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COPING WITH WATER SCARCITY: THE GOVERNANCE CHALLENGE

by Alan Richards

Water is becoming increasingly scarce all over the world. All indicators of water availability show that per capita supplies will continue to decline in the years ahead. A conservative recent estimate projects that 1.8 billion people will live in regions or countries with “absolute water scarcity” by 2025: that is, they will not have enough water to maintain their current level of per capita food production and also meet burgeoning urban demands, even at high levels of irrigation efficiency (Seckler, Molden, and Barker 1999). An additional 350 million will live in regions with “severe water scarcity,” “where the potential water resources are sufficient to meet reasonable water needs by 2025, but (only if the country) embarks on massive water development projects, at enormous cost and possibly severe environmental damage, to achieve this objective” (ibid., 1). There will also be additional, sometimes severe, localized water scarcities, even within countries that, in aggregate, have abundant water (for example, Sri Lanka: see Amarasinghe, Mutuwatta, and Sakthivadal 1999). Water scarcity will not go away.

It is encouraging that past predictions of future water use have been consistently too high: “Actual global withdrawals for the mid-1990s were in fact only about half of what they were expected to be thirty years ago” (Glieck 2000, 58). Linear projections of the past into the future have consistently underestimated the potential for changes in technology, social organization, and incentives that have made it possible to reduce per capita water use without negatively affecting welfare. This tendency offers opportunities for policy makers, since it can direct their action to those changes that can facilitate such benign responses to increasing water scarcity.

Nevertheless, rising water scarcity poses serious challenges. This paper develops a simple framework for analyzing the political implications of diverse strategies for managing water scarcity from attempts to augment supplies to managing demand by changing water users’ incentives. All responses provide opportunities for cooperation and creativity; all contain pitfalls and potential for conflict.

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Augmenting Supply, Containing Demand

Increases in supply are unlikely to be sufficient to meet future challenges. The world is already using perhaps 50 percent of available runoff. The percentage is far greater in countries where scarcity is most acute. The world's population will increase by some 40 percent over next 30 years, while the maximum increase in appropriable runoff is estimated to be only 10 percent. And we are already, nearly everywhere in the world, well into the area of diminishing return on investment in supply-increasing infrastructure: the best sites for dams have long since been utilized. A comparison of current costs to costs in the 1960s of providing an additional acre of rice land in Asia indicates that today's costs are three times higher in Sri Lanka, twice as high in India and Indonesia, and 1.5 times higher in the Philippines and Thailand (Spurgeon 1994).

However, there are powerful ideological, bureaucratic, and political reasons why the first response of many countries to increased water scarcity is likely to be to try to augment supplies. It is equally likely that such gambits will provide, at best, short-term palliatives for the underlying problem. The continued expansion of supply-augmenting public works will also often exacerbate political controversy and conflict. As always, the manageability of such conflicts is entirely dependent on the specific national and international context within which it occurs.

If expanding the supply of water is necessarily constrained, the only alternative is enhanced conservation or "water use efficiency." To put it in the language of economics, if supply cannot be reliably and consistently increased, improved demand management will necessarily loom much larger as a means of coping with scarcity. However, such an approach (which, of course, by no means precludes attempts to augment supply) has formidable requirements of physical infrastructure ("hardware") and management systems or configurations of incentives and modes of cooperating ("software") to make scarce supplies go further.

Consider "hardware." More efficient systems are typically expensive. Whether we are talking about lining canals, switching to drip irrigation, or installing water meters, reducing water system losses requires complementary investments. Because such investments are often substantial, they will be challenging for poorer countries, communities, and households. For example, the commonly used ratio of capital costs of surface flow to sprinkler to drip irrigation is 1:2:3. Operating costs are also markedly different: one estimate found that every cubic meter of water saved by switching from surface flow to drip irrigation required an additional liter of diesel fuel (Stanhil 1986).

Although much of this investment will be private, some of it will necessarily come from the public purse. In either case, one must ask, "Where will the money come from?" If the investment is private, will poorer users be able to afford the more expensive water-saving technology? If the funds are public, will the revenues come from domestic savers? If so, how will these revenues be raised, and with what political consequences? If the investment is foreign, which foreigners will provide the money? How will they be induced to make these investments? Finally, which local groups supported, and which opposed, these investments? All of these questions need to be asked to understand the potential consequences of investing in water conservation infrastructure.

Installing the "software" for more efficient demand management may be even more difficult. From an economic perspective, water becomes scarce once not everyone can have all the water they want at a zero price. Once this is true, then somehow the scarce resource will be allocated. Some groups will, of necessity, be deprived of their preferred supply of free water. There will be losers as well as winners, whether under current allocation procedures (for example, irrigation systems in which those at the end of the irrigation channel typically bear the brunt of scarcity, or urban allocation systems which subsidize middle-class households at the expense of the poor), or under "reformed," or economically more efficient, allocation systems, such as water pricing or water markets. Losers rarely enjoy their diminished status. Contestation and conflict over the rules of allocating increasingly scarce water should be expected.

There is a consensus among development professionals that 1) there will be increasing pressure on existing "software" or current systems for allocating water; and 2) a successful response will include greater decentralization, devolution, and empowerment of local actors (Serageldin 1995). In some circles, particularly in U.S. policy arenas, the need for increased reliance on such decentralized systems suggests implementing water markets. Although such markets have important potential, we shall see that the difficulties with this solution are more serious than are often recognized. This is particularly true for those long-run, intersectoral (for example, agriculture to urban) transfers which have the greatest potential to increase the nationwide efficiency of water use.

Improving demand management or enhancing water conservation is a difficult governance problem, involving a complex mixture of decentralization in some instances (for example, to promote greater on-farm efficiency through water users associations) and recentralization in others (for example, to cope with pervasive third-party effects). Both the infrastructural and institutional changes are likely to be significant. Further, significant interest groups in society and within the state apparatus stand to lose important rents and/or privileges. In some cases, these interests may be able to stall or to block reforms. Given the lags involved and the possibilities of significant unexpected negative shocks, the consequences of "business as usual" could be severe. That is, failure to reform systems, and, therefore, failure to deliver adequate water supplies to increasing numbers of people, has a destabilizing potential for some governments. Yet the process of decentralizing decision making can itself be destabilizing, depending on the context. The dynamics of reform of allocation policies within water-scarce societies have a large potential to add to social and political conflict. By the same token, however, there are significant opportunities to smooth the transition to more water-efficient allocation systems.

Water Scarcity and Conflict

The challenge of rising water scarcity offers both dangers and opportunities. A moment's reflection will show that there is no necessary connection between water scarcity and conflict. It should also show that rising scarcity has the potential to contribute to conflicts. Everything depends on how well (or poorly) the people affected can cooperate. This, in turn, depends on a host of factors, including wealth and the presence or absence of other unresolved disputes. The same measure of water scarcity in the western United States and the Gaza Strip will have radically different political implications.

It is essential to move the discussion beyond simplistic polar positions such as "Water wars are coming!" or "Cooperation is cheaper than fighting, so people will work it out." The political implications of water scarcity are entirely context-dependent. The potential for conflict depends on a host of factors, some quantifiable, many not, which will impinge on decisions of how best to cope with scarcity.

The impact of water scarcity on conflict is likely to be indirect. In complex, nonlinear systems, however, it is not productive to ask questions such as "How much of this problem was the result of such and such a variable?" This is like asking whether it is the "3" or the "2" which is "responsible" for "3 x 2 = 6." A strong case may be made that all human thought is metaphorical; we all use metaphors, either explicitly or implicitly, to make sense out of the world. In thinking about the conflict-generating potential of water scarcity, metaphors from chemistry are likely to be more helpful than metaphors drawn from Newtonian mechanics. The same degree of water scarcity can be associated with a highly equitable and efficient solution, with a socio-political breakdown, or with a whole host of intermediate outcomes. As with any historical process, it all depends on the context, in the same way a chemical reaction depends on the coexistence of a host of features at the same place and time.

A comparison with food shortages in history may be helpful. Food shortages have been endemic throughout history, but only occasionally did they contribute to political violence. When they did, such scarcities mattered. Any historian could easily demolish the proposition that "food shortages lead to revolt." Yet most historians of the French Revolution agree that food shortages, or still more importantly, *rumors* of food shortages (*la grande peur*) played a critical role in the complex of forces that culminated in the fall of the French monarchy (Lefebvre 1932). Water shortages are likely to be similar: their impact will be context dependent, and perceptions will be at least as important in driving outcomes as any "objective" assessment of water scarcity.

Finally, we should remember that the future might not resemble the past. Water scarcity has become much more acute in many areas of the world: this situation is without historical precedent. Although past experience remains the only evidence that we have, it is a highly imperfect guide to future developments. We need to guard against being like the man who fell from a ten-story building, and, as he passed the fifth floor, was heard cheerfully to remark, "So far, so good!" The fact that water scarcities have not, in the past, provoked large-scale social violence is no guarantee that violence will not occur if the scarcities are serious enough and if they occur in a context of distrust and anger over other, perhaps entirely unrelated, issues. "Water wars" may not be coming, but conflicts in which water plays a role are quite likely. Nonlinearities can harm as well as help.

Why Governments Keep Building Dams

Although the rate of construction of large dams has declined from its peak in the 1970s, when an average of two or three dams were commissioned every day somewhere in the world (WCD 2000), it has by no means stopped. As of 1998, there were 349 dams over 60 meters high under construction around the world. In the Yangtze basin, some 38 dams are under construction; in the Tigris-Euphrates basin, 19; and on the Danube, 11 (WRI 2000, 106).

There are both ideological and bureaucratic reasons for the continuing push for dam construction. Governments are used to responding to scarcity by boosting supplies; it is the most familiar response. Especially in arid countries, investments in dams and irrigation systems have long histories. Such investments have been–and often still are–seen as essential to forestall the ravages of drought on the agricultural sector. As such, investment in water-supply-enhancing infrastructure is seen as a critical component of national security: dams are believed to bolster national independence and sovereignty. Such a perspective has been institutionalized in significant government bureaucracies: in any arid country, the ministry of irrigation is often a principal player in the formulation of national water policy. These ministries are usually dominated by civil engineers and other professionals predisposed to seeking "supply-based" responses to any increased scarcity of water. Although some interests will be harmed by supply-augmenting policies (for example, those people who require resettlement because their lands are flooded by the reservoirs of newly constructed dams), these interests are often far weaker than either the bureaucratic forces that wish to increase supply or the interest groups that would be adversely affected by alternative scarcity management policies, such as increasing water charges.

Two cases, Morocco and China, help illustrate this form of government response.

Morocco

Moroccan irrigation development has a long history, with public investment in large dams and infrastructures a key factor. From 1912 to 1956 (the French Protectorate period) fourteen dams were constructed. In the first ten years of independence (1957–1967) three dams were built. In 1968, the Moroccan government proclaimed a "*politique des barrages*,"a policy designed with assistance of the World Bank. From 1968 to 1991, 14 dams were completed. The goal was to bring the total area under irrigation to one million hectares, a goal originally proclaimed by the French colonial Protectorate.

The commitment of the Moroccan government to irrigation has deep roots. Older Moroccans can remember the implications of complete dependence on rain-fed farming in a climate so prone to drought. A drought that began in 1935 and lasted for over two years in southern Morocco deprived several hundred thousand Moroccans of food supplies. The rural exodus was so massive that roadblocks were established and the population diverted to camps. Half a million people became entirely dependent on government food supplies. The experience led to the creation of the first major irrigation perimeter in which land was allocated to Moroccans, rather than to French *colons*. The vision of a million hectares of irrigated land was born in this period.

There was worse to come: in 1945 Morocco was hit by the most severe drought of the twentieth century. For eight months, there was no rain whatsoever. Half of Morocco's livestock perished. A massive relief operation was undertaken to distribute grain brought in from the United States, Canada, and Argentina. Distribution weaknesses meant that relief stations could distribute only 6 to 9 kg per person per month; since an average person needed about 15 kg per month, thousands starved.

With such a history, it is hardly surprising that the government of Morocco is so committed to the development and extension of irrigated agriculture. Despite the fact that the best dam sites are already in use, there is a continued push for new construction. Government plans called for the completion of 12 new dams by the end of the 1990s. The largest, the Al Wahda dam on the Ouerga River in the Sebou basin, is the second-largest dam in Africa, smaller only than the Aswan High Dam in Egypt. Fifty-one additional dams are planned for the coming 30 years. Investment in dams has stabilized in the past 15 years at 7 percent of total government investment (World Bank 1994b). Public spending on irrigation infrastructure doubled from 0.4 percent of GDP (1988–94) to around 0.7 percent of GDP (1995–2000). Total investment in the mobilization and distribution of water resources was projected to reach 2 percent of GDP by the year 2000, however, this target was not met, largely due to fiscal constraints. Further, a significant proportion of existing infrastructure is aging, and siltation of dams is a major concern, having diminished available capacity by nearly 8 percent.

Despite the fiscal costs and the increasing difficulty of augmenting supplies through "business as usual," the government of Morocco continues on this course rather than trying to enhance the efficiency of water use. As we shall see, there are some understandable institutional and political reasons for doing so.

