquifer and the La Mesa drain are tapped by individual and federal wells that irrigate a total of 19,800 ha. However, because the reduction of freshwater percolation will increase the salinity of groundwater, it is likely that negative impacts will eventually affect an area of 33,400 ha (Cortez-Lara 2004). The decrease in groundwater resources also renders the future supply of the growing urban areas more critical (Castro-Ruíz 2004).

Officially, the arrangement is said to be in accordance with the Colorado River Compact, which deals only with surface water allocation between the two countries, and therefore to conform to existing legal agreements. Focusing on the US side of the deal allows decisionmakers to picture the arrangement as a win-win situation, while ignoring surface water–groundwater interactions and overlooking the “lose” side of the agreement.

deforestation in upper catchments. Forests are believed to control flooding and to act as sponges, absorbing excess water and releasing it in the dry season. Despite contrary evidence in many regions, particularly in wet areas, and the critical negative impacts of species like pines, eucalyptus, and exotic tree plantations on water resources, the sponge myth drives large investments based on uncritical examination of local conditions (CLUFR 2005; Forsyth 1996). Trees do not produce water but consume it and therefore often diminish streamflows. Effects of land use on low flows, erosion, and floods are very complex and site specific (FAO and CIFOR 2005), so much caution is needed before blaming particular hydrological events or particular land use practices.

What these examples show is that well intentioned water conservation measures are frequently tantamount to reallocation or reappropriation of water. Recognized or not, desirable or not, compensated or not, the transfers often amount to robbing Peter to pay Paul (Molle and others 2004). Local efficiency concerns eventually translate into macro-level allocation and equity concerns. As basins close, the complexity of water paths increases and management becomes more arduous. Figure 16.4 illustrates the changes in water flows observed in the lower Jordan River Valley between 1950 and 2000 (Courcier, Venot, and Molle 2005).

Socioeconomic and political interdependency within river basins. As hydrologic interactions increasingly manifest themselves through competitive uses between upstream and downstream users, agriculturalists and urbanites, subsistence-oriented farmers and fishers figure **16.4** **Lower Jordan River Basin water balance**

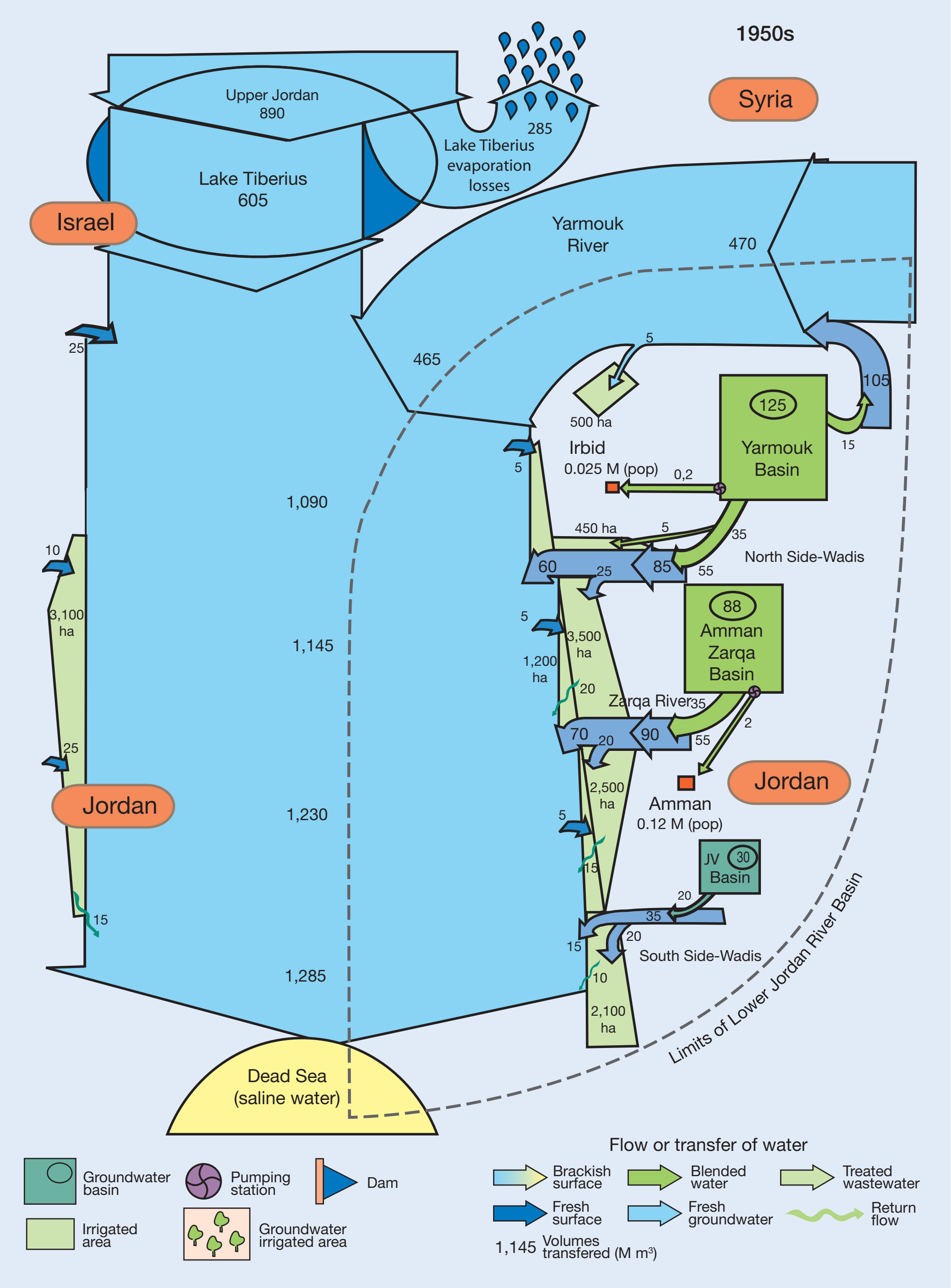
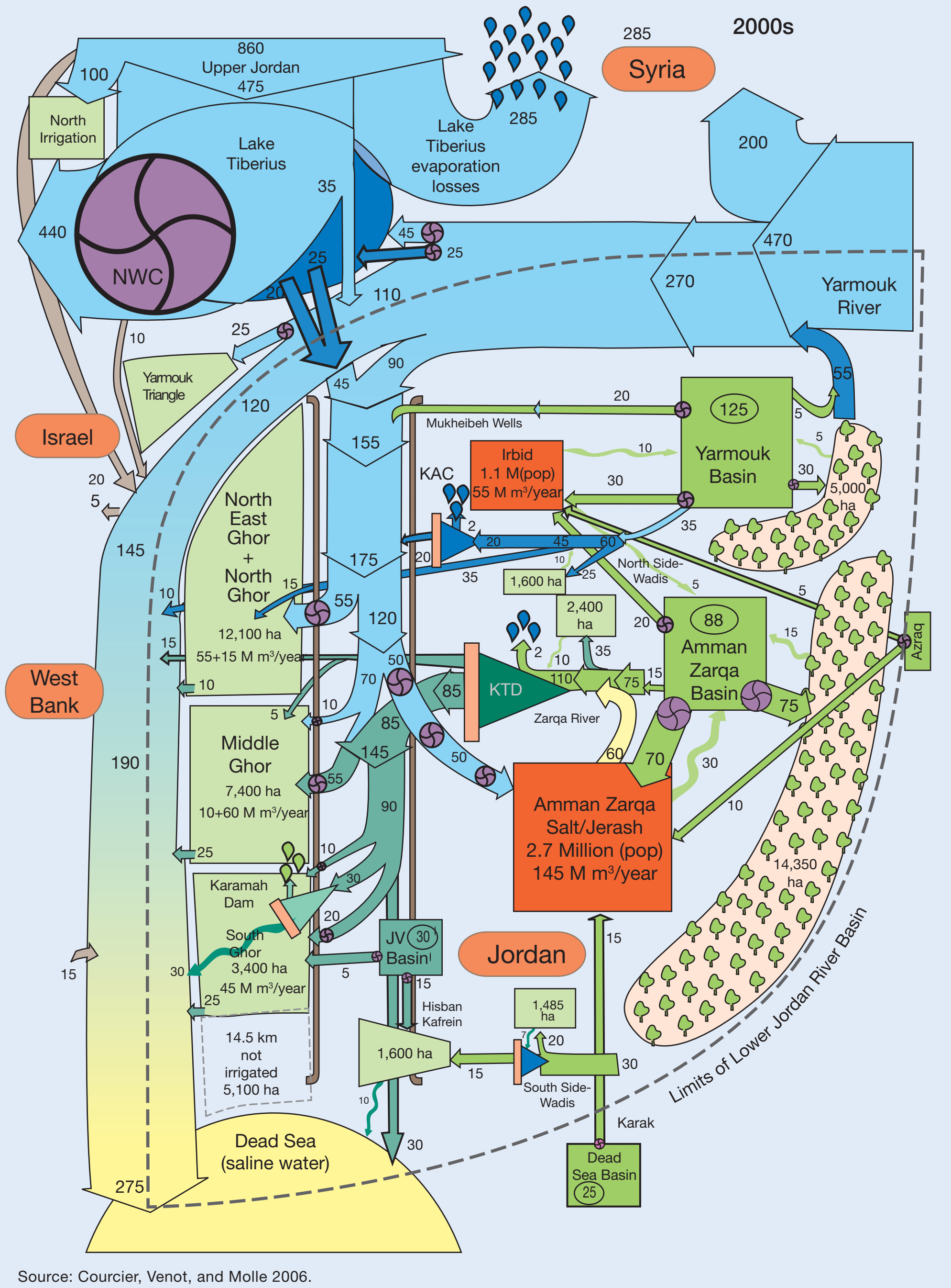


