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Water Reallocation: Drivers, Challenges, Threats, and Solutions for the Poor

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Abstract With rapid growth in demand for water, the resource is increasingly being transferred from agriculture to cities and industries. This paper examines trends and expected future changes in sectoral water demand, which drive water transfers. It then describes alternative mechanisms for water reallocation, including administrative reallocation, market-based reallocation, collective negotiation, and other means, including combinations of mechanisms, and illegal transfers. Transfer mechanisms and implications for rural livelihoods and the environment are illustrated for case studies in the western United States and Asia. The paper concludes with a series of suggestions for alternative policies and institutions for reallocation that could help reduce adverse consequences for the poor.

Key words: Water reallocation, Water scarcity, Water demand, Urbanization, Market-based reallocation, Collective negotiation

Introduction

Rapidly growing water demands in the agriculture, industry, and household sectors have led to increasing concerns about a 'Global Water Crisis'. The main drivers for increasing water demands are growing populations, increasing urbanization, and economic growth, as well as — at higher income levels — calls for increased water allocations to maintain water-based ecosystems. In addition, national-level and global policies and investments, either directly targeting water or those that affect water availability indirectly, such as agricultural subsidy policies or foreign direct investments in the industrial sector, have often contributed to growing demand for and reduced supply of water. In the longer term, climate change will significantly contribute to water scarcity.

When water uses approach or exceed renewable supplies or developing new water resources becomes increasingly expensive, an increasingly common response to water shortages has been reallocation of

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water from irrigated agriculture — by far the largest water user — to non-agricultural water uses, principally in urban areas. Such reallocations pose potentially adverse consequences for equity, environmental sustainability, and the livelihoods of the rural poor.

Water reallocation is often an implicit process, driven by investments in urban water supply systems and industrial zones. But several explicit reallocation and transfer schemes are being developed, including the multi-billion mega-projects of the South-to-North Transfer in China and India's National River-Linking Project. These transfers provide water for many uses, but meeting the needs of key urban and industrial uses is often a strong underlying objective.

Some economic studies suggest that the negative local impacts of properly managed water transfers from agriculture will be minimal, but popular perceptions and some case studies give a more pessimistic view. In aggregate percentage terms, the volumes of water needed for other sectors are usually small relative to agricultural water use, leading to arguments that efficiency gains in agriculture could free up this water. But in many cases the transfers are not spread evenly over the various agricultural water uses — they are concentrated in certain areas, and in certain (usually dry) seasons and years. Whereas much irrigation use is seasonal, non-agricultural requirements are year-round, necessitating storage. Transferring even seemingly small amounts of water out of agriculture can have impacts on a wide range of stakeholders, particularly in areas with significant irrigation development, if effective institutions to manage water transfers are not in place. We illustrate this with examples from the western United States, where such transfers have occurred over the past two decades, and Asia, where rapid urbanization and industrialization increasingly compete for water with longstanding irrigation systems.

Comprehensive reforms are required at each level of the water allocation process to allow transfers of water out of agriculture while sustaining crop yields and output growth to meet rising food demands. The following sections describe trends and expected future changes in sectoral water demand, which drive water transfers; describe the phenomenon of water transfers out of agriculture; describe selected reallocation case studies; list implications for rural livelihoods and the environment; and describe alternative policies and institutions that can help mitigate or reverse adverse consequences for the poor.

Drivers for water reallocation

By 2025 the global population is expected to increase to 7.9 billion, more than 80% of whom will live in developing countries and 58% in rapidly growing urban areas. In response to population growth and rising incomes, worldwide cereal demand will grow by a projected 46% between 1995 and 2025, and in developing countries by 65% (Rosegrant *et al.*, 2002, p. 91). One-half of the future growth in cereal production is expected to be met from irrigated agriculture. Moreover, more affluent diets will translate into greater demand for more water-intensive crops, such as sugarcane and horticultural crops.

While irrigation accounted for approximately 86% of global water consumption in the mid-1990s, this share is expected to decline to 76% by 2025 given the rapid increases in non-irrigation demands, albeit from a low base. While water consumption for irrigation is expected to increase from 1436 cubic kilometers in 1995 to 1492 cubic kilometers by 2025, non-irrigation demands will grow much faster, from 363 cubic kilometers to 588 cubic kilometers during the same time frame (Rosegrant *et al.*, 2002, pp. 67–71). Changes will occur at a faster pace in the group of developing countries (see Figure 1). Moreover, some of the increases in non-irrigation demand will be at a direct cost to the irrigation sector, as the projected decline in irrigation water use for China shows (Table 1).