China

Expanding irrigated land has been a critical component of the People's Republic's food security strategy. China's irrigated land provides two-thirds of the country's grain production, 60 percent of the cash crops, and 80 percent of the vegetables (OECD 1999). Population growth, and more importantly, rapidly rising incomes and urbanization continue to drive up demand for food and water. Unsurprisingly, expanding water supplies for farmers and urbanites remains high on government planners' agendas.

Officially, the percentage of irrigated arable land has risen from 16 percent in 1950 to nearly 50 percent today.[1] The irrigated area increased by 50 percent from 1961 to the late 1970s, but largely stagnated during the 1980s (Conway 1997). Probably most of the growth of China's irrigated areas was due to the expansion of tube-well technology, rather than to large-scale surface irrigation. The use of tube wells boomed once the communes were dismantled and farm families acquired a measure of land tenure security. Inputs such as fuel and electricity were heavily subsidized. The sustainability of such practices is in doubt, as is discussed later.

In contrast, much of the water control investment in the 1950s and 1960s was wasted. During the period of Maoist "politics in command," many irrigation works were designed and constructed in haste, using inferior materials and equipment. Many were not finished; still more lacked distribution and drainage networks at the tertiary and farm level. Many investments during the Great Leap Forward did more harm than good, as they often embodied Maoist and Lysenkoist fantasies (Perkins and Yusuf 1984; Becker 1996). In 1975, 62 shoddy dams collapsed in Henan Province during unusually heavy rains, killing between 86,000 and 230,000 people. An additional 2 million were trapped for weeks, and perhaps 11 million were afflicted by hunger and disease (Topping 1995). Investment for rehabilitation will likely have a high return, but will also be quite expensive (Li et al. 1997).

Dam construction continues in China: during the 1980s, China was building 183 dams over 30 meters high (Conway 1997). The most spectacular is the Three Gorges Dam on the Yangtze, which, when completed, will be the world's largest dam: 6,864 feet long and 610 feet high, with a reservoir capacity of 10.4 trillion gallons of water. This $25 billion project has caused much controversy, both within China and internationally. Critics lambaste the effects of a dam which will directly displace 1.3 million people and will have all the usual ecological problems: siltation behind the dam, loss of silt for farming downstream, flooding of faunal habitat and historical sites, and, of course, the threat of failure.

These concerns are not lessened by the rampant corruption in the People's Republic. Large-scale public works offer ample opportunities for "skimming," and Three Gorges Dam has been far from exempt from such activities. In July 2000 some 97 officials were convicted, and one executed, for embezzling funds connected with the dam (BBC News Service, 21 July 2000). Despite such corruption (dams have been reportedly called "tofu scum" by Zhu Rongji), the government presses on with this and other "supply-enhancing" investments.

The Pitfalls of Supply-side Solutions

Despite the ideological, bureaucratic, and other political attractions of "supply-side" responses to rising water scarcity, such approaches face serious constraints. First, the costs of new systems are much higher than they were in the past. Second, large public and foreign debt loads inhibit many countries from being able to raise the funds necessary for such projects. Third, there is increasing recognition of the many harmful environmental effects of large dams, and opposition to them can now be mobilized both nationally and internationally (for example, the Sarda Samovar dam controversy in India and the role of local, national, and foreign NGOs in organizing opposition the to project).

However, serious challenges also face "demand management" or conservation strategies. It is highly likely, therefore, that nations will continue to build dams. For example, some participants in the water policy debate in India simply assert that, despite the difficulties, there is no realistic alternative to expanding supply by building more dams. Certainly the Chinese leadership believes this as well. We should expect additional dam construction, with its attendant controversy, in the future, possibly resulting in heightened domestic (and possibly international) conflict.

How Governments Create Water Shortages

Any discussion of the political economy of water shortages and their potential for contributing to conflict and cooperation must include an examination of the role of governments in creating scarcity. Public irrigation or municipal water systems are the norm nearly everywhere. (A significant exception, discussed later, is the widespread use of tube wells for irrigation.) Most of these systems are old, decaying, and underfunded. They almost always heavily subsidize some users,

[1] The latter estimate is embroiled in the controversy over the accuracy of official land data. For a variety of reasons (for example, incentives to underreport to evade taxes) many observers believe official numbers underestimate the amount of arable land. Smil (2000) thinks that the actual percentage of arable land that is irrigated is closer to 30 percent, thanks to the underreporting of marginal (and unirrigated) cultivated land.

while simultaneously (and increasingly) failing to serve others. Decision making over water resources is usually fragmented among different, often competing, government bureaucracies. Past decisions on subsidized water use have created vested interests, which typically resist any attempt to foster greater conservation. Finally, as with any policy, governments use water allocation rules to reward friends and punish opponents.

Public Irrigation Systems

In developing countries, typically 70 percent or more of all water is used in agriculture, yet canal or flow irrigation systems are everywhere characterized by "waste"—that is, only a fraction of the water that farmers put onto the fields is actually used by the crops. The FAO estimates that only 45 percent of applied irrigation water is used effectively by the crop. The rest is "lost": 15 percent from the irrigation system, another 15 percent in distribution within the farm, and 25 percent when the water is applied to the field (FAO 1994).

At first glance, the potential for water conservation through cutting such losses seems excellent. However, experts at the International Water Management Institute have emphasized recently that some, perhaps most, of the water is not "lost" or "wasted" from a systemic perspective. The distinction is commonly called the "wet versus dry" savings issue. Although the details are quite complicated (and therefore also controversial) in any specific case, the essential point is that water which is not used in one field, one farm, or one irrigation block is not necessarily lost to the next field, farm, or block. In some cases, the water that flows over one field, but is not used for evapotranspiration and plant growth, simply flows onto the next field. In other cases, it may return to canals or to underground aquifers. It has been estimated that the water of the Thames passes through animals or machines three times before reaching London. Failure to understand such issues can lead to an excessively optimistic view of the potential "savings" available from increasing the efficiency of irrigation systems.

The measurement difficulties here are formidable. In the first place, even in the United States, the actual geological and hydrological relations between surface and ground water are "difficult to observe and measure" (USGS 1998). The specific relations are typically less well studied and understood in developing countries. The same may be said for "environmental demand." If all of the water in a system is consumed by crops, factories, and households, then nothing will be left over for wetlands, coastal protection, and other ecosystem functions. Accordingly, it is quite difficult to know how much of the water that is "not used" is actually being "wasted." This makes it correspondingly difficult to set the "proper" social opportunity cost (or price) of water.

Such uncertainties strengthen an already powerful "status quo bias" in policy making. After all, if hydrologists fear that reducing irrigation system "losses" will merely reduce available groundwater, the benefits of changing policy will not be clear to policy makers. Why should they take the risk of making changes that will almost certainly arouse the ire of powerful constituencies and interest groups? This is an area where technical assistance and greater scientific cooperation and study can raise the chances of adopting more effective water management policies.

Even when water is returned to an aquifer or a surface water course after being used but not consumed on a farm, the returned water is rarely, if ever, of its original quality. The returned water is far more likely to carry salts, as well as residues of pesticides, herbicides, and fertilizers; in short, although the existence of surface water/ground water linkages may reduce the severity of quantitative shortages, it may easily exacerbate shortages of water of a certain quality. The severity of the problem will again depend on the specifics of each case: Will the returned water will be used for drinking or for crops alone? If only crops, which ones? For example, since barley is more salt tolerant than cotton, it can be irrigated with water carrying a higher content of salt residue.

Despite these caveats, it is still very probable that, in most irrigation systems, poor efficiency contributes to water shortages. Why, then, are current efficiencies so low? The reasons have been thoroughly studied and are quite well understood. In the first place, farmers nearly always pay far less for water than it costs to deliver that water. In many irrigation systems in the Middle East, for example, farmers pay nothing directly for water use; their right to water is guaranteed as part of their ownership of land, land that is typically taxed at very low rates. In Bangladesh, Nepal, and Thailand, water charges are less than 10 percent of the cost of supply. Even in those systems where there is some fee, operations and maintenance costs are rarely paid for, and the capital costs are almost never covered. Water is, is essence, free to farmers.

Virtually free irrigation water has three fundamental implications:

- Farmers have little incentive to conserve water.
- Because of the resulting waste, some farmers–usually those at the tail end of the distri-

bution system–will not receive adequate supplies.

- The irrigation system will have insufficient funds to cover its natural depreciation, so the system will decay over time.

The consequences of the third implication are disturbing. Since many irrigation systems were installed at least twenty (and often, fifty or more) years ago, lack of maintenance means they will increasingly fail to provide irrigation water to farmers. Although there has been a shift in investment in Asian rice irrigation systems away from new infrastructure and toward improved maintenance and operation of existing infrastructure during the past twenty years, the quality of existing irrigation infrastructure has continued to decline (Pingali, Hossian, and Gerpacio 1997, 200ff). Neglect of irrigation infrastructure implies that, at some point, the irrigated area will decline. There is evidence that this is already happening. For example, studies in the Philippines have shown that a 1 percent drop in expenditure for operations and maintenance leads to a 0.26 percent drop in the wet-season irrigated area and a 0.46 percent drop in dry-season irrigated area (De Vera 1992). These problems are compounded by the negative externalities imposed by upland deforestation on lowland rice-production systems throughout Asia. (The same problem occurs in other agro-ecosystems as well).

These and related pressures on the world's dominant food production system have disturbing implications for Asian, and therefore world, food security. It is worth remembering that 80 percent of the increased production in cereals in Asia since the 1960s has come from irrigated land. Worldwide, some 50 percent of the total increase in food production from 1970 to 2000 has come from irrigated land; in the world's two most populous countries, irrigated land produces 70 percent of the food in China and 50 percent of the food in India. The decline in irrigation systems poses very significant challenges to the international community.

However, remedying this problem by raising water prices to farmers is fraught with pitfalls. Farmers oppose the imposition of operations and maintenance (O & M) charges, often claiming (with some justice) that the quality of service is so poor that they should not have to pay for it. There is a "chicken and egg" problem here: service cannot improve without increased funds (which must come mainly from farmers), but farmers are unwilling to provide funds because of the poor-quality service they receive.

Farmers will resist increased water charges for an additional, very understandable, reason. The value of "free water" is already capitalized into land prices. Farmers then reasonably view the imposition of water fees as an expropriation: they feel that they paid for the water when they paid for the land. Changing water allocation policies will redistribute assets, a process which is always and necessarily highly contentious. The problem becomes more serious when we remember that water use is often relatively unresponsive to price changes. In order to affect farmers' irrigation decisions significantly, prices may have to rise steeply—which implies a greater impact on farmers' incomes, and therefore also on the value of their main asset, land. For example, to reduce water demand by 15 percent in Egypt, the service charge (or water price) would have to reach the equivalent of 25–40 percent of farm income (GOE 1995). It is hardly surprising that the government of Egypt is reluctant to inflict such losses on its farmers.

A second source of public irrigation failure is rooted in the bureaucratic structure of responsibility for such infrastructure. Four key problems may be identified. First, decision making over the allocation of increasingly scarce water resources is often highly fragmented. Ministries of Irrigation vie with Ministries of Agriculture, who in turn compete with Ministries of Public Works, and so on. Second, within ministries most directly concerned with irrigation infrastructure, a corporate culture of civil engineering prevails. That is, the bureaucracies have, historically, been concerned with how to store and physically move water from one place to another by building dams and canals. They have been much less concerned with questions of economics or other incentive systems. They are geared to allocate or increase existing supplies, not to regulate demand and encourage conservation. Third, such public bureaucracies have suffered from personnel systems that typically do little to foster hard work. Staff are poorly paid, and promotion is most often based on seniority. Fourth, decisions are highly centralized, with minimal participation by stakeholders. All of these managerial features undermine the efficiency–and the equity–of existing public irrigation systems.

An additional difficulty facing many public irrigation systems is lack of investment in drainage to keep pace with past investments in water delivery. It is as if governments have focused nearly all resources on installing a system of arteries, but failed to provide veins. The results are unsurprising: poisoning of the organism, in this case, the accumulation of harmful salts in the soil, and a rising water table. Depending on the crop being grown, both of these consequences undermine agricultural production, and, therefore, food security and rural employment. The problem is acute in all irrigated farm systems, including the western United States. In the developing world it is quite serious in the Middle East, Pakistan, North India, many areas of arid Latin America (for example, Mexico) and China. Estimates of the magnitude of the problem vary, but there is consensus that the problem is significant. A recent study has estimated that some 45 million hectares of land, or about 20 percent of the world total of irrigated land, has been damaged by salinization (Wood, Sebastian, and Scherr 2001). The FAO estimates that 30 million hectares are "severely" affected by salinity, and another 60 to 80 million hectares are "moderately affected." Countries that have severe problems include Egypt, Turkmenistan, Uzbekistan, Pakistan, India, and China. In Pakistan, some 10 percent of the irrigated area suffers from salinization (Spurgeon 1994), while nearly one-third of Egypt's farm land may be affected.

The origins of this problem are more political and economic than technical. More than a century ago, in the 1890s, British hydraulic engineers in Egypt were well aware of the adverse consequences of extending the irrigation system without simultaneously installing adequate drainage. But fiscal constraints, combined with a short time horizon, prevented them from doing what they knew needed to be done. The anti-British Nasser regime repeated the same mistake when building the High Dam at Aswan (Richards 1982). Similar political–economic considerations explain failures elsewhere.