figure **16.4** **Lower Jordan River Basin water balance** (continued)



Source: Courcier, Venot, and Molle 2006.

and commercial enterprises, and off-stream and on-stream uses, so river basins become internally interdependent socially, economically, and politically.

Social and economic externalities of stressed river basins are accentuated by the fact that the categories of people who find themselves in competition often have varied priorities, objectives, and political power. Externalities occur when more powerful actors secure water at the expense of economically and politically marginal groups. For example, pine plantations in the upper Sand catchment in South Africa affect domestic water availability for high-density rural settlements, or Thai golf courses and orchards used and owned by well-off urbanites deplete water available to nearby rice farmers (Both ENDS and Gomukh 2005; Flatters and Horbulyk 1995). Industrialists generally have greater political clout and severely affect other uses, notably through pollution of waterways. Fishers are often displaced by water projects and are seldom compensated for the loss of their livelihoods (WCD 2000, chap. 3). Cities and industries generally get preferential allocation and adversely affect agriculture (though the reverse also occurs), and all three groups adversely affect the environment. Externalities are particularly salient in times of scarcity.

"How relations between basin users are managed is shaped by the sociopolitical and development context of the basin

Intergenerational externalities occur when the costs of current consumption are borne by future generations. Examples are the cumulative impact of progressive basin closure on riverine fisheries (such as in the Columbia River Basin), the contamination or exhaustion of aquifers, and the loss of wildlife diversity. Similarly, the past diversion of certain rivers to adjacent basins result in forgone benefits that are invariably glossed over but are already apparent in places like the Piracicaba Basin (diverted to São Paulo, Brazil; Braga 2000) or the Snowy River (diverted to the Murray-Darling) or that may surface in the mid-term in such places as the Mae Klong Basin (diversion to Bangkok) or the Karum Basin in Iran (diversion to Isfahan Province and beyond) or the long run in the Melamchi Basin (diversion to Katmandu; Bhattarai, Pant, and Molden 2002).

Water scarcity and resource capture (forcing other users to resort to more costly sources), emission of pollutants, or the displacement of flood damage to other areas by diking all generate externalities that travel across space and time and sociopolitical categories of stakeholders. They amount to a constant redistribution of costs and benefits along lines of power that eventually tend to determine who are the winners and losers among diverse stakeholders. Third-party impacts must be regulated, and the state usually has a critical role.

River basin problems also involve the interaction of—or even competition between—administrative bodies that often overlap at various levels (states or regions, districts, and subdistricts) and between sectors (various government ministries and agencies that deal with water issues, typically the ministries of water resources, agriculture, and environment) (Barrows 1998; Moss 2004). How relations between basin users are managed is shaped by the sociopolitical and development context of the basin. In a country such as Thailand the combination of political space for an active civil society and the long-standing experience of development-induced displacement from dams has meant that no single government-appointed river basin authority can achieve the legitimacy to represent all basin users. At the same time the bureaucratic and Bangkok-centric history of water management makes it difficult for the state to accept more open governance of water as an acceptable framework (Both ENDS and Gomukh 2005; Sneddon 2002). In Viet Nam, by contrast, the embryonic river basin organizations, to whose design not even provincial water authorities have made a significant contribution, are largely international agency–driven bodies established through a centralized state.

River basins as interconnected ecosystems. The third-party effects described earlier often focus on human use. Viewing a river basin as a continuum of nested ecosystems assists in understanding how changes in one part of a basin affect both water availability and environmental health in other parts of the basin. For example, the functions of seasonal and permanent wetlands are controlled by changes in flow regime as a result of impoundments and diversions elsewhere in the system. An ecosystem approach, defined by the Convention on Biological Diversity (CBD 2000) as a strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way, provides an analytical framework for examining tradeoffs between interventions in the hydrological cycle and ecological integrity and between nutritional values derived from alternative uses of water. Exclusive concern for increasing cereal production through water impoundment and extraction comes at the cost of neglecting impacts on fisheries, for example. In the Mekong River Basin fish typically provide 40%–80% of dietary animal protein, and this dependence is especially high among the rural poor (see chapter 6 on ecosystems).

> **Viewing a river basin as a continuum of nested ecosystems assists in understanding how changes in one part of a basin affect both water availability and environmental health in other parts of the basin**

Major ecological changes have been brought about by water resource development (see chapters 2 on trends and 6 on ecosystems). Dams, especially, have radically altered the flow of most large rivers. In some places these developments have undermined or destroyed elaborate human uses of ecosystems, at the cost of overall economic losses, declining food security, environmental degradation, and loss of ecosystem services (see the case of the Hadejia' Jama'a River in Nigeria, Barbier and Thompson 1998; or of the Kafue flats in Zambia, WWF 2003). It is also the case, however, that many flood-prone areas lie close to densely populated areas, so that flood control has allowed urbanization, and more intensive agriculture, and interseasonal regulation has allowed higher cropping intensities. The economic, environmental, and social record of these (often multipurpose) dams has been mixed and will not be addressed here in detail (see McCully 1996; WCD 2000; and chapters 2 and 6).

The systemic and complex nature of river basin ecosystems has often compounded the direct impact of dams, irrigation, and pumping schemes and led to a series of destructive effects that were not identified at the outset or have frequently been overlooked. These include the loss of springs (overdraft of aquifers in the Azraq Oasis in Jordan) or of wetland productivity, as the connectivity between river and floodplain is diminished through altered flood regimes (the impact of the Aswan Dam on the Nile Delta or of irrigated cotton development in New South Wales on the Macquarie Marshes). Many of the benefits associated with floods—fertility enhancement, replenishment of aquifers, support of wetlands, ecosystem sustainability, flood recession agriculture, and fecundity of fisheries—have been severely curtailed (WCD 2000).