In addition to these direct drivers for water reallocation, many other policies contribute to water moving out of agriculture. They include agricultural input and output price support policies and agricultural trade distortions that reduce international food prices, which, in turn, depress irrigation development and reduce the value of water in irrigation uses. They also include industrial protection policies and poor enforcement of industrial water quality and other regulations, which contribute to inefficient water usage in this sector, and, finally, preferential government support for more powerful urban water users, resulting in increasing gaps between urban and rural rates of drinking water coverage.

At the same time, irrigation development remains critical for food security in many regions of the world. Today's 250 million hectares of

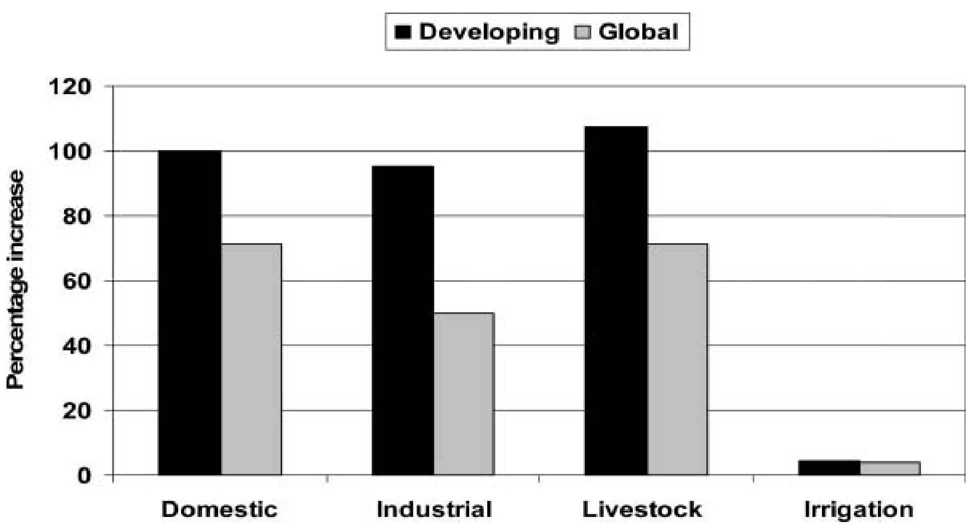

FIGURE 1. Projected increase in water consumption by sector, 1995–2025. *Source*: Based on Rosegrant *et al.* (2002).

Table 1. Projected changes in water use by sector (billion cubic meters)

	Domestic use		Industrial use		Livestock use		Irrigation use	
	1995	2025	1995	2025	1995	2025	1995	2025
China	30.0	59.4	13.1	31.1	3.4	7.4	244.2	230.9
India	21.0	40.9	7.2	15.7	3.3	8.1	321.3	331.7
Asia	79.1	156.7	48.3	90.7	11.7	25.6	920.2	933.3
Latin America and the Caribbean	18.2	30.7	17.9	29.9	6.9	12.5	88.3	96.9
Sub-Saharan Africa	9.5	23.9	0.9	2.4	1.6	4.1	50.3	62.9
West Asia and North Africa	7.1	13.1	4.6	8.7	1.8	3.3	121.6	137.1
Developed	58.7	68.6	94.7	113.8	15.3	18.2	271.7	276.9

Source: Based on Rosegrant, *et al.* (2002).

irrigated area is nearly five times the amount that existed at the beginning of the twentieth century. Without irrigation, the rapid increases in agricultural yields and outputs that we have seen over the past three decades could not have been achieved. While irrigation is often associated with adverse environmental and sometimes also social impacts, it remains one of the most critical inputs into farming, and can be an important poverty reduction tool, a crucial contributor to affordable food prices, and through its significant multiplier effects improves many other livelihood outcomes, such as health and nutrition (Rosegrant *et al*., 2002; Lipton *et al*., 2003).

Moreover, irrigation systems often serve many other rural water uses, including rural domestic water supplies, household gardens, livestock, fishing, recreation, and other enterprises (Bakker *et al*., 1999). Although these are generally high-value water uses, it is often women or marginalized social groups (e.g. pastoralists or fishers) who depend on these other water uses. These users are often not officially recognized and have even more difficulty than farmers in defending their water use against demands from more powerful cities and industries.