Remedying this problem is expensive. The installation of a drainage system in Egypt, largely funded by the World Bank, has cost over $2 billion. Countries such as Pakistan, which do not enjoy Egypt's relatively favored position with international agencies, have found it much more difficult to borrow money for such projects. And there is always a critical shortage of funds for government infrastructure investment worldwide.

Pakistan may be the country most severely affected by the problem of rising salinic and sodic water tables. The Indus River has a high salt content to begin with, and there is no natural drainage system other than the river itself. Downstream areas are suffering from increasingly saline and polluted water. As polluted water tables rise, sewage rises to the surface, leading to sewage overflows in many villages. Water problems stimulate rural to urban migration, undermine food security efforts, and contribute to the general decay of the Pakistani state and rural society. Accusations of corruption in water allocation, both in rural and urban areas, are widespread. A "water mafia" allegedly taps water from the public system in Karachi and then sells the stolen water at high prices to that city's unfortunate inhabitants.

In addition, water scarcity exacerbates regional tensions in Pakistan. The Sindh Research Council alleged in 1999 that the province would lose an estimated $5.4 million in agricultural production because Pakistan's Water and Power Development Authority (WAPDA) reduced the share of water due to Sindh Province as punishment for its opposition to a proposed hydro-electric dam that will siphon water from the Indus River to the Punjab Province (Environmental News Network, 29 May 1999). As reported in *Dawn*, a daily English language newspaper published in Karachi, Pakistan, as of January 2001 the Indus River System Authority was unable to resolve the dispute between Punjab and Sindh over how to share limited supplies, despite the existence of a 1991 agreement between the two provinces (*Dawn*, 28 Jan. 2001). Pakistan well illustrates the potential for water scarcity to interact with other problems in exacerbating conflict.

Groundwater and Private Irrigation

Much of the increase in the spatial extent and temporal reliability of irrigation water in developing countries has come not from public surface irrigation systems, but from the rapid expansion of private irrigation, particularly the increasing use of tube wells to tap groundwater. Governments have promoted such irrigation by subsidizing power (most often diesel fuel or electricity), by reducing the tariffs on imported pump sets, and, in some cases (as in Bangladesh) by eliminating import bans on cheaper (in this case, Chinese) pump sets. The consequence has been the rapid expansion of this form of private irrigation. In India, such pumps irrigate a larger area than is irrigated by all surface systems. The number of shallow tube wells used to draw groundwater rose from some 3,000 in 1960 to 6,000,000 in 1990. While India doubled the amount of its land irrigated by surface water between 1950 and 1985, it increased the area watered by groundwater 113 times. Northern China, which has two-thirds of the country's cropped area but only one-fifth of the water (31 percent of the groundwater), has seen a dramatic expansion of tube wells during the past two decades. In the Fuyang river basin in North China, for example, as surface water was increasingly diverted to industrial use, farmers responded by boring over 91,000 wells (Shah et al. 2000). Nationally, the number of tube wells rose from a very low base in 1949 to some 2 million in 1977 to 3.5 million in 1998 (Crook 2001).

The contribution of such irrigation to increases in food production exceeds any estimate of areas irrigated, not only because groundwater can be exploited in the dry season, but also because its reliability has been much greater than that of many public systems. Further, the water is used much more efficiently than surface water, largely because farmers have to pay the incremental cost of lifting the water to their fields (even though the costs are subsidized, they are rarely zero, unlike irrigation water delivered by canals). In India, yields per unit of groundwater tend to be 20–300 percent higher than yields per unit of surface water. Poorer farmers, who have to pay market prices for water to their richer neighbors who own pump sets, often pay $0.10–0.14 per cubic meter of water, rather than the fraction of a cent which heavily subsidized users of public surface irrigation systems pay. The yield impact of carefully allocated scarce water can be very large: for rain-fed crops, an additional 5 cubic centimeters of tube-well irrigation can raise yields by 50–250 percent (Shah et al. 2000). Tube wells permitted an expansion of the irrigated area in the North China plain from 8.5 million hectares in 1965 to 21 million hectares in 1998. Tube-well irrigation also permitted the introduction of double cropping of grains, with output rising from 44 million tons in 1965 to 129 million in 1998 (Crook 2001).

However, the expansion of tube-well irrigation has run into a classic problem: aquifers are shared, and their boundaries do not coincide with the boundaries of surface property. In most parts of the world, particularly in South Asia, groundwater is treated as a common resource. This has created a classic "tragedy of the commons" problem: although one farmer's water pumping implies less water for his neighbor, he does not have to pay for this consequence. Overpumping then becomes the general rule. The consequence is the same as in many areas of the western United States: dramatic lowering of water tables, and increased energy and capital costs of pumping. In India, the extraction of water from aquifers exceeds natural recharge by 200 percent or more. Water tables in the North Indian plain are falling by 1 to 3 meters every year. As the water table falls, the costs of extracting it rise, since more energy has to be used and/or larger pumps have to be installed. Such cost increases favor relatively wealthy farmers, who are not slow to take advantage of this situation to sell water, often at monopoly prices, to poorer farmers. These social inequities interact with other local conditions, but typically do little to foster social and political peace.

The same situation occurs elsewhere in the world. In Mexico's agriculturally dynamic Guanajuato state, water tables were declining by 2 to 5 meters per year by 1996 (Kloezen, Garces-Restrepo, and Johnson 1997). In Baluchistan province of Pakistan, water tables are falling by 2 to 3 meters per year. The provincial governor, Justice (Ret.) Amirul Mulk Mengal, has said that shortage of water was the biggest problem of the province (*Dawn*, 13 July 13 2000). An intensive study of Pakistani Punjab irrigated agriculture found that "current irrigation and agronomic practices are not sustainable. . . . groundwater is mined, water tables drop, and salt continues to be added to the root zone because of the relatively high proportion of irrigation water derived from pumped groundwater. If the current high crop intensities are maintained, further degradation of land and water resources is inevitable" (Kijne 1996). In March 2001, the Punjab Private Sector Groundwater Development Project told the provincial government that "the groundwater resources will be exhausted in the parts of the Punjab during the next two years if the present drought conditions persist and no systematic monitoring and management is introduced by the government" (*Dawn*, 26 March 2001). The same source reports that the Punjab aquifer suffered from a deficit of 6.2 million acre-feet in 2000–2001, largely due to overpumping.

Similarly, between 1991 and 1996, the water table beneath the north China plain fell by an average of 1.5 meters a year. In some areas of the North China plain, the water table fell by 30 meters between 1964 and 1993. Cones of depression, land subsidence, and saltwater intrusion in coastal areas are widespread (Crook 2001). In the poor inland province of Gansu, unsustainable groundwater extraction finally led to the abandonment of 25,200 hectares of previously cultivated land (Economy 1997). Wherever groundwater irrigation matters, the problem of overpumping is becoming increasingly severe.

Yemen may offer the most serious case. The area irrigated by wells rose from 37,000 hectares in 1970 to 368,000 in 1996. Government policy strongly encouraged this development. Until 1995, diesel fuel was priced at around $0.02 per liter, while international prices ranged from $0.15 to $0.20 per liter. Agricultural borrowers also enjoyed generous interest subsidies, paying 9–11 percent compared to market rates of 50–60 percent. Consequently, water was priced at $0.04 per cubic meter, whereas covering only the marginal cost of extraction would have required a price three to five times higher. Finally, the government protected the domestic fruit and vegetable market, and did nothing to restrict the boom in *qat*, a mild narcotic. Production of *qat* uses some 30 percent of all irrigation water in the country (Ward 2000). Unsurprisingly, IWMI experts describe the groundwater situation in the country as a "basket case" (Shah et al. 2000, 1). Extraction now exceeds recharge by 400 percent, and "Yemen is probably the only country where groundwater abstraction exceeds recharge for the country as a whole" (ibid). Water tables have fallen dramatically, as wells have been deepened two to four times in the Sa'adah basin (Lichtenthaeler and Turton 1997). The respectable growth of Yemeni agriculture during the past decade (5 percent per year) is clearly unsustainable. This has serious negative implications for Yemen's welfare, since roughly 75 percent of the labor force works in agriculture. During the past decade, the Yemeni government, faced with a large balance of payments crisis in the wake of the expulsion of Yemeni from the Gulf during and after the Gulf War, has embarked on a process of economic reform, including reforms that should enhance water conservation. The path, however, has been rocky, as is detailed later.

Urban Water Systems

Half of the world's people now live in cities. By 2030 this percentage is likely to increase to 60 percent. In the developing world, the urban population is projected to double from today's roughly 1.9 billion in 2000 to just under 4 billion by 2030. Worldwide, about three-quarters of all current population growth is urban. There are an estimated 55 million more urban residents each year–more than 1 million new residents each week. In most developing countries, cities are typically growing between two to three times faster than the national population. "Megacities" (cities with 10 million or more residents) have proliferated. In 1975 there were only five such cities in the world. Today there are 19 (15 of which are in developing countries), and by 2015, projections suggest that there will be 23. In many cities in developing countries, 25–30 percent of the urban population live in squatter settlements, shanty towns, *favelas*, and so on. For example, of Rio de Janeiro's 10.6 million residents, 4 million live in such places (Hinrichsen and Roby 2000).

Although urban areas worldwide use less than 10 percent of total water, their rapid growth has meant that the demand for water in cities has been the fastest growing component of demand nearly everywhere. Extending water and sanitation services to these exploding urban populations has been both expensive and difficult. There have been important achievements: since 1980 about 2 billion people in developing countries have acquired access to improved water supplies, and 400 million have been hooked up to sewerage systems. However, urban population growth has meant that much of this progress has been "running to stand still": 1 billion people still lack access to clean drinking water, and 2 billion lack similar access to sanitation. (It is worth noting that such round numbers come from national statistics.) Definitions of what is "safe water" vary considerably; in some cases, "being served" means access to a single water tap shared by an entire neighborhood. In urban areas, the numbers of people living in cities without access to sanitation increased by 70 million during the 1980s. Even after two decades of rapid economic growth, only half of Southeast Asia's 550 million people have access to safe drinking water. In Jordan and Morocco, one-third of the urban population lacks adequate sewage services.

The health consequences of this situation are grave. Dirty water probably kills and sickens more people each year than any other form of pollution. Water-related diseases affect 2.3 billion people annually; 12 million people (roughly the population of Los Angeles or Buenos Aires) die every year from water-borne diseases. The majority of them are children in developing countries. The potential for large-scale disease outbreaks in the burgeoning "megacities" such as Cairo, Jakarta, and Lagos is increasing. Smaller (but still large) cities are, if anything, in even worse condition than national capitals: for example, Damietta, Egypt, a city of nearly one million, has no sewerage system at all. The city depends entirely on the Nile, which is heavily polluted. Up to 50 percent of the population in the governorates of Damietta and neighboring Daqahliya may be suffering from liver and kidney ailments from water pollution (*Middle East Times*, 10 September 1999). Cholera outbreaks have occurred repeatedly during the past three years in sub-Saharan African, South Asian, and Southeast Asian cities. The continued growth of cities, the large backlog of underserved urban residents, and the health consequences of failure all suggest that urban water demand will continue to be highly problematic.

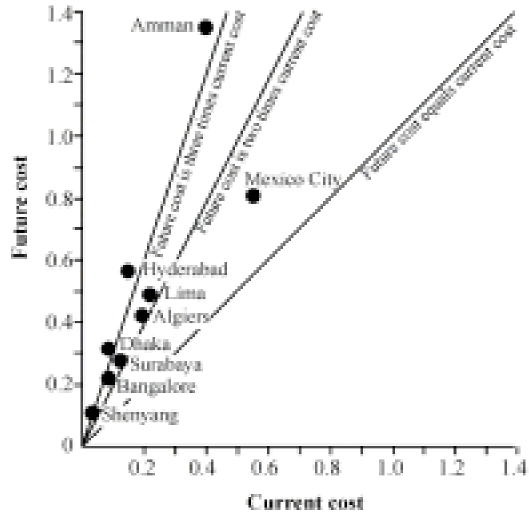
Meeting this demand will be very expensive. Currently, governments in developing countries invest $25–30 billion every year in water-related infrastructure. As large as these sums are, they will certainly grow in the future. This is not only because of the rapidly growing number of consumers, but also because, in a manner similar to that of increasing irrigation supplies, the supply cost of water is rising. Cities throughout the world are being forced to take their water from deeper under the ground, or from farther away, than ever before. The additional water is also often of lower quality, requiring more expensive treatment before it can be used. Beijing now has to get its water from 1,000 km away; the incremental cost of supplying water to Lima, Peru, has doubled during the past two decades. The cost of supplying Mexico City has increased by 55 percent now that the city has to pump water through a 180-kilometer-longpipeline from the Cutzamala River, rather than take it from the dangerously depleted and polluted aquifer of the Valley of Mexico. The costs of supplying Amman, Jordan, have increased by a factor of three during the past 20 years. A World Bank estimate of the relation of current costs to future costs for some major cities of the developing world is shown in Figure 1.