Because most environmental assessments of large projects miss many of these ecosystemic impacts and fail to fully factor externalities into decisionmaking, projects whose overall costs may exceed their benefits are allowed to go ahead (WCD 2000). Each project tends to be accounted for without reference to its impacts on other projects—not to mention other river basin values—thereby ignoring the finite supply of water and often leading to multiple accounting of benefits at the basin level.

The value attributed to a pristine environment by urbanites and environmental nongovernmental organizations, when translated into political clout, has moderated overly developmentalist approaches. Environmentalists have increasingly influenced the definition of landscapes and water regimes. In Europe environmental concerns have been the major force behind the recent European Water Framework Directive (Kaika 2003). In a bid to combat the neglect of ecological impacts derived from land and water development, environmentalists have centered their efforts on several issues:

> The notion of environmental flow—the flow regime needed to maintain environmental functions in a river ecosystem—is an attempt to find a compromise between productive uses and some protection threshold

- *Economic valuation.* Many environmentalists have developed methodologies for valuing ecosystem services both to make the hidden costs of interventions explicit and to influence cost-benefit analysis and feasibility studies in favor of environmental preservation (see chapter 6 on ecosystems). They also argue that higher water prices could encourage conservation (thus increasing river flows) and have developed the concept of payments for environmental services.
- *Opposition to dams.* Many dam projects have been shelved because of heightened opposition from civil society, but many others in countries like China (Three Gorges Dam), Turkey, and Viet Nam or on upper reaches of international rivers, such as the Lancang-Mekong in China, are under construction.
- *Dam removal.* Shifts in societal values and their internalization into politics and public choice have resulted in the removal of some smaller dams (for example, in the United States and on the Loire River in France) to restore fisheries and riverine ecosystems.
- *Negotiated flow regimes.* Following a similar dynamic, negotiated flow regimes from some dams have partly restored wetlands and other ecological values, for example in the Senegal River Valley (Fraval and others 2002) and in Canada (Ryder 2005). Elsewhere, affected people have pressed for alteration of dam operating regimes from peak to baseload production on a seasonal basis (for example, along the Se San River in Cambodia; Hirsch and Wyatt 2004).
- *Environmental flows.* The notion of environmental flow, defined as the flow regime required to ensure the maintenance of particular environmental functions in a river ecosystem, is an attempt to find a compromise between productive uses and some protection threshold. The scientific determination of these environmental flows is problematic (see chapter 6), and the values considered in practice are more often the outcome of negotiated tradeoffs than of scientific studies.
- *National parks and reservation areas.* Such designations as in the Okavango Delta, at the end of one of Africa's undeveloped rivers, have allowed some areas to be preserved, although sometimes at the cost of the livelihoods of local residents (Swatuk 2005a).

The river basin and beyond. Although determining the physical boundaries of river basins appears straightforward, the complexity of both nature and societies places limitations on river basins as territories of governance. Surface waters are interconnected with aquifer systems that may span several basins. Deltas are geographic entities that often fuse several rivers and make watershed boundaries irrelevant. Surface waters are frequently diverted to cities or to irrigated areas that belong to other basins. But even these cases can generally be accommodated as extensions of the original concept of river basin without diminishing its usefulness and relevance.

More crucially perhaps, many other factors and processes originating in wider spheres have critical impacts on water use and management within the basin. Climate change, for example, may increase hydrologic variability and the frequency of extreme events. These seemingly extraneous factors are sometimes so crucial that the causes of some basin problems—and their solutions—may lie well outside the basin or even the water sector (Allan 2004).

> The causes of some basin problems—and their solutions—may lie well outside the basin or even the water sector

First, river basins are part of a national and transnational economy. Sectoral and market linkages have spatial implications for basin agricultural production and water use, while relative or shifting factor prices, taxation or subsidies, migration, the World Trade Organization or other free trade agreements, and the evolution of world markets sometimes have sweeping consequences. Economic incentives established by state policies may encourage or discourage certain water uses. For example, EU subsidies through the Common Agricultural Policy have prompted the development of cereal cultivation in Spain, contributing to the depletion of aquifers (Garrido 2002). The North American Free Trade Agreement led to intensive development of water-intensive export cash crops in northern Mexico, at the cost of severe aquifer depletion (Barker and others 2000).

Second, politics also have a direct bearing on water resource development in river basins. Territories conquered by Israel during wars with its neighbors allowed it to divert the full flow of the upper Jordan river to its own benefit. In other countries water infrastructure has sometimes been used as a geopolitical tool to control certain regions or as a buffer against guerillas. Impacts of political events are sometime unexpected and indirect. The influx of several hundred thousand Yemeni and Palestino-Jordanian citizens working in the Gulf to their home countries after the first Gulf War led to a dramatic increase in the number of wells and in groundwater abstraction, with a severe impact on aquifers (Mohieldeen 1999). Conversely, the Mekong River Basin is "underdeveloped" largely because the wars in the region have prevented realization of the TVA-like development plans drawn up after the second world war (Bakker 1999).

Third, shifts in ideologies, worldviews, or values also often have unexpected impacts. Food security or nationalism-driven self-sufficiency policies were achieved at the cost of sustainability, as in China where promotion of winter wheat resulted in the overdraft of aquifers. The growth of environmentalism in western countries has translated into the sanctuarization of pristine natural areas for tourism, to the detriment of local users, such as in the Okavango Delta (Swatuk 2005a). The emergence of environmentalism in developing countries has fueled successful opposition to dams, as occurred recently in China on the upper Salween River.

Some arid countries have established piped water systems that span large areas and tend to do away with the physical notion of a river basin (for example, Cyprus, Israel, Jordan, and Tunisia). Basins have been challenged as obsolete at a time when technology allows interbasin transfers that demand wider planning perspectives (Teclaff 1996). Several large-scale capital-intensive diversion projects have been initiated or are under discussion (the South-North project in China, Berkoff 2003; the interlinking of rivers in India; the diversion of the São Francisco in Brazil; the Red Sea–Dead Sea project in the Middle East), perhaps signaling growing recourse to such options.

> Basin management is currently more about mediating conflicts and allocating water than about development

Trends in the governance and management of river basins

The growing pressure on water resources and the increasing hydrological, social, and ecological interdependencies in closing river basins has led to widespread recognition of the need for holistic approaches to water management. There is a renewed emphasis on river basins as the most appropriate spatial unit for water management. The decision to manage water on the basis of river basins is a political choice, and river basins thus become a scale of governance in which tensions arise between effectiveness, participation, and legitimacy (Barham 2001; Schlager and Blomquist 2000; Wester and Warner 2002). Progress in establishing adaptive, multilevel, collaborative governance arrangements for river basin management has been weak, with undue emphasis on form (setting up river basin organizations) over process.

From river basin development to river basin management. The idea of using river basins as the unit for water development and management has evolved over the past 150 years. The first conceptualizations, born with the progress in natural sciences and tinged with utopianism and scientism, emerged in the late 19th century and gathered force in colonial undertakings (particularly in the Nile and Indus basins) and in the Western United States (Teclaff 1996; Molle 2006). The idea of constructing numerous dams on a river for multiple purposes (navigation, power, irrigation, flood control) took hold and led to the formulation of water development plans for the entire river basin.