Alternative mechanisms to implement water reallocation

Throughout history, the most common response to growing water demands has been to develop new supplies. But by the end of the twentieth century, most of the easily exploited water resources have been tapped, and increasing the water supply carries increasing financial and ecological costs. Because irrigation is the largest water user, and because returns to irrigation per unit water use are generally low compared with other sectors, reallocating water from irrigation to other uses that have either higher economic returns (e.g. industry) per unit water or greater political pressure (e.g. urban domestic use) has become more common. Although generally seen as reallocation from irrigation, these water transfers can have profound effects on other rural water uses.

Water transfers take place through a variety of formal and informal mechanisms, including administrative reallocation, market-based transfers, and negotiations with communities. The nature of the transfer process has important implications for the degree to which third-party effects (significant negative — or positive — economic, environmental, or other effects on parties that are not directly involved in the transfer) are considered, the types of compensation provided, and the public response to water transfers (see also Table 2).

Administrative reallocation

Administrative reallocation often occurs from large bodies of water such as rivers, lakes, reservoirs, and large irrigation systems managed by state agencies. The inherent assumption is that water is public property. The state justifies its rights to regulate and reallocate water for the benefit of the 'wider public', but often focuses on the more powerful sections of society — municipalities and factories. Formal hearings are rarely held, although farmers may protest the transfers through their politicians or other forms of agitation, as they successfully did in the Bhavani basin (see below). In these cases, indirect compensation may be given, but users' prior rights are rarely recognized, even for irrigated farmers, much less for other rural water users (for example, see Dixit, 1997).

The 'invisibility' of other rural water uses, such as fish production, livestock watering, homestead gardens, domestic use, and rural enterprises, at least from the perspective of the state and municipal and industrial users, can lead to serious livelihood consequences for women and other marginal groups when water is transferred out of agriculture. Molle and Berkoff (2006) find that compensation for administrative reallocation typically occurs where users are readily identifiable, and are able to bring political pressure to bear on the decision-makers. Even where

Table 2. Principle mechanisms for water reallocation

	Administrative reallocation	Market-based reallocation	Collective negotiation
Examples	China; South-to-North transfer	Chile, western United States, New Mexico	Tanker's association, Kathmandu; California municipalities
	India; National River-Linking Project Bhavani, NIA (Philippines)		
Third-party effects	Seldom taken into account	Sometimes taken into account, depending on statutory law	Can be taken into account if reallocation is small scale
Compensation for users	For visible, easily identifiable users; beneficial use rights, low levels	Yes for those who directly transfer water	For whole communities, but maybe in alternative form
Public response	Protest more likely if transferred to industries	'Privatization' of water may prompt protests	Probably most positive response

these conditions apply to irrigated farmers, they rarely apply to these other 'invisible' users. Providing recognition to these users is a first step towards securing their rights to water and/or compensation when they are affected by reallocations, but this needs to be followed up with some form of enforcement, which is rarely forthcoming.

Because both state and customary law generally accord high priority to drinking water, farmers often accept transfers of water for domestic use, particularly if the transfer is perceived as fair. If farm households perceive that municipalities will be receiving a higher level of water service than is available to their rural areas, however, there are often protests, either through appeals to government or even through sabotage of the pipes transferring water (Meinzen-Dick *et al.*, 2004).

Administrative reallocation for industrial use is generally less acceptable to people who lose water access, than transfers for domestic use. However, in that case, it is often not the depletion of water quantity that results in protests, but reduction of water quality due to effluents that factories discharge back into waterways.

Market-based reallocation

There is increasing use of formal and informal market mechanisms through which water is either sold directly to buyers for non-agricultural uses or land is leased or sold to individuals or factories, who then either abstract groundwater beneath the land or use the share of water allotted to the land from irrigation systems. The operation of water markets with compensation for those who give up water presupposes fairly strong recognition of private water rights.

The western United States and Chile have both used a variety of market or semi-market mechanisms in which individual farmers lease their water use rights to other users or sell their rights permanently (Easter *et al.*, 1998; Rosegrant and Ringler, 1998). State recognition of private water rights, and especially water rights that are separable from land, have facilitated such market transfers, and state regulation of these transfers (Scott and Coustalin, 1995; Easter *et al.*, 1998). Market transfers directly compensate those who engage in the transfers, but generally do not take into account the water claims of others who may be affected, unless there is specific state regulation.

Collective negotiation

Collective negotiation for water reallocation can be either between existing water users and the state or between the old and new users themselves. Negotiated approaches can expand the range of options, for example, by seeking 'win–win' solutions (Bruns and Meinzen-Dick, 2000). In California some municipalities have secured additional water for drought years by paying farmers to either install water-conservation devices or to increase groundwater recharge in wet years, with the city, for example, receiving the additional water saved or stored (Howitt, 1998). A tankers' association supplying middle-class residents in Kathmandu negotiated with a Village Development Committee to purchase water from a stream near the community (Meinzen-Dick *et al.*, 2004). But unlike water purchases from individuals, in this case the funds go to the Village Development Committee for investment in other community assets.