Where will the necessary funds to provide urban water come from? There is little doubt that urban residents are willing to pay for water: after all, no matter how poor you are, you still must drink. Typically, the poorer residents of cities in developing countries pay itinerant water salesmen twelve times more for water than do residents who are connected to the public piped water system. In Egypt, for example, residents of squatter settlements pay a price for water roughly equivalent to the supply price of desalinated water (around $1.25 per cubic meter). Such prices for the poor imply that they are spending a very large fraction of their income on water; studies in Nigeria, Bombay, and Haiti suggest that poor households spend between one-fifth and one-third of their income on water.

Those connected to public water systems pay only a small fraction of the cost of delivering water. Indeed, the World Bank reports that cost recovery for water is lower than that of any other major category of public infrastructure (see Figure 2). The problems are the same as for public irrigation systems: because user fees are so low, the system depends on the general budget to cover the deficit. Such funds always have many claimants, and urban water authorities rarely have enough money to extend the system to the ever-larger number of people who need it.

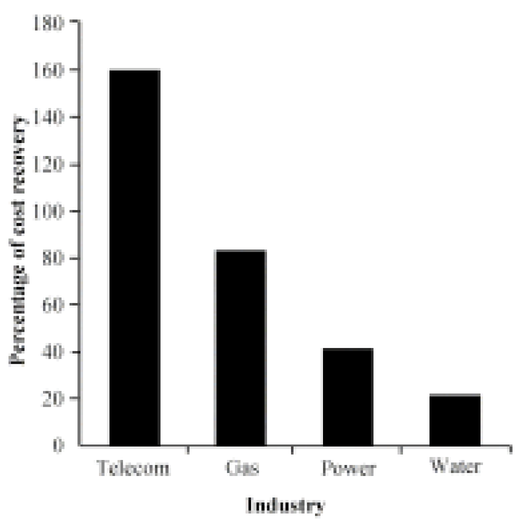
Indeed, urban water authorities typically do not have enough money to maintain the existing system. Since many urban water systems were built 50 to 100 years ago, depreciation and decay has been considerable, thereby exacerbating water waste. A 1986 survey of 15 Latin American cities found that municipal systems lost between 40 percent and 70 percent of their water (WHO 1992, 106–44). An estimated 40 percent of the Mexico City's water is lost through leaky pipes built at the turn of the century. In India over 40 percent of the total municipal water supply is lost before it can reach consumers (Suresh 1998). In Malta, one of the world's most water-stressed countries, 30 percent of the water intended for consumers leaks out of the system (Pearce 1993).

Such systemic weaknesses are particularly problematic when both sewage and drinking-water pipes leak, sometimes seriously compromising purity. Frequent breakdowns and clogged sewage pipes mean that sewage treatment plants in Karachi often operate at no more than 15 percent of capacity (Hinrichsen and Robey 2000). The majority of sewer water leaks out into the surrounding soil, contaminating drinking-water supplies. The potential for such prosaic failure of public utilities to contribute to large-scale outbreaks of water-borne disease is considerable. For example, in Karachi, "experts fear a major outbreak of diseases . . .



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

Figure 1. Current cost and projected future cost of supplying urban water.



Source: World Bank, *World Development Report, 1996.*

Figure 2. Degree of recovery in infrastructure sectors

because of leaking sewerage pipes. In the old city areas, 95 percent of the boreholes and wells are said to be contaminated. The leakages are blamed on substandard construction and materials as well as on road repairs and illegal connections" (*Dawn*, 2 May 1999).

Like their rural irrigation system counterparts, urban utilities are often quite inefficiently managed. In Western Europe, water firms usually have 2–3 workers for every 1,000 water connections. In most of Latin America, the number is 10–20 workers (Litvin 1998). Not all of this difference can be explained by inefficiencies: labor is much cheaper in Latin America than in Europe, and capital more expensive. But since public sector jobs are usually pay well, and since it is difficult to reduce staff for any reason, public water utilities in developing countries suffer from the typical inefficiencies of state-run enterprises.

Two policy recommendations are commonly made to help cope with the burgeoning water demand in these cities: 1) raise fees to existing users; and 2) enhance the efficiency of urban water utilities–perhaps by privatizing them, or by contracting out some of the services to the private sector. International agencies such as the World Bank and IMF have been prominent in advocating such policy shifts. A recent review of IMF loan policies found that during 2000, IMF loan agreements with 12 countries included provisions for privatizing water companies and moving toward full cost recovery (Hennig 2001). A partial list of countries that have experimented with full or partial privatization of urban water systems includes Argentina, Bolivia, Brazil, Chile, India, Indonesia, Jordan, Kenya, Mexico, Morocco, Nigeria, the Philippines, Poland, South Africa, Turkey, and Zambia.[2]

Neither of these approaches is simple, and neither will be free from contestation and conflict. Many urban residents view water as an entitlement, and privatization, particularly to foreign firms, raises many political issues. Recent experience with such privatization has been mixed. After the decentralization of water services in Mexico at the end of the 1980s, cities and towns usually either contracted out services to the private sector, or, in a few cases (Cancún, Aguascalientes, Navajoa, and Nogales) privatized the systems entirely. Since resistance to full privatization is strong in Mexico, mixed public–private arrangements have been more widely adopted. The government of Mexico City has taken this approach with some success: reports suggest that leaks were reduced from 37 percent in 1997 to an estimated 32 percent in 1999. (Business Mexico, March 2000). In Buenos Aires, privatization of the public water company led to a decline in the labor force from 7,500 to under 4,000; although the company asserts that it has undertaken extensive renovations, the municipal government has complained about the low water pressure on the line.

Political resistance to privatization comes from unions, nationalists, and opponents of corruption. Trade union representatives often oppose such actions, fearing job losses. Nationalists decry the handing over of water systems to foreign firms. Lack of transparency of the privatization process and charges of corruption are common. Unsurprisingly, such privatization has lead to conflict in a number of otherwise diverse cases. For example, the Argentine city of Bahia Blanca (pop. 420,000) privatized its system to a subsidiary of Enron. When the tap water was found to contain toxic bacteria, however, protesters took to the streets. Several other examples from the past two years also illustrate the point.

In Jakarta, Indonesia, in May 1999, the state governor accused the employees of Jakarta's water company, PDAM Jaya, of disrupting water services. What began as a wage dispute grew into a protest against a joint venture between the company and Thames Water International (UK) and Lyonnaise des Eaux (France). "Lawyers representing the workers said the partnerships were illegal because of collusive, corrupt, and nepotistic practices. The governor said the president of PDAM Jaya, who is thought to be behind the protests, would be removed if he did not halt them" (*Jakarta Post*, 3 and 4 May 1999).

In Cali, Columbia, in September 2000, the government privatized Emcali, the government water, sewerage, electricity and telecommunications company serving some 3 million people. SINTRAEMCALI, the Municipal Employees Union of Cali, has fought the privatization for more than seven years, and has accused the authorities involved in the deal of corruption. The government, in turn, charged 55 union members with rebellion. Paramilitary groups assassinated four union activists in 2000. In August of that year, the union's president had to leave the country because of repeated death threats (*Water and Sanitation Weekly* (WSW), 17 November 2000).

In Johannesburg, South Africa, the South African Municipal Workers' Union (SAMWU) has opposed the planned privatization of municipal services, including water supply, since January 1999. The union fears that privatization will lead to "job losses, excessive high prices of services, non-sharing of risks by private companies, and worse standards of service." (WSW, 22 February 2000). Given the intense ethnic tensions and

[2] See the full list at <www.psiru.org/sector/-water/news.htm>.

endemic political violence in that city, such a conflict could quickly become explosive.

In Cochabamba, Bolivia, a week of riots in January and February 2000 led to the death of one person and the injury of at least 46 others as police used live ammunition and tear gas against demonstrators. The government proclaimed a state of emergency. The protestors opposed the privatization of the city water system, a proposed system of permits for rural water extraction, and increases in water prices implemented in January 2000 by Agas del Tanner, a joint venture led by International Water Ltd. (IDL) UK, jointly owned by Bechtel and Edison SPA (Italy). The companies charged that the leaders of the protests, The Coordinating Committee for the Defense of Water and Life, "was mostly composed of people and organizations having an interest in the parallel water market." Both IDL and the government also asserted that cocaine traffickers financed the protest. Critics of the privatization process charged that the process was not conducted openly and that businessmen linked to the government profited substantially. (WSW, 21 April 2000) In April 2000, the companies withdrew, leaving the Committee in charge of the system, but many believe that the conflict is far from over (*San Francisco Chronicle*, 11 February 2001, 2).

Evidence to date suggests that few private sector municipal water investments have been very profitable. Partly for this reason, and unlike the situation in telecommunications or energy, there are a small number of firms bidding on such contracts. The major players are a handful of American, British, and French firms. As John Briscoe of the World Bank puts it, "water and sewerage is a low-return, high-risk business" (cited in Litvin 1998, 6). In some countries, the existing public companies have few attractions for buyers. In Malawi, for example, attempts at privatizing utilities "have been hobbled by the parastatal's huge debts, outstanding client accounts, and weak debt collection systems" (African Eye News Service, 22 May 2000). Although the IMF has pressed Sao Tome and Principe (among other parastatals) to privatize its water company, no buyer has yet been found (Hennig 2001).

Privatization offers no panacea for the problem of rising water scarcity in cities. Given the large economies of scale involved in piped water systems, continued government regulation will be required, even if the daily operations are turned over to the private sector. Managing such regulation is difficult even when governance structures are robust, the press aggressive and ubiquitous, and civil society groups active–as the difficulties of deregulating California's energy sector show. If governance structures are weak, the government corrupt (or even perceived to be so), and civil society intimidated, the resulting regulation is likely to be desultory, and consumers will have simply traded an inefficient public monopoly for an inefficient private one. If, in addition, the private agents are foreigners, there will be further political difficulties: foreigners always provide a tempting target for politicians.

Privatizing operations into the hands of well-connected "cronies" of ruling elites can also understandably raise political hackles. Accusations of such behavior may be found around the world, from Manila to Milan, from Gdansk to Nairobi. Such corrupt practices are not limited to developing countries: in France the city council of Grenoble voted for the return of water supply and sewerage to public control in March 2000, 11 years after the systems were privatized. The mayor in charge of privatization, Alain Carignon, was sentenced to prison on corruption charges. The mayor apparently ensured that Suez-Lyonnaise des Eaux was able to buy the company in exchange for contributions toward his political campaign (<www.psiru.org/news/3870.htm>). The political implications of such corruption will vary widely. However, the combination of rising scarcities and perceived profiteering by foreign companies and local elites has considerable potential to foster conflict.

Why Governments Create Water Shortages

Governments have not fostered shortages by heavily subsidizing farmers' and city dwellers' use of water out of ignorance. Simultaneous water-supply expansion and subsidized use has a compelling political logic. For purposes of exposition, we divide this logic into the roles of interests and ideology.

Interests

The role of interests may be the more obvious. Someone, after all, benefits from water subsidies. Large-scale public works, which provide subsidized services, are a highly visible way for governments to reward their constituents and build alliances with social groups whose support they seek. In the absence of water markets, subsidized irrigation water quickly becomes capitalized into the value of land (which does have a market), turning the owners of irrigated land into a potent lobby for the continuation of subsidies. Landowners then find allies in the government bureaucracies responsible for implementing these subsidies, forging a political coalition that strenuously opposes any increase in water charges.

Examples of such behavior may be found throughout the world. In the Middle East, for example, such political thinking contributes to the Moroccan government's strong support of heavily subsidized public irrigation. Ever since 1961, the Moroccan government's rural development programs have sought, successfully for the most part, to strengthen rural elites who have long been among the key supporters of the monarchy (De Mas 1978; Leveau 1985). Perhaps 9,000 to 9,500 large landowners own some 2.2 million hectares, or nearly 30 percent of the country's farmland (Swearingen 1987, 187). They constitute a critical constituency for the monarchy, as do the much larger number of smaller farmers, who know perfectly well that their relative wealth is in large measure the result of public investment.

Similarly, the expansion of irrigated agriculture in Mexico was driven by the (then) ruling party's (Partido Revolutionario Institutional , or PRI) goals and needs. Irrigation investment was concentrated in the arid North, and not only for hydrological reasons. The North historically had been a hotbed of opposition to the central government, and part of the "pacification" strategy of Elias Calles (effectively in power from 1924 to 1934) was to concentrate irrigation investment in the northern states of Baja California, Sonora, Sinaloa, and Tamaulipas, which together received more than half of all such investment. Calles "distributed much of the irrigated land to co-opt enemies and consolidate fragile political alliances, creating a new class of well-to-do farmers out of political bosses . . . " (Ascher 1999, 133). As is usually the case, this investment was funneled through a specific bureaucracy, in this case, the National Irrigation Commission (CNI). Although the original plan called for the system to be self-financing, this did not happen.