These conceptions coalesced in the creation of the TVA in 1933, where the establishment of a river basin authority was seen as necessary for the unified planning and full development of water resources on a river basin scale in order to achieve regional development (Lilienthal 1944; White 1957). The strong appeal of the TVA model to engineers, planners, and diplomats (Ekbladh 2002), and the political constellation after World War II led to the global spread of river basin authorities, primarily to developing countries. While the TVA and its clones achieved little in terms of unified, bottom-up development (Newson 1997; Scudder 1989), they served as an enabling concept for building dams on a massive scale and sometimes for entrenching authority in the hands of large hydraulic bureaucracies. To date, most river basin organizations are manager/operators (Millington 2000).

River basin development started to lose momentum in industrialized countries in the early 1970s, with the growing recognition of associated social and environmental costs, but also with the decreasing availability of suitable dam sites. Priority shifted toward management of water quality and environmental sustainability. In the early 1990s these concerns were reflected in the Dublin Principles (ACC/ISGWR 1992) and the formulation of integrated water resources management approaches, and later formalized by the European Union in its Water Framework Directive (EU 2000) (box 16.3). Once again the river basin was sanctioned as the appropriate unit for managing water.

As river basin management becomes more holistic, it has to come to grips with a much more complex set of issues, such as population growth, urbanization, and the diversity of competing values, livelihoods, and economic interests, all depending on the same hydrological cycle. This means that river basin management is currently more about mediating conflicts and allocating water in contexts of skewed distribution of wealth and power, critical environmental changes, and increasing variability in water supplies due to climate change. This reorientation from development to management, however, is driven mostly by western countries that have already largely developed their river basins and is sometimes resented by countries that believe that their infrastructure is still insufficient (Thatte 2005).

box **16.3** | **The challenges of integrated approaches to water management**

Pervasive conflicts, environmental degradation, administrative bickering, and contradictory water policies have prompted the need for more integrated approaches to water management. The principles of integrated water resources management were internationally endorsed during the 1992 United Nations Conference on Environment and Development in Rio de Janeiro (Earth Summit), as formulated under point 18.8 of Agenda 21:

> *Integrated water resources management is based on the perception of water as an integral part of the ecosystem, a natural resource, and a social and economic good, whose quantity and quality determine the nature of its utilization. To this end, water resources have to be protected, taking into account the functioning of aquatic ecosystems and the perennial nature of the resource, in order to satisfy and reconcile needs for water in human activities. In developing and using water resources, priority has to be given to the satisfaction of basic needs and the safeguarding of ecosystems.* (UN 1992, p. 197)

As summarized by Millington (2000), integrated water resources management is about allocating water between competing uses, safeguarding aquatic ecosystems, and supplying clean drinking water to all people. It aims to reconcile economic efficiency, equity, and environmental preservation goals (including ecosystem services). This assumes that these values can be harmonized. Yet they are often mutually exclusive: the partial attainment of one has negative effects for the attainment of the others. Integrated water resources management offers a principled and normative vision of what water management should be (van der Zaag 2005), but few guidelines on how to get there (Biswas 2004) and even fewer successful examples in the real world (Biswas, Varis, and Tortajada 2005). That its objectives rarely add up in practice is frequently obfuscated, and mechanisms to balance economic, social, and environmental values are weak or not present.

The integrated water resources management literature tends to promote a technocratic vision of reforms. Experts are to supply the right institutions, establishing proper policies and legislation, creating adequate administrative and coordinating mechanisms, ensuring law enforcement and participatory decisionmaking, and so on. But reforms are essentially political processes (Mollinga and Bolding 2004; Swatuk 2005b), both in the sense of bureaucratic changes permeated by politics and in the wider sense of a continuous reshaping of the access to resources and the power structure.

While it has long been argued that management of land and water resources requires a basin perspective, examples of integrated river basin management are rare (Barrows 1998; WCD 2000). Several reasons are said to account for their rarity. First, political and administrative jurisdictions do not correspond to basin boundaries, making accommodation between different states or provinces difficult. River basin management is a classic example of the problem of fitting biophysical systems to political-administrative territories (Moss 2004). Second, river basin institutions set up to overcome this dilemma frequently create new boundary problems with existing line agencies and other policy fields that have a major impact on water use, such as urban development, land-use planning, transportation, energy, and forestry (Mitchell 1990; Millington 2000). Third, many local problems do not have to be addressed at the basin level (Moench and others 2003), and the articulation between different scales is often problematic, in both hydrologic and governance terms. Fourth, river basin management needs to be financed, whether out of user or polluter fees or through government subsidies, and this revenue is often precarious or uncertain (Abernethy 2005). Last, basin management may be undermined by several other factors, such as political infighting, lack of awareness or interest in problems, and insufficient hydrological data.

Although there may not be a central basin manager, this does not mean that river basins are not managed (Schlager and Blomquist 2000). This can be brought out by identify the roles of the various actors engaged in water management in a river basin, asking who does what, where, to what end, and how well. In any river basin essential functions are partly or wholly carried out, with their sum constituting basin governance (table 16.1).

table **16.1** **Essential functions for river basin management**

Function	Definition
Plan	Formulation of medium- to long-term plans for managing and developing water resources in the basin.
Construct facilities	Activities executed for the design and construction of hydraulic infrastructure.
Maintain facilities	Activities executed to maintain the serviceability of the hydraulic infrastructure in the basin.
Allocate water	Mechanisms and criteria by which water is apportioned among different use sectors, including the environment.
Distribute water	Activities executed to ensure that allocated water reaches its point of use.
Monitor and enforce water quality	Activities executed to monitor water pollution and salinity levels and ensure that they remain at or below accepted standards.
Preparedness against water disasters	Flood and drought warning, prevention of floods, and development of emergency works, drought preparedness, and coping mechanisms.
Resolve conflicts	Provision of space or mechanisms for negotiation and litigation.
Protect ecosystems	Priorities and actions to protect ecosystems, including awareness campaigns.
Coordinate	Harmonization of policies and actions undertaken in the basin by state and nonstate actors relevant to land and water management.

Note: The functions listed here subsume supporting functions such as data collection and resource mobilization, which are not ends in themselves, but rather facilitate the higher level functions listed.

Source: Adapted from Svendsen, Wester, and Molle 2005.

How well functions are carried out, from whose perspective, and for whose benefit are empirical questions. Since many organizations and stakeholders are involved with water management in a river basin, a number that generally grows with basin closure, more than one organization may be involved in performing individual functions. This points to the importance of finding ways to get the multitude of water management stakeholders to work together in a river basin.

Trends in institutional arrangements for river basin governance. Much attention has been given to the ideal organizational model for river basin management, while much less emphasis has been placed on the process of developing, managing, and maintaining collaborative relationships for river basin governance. More fundamentally, the essential function in river basin management—allocating water between competing uses and users, including the environment—has not received sufficient attention, although it is at the heart of integrated water resources management.

> **The essential function in river basin management—allocating water between competing uses and users, including the environment—has not received sufficient attention**

There are two main trends in basin governance. One trend concerns watersheds, or subbasins, of a limited size (typically from tens of square kilometers to 1,000 square kilometers), where local stakeholders and agencies attempt to solve their land- and water-related problems (box 16.4). A second trend concerns the management of wider river basins. This trend has three salient aspects (Svendsen and Wester 2005). First is the consensus that integrated water resources management should be carried out at the river basin level. This, together with the desire to realize the promise of integration, has placed river basin management on the agenda of governments and international funding agencies and has led to many new river basin initiatives (see box 16.4).

Second, the number of public and private sector actors involved in, or concerned with basin planning and management is increasing, from environmental agencies and civil society or interest groups to regulatory bodies and service providers for agricultural, municipal, and industrial water users. With rising standards of living, urbanization, and continuing environmental deterioration more diverse stakeholders and worldviews need to be integrated.