In negotiated reallocation of water it is, in theory, possible that the rights of non-irrigation rural uses of water — for example, for livestock, fisheries, kitchen gardens, and so forth — are taken into consideration. However, rights and uses for non-irrigation rural uses are typically 'invisible' to the state, market, and irrigators. Furthermore, the pastoralists, fishers, and women who are most concerned with these uses are generally less powerful. These uses are thus hardly ever taken into consideration during negotiation.

Other means of water transfer

While it is useful to construct ideal types of administrative, market, and negotiated transfers, many empirical cases involve a combination of these reallocation processes. Moreover, illegal means such as stealing water from canals or extracting water from groundwater are also common (as illustrated for West Java by Kurnia *et al.*, 2000). Some of the means rely not on any type of law to justify them, but rather on force or stealth. In the following sections we examine empirical cases of water transfers, and their impacts.

Case studies on water reallocation

Western United States

The western United States is perhaps the best-known region for water transfers from agriculture to municipal/industrial as well as environmental uses. Transfers have generally been arranged through a variety of market or quasi-market mechanisms in which individual farmers have opted to sell or lease their water use rights to other users. Such transfers have been facilitated by the predominance of prior appropriation water rights, which are separable from the land, and because, in allocating priority of rights, the state has generally established the nature of the water flows and the volume or shares of the individuals' rights (Howe, 1998).

There are important differences in the nature, and hence the outcomes, of intersectoral transfers in the different states of the western United States. Arizona and Utah conduct transfers through the State Engineers' office, which determines technical characteristics of all proposed transfers and conducts hearings on third-party effects. Colorado uses water courts, which have much higher transaction costs for both those who propose the transfer and those who might want to protest it. As a result, Howe (1998) reports that small water users with legitimate protests are often excluded. Furthermore, only 'beneficial use' rights, and not public uses, are considered. Therefore, there is little recourse for those who are affected by the transfers through reduced return flows, reduced recreational or environmental water uses, or loss of livelihoods, and hence the tax base in agricultural areas as they go out of irrigated production. The result has been a popular backlash against intersectoral water transfers, and attempts to block inter-basin transfers in the state legislature.

New Mexico's system for water transfers through the State Engineers' office pays more attention to the rights of small water users, as well as third-party effects. Nevertheless, small farmers from *acequias* (traditional farmer-managed irrigation systems) may have difficulty in defending their rights, even though they are the most senior rights in the state. These farmers, who are generally of Hispanic descent, are socially marginalized because they have generally less education and are often not fluent in English, the language of the legal documents and hearings. The involvement of a public interest law firm has been instrumental in promoting legal literacy regarding acequia water rights and transfer procedures, as well as representing the *acequia* owners and promoting measures to ensure greater participation by the *acequia* members (Northern New Mexico Legal Services, 2000).

Since 1991, transfers in California have been conducted through a State drought water bank, which arranges purchases from individual farmers for transfer to other users. Most transfers have been temporary leases of water rights, rather than permanent transfers, in part because of the restrictions on water rights but also because agriculture is economically strong in California, and most holders of water rights do not want to permanently give up their water (Howitt, 1998). In some cases, municipalities have secured additional water for drought years by paying farmers to either install water-conservation devices or to increase groundwater recharge in wet years, with the city receiving the additional water saved or stored.

The impacts of water transfers from agriculture to other sectors in the United States have been mostly evaluated from an economic perspective, with some attention to broader livelihood and community outcomes. For example, Howitt (1998) estimates 'gains from trade' in California in terms of increases in the dollar value of output per unit water, as well as employment in rural and urban areas. Even with payment for water sales, the water-exporting regions lost more in crop production than was paid for the water, but the gains in water-importing regions created a net gain for the state as a whole. The same pattern applies for employment: the increases in jobs in water importing areas were estimated at 2.3 times the job losses in water-exporting areas. However, he notes that the 'job multipliers' for urban use as a whole are much less than for industry alone, because a considerable portion of municipal water is used for landscaping.