When Lazaro Cardenas became president in 1934, he re-oriented irrigation investment toward the generally grossly undercapitalized *ejidos,* or communal groupings of small farmers. By 1940, although such farms held only 15 percent of agricultural land, they contained 60 percent of the irrigated land. During this period, water subsidies became institutionalized, as Cardenas placed responsibility for water prices in the hands of his followers in the Banco Nacional de Credito Agricola. This bureaucracy, in turn, decentralized water-pricing decisions to local political leaders and district irrigation managers. Although the original intent seems to have been to subsidize only the poorer farmers (based on "ability to pay"), it proved impossible for local decision makers to deny subsidies to richer farmers. As a result, by the 1940s, the system was recouping perhaps 43 percent of operating costs (Wionczek 1982, cited in Ascher 1999). The irrigated area roughly doubled during this decade, as irrigation infrastructure dominated public investment in the agricultural sector.

Calls for reform began in the late 1950s and continued periodically for the next generation. During the 1960s user charges rose, covering 70 percent of operating costs in 1969–71. This was due as much to a decline in spending on operations as to any increase in fees, however. The quality of the infrastructure continued to deteriorate. During this period, wealthier farmers seem to have captured a still larger percentage of the total subsidy, further entrenching the policy. During the years of high oil prices, Mexican agriculture suffered from the "Dutch disease" (basically, a competitive disadvantage caused by the overvaluation of the peso). This macroeconomic environment bolstered farmers' resistance to increased charges, but as the infrastructure continued to deteriorate, the costs of lifting water to the fields rose still higher. Although the government tried to raise fees in 1981, the attempt failed, thanks to farmer opposition and the absence of any strong constituency for change. Real change had to wait until the complex process of Mexican economic and political reform of the past twenty years reached irrigated farming.

In India, irrigation expansion must be seen as part of the system of Congress Party rule. It has been cogently argued that, until very recently, India was governed by a coalition of three principal interest groups: powerful business interests (the "houses," such as Tata), government bureaucrats and employees, and the more well-to-do farmers (Bardhan 1984). The weight of farmers as a voting bloc in a still largely rural society combined with the constitutional structure of the country (most agricultural policy is a state affair) to ensure that those who benefited the most directly from irrigation expansion would become a powerful, entrenched interest group. Politicians offend this bloc at their peril.

In some cases, water subsidies have been used to co-opt potentially hostile groups. The Egyptian government has used irrigation expansion in the so-called New Lands (reclaimed land on the fringes of the Nile Delta) as a way to provide employment and assets to university graduates. The Mubarak government inherited a difficult economic situation: thanks to past population growth, perhaps 500,000 new jobs needed to be created every year. At the same time, macroeconomic imbalances and microeconomic inefficiencies inhibited job-creating investment. Reforming the ponderous system of socialist subsidies and state-owned enterprises was politically very delicate, and the regime opted for a gradualist approach. In the meantime, however, the government also confronted the problem of having a law on the books, dating from the Nasser era (1952–1970), which guaranteed jobs to all university graduates. The government could no longer offer graduates jobs in the public sector: public enterprises and the bureaucracy were already grossly over-staffed, and the macroeconomic pressure on the government budget was too severe. Worse still, Islamist opponents of the government had made important inroads into student opinion. Part of the government's response was to offer graduates heavily subsidized irrigation water, together with land, in the New Lands. Water scarcity in Egypt was created by these policies: without the New Lands–where the value contributed by water is the lowest in the country—it is probable that, throughout the 1990s, all other Egyptians could have had all the water they wanted, at a zero price. Here, truly, was "water scarcity by government decree."

Ideology

Ideology has also featured prominently in governments' provision of unsustainable public water systems. First, most governments at least pay lip service to economic development goals; many are actually committed to such agendas. For most countries, until recent decades, this has implied that agriculture would have to provide investment funds for the rest of the economy. Accordingly, farm goods needed to be taxed while the country tried to build up its domestic industrial base. This so-called import-substituting policy was the norm in developing countries from the 1930s until the 1980s. The implications of this policy were that agriculture would be taxed, usually by lower prices and/or overvalued exchange rates. But a stagnating agricultural sector, burdened by taxation and low productivity, would (and often, did) undermine such a strategy. Investing in irrigation infrastructure provided a means to continue to tax agriculture, while still providing incentives for the sector's growth.

In many countries, part of the ideology mandating subsidized water comes in the guise of promoting food security. This is especially prominent in the Middle East, but it may also be found in countries as otherwise diverse as Mexico and China. The notion is simple: it is believed to be far too risky, not merely economically, but also politically (too risky to national independence) to rely heavily on food imports.

In some cases, such concerns have been carried to absurd lengths. For example, Saudi Arabia paid farmers from five to six times the international price of wheat during the early 1980s, while simultaneously subsidizing inputs; the effective rate of protection (the combined impact of protected output prices and subsidized inputs) may have reached 1,500 percent in the late 1980s (Wilson and Graham 1994). Saudi government loans to farmers rose from under \$5 million in 1971 to over \$1 billion in 1983; from 1980 to 1985 the Saudi government spent some \$20 billion on agriculture, mostly in the form of subsidies (*Economist*, 6 April 1985, 80–83). As a consequence, wheat output rose from less than 3,300 tons in 1978 to over 3.9 million tons in 1992—at an estimated cost of \$2.12 billion in subsidies. Saudi Arabia became the world's sixth largest wheat exporter, with production rising by over 700 percent from 1971 to 1983, entirely replacing imports and actually creating a small export surplus. Critically, nearly 90 percent (13.3 of 15.3 km^3) of agricultural water was deep aquifer fossil water. At the 1990 rate of abstraction, usable reserves were estimated to last for a maximum of 25 to 30 years. Fortunately, budgetary concerns greatly reduced these subsidies during the fiscal crunch of the early 1990s. From 1992 to 1995 subsidies to wheat producers were cut in half (\$850 million, down from \$1.87 billion in 1993). However, with more than 45,000 private and nearly 5,000 multi-use public wells, farmers seem to have simply shifted away from wheat into fruits and vegetables. Although the efficiency of water use has increased as a consequence, groundwater depletion, stimulated by food security fears, continues (FAO 1997).

Perhaps the most potent, and most understandable, ideological force has been a focus on economic growth at any cost. Factory managers, irrigation system administrators, and municipal authorities have argued against increasing water charges by raising the specter that additional costs will slow economic growth. It is easy to see that government officials in poor countries might defer policy shifts toward water conservation if they believe that such a move means lost jobs or smaller harvests. Indeed, only recently has the (much wealthier) international development community recognized that "grow now, clean up later" is a flawed economic development strategy (see, for example, Thomas and Belt 1997). It is hardly surprising that governments of poor countries have put growth before water conservation measures.

As is often the case, such an ideological force swiftly becomes converted into an interest. In China, for example, much of the rapid economic growth of the past two decades has been driven by the Township and Village Enterprises (TVEs)–enterprises that are also among the worst offenders in water pollution. Yet despite this, local people and officials often prefer the jobs (and the pollution) to any policy shift that might threaten recent improvements in living standards.[3] National leaders listen: the director of China's environmental protection agency promises that enforcement of environmental regulations will not be allowed to interfere with the growth of rural industry (Economy 1997).

A final ideological force may be labeled "The Pharaonic Temptation": the use of immense, highly visible public works projects for propaganda purposes. The original county of the pharaohs, Egypt, certainly has built projects of this type. Given the declining amount of cultivated land (now 0.05 hectares per person), reclaiming desert land has been an understandable obsession with Egyptian planners for half a century. Its most recent manifestation is the Toshka Canal project. Construction on the project began in October 1996 in the Western Desert north of Abu Simbel, on Lake Nasser (behind the Aswan High Dam). The project aims to double the size of Egypt's arable land in fifteen years' time. The project's estimated cost is $88.5 billion, with the government committed to providing $5 billion in major infrastructure work and the balance of funding expected to come from the private sector. Investment incentives include tax exemptions, customs exemptions, and low land prices. The project has been subjected to considerable technical criticism; not only have no serious environmental impact studies been conducted, but even more basically, the project intends to increase total water use in Egypt by 5.5 billion cubic meters. Since Egypt is already using a greater volume of Nile water than the amount to which it is entitled under the 1959 treaty with Sudan, critics wonder where this water will come from.

The political temptations, however, appear irresistible. The project is visible. It entices foreign investors (the first investor to buy a farm in the new areas was Prince Waleed Bin Tawal of Saudi Arabia). It provides evidence that the government cares about the poor and neglected south (Upper Egypt), and if people settle there, it will fortify the country's southern border with its often difficult Sudanese neighbor. The latter concern is even more obvious with respect to reclaiming land in the Sinai, which was occupied by Israel from 1973–1980.

Egypt is not the only country to suffer from such "Gigantist" fantasies. The government of China is also contemplating a series of massive projects beyond the Three Gorges dam. Because water is relatively abundant in China's southern regions, schemes to transfer huge amounts of water from the relatively well-watered south to the arid north repeatedly surface. Serious water shortages in Beijing have propelled proposals to divert water from the Yangtze to Beijing and Tianjin, despite opposition from officials in Hubei and Henan, where an estimated 225,000 people will be displaced. The diverted water will be entirely for urban and industrial use—none is slated for farmers (Crook 2001). The project as planned will cross 219 rivers and streams, and will cost an estimated $17 billion. Many observers believe that this is an underestimate of the direct construction costs, and ignores the very substantial adverse ecological effects of the project (Crook 2001; Economy 1997). Nevertheless, the dream of a new "Grand Canal" moves ahead—indeed, water is already been transferred as far north as Jiangsu province.

In summary, governments, always faced with multi-dimensional challenges, often seek to enhance their legitimacy, burnish their reputation, reward their friends, and co-opt potential opponents through highly visible public works. As they do this, they create powerful vested interests in the beneficiaries of subsidized water . Such interests often also become vested in specific bureaucracies, which look at the world through a "supply expansion" lens. Such political rationales provide some (but not all) of the reasons for a persistent reliance on supply-enhancing approaches to water scarcity, despite their increasingly dubious hydrological, economic, and environmental logics.

The Political Economy of Water Conservation

In contrast to supply-enhancing approaches, implementing water-conservation measures offers few immediate political benefits. Existing resource users will lose current income, and the efficiency gains are often not visible for some time. Indeed, they may never materialize. Nevertheless, pressures to reform are becoming steadily stronger: in the absence of feasible projects to expand supply, increased water conservation and efficiency become the only alternative. Adopting such policies is neither simple nor assured of success, and the process of reform is unlikely to be free of conflict.

[3] "In the early 1990s, a tannery established by farmers in a rural village in Hebei Province earned them revenues of 300 million yuan (U.S.$36.6 million). However, in 1993, this tannery discharged 11.3 million cubic meters of wastewater, with a high content of sulfides and chromium, directly into sewage pits. This wastewater seriously damaged surface and groundwater, reduced crop yield, and produced 'sour' fruit. However, the farmers claimed that they were indifferent to the poor yield because the tannery was far more important to their economic well-being" (Economy 1997).

Whether or not the challenge of rising water scarcity can be managed smoothly and peacefully depends largely on the ability of the interested parties to compromise and cooperate—to reach agreements on how water will be allocated, and then to monitor and enforce these agreements. Societies will differ greatly in their capacities to agree. "Social capital"—basically, the ability of people to trust each other and therefore to form viable groups to pursue collective goals—will be a critical variable in determining how well different societies and countries can manage the transition to sustainable water management strategies.[4] The absence of such abilities will be a key driver (arguably, the key driver) of whether the inevitable increase in water scarcity contributes to political conflict.

It is sobering to note that some societies which are conventionally thought to have a high degree of social capital or adaptability, such as the United States, have so far failed to adopt the kinds of systematic demand-management policies that nearly all water analysts believe should improve efficiency and promote conservation. Consider California, the largest irrigated water system in the United States. For more than twenty years, the state government promoted the use of water markets to reallocate water from agricultural to urban uses. Some estimates place the net social benefits of such transfers at $2 billion. Yet despite these efforts and despite these huge sums (which, one would have thought, would handsomely compensate the losers in the transfer), few (4–7, depending on the definition) long-term contracts for such transfers have been signed. As of this writing, no "wet" water has actually been transferred (Haddad 2000 and personal communication). If the problems of reallocating water are difficult in California, they are likely to be at least as difficult in developing countries. Indeed, there are a number of reasons why they are likely to be considerably more serious.

It is reasonably clear what will happen if more efficient and equitable allocation mechanisms are not negotiated, monitored, and enforced. As scarcity rises, access to water becomes increasingly valuable. "Business as usual" implies that powerful individuals and/or favorably situated groups will appropriate the water for their own use, with little or no regard for the consequences of their actions on other parties. Such "resource capture" (Homer-Dixon 1999) may be seen in many diverse contexts. For example, as the introduction of Green Revolution technology raised the value of land and water in Pakistan, richer farmers (so-called influentials) managed to bend the old, relatively equitable *warabandi* system for water allocation in their favor, forcing poorer farmers to bear the brunt of rising water scarcity (Bandaragoda 1998). In the Sa'dah basin of North Yemen, communal systems of land use prevailed until the mid-1970s. Escalating conflict between herdersand farmers over the use of run-off water was adjudicated by religious scholars; a decision in 1976 (unanimously accepted by all tribes) induced many tribes to privatize their land. Subsequently, merchants and other tribesmen of comparative wealth were able to capture most of the groundwater by investing in pumps (Liechtenthaeler and Turton 1999). Losing groups rarely regard such resource capture as legitimate, although tribal Yemen in the late 1970s appears to be an exception (ibid.). The potential of such phenomena to exacerbate internal social conflicts is likely to be considerable.