Third, organizations associated with basin planning and management have become more specialized and differentiated into regulators, resource managers, and service providers (Millington 2000). Regulation and standard-setting are carried out in the public interest and are necessarily functions of government, but other tasks may be fulfilled by commercial or hybrid public-private organizations.

In many people's minds river basin management requires a unitary basin management organization. River basin organizations have emerged as a consensual pillar of the integrated water resources management toolbox. However, they cover a wide gamut of organizations with quite varied roles and structures. At first sight this seems a source of confusion, but it also suggests that both the nature of the problems faced (for example, development or management) and the particular history and context of each basin reflect on each river basin organization. The following typology can be inferred from a broad-brush review of river basin organizations, keeping in mind that there are no clear-cut definitions and that there is a large variation in roles and power even within the same category (the generic terms may not correspond to particular bodies):

box 16.4 **Trends in basin governance: watershed management and solutions at the local level**

In developing countries watershed management has gained increasing importance since the 1970s as a response for arresting land degradation, securing downstream water-related services, and improving agriculture and natural resources management (Tiffen and others 1996; Joy and Paranjape 2004). In Australia and the United States growth of watershed management initiatives was linked to efforts to adopt more holistic and regionalized ecosystem approaches to resource assessment and management and to restore environmental quality in line with new values and uses, such as recreation and aesthetics (Omernik and Bailey 1997; Lane, McDonald, and Morrison 2004; Kenney 1997).

Watershed management is based on recognition of the watershed area as the spatial integrator and appropriate unit for managing land and water resources based on hydrological principles of upstream-downstream linkages. Thus, watershed management projects generally aim at establishing an enabling environment for such integrated management to accomplish resource conservation and biomass production objectives (Jensen 1996). A coordinated, multiobjective dynamic involving many sectors and stakeholders is implied, with an emphasis on community-level activities in governance and improved production and conservation technology.

The concept of watershed management has evolved over the past 40 years in response to implementation experiences and changing policies and development paradigms on land husbandry, good governance, and poverty alleviation. Generalizing, the projects of the 1970s and 1980s may be characterized as top-down watershed protection projects aimed at arresting land degradation and securing downstream water supply, using a soil and water conservation engineering approach driven by physical targets. The impact of most of these projects was small and limited to the project period. A lack of people's participation and a technical focus on conservation were broadly identified as major causes of failure (Doolette and Magrath 1990; Chenoweth, Ewing, and Bird 2002; Kerr, Pangare, and Pangare 2002).

A new generation of projects, generally referred to as participatory watershed management projects, emerged in the 1990s with a more complex mix of strategic concerns: poverty alleviation, local participation and ownership, collective action and institution building, production system and land husbandry, cost sharing, programmatic approaches with policy linkages, and sustainability (Farrington, Turton, and James 1999). These projects are generally considered likely to be more successful and are being further developed within the context of political and administrative decentralization, privatization, and the wider perspective of sustainable rural livelihoods to enhance equity, institutional sustainability, and replicability.

This evolution parallels that on river basins—the second trend in basin governance—and reflects an adaptation of the watershed management concept from a narrow focus on hydrological linkages to a wider recognition of the human element and interconnectedness of ecosystems. A major lesson, relevant to all scales (field, farm, village, watershed, and basin), is that conservation or environmental objectives can be achieved only in combination with an upstream-oriented development objective: conservation through use (Badenoch 2002). Watershed initiatives also signal a type of fragmentation of river basin management, and the links between these scattered initiatives and the larger basin remain a crucial question.

- *Basin authorities* are autonomous executive organizations with extensive mandates for their river basin, undertaking most water-related development and management functions. They are regulator, resource manager, and service provider all in one. The TVA is the epitome of this type of organization and has been exported as a model to many countries, with large variations and mixed success. The Damodar Valley Corporation in India, the Mahaweli Authority in Sri Lanka, the Companhia de Desenvolvimento dos Vales de São Franciscoe do Parnaiba in Brazil, and the Confederaciones Hidrograficas in Spain are other examples. Authorities generally show poor responsiveness to local demands and are often undermined by bureaucratic conflict because they infringe on the competence of other government agencies and line ministries.

Some of these authorities received a basinwide, multifunctional mandate covering various domains but were not endowed with the legal, political, or administrative power to achieve them. They generally ended up focusing on construction works and dam management (mostly for hydropower or flood control). Examples include the Damodar Valley Corporation in India (Saha 1979), the River Basin Development Authorities in Nigeria (Adams 1985), and the China River Commissions (Millington 2000). Some authorities were designed to ensure regional infrastructure development (the early River Basin Commissions in Mexico), others endured as powerful manager/operators (Brantas basin in Indonesia, Tarim in China), while others shrank and were confined to one issue or degenerated into powerless parallel structures with narrow scope and erratic funding (A. Dourojeanni, personal communication).

- *Basin commissions or committees* focus on policy setting, basinwide planning, water allocation, and information management, with varying degrees of stakeholder participation. They are usually endowed with authority to manage water resources (allocating permits, defining taxation, negotiating water allocations, defining effluent standards) and sometimes to plan future developments, but are not involved in operation or construction. Examples include the Delaware Commission in the United States, the Murray-Darling Commission in Australia, the British water authorities, and the French agences de l'eau.
- *Coordinating councils* are deliberative decisionmaking bodies incorporating public and private stakeholders and integrating policymaking across different policy areas. They are not organizations in the strict sense, but rather bring together stakeholders from various agencies and water-use sectors. Their role is coordination, conflict resolution, and review of water resources allocation or management. Examples include the river basin councils in Mexico (Wester, Scott, and Burton 2005), the proposed catchment management agencies in South Africa (Waalewijn, Wester, and von Straaten 2005), the Zimbabwean catchment councils (Jaspers 2001), the river basin committees and users commissions in Brazil (Lemos and Oliveira 2004), and several river commissions in the United States.
- *International river commissions* may be set apart because coordination is achieved between countries rather than among stakeholders and because political dimensions are pervasive. They were frequently established as part of a treaty signed between riparian countries or to manage dams on shared rivers (for example, Senegal, Volta, or Zambezi Rivers) (Barrows 1998; see below). They mediate water conflicts through consultation and cooperation but may also manage common databases, and their work may lead to concrete agreements.

From a governance perspective institutional arrangements for river basin management may be distributed along two axes, one that distinguishes between state-driven and stake-