The distribution of gains and losses is not only between importing and exporting regions, but also within the exporting area. In one community in Mendota, California, Villarejo (1997) found the number of farms fell by 26%, but small farms declined by 70%, labor demand decreased even more rapidly than cropland, and three out of seven wholesale produce firms went out of business when water was reallocated from agriculture to urban use during 1987–1992. However, in some cases water transfers do not cause much loss of agricultural income or employment, especially where water was not used efficiently in agriculture, or where shifts to new technologies or higher-value crops allow farmers to produce more with less water. In the suburbs of Beijing, for example, new irrigation technology and crop diversification supported increases in grain and overall agricultural output values at the same time that water was diverted to the urban core and the overall irrigated area had declined (Nickum, 1997).

For the case of Colorado, Howe (1998) discusses some broader impacts of water transfers. As water rights are sold and land goes out of agricultural production, not only are local agricultural service businesses affected, but property values also go down. This affects the rural tax base, and hence public services, including schools. Even the loss of recreational uses and aesthetic values can have significant impact on employment, land values, and tax revenues, where tourism is a significant industry in rural areas. These effects are larger in areas where water rights are sold, compared with where rights are leased or traded on a temporary basis, like in California.

Losses of income, employment, land values, and tax revenues can all be quantified (although with difficulty, especially in the case of employment multipliers), and compensated with monetary or other economic measures. What is harder to measure, much less compensate for, is loss of social and cultural values. In New Mexico, members of one *acequia* filed a court case to block water transfers to a ski resort on the grounds that they would disrupt the cultural core of the acequia community, which was built around mutual cooperation to maintain the acequia. This case won an injunction blocking the sale of water but the case was overturned in the Appeals Court (Howe, 1998).

Asia

While water transfers have received greatest attention in the West, they are occurring at an increasingly rapid rate through much of Asia, from China to Viet Nam, the Philippines, Indonesia, and South Asia. Neither the water reallocation mechanisms nor the studies of their impacts have been well established in that region. The diversity of water rights and livelihood strategies within communities is a source of further complexity in this region.

In the Philippines, the Angat-Maasim river system serves both an irrigation system of over 20 000 hectares and the burgeoning municipal and industrial water demands of Metro Manila. State-recognized water rights from the reservoirs are held by three different government agencies, representing different sectoral water uses: the National Irrigation Administration (NIA), the Metropolitan Waterworks and Sewerage System, and the National Power Corporation. The NIA has the most senior water rights, but it is the agency that holds the rights to water in the reservoir, not the farmers, and the Water Code has emergency provisions giving priority to domestic use. On average there is sufficient water for all users to date, but during droughts there are definite episodes of severe water shortages where agriculture loses out heavily to municipal, and especially industrial, use. For example, during the 1997 El Niño, agriculture received no water for the dry-season crop, while industry's allocation fell only slightly. Although these may be short-term or annual fluctuations, the lack of water for an entire irrigation system has serious repercussions for food production and rural livelihoods, as well as for the irrigation agency's income. In addition to the irrigation system losing 125 metric tons of rice production and the crop's income, those renting land still had to pay their rent, and hence went into debt or lost their land (International Rice Research Institute, 2000). The NIA is itself a stakeholder that is negatively affected by these transfers, because the agency is dependent on irrigation service fees for its budget. Because the irrigation system is a government system and farmers only had weak water use rights, no formal compensation was provided, although there were some government employment programs to help offset agricultural losses, and there was a suggestion (not implemented) that the government would compensate the NIA for their budgetary shortfall.

Increasing competition over water between irrigation, industry, and suburban developers in Indonesia has led to a variety of transfer mechanisms. Kurnia *et al.* (2000) show how textile factories in West Java have obtained water through government-allocated permits drawing on surface irrigation water or groundwater, through negotiation with local farmers to buy or rent their land or acquire individual irrigation turns, and by adding extra inlets, putting pumps on the pipes to draw more water than normally allowed, or taking water out of turns. The first mechanism, through administrative allocation, is sanctioned by state law. Buying or renting land and taking the water allotted to the land is not sanctioned in state law, but local law generally accepts it as a legitimate means of acquiring water. That is, although the water is not supposed to be separable from the land, farmers in the system acknowledge that the owners of fields have a right to a certain turn of water, and that this amount of water could be used for non-agricultural purposes. However, the additional inlets, pumps on pipes, and taking water out of turn are not sanctioned by state or local law, but continue by virtue of the power of the factories. Factories also negotiated with upstream farmers and provided them with benefits (e.g. help in rebuilding a drainage structure) so that the farmers would not object to the extra water that factories take, while the downstream farmers got less water. This approach compensates some farmers, but not those who bear the greatest costs; as a consequence of lost production and increased insecurity of supply, many farmers have been forced to sell their land. Although the farmers in this case have the strongest water rights in both local and state law, they are generally not able to defend those rights because of the greater economic and political power of the factory owners.