The alternative to "business-as-usual/resource capture" is to move toward greater reliance on water demand management. Such a policy change constitutes a subset of the general shift toward reliance on decentralized mechanisms of resource allocation, a process known in the development community as "economic reform." Students of this wider phenomenon have noted that some changes are easier to make, and some circumstances are more favorable to reform, than are others. Several broad conclusions from this literature are relevant here:

Change is greatly facilitated by crisis. Dramatic events disorganize the opponents of change, and help to delegitimize their arguments for the status quo. Severe shortages of foreign exchange, which make it impossible to buy critical consumer goods and production inputs, facilitate economic policy changes. Droughts sharply focus the public's and planners' attentions on the need for increased water conservation measures, facilitating water policy changes.

Change is much easier if winners outnumber losers. Such a situation is far more likely to prevail when the overall efficiency benefits are larger than the redistributive impact. For example, it is easier to implement measures to halt runaway inflation (which typically harms nearly everyone) than to reduce import tariffs (which typically redistribute more income than is created from increased efficiency, at least in the short run). Unfortunately, raising water prices, whether to urban or agricultural users, most likely falls into the second, more difficult, category.

"Packaging" reform is critical. It may be easier to make difficult changes if they are implemented at the same time as other, more popular

[4] For an extended general discussion of this point in the context of water demand management, see Turton 1999.

policies are shifted (Rodrik 1994). This has come to be known as relying on "win-win" policy shifts: changing a policy for its own sake and also because of additional benefits that may materialize later.

"Win-win" Water Policy Changes

One of the easiest ways to improve the efficiency of irrigated irrigation is to stop subsidizing the prices of water-intensive crops. In Jordan, Morocco, and Yemen, for example, governments had placed various restrictions on imported commodities. During the 1990s, each of these governments faced the necessity of implementing trade reforms. By reducing the level of protection afforded to water-using crops as part of the reform of trade policy–which, in turn, is often implemented as part of wider "structural adjustment" and "stabilization" programs–governments can provide incentives for conservation without ever mentioning water, much less water prices. The cheaper imports now compete more vigorously with domestic products (for example, Somali bananas now compete with bananas grown in the Jordan valley). Local growers may thus be encouraged to shift to other, less water -intensive crops. Since such policy changes are usually desirable for their own sake (because they increase the economy's overall efficiency of resource use), reforms of trade policy may provide an important "win-win" policy for water conservation.

The same is true for reducing or removing subsidies on other inputs whose use facilitates water waste. A prime example is diesel fuel, used to operate pumps. The Yemeni government raised the price of diesel fuel from $ 0.02 per liter in 1996 to $0.10 per liter in 1996, to $0.16 per liter in the year 2000. The changes were implemented in order to cope with Yemen's post–Gulf War economic crisis. When hundreds of thousands of Yemeni workers were expelled from Saudi Arabia and other Gulf states in 1990–91, the resulting precipitous fall in remittances exposed deep structural weaknesses in the Yemeni economy. After the civil war that reunited the country, the government embarked in 1995 on a stabilization and structural adjustment policy. Increases in diesel fuel prices, as well as the end of credit subsidies and the lifting of import bans on fruits and vegetables, have provided significant incentives for greater water conservation and more efficient agricultural use of water (Ward 2000).

The Yemeni case also indicates, however, that such changes are hardly likely to be conflict-free. In 1993 the public rejected the government's first proposal to raise diesel fuel prices. In 1995 the government's tripling of prices sparked riots in which 20 people were killed (Ward 2000). There were further riots with the same trigger in 1996 and especially in 1998, when Islamic activists emerged as leaders of opposition to the government, and denunciations of "foreign interference" in the economy became more widespread. The protests were not, of course, mainly focused on water issues. Rather, they concentrated on the impact of increases in fuel and food prices as well as governmental corruption and the lack of transparency of the entire process. (*Yemen Observer,* 10 January 1999).

Political considerations can block the adoption of such "win-win" policy changes. For example, the Egyptian government has refused to remove subsidies to sugar producers. Sugar-cane fields use 12,000 cubic meters of water per acre, which exceeds that of rice (8,800), and far exceeds that of major food grains such as wheat (1,590) or the main export crop, cotton (3,180). Indeed, the returns to sugar per unit of water are the lowest of any major crop; a 1994 World Bank study found that water used for sugar produced only half the value of water used in rice, one-fourth that of water used for corn, and one-eighth that used for tomatoes (World Bank 1994a). Egypt not only wastes water but also loses foreign exchange by growing sugar.[5] By any economic analysis, sugar cane is a loser.

One of the simplest ways for Egypt to cope with water scarcity would be to stop pouring water into sugar cane. However, strong political considerations block this apparently simple road to water conservation. Sugar is grown in a very poor part of the country, the Sa'id (Upper Egypt). This area has a history of neglect by the central government and is torn by endemic violence. The region is a stronghold of Islamist extremism, and martial law often prevails there. The government is clearly not going to do anything to increase economic hardship on the Sa'idis. Political considerations block the adoption of what at first glance appears to be an eminently sensible, and fairly simple, way to save water.

Changes in water policy in Israel provide an instructive contrast. It had long been assumed that the strength of the Israeli farm lobby would block any change in water policy. However, the lobby proved to be a paper tiger, thanks to a combination of drought-induced crisis and the increasing importance of non-agricultural activities in the economy. The drought of 1986 forced the Israeli Water Commissioner to cut water to farmers, but the lobby's strength overturned this decision. When the country suffered three consecutive additional

[5]The domestic resource cost ratio (foreign exchange spent producing a good divided by foreign exchange earned) for sugar cane is approximately 1.4.

drought years the cuts were re-imposed in 1991, and the agricultural sector's water allocation was slashed a whopping 65 percent. Although much water was restored after the drought ended, the sector nevertheless wound up with 25 percent less water than it had in 1986. Part of the explanation was the shift in economic (and political) clout in Israel, thanks to the country's rapid transformation into an industrial and skill-intensive services economy.[6] At the same time, farmers did not lose all of their subsidies: in return for acceding to the (eminently efficient) policy of making agriculture the "residual user" of water in the event of a drought, farmers wound up paying $0.20–0.25 per cubic meter for irrigation water, rather than the $0.65 real cost of delivery (Allan and Karshenas 1996). Water conservation measures came to Israel thanks to droughts, development, and a deal.

Devolution to the Rescue?

There is a consensus that decentralization of decision-making power over irrigation systems must be a component of any meaningful water policy reform. Indeed, the World Bank now has an entire section devoted to promoting such decentralization. The logic is compelling: given the many failings of centralized water allocation systems, devolution of decision making to those who are both most affected by the problems of the irrigation system and those who stand to benefit the most from change should help. The current enthusiasm for transferring control of surface irrigation systems (often called "irrigation management transfer," or IMT), and, in some cases, local municipal water systems, to groups of farmers or water consumers is certainly understandable. More than 25 countries (including Chile, Peru, Mexico, Brazil, the Dominican Republic, Colombia, Haiti, Senegal, Mauritania, Niger, Zimbabwe, Tanzania, Sudan, Somalia, Madagascar, Turkey, Pakistan, India, Sri Lanka, Bangladesh, Lao PDR, Vietnam, China, Indonesia, and the Philippines) have undertaken IMT on various scales (Vermillion 1997).

Enthusiasms may mislead, however. A thorough review of evidence on the impact of IMT (Vermillion 1997) found ambiguous results. Much of the literature appears to be based as much on *a priori* reasoning (or ideological positions or hopes) as on detailed, empirical foundations.[7] The best information covers the impact of IMT on irrigation system finances and management. On balance, IMT improves the financial status of irrigation systems, reduces government expenditures on irrigation, and raises the responsiveness of government irrigation personnel to farmers. Although these findings are far from universal, they do seem to reflect the balance of the available (and problematic) evidence (Vermillion 1997).

There is, as of yet, little evidence about the impact of such transfers on water-use efficiency. There is some evidence that IMT may reduce the amount of water used per hectare, but the picture is quite mixed. This is partly because IMT is a relatively new phenomenon. Until recently, most evidence came from countries such as Australia, Chile, and the United States. In these countries, governments transferred systems to a small number of relatively affluent (and therefore, creditworthy) farmers, producing for well-established and relatively efficient output markets. Most importantly, the legal framework was well established (Turral 1995). Another recent analysis of IMT experience of the past decade summarized the conditions necessary for success of IMT as follows:

- the irrigation system is central to a dynamic, high-performing, wealth-creating agriculture;
- average farm size is large enough for a typical or a significant proportion of the command area farmers to operate like agribusinessmen;
- backward linkages with input supply systems and forward linkages with output marketing systems are strong and well developed;
- the costs of self-managed irrigation are an insignificant part of the gross value product of farming (IWMI 2001).

Such conditions are hardly typical of many developing countries' irrigated agricultural sectors. For example, in Indonesia fiscal constraints and poor performance led to the government to institute the Small-Scale Irrigation Turnover Program in 1988. This program was designed to affect all systems covering fewer than 500 hectares–some 2.1 million hectares, or 30 percent, of the entire irrigated area. Average farm sizes in Java are perhaps 0.25–0.33 hectares; irrigation efficiencies in

[6]By 1997, agriculture accounted for only 2 percent of Israel's GDP, compared with 17 percent for industry, and 81 percent for services (CIA 2000).

[7]"Most reports about impacts are qualitative and hard to validate. Over a hundred papers were prepared for the International Conference on Irrigation Management Transfer, held in Wuhan, China, in September 1994, but only 25 contained data on performance outcomes of management transfer. Most of those papers presented only data on performance after transfer, using at most two or three performance measures. Four papers presented before-and-after comparisons; one paper presented a with-and-without comparison . . . It is often difficult to distinguish the effects of management transfer from rehabilitation or changes in inputs or technology" (Vermillion 1997).

these small-scale systems are estimated at 40–50 percent (although, given return flows and reuse, the overall system efficiency is much higher).

However, the efficiency consequences of IMT have been quite modest: farmers experienced no increase in irrigation costs, and although water distribution seems to have either remained the same or improved, there has been no change in the returns to water (a measure of the economic efficiency of water use). More disturbingly, farmers have underinvested in maintenance, which, of course, bodes ill for the future. The problem of underinvestment, which was part of the motive for the turnover in the first place, is not easy to solve when large numbers of small farmers are supposed to find the necessary funds for O & M expenditures (Vermillion et al. 2000).

Part of the problem came not from the farmers but from the government. The government's earlier experience in extending irrigation to promote the adoption of the Green Revolution was very much a "top-down" affair, characterized by no farmer participation, a focus on physical infrastructure, and confused lines of authority. Such behavior persisted during IMT. The transfer process lacked farmer participation since it was driven by governmental financial concerns, and, in turn, by pressure from the World Bank and the Asian Development Bank. The agency whose personnel had the most to lose from the process was placed in charge of IMT, and, of course, the notion of genuine participation in a dictatorship such as Suharto's Indonesia is laughable. Farmers and their associations lacked any well-defined legal water rights. In summary, the IMT program in Indonesia devolved only a limited amount of authority to weak water user associations (WUAs). In a context of increasingly severe environmental limitsto better performance of irrigated agriculture, farmers continued their former water practices. Unsurprisingly, there were few, if any, gains in water use efficiency (Vermillion et al. 2000).

The oft-cited Mexican case further illustrates the point. Indeed, it is perhaps not accidental that the relatively successful IMT in that country coincided with the weakening both of centralized governance in many areas, and, particularly, with the demise of the monopoly on political power of the PRI. The transfer program in Mexico was implemented swiftly, beginning in 1989: by 1996 nearly 90 percent of the 3.3 million hectares of public irrigation land had been transferred to WUAs (Johnson 1997). The financial results have been encouraging. Since decentralization has greatly increased collection rates, in some areas fees now cover 100 percent of costs, as opposed to 20 percent before IMT (Johnson 1997; Kloezen, Garces-Restrepo, and Johnson 1997). The restoration of financial viability and the salutary impact of decentralization on management responsiveness have combined to improve system maintenance, halting the deterioration that was so noticeable from 1970 to 1988.

However, there is little evidence that IMT in Mexico has led to an increase in the price of water to farmers, much less to a price even vaguely resembling water's social opportunity cost. A detailed study of IMT in an irrigation district in the state of Guadalajara found that water costs remained a small fraction (5 percent) of the cost of production, and that the WUAs were either unable or unwilling to allow water prices to reflect inflation (Kloezen, Garces-Restrepo, and Johnson 1997). Since the rate of inflation in Mexico during the 1990s was at least 20 percent per year, fixing nominal water fees implies a decline in the real price of water. Even the improvement in system maintenance may be transitory: the WUAs in Guadalajara did not set aside any "contingency funds," and the apparent return of fiscal viability assumes no large investment expenditures. Given the age of the physical infrastructure of the irrigation system, and the withdrawal of the central government from financing investment in maintenance, this may prove a serious deficiency. Even in Mexico, where the conditions for IMT are more favorable than in many other countries, the evidence that such decentralization has led to any substantial improvement in water demand management is tenuous.