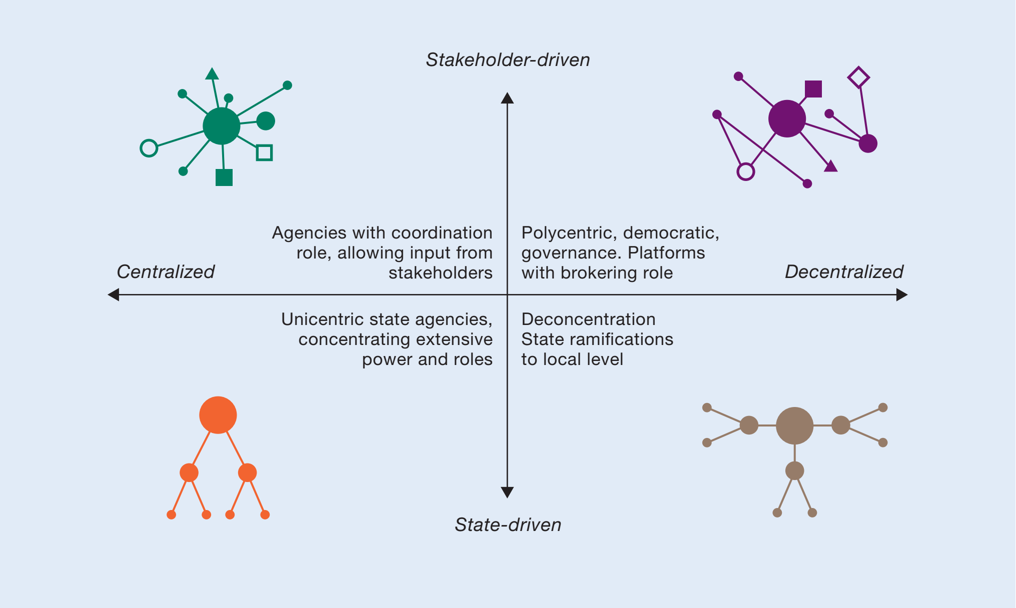
Institutional arrangements for river basin management may be distributed along two axes, one that distinguishes between state-driven and stakeholder-driven functioning, and one that contrasts centralized and decentralized modes

holder-driven functioning, and one that contrasts centralized and decentralized modes (figure 16.5). This yields four models for basin governance: unicentric (state-driven, centralized), deconcentrated (state-driven, decentralized), coordination (stakeholder-driven, centralized) and polycentric (stakeholder-driven, decentralized). Under the unicentric model a basin authority or line ministry manages the river basin. In the polycentric model the actions of existing organizations, layers of government, and stakeholder initiatives are coordinated to cover an entire river basin or subbasin.

Integrated management at the basin level tends toward the unicentric model, as it implies a degree of centralization of data, water allocation decisions, and decisionmaking power in order to internalize third-party effects and to address interactions between users across the basin. This reinforces state control and may militate against the integration of the values and interests of all stakeholders. Decentralization, involvement, and participation of users and stakeholders, local community management of upper watersheds, and the principle of subsidiarity point toward polycentric governance. This poses a challenge for the definition and emergence of institutional arrangements that can ensure that water use is consistent with available resources and ecosystem integrity, upstream-downstream interactions are balanced, and asymmetries of power between stakeholders are recognized.

The polycentric model leads to a more responsive governance process and improves intersectoral linkages, as coordination is among stakeholders, agencies, and other jurisdictions responsible for a range of policy sectors. However, decisionmaking can be cumbersome, coordination costs may be high, and political changes in participating jurisdictions can upset agreements. Polycentric and multilevel governance seek to reconcile stakeholder

figure **16.5** **Typology of river basin governance**



values and objectives by ensuring that information becomes available to all stakeholders and that conflicting actions are flagged in advance and duly debated (Svendsen, Wester, and Molle 2005; Schlager and Blomquist 2000). This requires a culture of democratic debate and not too severe imbalances of power, and it becomes more difficult to achieve as the size of the basin increases.

River basin management without a unicentric manager is the prevailing mode of basin governance in the Netherlands and in the Western United States (Schlager and Blomquist 2000). In the United States formal bodies for managing river basins are rare, with policymaking authority distributed among a variety of federal and state agencies and departments. Coordination is achieved through multiple committees and working groups linking stakeholders into discussion and decisionmaking forums. Legislation and negotiated legally binding agreements are important instruments for establishing policy and practices, and the court system is routinely invoked to resolve disagreements and disputes. Thus, a more dispersed set of organizations can also manage a basin effectively if they are knit together with suitable processes, rules, and other institutions.

Some 158 international river basins lack any type of cooperative management framework

Challenges and trends in managing transboundary river basins. For international rivers as for river basins contained in one country, there is a growing need for collaboration and cooperation. More than 45% of Earth's land area lies within the world's 263 river basins that cross national boundaries. These international river basins are home to about 40% of the world's people and account for 60% of the flow in the world's rivers (Wolf 2002). During the twentieth century 145 treaties were signed concerning nonnavigational uses of international rivers (Wolf 1998), with most of the treaties between two countries, even in river basins shared by three or more countries. Very few of the treaties deal with water allocation, only one in five has enforcement mechanisms, and only one in two has any monitoring provisions (Wolf 1998). Classical examples of functioning institutional arrangements for transboundary river basins include the Danube, Elbe, and Rhine (pollution and navigation); the Colorado, Ganges, Indus, and Nile, (arrangements for water allocation); and the Mekong, Niger, Senegal, and Lake Chad Basin (agreements for joint management).

Despite these achievements 158 international river basins lack any type of cooperative management framework (Wolf 2002). In the absence of treaties states are still bound by the general rules of customary international law governing the use of shared freshwater resources. The 1997 UN Convention on Nonnavigational Uses of International Watercourses establishes two main principles: "equitable and reasonable use" and the obligation not to cause "significant harm" to neighbors. However, as of March 2003 only 12 countries were party to the Convention, far short of the 35 needed for it to enter into force (Giordano and Wolf 2003).

Reaching agreement on sharing the waters of an international basin proves difficult. Most treaties ignore issues of water allocation, and the treaties that do often allocate water in fixed amounts (Giordano and Wolf 2003). Riparian relations are embedded within more immediate, and often more influential, dimensions of historical political relations between neighboring countries. Sentiments of territorial sovereignty often override notions of territorial integrity in a shared basin, eliciting unilateral actions in the name of national development and poverty alleviation. When negotiations stall, it may help to introduce issues unrelated to water, such as trade, or issues related to another river basin, which helped Mozambique, South Africa, and Swaziland to successfully conclude a water-sharing agreement over the Incomati and Maputo Basins in 2002 (van der Zaag and Carmo Vaz 2003).

A recurring complaint in transboundary management is that the mandate of the basin organization is too limited to allow for effective joint management. It may be questioned, however, whether the scaling up of executive powers beyond the riparian states will increase effectiveness if the basin organization is seen primarily as a TVA-style facilitator for infrastructure construction rather than as a regulatory body for ensuring fair and sustainable allocation of water among different users (not just different riparian states). Because of their shaky record on transparency, accountability, and representation of multiple stakeholder interests, a further concentration of power in multilateral organizations may not be the way to go. More emphasis should be placed on negotiating water allocation treaties that ensure "equitable and reasonable use."

River basin management in the future will seek varying expressions within a spectrum bounded by two water paradigms: the water development approach and the ecosystem approach

A striking omission in many transboundary basin agreements is in mechanisms of monitoring and enforcement. Monitoring through remote sensing may be a strong confidence builder. Data sharing, whether from remotely sensed sources or from hydrometric networks and national sources, is a basic condition of cooperation and transboundary water management. Without knowing and understanding the complexity of both the hydrology and the benefits derived from water, it is difficult to reach agreement over the equitable use of the water resources of an international river.

The emphasis on stakeholder participation exposes the lack of public involvement in interstate water agreements, which have often been concluded between a narrow group of actors and interests after behind the scenes negotiations. International river basin agencies such as the Mekong River Commission still have only minimal ties to civil society or involvement in the key dimensions of competition and conflict over water. The new river basin councils, platforms, and forums in which water user representatives discuss plans and allocation issues within a country provide the necessary deepening of superficial interstate agreements—and an important counterbalance. The Zambezi Basin is an example of a genuine, albeit costly, attempt to develop a basin strategy that actively involves stakeholder groups in all eight riparian countries.