India also has increasing cases of water being transferred from agriculture to industrial and municipal use, mostly through administrative reallocation, but negotiations, informal market transactions, and illegal means can also be found. The Bhavani River serves over 100 000 hectares in irrigation systems that date back to the fourteenth to seventeenth centuries and is the main source of water for the city of Coimbatore, with approximately 1.5 million people, as well as hundreds of villages in the area. There are numerous industries in the area, especially water-intensive textile industries, both in the city and dispersed in rural areas. Growing demand for municipal and industrial water uses has been met by a series of administrative reallocations since 1960. Informal groundwater markets have also developed, with farmers selling water to industries, businesses, and urban consumers. Palanisami (1994) found that the returns to farmers from these sales are significantly higher than returns to farming, but unsustainable withdrawals of groundwater have resulted in a significant lowering of the water table, up to 230 meters. Thus, even though farmers participating in the informal groundwater market may benefit from these water transfers, there is environmental damage, and surrounding farmers and others in the community are negatively affected.

The water transfers led to a fall of almost 50% in farm income in the tail end of the system, but many farmers diversified their household activities to reduce dependence on (mostly) rice farming. There was an increase in poverty among farm households (from 3% to 15%). Hardest hit were the landless agricultural laborer households, who lost employment and had poverty rates increase from 15% to 34% (Palanisami and Malaisamy, 2004).

Competition over water is not on quantity alone; water quality issues are gaining prominence in the area (Janakarajan, 1999). A sugar factory located in the basin also withdraws and returns large volumes of water, and local demands for treatment of the sugar factory effluent are gaining momentum. A viscose (organic liquid used to make rayon and cellophane) factory has also let effluents into the Bhavani River.

In addition to protests from the farmers' association, a civil society movement has campaigned on a number of environmental issues, particularly related to water quality. After a number of civic protests (with thousands of people) and court cases over the pollution, the viscose plant was closed for failing to treat effluent. This was a major event, leading to the loss of over 2000 jobs, but also to an increase of fish production from 1036 metric tons in 1995/96 to 1368 metric tons in 1999/2000. The gain in fisheries production does not, in narrow economic terms, offset the loss of income and employment from the factory, but, as an indicator of ecosystem health and its overall impact on people and nature, it is a very positive sign.

Implications for rural livelihoods and the environment

At the macroeconomic level, water transfers out of agriculture contribute to growing water shortages and declining reliability of irrigation water supplies. Over the next two decades reliability will decline globally, but shortages will be particularly severe in water-scarce basins, including the Indus in India, the Haihe and Yellow river basins in northern China, basins in northwestern China, Egypt, West Asia, and North Africa, and important US food-producing basins including the Colorado, Rio Grande, and Texas Gulf basins (Rosegrant *et al.*, 2002). Moreover, scarcity fueled through transfers not only limits area expansion but also slows crop yield growth. Poor countries relying on irrigation will be particularly hit by declines in food production resulting from growing water transfers out of agriculture.

If badly managed, transfers can result in sharp price increases of staple cereals in global food markets, resulting in broadly negative impacts on low-income developing countries and the poor consumers in these countries. Even if food imports (which are often considered ‘virtual water’) can offset food production declines, rural livelihoods will still be disrupted. At the local level, farmer interests and impacts from transfers out of agriculture can vary substantially. A few, especially larger farmers, may benefit substantially by selling water or because of the increase in the value of land (if employment stays local). Landless and marginal farmers may also benefit if they can find work in the newly set up factories. As rural households diversify their livelihood strategies to include more non-farm activities and migration to towns, interests in water for different uses become more complex. Reviewing the evidence on regional impacts of water transfers, Rosegrant and Ringler (based on Howe *et al.*, 1990) report that:

> the severity of economic impacts on the area of origin will differ according to (a) whether or not the destination of transferred water remains within the same area of economic activity; (b) whether or not transfer proceeds are reinvested in the area of origin; (c) the economic vitality of the area of origin; and (d) the strength of backward and forward linkages of the irrigated agricultural sector. (Rosegrant and Ringler, 1998, p. 574)

The extent to which local residents accept water transfers as legitimate may depend, in part, on the extent to which they share in the benefits from new uses. Where local profits or employment are substantial, transfers are perceived to be fair, or where agricultural production is not significantly impacted, there is likely to be less opposition. However, if the municipal and industrial uses generate pollution, then farmers and rural dwellers often resort to protests. A summary of the different drivers of water transfers and the issues that each is likely to raise is presented in Table 3.