The problems of devolution of authority over irrigation systems parallel those of urban water infrastructure. The systems are often characterized by large, lumpy investments; the resulting economies of scale can be considerable. Entirely decentralized resource allocation mechanisms are likely to overlook the impact on third parties, particularly issues of run-off quality. Perhaps most importantly, devolution of surface water irrigation systems may undermine the "unitization" which is needed for improved management of groundwater. One can conceive of management systems that would solve both problems simultaneously; the human and social capital requirements, however, are likely to be large. Failures, or only partial successes, should be expected. Decentralization of surface water irrigation systems, while arguably a necessary condition for implementing better water demand management systems, is hardly a sufficient condition.

Finally, genuine devolution of decision-making power from the central government to localities is not a politically neutral process. Governments may fear that such decentralization, however desirable on water allocation grounds, threatens to strengthen local groups who oppose the central government for unrelated reasons. Only a truly strong state can decentralize and still remain a state. It may happen that decentralization weakens the central government's already tenuous hold on power, which may lead to destabilizing violence. For example, in both Pakistan and Yemen, decentralization of water allocation decisions may do little for water conservation, state efficacy, or containing political violence.

None of this should be taken to imply that IMT is undesirable or useless. It is intended as a set of cautionary tales: improved demand management for water raises a host of difficult issues for the designers of water conservation incentives. The list of features that need to be present for successful implementation is lengthy; the set of circumstances that would ensure that decentralization dramatically enhances water use efficiency is complex. Useful as IMT might be, it is not a cure for water scarcity.

Nevertheless, decentralization and devolution will be essential in developing future strategies for coping with water scarcity. The inefficiencies of large, top-down, supply-enhancing systems mean that they cannot continue to deliver the same volumes of water as in the past. Whatever the difficulties of decentralized management, those of centralized approaches remain at least as serious. Additionally, some promising approaches, such as rain-water harvesting or small-scale irrigation, can only be managed at the local level.

The best approach is likely to be enhancing the ability of communities to manage their local systems. Foreign governments, NGOs, and, in some cases, private firms can help here, but, in the end, only the people who are directly affected can govern such systems. Some will govern relatively well: Others will not. One lesson that might be drawn is that decentralized water management is likely to succeed in areas and countries where the ingredients for good governance (an adequate level of trust, relatively equitable and transparent mechanisms for making, monitoring, and enforcing agreements, and so on) are present, and is likely to fail in areas where these features are missing.

Water Markets and Their Discontents

Many analysts hope that water markets can play a significant role in improving the efficiency of water allocation. Indeed, increased reliance on markets and the private sector is the centerpiece of the "Washington consensus." In the case of water, it is argued that water pricing, and, ideally for many economists, a system of tradable water rights can induce much needed water efficiency. The general point is simple: "If people have to pay for something, they will be less ready to waste it." Thinking of this kind lies behind pronouncements of the World Bank's World Water Vision that "treating water as an economic good" must be a central component of any viable shift toward coping with rising water scarcity. Increased reliance on price increases and water markets are also implicit in the logic of decentralizing water allocation responsibilities: markets are, after all, the quintessential mechanism for decentralized resource allocation.

Such a perspective has hardly gone unchallenged, however. There are several (often interacting) difficulties with instituting water markets. First, although drinking water is a small fraction of total water use, the fact that such water is essential to life makes many people feel that access to it is better treated as a right. There are often strong philosophical, religious, and emotional objections to making water a commodity.

Second, any market for any good anywhere requires a prior distribution of property rights. However, if the initial allocation seems unfair, and/or if it is difficult to get agreement on these rights, it will be difficult to implement a water market. It is, in general, not possible to finesse the prior distribution of property rights to water. The costs of making, monitoring, and enforcing agreements to trade water are likely to be high and to demand robust and sophisticated supporting institutions.

Finally, water, as a commodity, has a number of characteristics which make it difficult to use a market mechanism. These difficulties include pervasive externalities or "third-party effects," high transactions costs, the fact that trades for water today may easily affect the potential availability of water tomorrow, and the fact that complementary, often quite expensive, infrastructure is necessary if rural to urban water transfers are to occur. Water is also not a "uniform commodity." Different users need different qualities of water, and with shared large-scale conveyance structures, it is hard to tailor the product to fit end users' needs. For these and other reasons, those water markets which are likely to have a substantial impact on water demand management are best thought of as markets for long-term assets. Such markets are more complicated than spot markets, and require relatively sophisticated rules and institutions to govern them properly.

Commodity Fetishism?

The UN has proclaimed that access to clean drinking water is a human right (a human right which remains denied to 1 billion people). The discourse on rights is fundamentally different, and, at many critical points, opposed to that of economics.[8] It is also often used by those who believe they will be "priced out" of access to a resource by a market mechanism. Particularly in cultures where water is viewed as a gift of God or an inherent right of groups or individuals, attempts by multinational agencies to promote the "economic approach to water" have the potential to foment conflict.[9] This may be exacerbated if a government implements, say, privatization to foreign companies utilizing World Bank expertise, as noted earlier. Interests that are adversely affected by policy shifts–most prominently, public-sector workers and their representatives–often attack such policy shifts on nationalist grounds. Treating water as an economic good hardly commands universal assent.

Those who oppose treating water as an economic good are not necessarily saying that all water should be treated as a right. Drinking water and water for some minimum level of household use should be available to everyone, regardless of ability to pay: access to some minimum level of water is a basic need and a human right. Most water allocation mechanisms pay at least lip service to this concept. This concept undergirds the most prominent mechanism for allocating urban water, the "block tariff" system, whereby some initial amount of water costs nothing or very little, while subsequent, larger volumes cost more. Few analysts dispute that some minimal amount of water should be made available to everyone. The vastly larger amount of water, which is used for industry and agriculture, could then be allocated by some pricing mechanism.

Pricing water for agriculture and industry, as reasonable as it may appear to many of us, is also contentious. Part of the problem with pricing larger volumes of water (which is what "treating it as an economic good" means) is that different social actors have very different perceptions of the legitimacy of asset distribution in the economy, of which water is merely one example. Since the value of water is often capitalized into the value of land, conflict over the justice of the land distribution will, almost inevitably, be translated into conflict over water rights. Failure to agree on the initial distribution of assets–here, failure to agree on some initial distribution of water rights–can be fatal to any attempt to induce conservation by raising prices or by instituting a market mechanism to trade water rights. As scarcity rises, such land disputes can easily impede the adoption of technically sensible proposals to improve water management.

Recent Israeli-Palestinian negotiations illustrate the point. Water experts in the area are concerned over the seepage of raw sewage into the West Bank aquifer. None dispute that the sewage comes from both Palestinian towns and Israeli settlements, and all agree that such wastes pose a potentially serious threat to water quality. However, the Palestinians refuse to consent to technically superior, joint sewage treatment plants. The Palestinians regard agreement to any joint project as recognizing the legitimacy of Israeli settlements, which, of course, the Palestinians refuse to do. A dispute over land thus becomes, indirectly, a dispute over water management (in this case, water quality management) (Rouyer 1999). Wherever there are disputes over land rights, instituting any system to price or trade water, or to manage demand for it will be difficult.

Property Rights, Transactions Costs, and Asset Markets

Many analysts recognize the centrality of a pre-existing, legitimate distribution of water rights for any water market to function properly (for example, Perry, Rock, and Seckler 1997). Given the prevalence–and the viciousness—of land disputes in the world, it is perhaps unsurprising that some analysts have attempted to side-step the thorny problem of assigning property rights to water.[10] Franklin Fisher argues that "the question of water ownership rights and the question of water usage are analytically independent and should not be confused." On this assumption, his team quantified the benefits of water use in the Mashreq. They find that these benefits are "small": \$110 million for 1995, rising to no more than \$500 million per year (Fisher 1995, 379). They then conclude that with appropriate side-payments, it should be relatively easy for the nations of the Mashreq to come to an agreement on water sharing. They argue that all the fuss about water conflict and negotiations is, in effect, "much ado about nothing."

The argument is understandable: any observer of the Middle East would be delighted if it were possible to break out of zero-sum thinking. The argument is ingenious: by looking beyond the

[8] Philosophically, the difference may be summarized as "Kant versus the Utilitarians."

[9] This difficulty may be easily exaggerated, however. The "right" to water is, essentially, a right to drinking water, which is a tiny fraction of total water use. Religious scholars can be very ingenious in finding ways to reconcile scriptural strictures with the exigencies of water scarcity. See, for example, Liechtenthaeler and Turton's fascinating 1999 study of the role of Zeydi Imams in changing water allocation rules in tribal Yemen.

[10] The following draws extensively upon Richards and Singh 2001.

conflict over property rights, it tries to shift our focus to water's productivity in agriculture, industry, and services, and its utility in consumption. The argument is helpful: it provides a useful attempt to quantify the value of water in a difficult dispute. Surely it is true that if water's value were perceived to be some $500 million, the chances of conflict would be reduced?

Unfortunately, the argument is also wrong: it is impossible to separate questions of water ownership rights from questions of water usage. The questions are, in fact, not analytically independent. Economics offers no neat exit from the zero-sum world of determining an initial allocation of property rights. Markets will not provide the sword to cut the Gordian knot laced through decades of hatreds. The fundamental problem is that the separation of use and property rights can only be done under certain conditions, and these conditions are highly unlikely to be met in the case of water, particularly in developing countries.

Much to the despair of U.S. economists and diplomats, highly informed local experts often assert that "our water is not for sale." U.S. government specialists trying to further water negotiations in areas such as the Middle East often bemoan the fact that regional government officials do not think of water economically. The local view may in fact reflect more than bargaining positions or some mystical vision; this perspective simply recognizes the presence of what economists call "wealth effects" in water exchanges. [11] Fundamentally, these "wealth effects" imply that the price I am willing to accept to sell something which I own may be higher (often, much higher)[12] than the price I am willing to pay to acquire that same somethingIn such a case, the distribution of property rights matters hugely to the outcome of any exchange.

People also fear that any agreement to exchange a good may jeopardize their future property rights to that same good: "If I sell them the right to the water for five years, and they use it, then they will come to think of this water as 'theirs by right,' and I will lose my rights to the water." In theory, laws can be constructed to avoid this problem, but in practice, it may be very difficult to do so. This problem has played an important role in slowing the development of long-term rural–urban water market transfers in California, for example (Haddad 2000). Once the importance of wealth effects are recognized, the statement that "our water is not for sale" reveals not irrational emotionalism but shrewd and sophisticated economic logic.

Reluctance to buy and sell water also reflects the presence of (very large) transactions costs. Although there are many of these, consider just two: the role of uncertainty and the problem of making credible commitments. Agents often do not believe that the sums they require to part with water (what they are willing to accept) will actually be paid. Put in financial language, the risk premia on such contracts are very high, indeed, so high as to make any commitment to pay them not credible.

An additional uncertainty and transaction cost arises from the problem of enforcing contracts. Enforcing contracts is not costless, and the cost of enforcement may appear to potential market actors as prohibitive or unattainable. If a party such as the Palestinian Authority does not "own" (that is, have residual decision-making rights and residual rights to the income stream generated by the utilization of the asset), then that party is faced with very large uncertainty on whether the other party, in this case Israel, will renege on the contract. The same problem prevails whenever there are reasons for distrust, which of course may also happen within a political entity, as well as in transnational disputes.

Willingness to enter into a contract which is not simply a "one-off," immediate trade (such as the contract that occurs when you buy groceries) requires that agents can answer the question "How do I know that the other party will keep his/her side of the bargain?" There are three broad classes of answer to this question, only one of which is even remotely apposite in most developing country contexts:

"If she reneges, I can take her to court." What court? Most fundamentally, whose court? Using which set of rules? Enforced by whom? How long will it take to get a decision? Are judges often bribed? What about enforcement agencies, are they corrupt? Who has greater access to them? and so on. Unquestionably, the weakness of legal structures can be a major impediment to the development of water markets.

[11] Formally, the absence of wealth effects requires that: 1) given any two alternative decisions *x* and *y*, there is a specific amount of money, $*z*, which would compensate a decision maker to switch from *x* to *y*, or *y* to *x*. 2) if the decision maker were given some additional amount of money, the amount necessary to induce him/her to switch from *x* to *y*, or *y* to *z*, would remain the same ($*z*); 3) the decision maker must have enough money to absorb the wealth reduction necessary to pay for switching from the less preferred to the more preferred option. (Milgrom and Roberts 1992, 35).

[12] In the environmental economics literature, it is well known that "willingness to accept" typically exceeds "willingness to pay" by at least 300 percent (Bromley 1995).

"We will deal with these people over and over in the future, and they value their reputation as people who comply with agreements." As it stands now, most ongoing water conflicts are so contentious that reputations are already damaged, whether these conflicts are local or transnational. For example, it would be difficult to imagine an historical–political setting in which the respective "reputations" of the parties were more tarnished in the eyes of the other than in the Mashreq. The mutual suspicion, often amply justified, of each party for all the others is enormous. Distrust is also endemic between the rural poor and their richer neighbors. Reputation mechanisms seem highly unlikely to help answer the fundamental contracting question.