Easing the pressure: response options for governing river basins

River basin management in the future will seek varying expressions within a spectrum bounded by two water paradigms: the water development approach and the ecosystem approach. The development approach focuses on harnessing nature and controlling water for human benefit through infrastructure development, while the ecosystem approach promotes restoring and maintaining the integrity of the water cycle and aquatic ecosystems. It is well established that political choices need to be made to initiate a transition toward more balanced practices, with more attention for ecosystems and for the tradeoffs in the development and management of water resources. In closing river basins continuing the emphasis on supply-side approaches will only intensify the pressure on water. Doing better with what we have has profound implications for the choice of responses to basin closure end for the traditional engineering approach; for the allocation of scarce water resources, with a view to sustaining ecosystems and ensuring equity; for the emergence of patterns of governance that will ensure these goals; and for the need to manage water resources in a context of growing complexity and multiple worldviews. This section points to some ways forward and offers recommendations on these four issues.

Developing and conserving water resources

Developing more infrastructure to withdraw more water, as discussed earlier, is often an attractive option for decisionmakers and politicians, even if this is an expensive way to respond to water stress. In several countries, including many in Sub-Saharan Africa, increasing storage to improve water regulation over time and to expand productive uses is often seen as necessary. In closing river basins the cost of mobilizing additional water resources rises steeply because only marginal or distant resources remain available. With existing resource commitments already high, such mobilization also tends to have increasing environmental impacts.

> Subsidized projects increasingly create economic distortions and incentives for uses of water that do not reflect the real cost of providing water, let alone other social or environmental costs

Interbasin transfers are another way to reopen closed basins by bringing in large amounts of water. This can improve the balance between supply and demand in the receiving basin, but it usually implies large losses in terms of direct impact and long-term forgone opportunities for the donor basin, may foster lavish use of water in low-return activities, and may have substantial ecological impacts in the receiving and donor basins (Davies, Thoms, and Meador 1992). Such transfers pose specific problems that tend to be proportional to their scale but they are almost invariably designed in secrecy and imposed by strong political will rather than discussed publicly and openly.

To varying degrees, all impoundment or diversion projects, whether in open basins (avoid past mistakes) or in closed basins (deal with increased interconnectedness), face the same challenges. They must be based on a thorough understanding of their hydrological and ecological impacts and ramifications for water management and water entitlements, and choices must be informed by a review of alternatives (see the rights and risks approach developed by the World Commission on Dams, WCD 2000). Increased scrutiny and openness must be brought to bear on projects stemming primarily from hydraulic bureaucracies seeking to perpetuate themselves or states looking for national icons, politicians for votes, or private operators for financial benefits.

The costs of water resource development or interbasin transfers should be fully accounted for, and full compensations of losers should be ensured. Subsidized projects may have been justified in the past, but they increasingly create economic distortions and incentives for uses of water that do not reflect the real cost of providing water, let alone other social or environmental costs. The political logic of such projects should be countered through greater economic rigor and more stringent environmental impact assessments. These tools have so far achieved only moderate success, even in developed countries, and are of limited use if not accompanied by openness and public scrutiny.

However, the recent freezing of the Ebro River diversion in Spain shows that economic rationality and environmentalism, if backed by political clout, may counterbalance the arguments put forward to justify such projects (Embid 2003). Decisionmakers are urged to comprehend the mechanisms that generate overbuilt basins and the negative consequences of such processes.

The main alternative responses to water overexploitation in closed basins revolve around water demand management. While the scope for real water savings diminishes as basins close, this should not deter efforts to identify situations where real gains are possible and others where reallocations associated with conservation are desirable. City distribution networks often have losses as high as 40%. And even though these losses may return to the aquifer and be reused, this costly treated water should be conserved as much as possible. Outdoor domestic use and industrial use are also amenable to substantial water savings (Gleick 2000). Slack irrigation management may increase nonproductive losses (such as evaporation during lengthy land preparation periods in rice cultivation; see chapter 14 on rice), and the quality of drainage water may become degraded or even flow to sinks (for example, saline aquifer) and become unrecoverable. Some return flows through aquifers may also have long time lags and not be readily available. Reuse also often involves pumping, which increases overall costs. Each situation must therefore be analyzed individually, through a thorough quantitative description of water fluxes and paths.

Water balances often consider only surface water. Water accounting, water quality assessment, ecosystem approaches, and similar exercises are needed for a more complete picture

Understanding hydrological and ecological interconnections requires more effort than is usually thought. Water balances often consider only surface water. Water accounting, water quality assessment, ecosystem approaches, and similar exercises are needed for a more complete picture. Because basin management increasingly resembles a zero-sum game as the basin closes, it is important to identify implicit spatial reappropriation caused by interventions, notably conservation efforts, especially the final impact on the environment. The use of wastewater in agriculture is also a way to increase beneficial use in the basin and is a promising path (see chapter 11 on marginal-quality water). In sum, demand management and conservation options are important responses in closing basins, but their pervasive third-party impacts at the basin level must be fully examined.

Water allocation: sharing costs and benefits

Water allocation, which is a scarcity-sharing mechanism, is the core issue in closing basins. Sharing the "water pie," however, is often wrongly equated with more concrete issues such as the division or distribution of (nearly) static assets like land. Water allocation is characterized by contingent levels of variability and uncertainty, both temporal and spatial. In the mid- to long term hydrologic regimes may vary because of changes in rainfall, temperature, land use, and runoff patterns; in the short term they reflect the variability of seasonal rainfall patterns. Climate variability tends to increase with aridity and with climate change. Allocation is also spatially distributed and has to be defined at several nested levels that are made interdependent by the nature of the hydrological cycle. Allocation arrangements must therefore be defined at several levels in the basin, principally between sectors and bulk users (but also within irrigation schemes), and must take temporal variability into account.

Three modes of allocation are commonly recognized (Dinar, Rosegrant, and Meinzen-Dick 1997). First, the state allocates water administratively according to rules that may, or may not, be very transparent or explicit. Allocation is sometimes volumetric, in general at the bulk level, and various (often fuzzy) mechanisms are used to reduce entitlements in times of shortage. Second, allocation can be ensured by a group of users among themselves. This case is more common in smaller systems (for example, a tank in India, a qanat in the Middle East), but users may also manage large schemes. Third, water may be allocated through markets of tradable rights, as in Australia or Chile. Underlying all three modes of water allocation are water rights, either de facto or usufruct rights, or more legally defined ownership rights.

These three modalities are not necessarily exclusive. Markets, for example, need strong state involvement for law enforcement or control of environmental externalities, while users may still have to share water allocated in bulk. Each has prerequisites, advantages, and drawbacks related to their impact on equity, economic efficiency, and environmental sustainability (Meinzen-Dick and Rosegrant 1977). It is often believed that markets, because they are assumed to be impersonal and neutral, provide an efficient way to allocate water to high-value uses while circumventing resource capture by powerful parties. However, skewed political or social power, lack of accountability and transparency, and a weak state with weak law enforcement capacity preclude fair markets just as much as they warp the outcomes of administrative or collective allocation. Societies with a capacity to keep such negative factors under reasonable control can more successfully allocate or manage water, whether through markets (Australia), public bodies (France), or people's associations (Taiwan). In sum, allocation mechanisms should not be based on ideological inclination but on a sound understanding of each context and situation.

Water allocation mechanisms should not emerge from ideological inclination but from a sound understanding of each context and situation ,

Considering the confusion and conflicts commonly generated by water-sharing mechanisms, it is tempting to propose state definition of ownership rights to water as a way out. It is hoped that defining state-sanctioned water rights for all users, or all groups of users, will transform chaotic and confrontational situations into a clear-cut list of numbers defining—and matching—supply and demand. Many consultant reports, national water policies, or even water laws emphasize the need to formalize water rights but tend to overlook the prerequisites for such arrangements to be effective:

- Sound knowledge of the resource (in particular surface-groundwater interactions, return flows, water quantity and quality interactions) and of existing users.
- Means to control effective diversions and abstraction and to prevent increased water use.
- Technical capacity to share water volumetrically, and mechanisms to adjust these shares in deficit years.