In both the West Java and Bhavani cases discussed above, increasing industrial water use has had serious negative impacts on agricultural production and fishing — because of greater water scarcity and because of pollution and temperature increases due to factory discharges. While employment increased locally, most jobs went to non-local people. The Indonesian case differs from outcomes reported in the United States in one important respect: agricultural land values increased with industrial development, rather than decreased because the industrial development was in the same rural area, so that the employment and incomes generated stayed locally.

In the Bhavani case, farmers and other environmental activists have protested the industrial water use, even filing court cases petitioning that the factories be closed down for not meeting pollution control standards. But as in Indonesia, the employment and export revenues generated by factories were a key factor in their political power. The state government agencies in the Bhavani area attempt to strike a balance between the demands of the farmers' and factory owners' lobby, both of which carry considerable political weight (Saravanan and Appasamy, 1999). The duration of transfers also affects their impact. Where water is leased rather than transferred permanently (as in the California drought banks or the Nepal Village Development Committee case), there is an income stream that comes in each year, rather than a one-time lump sum payment. This is likely to be less damaging to rural economies overall.

Consideration of the impact on third parties who are affected by the transfers is also critical. Water transfers in the western United States have given some attention to third-party effects. The process of transfer through the State Engineers' Office appears to give more weight to the impact on

Table 3. Principle causes for water reallocation

Driver	Urbanization	Industrialization	Drought emergency
Examples	Western United States	Indonesia	Angat, Philippines
		Bhavani basin, India	California Drought Bank
Probable issues	Equity	Water quality	Rapid response versus long-term planning, setting up mechanisms
	Urban–rural lifestyles	Location of industries	
		Economic power	
		Who benefits from employment (local or outsiders?)	

others who might be adversely affected by the transfers, and is somewhat easier for small farmers and other interests to have a voice, compared with other transfer mechanisms, especially those involving water courts. However, many developing countries have not yet developed such mechanisms to consider or redress negative impacts on the welfare of other rural residents, or the broader environment.

Institutions for reallocation that reduce adverse consequences for the poor

In the past, supply augmentation of water through new water development has been common to address water shortages. In maturing water economies, characterized by increasing scarcity values for water (Randall, 1981) but also growing transfers of water (in scale and number), demand management increases in importance. The task of demand management is to generate both physical savings of water and economic savings by increasing output per unit of evaporative loss of water, by reducing water pollution, and by reducing non-beneficial water uses. This can be supported through a variety of policy measures, including economic incentives to conserve water use (e.g. pricing reform and reduced subsidies), but also complementary regulations on water use rights, and policies targeting poor and vulnerable groups, education campaigns, leak detection, retrofitting, recycling, and other technical improvements, enhanced pollution monitoring, and quota and license systems. And while many demand management measures have targeted irrigation, as the largest water user, municipal and industrial water use cannot grow unchecked; regulation and economic incentives are needed to reduce the negative ecological, economic, and social impacts of these uses, especially on water quality.

Other supporting policies include an enhanced enabling environment for both the irrigated agriculture sector and the general economy to operate. Measures here include the introduction or improvement of market mechanisms and the reduction of distortions in the food, industry, and trade sectors, combined with targeted interventions for the poor. This strategy should also facilitate internalization of adverse environmental impacts of water transfers.

At the micro level, case-specific inter-linkages between urban and rural sectors and the importance of local and basin-level characteristics make it difficult to generalize about better reallocation institutions. However, key mitigation institutions include the establishment of secure rights to water that are monitored and enforced by adequate institutions and organizations; transfers of relatively small amounts from many irrigators, inducing conservation measures instead of plot abandonment; adequate compensation of sellers and affected third parties; and reinvestment of gains-from-trade in the rural communities.

Tools need to be combined and tailored to specific situations, but typically include decentralization of water management functions to appropriate levels; the use of incentives including pricing reform; enforcement of pollution control, and markets in tradable property rights; the introduction of appropriate water-saving technologies; and informal water leasing or sharing as well as formal markets in tradable water rights established in a participatory and rational manner.

The Bhavani case study illustrates how conflicts have arisen in part because of the lack of consultation or negotiation over water transfers. The result has been a number of protests and court cases. Water quality has also become a critical issue, but perhaps too late. One wonders whether the closure of the viscose factory and the loss of thousands of jobs might have been prevented if the water transfers had been publicly discussed, and more careful enforcement of effluent treatment requirements had been maintained from the beginning. It appears that serious enforcement of these standards is now increasing the costs of industries, and decreasing further demand for industrial water allocations.