Instead of trying to establish formal water rights at once, it may be preferable first to define seasonal entitlements based on existing usufruct rights, both within irrigation systems and between bulk users of the same basin. These entitlements can be flexible and negotiated with users' participation and may constitute a desirable first step toward defining more formal water rights that may be amenable to some form of trade or financial compensation in times of scarcity.

Currently, the main trend in the allocation of water is the transfer of water out of nature to agriculture and out of agriculture to urban uses (Meinzen-Dick and Rosegrant

1997; Molle and Berkoff 2005). The first transfer needs to be stalled or reverted, while the second is going to continue and its consequences must be addressed. The environment tends to be the ultimate loser. The definition of environmental flows is a starting point for negotiations and, when enforced, incorporates the environment into allocation. Average allocations often pose few problems in a normal year. But the rather incompressible needs of industries and cities are salient in times of droughts, when agriculture and nature are squeezed and appear to be the residual users in the system. Planning for such contingencies, rather than hiding the fact that some parties will be affected more than others, should include defining temporary compensation mechanisms.

River basin governance is about the emergence of the appropriate blend of government, civil society, and markets in decisionmaking and regulation

A desirable water allocation mechanism for surface water has three tiers: a reserve for basic human needs and the environment (as in South Africa), a reserve for productive water for the poor, and a reserve for productive use, including water for urban areas and agriculture. After the first two tiers have been satisfied, proportional (or otherwise) allocation on an annual basis would determine the water available for other productive use. In any case, designing and enforcing allocation rules or priorities that are socially—and not just bureaucratically sanctioned—require that stakeholders be represented in forums with decisionmaking powers. More generally, the values of water for local stakeholders may vary and may not always be amenable to economic evaluation; they should be at the center of decisionmaking.

The basin governance challenge

River basin governance is about the emergence of the appropriate blend of government, civil society, and markets in decisionmaking and regulation. In addition to greater control, rigor, and openness for water resource planning and allocation, as just described, integrated river basin management demands adequate governance. This brings out two main challenges: ensuring that all stakeholders, including the environment, have a voice, and coordinating uses and policies within the basin.

Although frequently advocated as a key to achieving effective water management (Rogers and Hall 2003), stakeholder participation in river basin management is not straightforward, and including the poor and achieving substantive stakeholder representation have proven elusive in practice (Wester, Merrey, and de Lange 2003). Emphasizing participation in river basin management may draw attention away from the very real social and economic differences between people and the need for redistributing resources, entitlements, and opportunities. This is unlikely to happen without challenges, and decisionmakers committed to social equity need to devise mechanisms that strengthen the representation of marginal groups in river basin management and empower them.

Stakeholder platforms, whether river basin councils, catchment management agencies, or watershed councils, democratize river basin management by giving voice to multiple actors. However, much depends on the institutional arrangements from which these river basin management institutions emerge, as many roles, rights, and technologies and physical infrastructure for controlling water are already in place. Stakeholders have different levels and kinds of education, differ in access to resources and politics, hold different beliefs about how nature and society function, and often speak different languages

(Edmunds and Wollenberg 2001). If these differences are not taken into account when creating new rules, roles, and rights, the institutional outcome can easily privilege those who are literate and have access to the legal system and eventually institutionalize inequality and power differentials instead of giving voice to marginal groups (Wester and Warner 2002).

While the complexity of integrated management of sizable river basins invites centralization and technocracy, participation suggests subsidiarity (delegation of decisions and management to the lowest appropriate level) and small-scale operations, inviting people to think creatively about the issues with which their lives are intimately linked (Green and Warner 1999). However, subsidiarity may work against integrated management if local users take decisions that disregard spatial, ecological, and social interconnections across scales. Watershed management may be achieved by groups of people who are spatially connected, but links and coordination with other scales must be ensured. In large basins management would thus entail a layered system of representation and management, with local actions subjected to normative regulations and supervision (or direct support) of both technical and political bodies.

Basins facing complex problems of conflicting societal values and pressure on resources will probably not be well managed by a single body

This review of basin governance patterns identified the various types of organizations and arrangements for basin management. A strong civil engineering body capable of planning, designing, and constructing infrastructure to tap available water is useful and effective when resources are plentiful and management is not a strong requirement. In later phases of basin closure, however, experience shows that large civil engineering organizations (and agricultural or other line agencies) are not well suited to dealing with the challenges of basin governance. They have limited experience in political negotiation or interacting with key stakeholders and lack the breadth of experience in dealing with complex, broad-based issues and multiple values. Further, they often tend to adopt stances based on vested interest in continuing infrastructure development, a position antagonistic to that of stakeholders with ecosystem concerns. Countries that have strong civil engineering organizations reluctant to cede any power will face intense negotiations and struggles before an acceptable form of river basin coordination emerges that is capable of undertaking the key tasks required. But wherever the scope for construction is reduced and societal values have changed, the trend is likely to follow that of countries such as Australia and the United States, where engineering bodies have contracted and evolved into environmental agencies.

Decisionmakers should not infer from the integrated water resources management message that river basin management needs a strong centralized organization. Basins facing complex problems of conflicting societal values and pressure on resources will probably not be well managed by a single body. Nested or polycentric patterns of basin governance, in which user and community organizations, layers of government, and stakeholder initiatives are coordinated at the basin level, perform better and can be especially effective in settings where participation and democratic practices are well established (see chapter 5 on policies and institutions). Moving toward sustainable river basin management requires much more emphasis on developing, managing, and maintaining collaborative relationships for river basin governance, building on existing organizations, customary practices, and administrative structures.

Concluding remarks

The focus on river basins and on river basin organizations must not distract decisionmakers from the evidence that many external events or changes in wider economic and political spheres can also have large impacts on basin water use. Changes in import and export tariffs, for example, may alter crop choices and the amount of water used. Importing food grown from water-demanding crops may amount to importing virtual water, but other factors such as food security and geopolitics also have a bearing on such choices. The impact of climate change on resource variability may exacerbate conflicts. Societal preferences change with time, leading to shifts in the balance of political power. Ecosystem dynamics are hard to comprehend, are often nonlinear, and require adaptive management. In other words, both basin-based arrangements and wider policies must remain flexible and capable of incorporating change.

Reflecting on the challenges facing basin governance, it is clear that where poverty is widespread, river basin management needs a strong developmental dimension. At a minimum, strategies for river basin management should detail mechanisms for addressing imbalances in access to water and establishing recognized and secure water entitlements for the poor. While much can be learned from institutional arrangements for river basin management in affluent countries, these arrangements do not operate in the same way in the conditions of low-income countries: dominance of smallholder agriculture, weak institutions, insufficient financial and human resources, marked social inequity, and extreme poverty. Water management can only partly address these issues, which must explicitly form the points of departure in the reform of institutional arrangements for river basin management in developing countries.

Reviewers

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Notes

1. This definition differs from the hydrologic definition of a closed basin, where rivers do not discharge into the ocean but to internal seas, lakes or other sinks.

2. Conceptualizations of basin trajectories have been developed by Keller, Keller, and Davids (1998), Keller (2000), Turton and Ohlsson (1999), Ohlsson and Turton (1999), and further by Molden and others (2005) and Molle (2003).

3. Total annual renewable water resources in the basin are defined as total runoff in the basin plus the safe yield of the aquifer, where the safe yield is the level of abstraction whose consequences, in average reduction in groundwater stocks and base flow, are considered acceptable.

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River basin development and management

2007

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