While improving irrigation water use efficiency is shown to be an effective measure for increasing water productivity, there is little room for such measures in some of the basins with greater water scarcity. Lining a canal, for example, may reduce seepage ‘losses’, but if the seepage water was the source of groundwater for other users or the environment (as described in California and Delhi by Molle and Berkoff, 2006), increases in efficiency can become a shell game. In these areas, food production and farm incomes could fall significantly if water for irrigation is transferred to other uses. To mitigate the negative impact of water transfers here, investments in new agricultural technologies and diversification into alternative crop management practices, including the diversification of farming into less water-intensive crops, and measures to support the eventual reduction of the economic role of agriculture will be important to increase allocative efficiency of water and to provide alternative livelihoods for those who currently depend on irrigation. Renewed investments in new irrigation systems in areas that can support further water withdrawals and food production growth will be necessary to compensate declines in severely water-scarce basins.

Although economic factors certainly play a major role in shaping water transfers, it would be naïve to ignore the broader political economy: as the case studies indicate, powerful groups are most likely to obtain water at the expense of less powerful users. Rural domestic, livestock, fishing, and environmental uses are often overlooked in the process. Molle and Berkoff (2006) report that many transfers follow the ‘paths of least resistance’; that is, transfers by stealth, diversion from downstream ecosystems, overuse of groundwater, and developing costly new infrastructure. Special measures are needed to ensure that poor or marginal groups and environmental water uses have a voice in any water transfers. Despite the greater economic and political power of the municipal and industrial interests demanding more water, the New Mexico and Bhavani case in India provide indications of how this might come about. A combination of concerned state institutions (the State Engineers' office in New Mexico and the courts in India) and pressure from civil society was successful in gaining a larger say for those who were most negatively affected by the transfers. In the New Mexico case, a group of public interest lawyers helped the acequia owners to protect their collective interests as developers sought to buy up water rights; in Bhavani, collective action among local citizens was able to stand up against a powerful polluting industry.

Conclusions

With urbanization and industrialization, rapid increases in demand for municipal and industrial water supplies are putting pressure on water supplies, especially in developing countries. This is especially problematic because growing demand is often concentrated in water-short basins, and greater municipal or industrial uses come at the expense of existing users or the environment. As a result, agriculture, especially irrigation, is increasingly called upon to give up water. Because agriculture is the largest water use and the incremental amounts for cities and industries are often small relative to total agricultural uses, it is often assumed that these changing demand patterns can be accommodated with small 'savings' in agriculture. However, the evidence reviewed in this paper indicates that, at the local level, the impacts on the livelihoods of farmers and other rural people can be substantial. It is not only the changes in water quantity that need to be considered; deterioration in water quality due to municipal sewage and industrial effluents often has even greater impacts.

Thus, meeting the vital water needs of all requires greater attention to the policies and institutions, as well as the technology for water management. Demand management measures — including regulation, economic incentives, and public awareness campaigns — need to be applied not only to irrigation systems, but also to municipal and industrial systems.

When inter-sectoral water transfers occur, they are most often done by administrative reallocation, with a government agency making the decisions. Existing users are frequently not consulted or compensated for their loss of water. Even when recognized irrigators are compensated, the impacts on many other rural water users, such as livestock keepers, are not addressed. A growing number of countries use at least some forms of market-based transfers, in which established irrigators or other water rights holders who are willing to transfer some or all of their water to other users receive payment. This can finance investment in water-saving technology, or support diversifying cropping patterns or livelihoods. At the same time, to meet the food needs of growing populations, large-scale reductions in food production in some basins will need to be balanced with increasing agricultural production in other areas.

While market-based approaches to water transfers — if adequately implemented — may reduce farmer's opposition to water transfers, particular attention must be given to address third-party effects on other water users (including the environment). Thus, there remains a strong need for state regulation to mitigate the effects on others, even under market-based reallocation.

Because water is such an essential resource for lives and livelihoods, forced expropriation of water from farmers and rural areas is likely to lead to protests. Institutional and legal environment reforms must empower water users to make their own decisions regarding resource use, while at the same time providing a structure that reveals the real scarcity value of water, and the full costs of pollution. Voluntary transfers that provide compensation to those who give up water and to third parties that are affected are likely to be more acceptable than administrative reallocations that do not give voice to existing users' concerns. Failure to implement these reforms could significantly slow the growth in crop production in developing countries and could have devastating impacts on the livelihoods of the rural poor.

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