"If he reneges, he will lose other things which he values highly." This reflects the oft-noted phenomenon that transnational water agreements are "the tail of the dog," that they are arrived at only after, and as part of, more general strategic agreements (for example, the Israeli-Jordanian peace agreement). From a theoretical (and practical) perspective, the fact that military security, the quintessential public good, must be introduced to get an answer to the fundamental contracting question immediately alerts us to the importance of third-party effects–which in turn imply that the division of property rights cannot be separated from questions of resource allocation.[13]

Establishing water markets faces further difficulties. However general contracts are enforced, water contracts are inevitably subject to uncertain contingencies. A severe drought may hit; crop diseases may spread; the prices of imported foods may suddenly rise; and so on. It is highly likely that, in an environment of profound distrust, the subjective probability of negative shocks is an increasing function of the extent to which water supply sources are owned or controlled by deeply distrusted Others. Even if a way is found to provide insurance for such contingencies, we have introduced the moral hazard problem: if they are insured, why should they be careful?

Part of the problem is that enthusiasts for water markets often conceive of them as spot commodity markets—the simple markets of Economics 101 or your corner grocery store. Water markets actually look much more like asset markets, for example, the market for corporate bonds or for houses. Asset markets are markets for long-term contracts: I buy an asset because it yields a flow of benefits over time. Once we are dealing with such long-run issues, problems of uncertainty and imperfect information immediately intrude. Problems of imperfect knowledge of water quantity, water quality, future contingencies (such as those mentioned in the preceding paragraph), and the future enforceability of contracts must be considered. These problems are difficult to resolve and require robust institutions to adjudicate. They also demand at least a minimal level of trust among the contracting parties. Water markets will require extensive regulation and legitimate dispute resolution mechanisms. Asset markets need sophisticated regulation rules, which can be highly problematic even in economies with well-developed legal systems and other governmental institutions. In short, water markets will require a high level of social capital to function properly–just like financial markets. This is unlikely to be simple.

To understand the danger of focusing purely on spot transactions, consider the status of markets for groundwater in India or Pakistan. These are sometimes viewed as increasing the efficiency of water use, since farmers with low marginal values can sell to those with higher marginal values. As we have seen, however, there is no prior allocation of water rights: the situation is actually a free-for-all, and "ownership" of water is de facto, through the use of pumps. The overall use of water, therefore, by no means reflects its true scarcity value; the presence of water markets here does little to enhance efficiency.

Water Is a (Peculiar) Economic Good

In most cases, to enjoy water we must simultaneously invest in complementary infrastructure. Nearly all users consume water conveyed to them through pipes and canals. If I want to drink water from my tap, then someone must lay pipes. If I want to irrigate my fields, then someone must build canals, dig wells, and/or buy pumps. These are often large, lumpy assets, which require costs now to reap benefits later. The benefits from such infrastructure will only justify the costs if I can overcome the problems of uncertainty. Such investments, once made, are irreversible. They also mean that once I have invested in the necessary infrastructure, I will worry about whether my (perhaps despised and distrusted) contracting partner may take advantage of my sunk costs, and renege on his agreement, then try to drive a harder bargain.[14] There are ways of solving this problem (for example, joint ownership of the infrastructure) but, again, most solutions demand a relatively high level of institutional and social capital to work effectively.

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[13] Formally, the Coase theorem does not apply.

[14] That is, water markets will be subject to what industrial relations specialists label "the hold-up problem."

Another aspect to the infrastructure problem is that large-scale water transfers may require very expensive investments. It is one thing to say (correctly) that water has a much higher utility as drinking water in Amman than as irrigation water for bananas in the Jordan Valley. It is altogether something else to lift that water from the valley to the city, an elevation rise of some 1,500 meters. Similarly, in Pakistan, farmers may trade water extensively (although, as we have seen, not necessarily efficiently) within a water course; but transfers across water courses or transfers to urban areas typically require substantial infrastructural investments and institutional changes. Once these additional costs are included, the efficiency gains of intersectoral transfers may be less than initially calculated.[15]

Finally, water is plagued by ubiquitous externalities, or third-party effects. As Perry, Rock, and Seckler (1997, 10) put it, "there are few, if any, economic activities that have as high an incidence of external effects, both costs and benefits, as water." Because water recycles and because "use" and "consumption" are different, externalities are huge. Elementary economics teaches that, in such cases, there is no guarantee that an unregulated market will yield a socially useful outcome. Indeed, there is every reason to suspect that such a market will yield socially negative consequences. Because of pervasive externalities and the "asset market" features of water markets, when water markets do emerge they are likely to be "thin" markets. Those with rights to water often have many rational reasons for being reluctant to trade their water to others.

These considerations may be illustrated by a glance at the country whose water markets have been held up as an example for emulation: Chile. Prominent observers such as Mark Rosegrant and Hans Binswanger (1994) cite Chile with high approval as an example of what can be done. Certainly the establishment of tradable property rights in water has facilitated exchanges among farmers, and, by establishing an explicit price for water, has facilitated the shift from more to less water-intensive crops in some areas (Rosegrant and Binswanger 1994). However, several recent detailed analyses based on field work (Bauer 1997; Hearne 1995) found that even Chilean water markets have been "thin" markets: although there have been some gains from trade, water transfers apart from land transfers have been relatively rare. The reasons include the relative paucity of infrastructure, such as medium or large-scale reservoirs, needed for transfers; uncertainty about water rights, particularly third-party rights; overloaded courts, which also lack expertise in hydrology; and a variety of other transactions costs.

The water prices that emerge from this relatively thin market are far below what many economists might expect, and certainly far below any long-run marginal cost of supplying additional water. Farmers are very reluctant to sell water rights (unless they are also selling the land), because, in Chile's central agricultural zone, irrigated land is three to ten times more valuable than unirrigated land. Economic theory suggests that the price of water should be nearly as high as the price of irrigated land. But then, why buy the water without the land? Those who sell their water rights, like those who sell their land, are typically people who are leaving agriculture altogether. Farmers also fail to sell water rights because they wish to hold onto water rights as "drought insurance" (water rights are defined as a right to a percentage of total flows, which, of course, are highly variable). They also refuse to sell water rights because they are speculating on increasing water scarcity raising the price in the future.[16]

Finally, there is relatively little evidence that these thin water markets have had any large impact on reallocating water or have dramatically enhanced water conservation (Bauer 1997). And this is the situation in Chile, a country with well-developed institutions, high literacy, and relative prosperity, whose military government was dedicated to the promotion and protection of private property and to the relentless application of laissez-faire, "Chicago school" economics, and whose subsequent civilian regime continued many of these same policies. One can easily imagine that the difficulties of designing and implementing water markets in less favorable conditions will yield still more ambiguous results.

Water Markets: A Useful, but Limited, Response to Rising Scarcity

The potential obstacles to water markets in developing countries may be summarized as follows:

- Ubiquitous externalities (especially for "return flows")
- Inadequate infrastructure for out-of-basin transfers or to measure on-farm use
- Very poorly specified property rights and fear that engaging in long-term trades may jeopardize whatever tenuous right one has

[15] A point forcefully made by Perry, Rock, and Seckler 1997.

[16] Unlike many states in the western United States, Chilean water law has no "beneficial use" doctrines ("use it or lose it"), which were designed, in part, to prevent such speculation.

- Sharp divergence of value systems (for example, Islamic law versus neoclassical economics)
- Adjudication mechanisms that are often weak, corrupt, expensive, or nonexistent
- Weak or absent mechanisms for dealing with third-party effects.

The situation with respect to water markets is very similar to that of IMT. They are a good idea, they should be encouraged whenever and wherever feasible, they can certainly help–*and* they are unlikely to work well enough, often enough, or widely enough to ensure more efficient demand management. Small-scale water markets are already ubiquitous and should receive continued encouragement: nearly everywhere in the world, farmers sell or otherwise exchange water within irrigation systems. Greater transfers from agriculture to urban areas will be needed, which water markets may facilitate. But the need for large-scale infrastructure investment, along with the necessity of sophisticated regulation and adjudication mechanisms will be equally essential. Neither will be easy, and neither will be cheap. It is naive to expect that all societies have the financial, human, and social capital to institute demand management systems that might obviate the possibilities for social conflict. The hardware and the software requirements are formidable: their implementation is opposed by numerous vested interests, and it will require a high level of trust among the many parties who will be affected by changes in water allocation rules.

Conclusion: Implications for Conflict and Cooperation

Rising water scarcity will be a fact of life for most societies for the foreseeable future. Growing populations, increasing urbanization, higher incomes, and greater sensitivity to the environmental functions of wetlands will all fuel greater demand for water. An increasing demand for water is as certain as Mark Twain's "death and taxes." Expanding supplies by conventional means will make some limited contributions, but cannot be expected by itself to provide an adequate management strategy. Many more millions of people will be unable to have all the water they want at a zero price. Inexorably, therefore, rationing systems will become increasingly important, whatever the current system of rationing may be. Which rationing system is used, how it is selected and installed, how well it alleviates scarcity, and who benefits and who loses from both scarcity and its amelioration will have significant political effects.

Of course, those effects will be mediated by a rich texture of other, entirely unrelated issues. Water is unlikely to be the only source of political conflict. However, as scarcity rises, the management of that scarcity is likely to become increasingly visible. Water shortages, like energy shortages, have a way of grabbing everyone's attention very quickly. Since implementing more efficient and more equitable rationing systems will make significant demands on financial, human, and social capital, and since societies vary very widely in their access to such resources, the range of outcomes generated by rising water scarcity, whether conflictual or cooperative, will be very broad.

This paper has proposed a framework for thinking about how rising water scarcity may foster conflict or cooperation organized around the theme of rationing mechanisms and their implementation. In conclusion, we suggest a simple taxonomy of outcome scenarios. The scenarios are mere sketches; any detailed portrait will, of necessity, have to be highly case-specific. The fundamental organizing principle of the taxonomy is the adoption, or the non-adoption, of more sophisticated demand management strategies. What follows is intended to be merely suggestive.

Type 1: "Business as Usual"

Typically, increased scarcity initially leads to rationing by queuing: that is, favored individuals and groups get all the water they want for very little cost, while others are excluded from cheap supplies and are forced to rely on alternative, more expensive sources. We have seen that this is today's norm in many irrigation and urban water supply systems. "Status quo bias," which arises from both stakeholders' interests and the managerial culture of the relevant bureaucracies, virtually ensures that this will be the initial response. However, the inequity of such systems also almost guarantees that the ensuing allocation will be contested and will foster conflict as water scarcity rises. How long such "non-responses" persist will be a function of the degree of water scarcity, the level of mobilization of beneficiaries of inaction compared with those who are penalized by the current queuing system, the degree of solidarity (or its opposite, distrust) among different groups of stakeholders, the institutional capacities for change in the government water allocation rules, and the financial costs of shifting to alternative allocation mechanisms.

Blocking the transition to more sophisticated demand management strategies will, of course, not make the shortages disappear. Indeed, shortages will become increasingly severe as long as reform is stymied. The potential for relatively unpleasant outcomes seems highest in this scenario, as vested interests prevent change, which spawns still greater scarcities, which fosters increasingly vicious resource capture on the part of already privileged elites, which provokes resistance among those excluded, which stimulates repression, and so on. Such a scenario is highly unlikely to unfold with respect to water alone; it is far more likely in a generalized environment of scarcity, in which land, food, money, and other desired goods are also increasingly scarce. Dynamics of this sort have already begun to unfold in Pakistan, the Indian state of Bihar, and Yemen. Other possible candidates may include poorer, dryer regions of Latin America, and North and Western China, although in these latter cases greater levels of social capital make it likely that they will fall into the second class of scenarios.

Type 2: Conflictual Adaptation

In these cases, rising scarcity leads to a shift toward some system of rationing that is different from the status quo "queuing" system. Examples have been explored above: devolution of irrigation management, privatization of urban water systems, instituting water markets, and so on. Some common features of these scenarios include greater decentralization and increased reliance on incentives (price or other) to induce people to use water more efficiently, and thereby, to use less. Such decentralization might foster conflict in several possible ways:[17]

- *Decentralization occurs in a context of highly unequal distribution of complementary inputs (for example, land), and more generally, highly unequal distribution of power.* In such cases, decentralization may simply enable another round of Thomas Homer-Dixon's "resource capture and marginalization" dynamic.
- *Decentralization may succeed politically and may not foster much social conflict.* However, if such decentralization ignores third-party effects or neglects externalities (for example, instituting water markets in the context of unregulated access to common groundwater sources), it may exacerbate water scarcity, setting the stage for more severe consequences as in Type 1.
- *Decentralization strengthens local power wielders at the expense of the central government.* Decentralization of water allocation systems may then contribute to the wider process of state weakening, or, in extreme cases, state collapse, with potentially destabilizing consequences. Although this might be more likely in multi-ethnic polities, any deeply felt division between center and periphery may have the same consequence. There is some evidence, for example, that decentralization in Yemen, driven by fiscal desperation, has strengthened northern tribal forces (with their intimate links to Islamic revivalists) at the expense of the central government.

[17]These are not mutually exclusive scenarios.

Type 3: Successful Transitions

The definition of success here is simple: water scarcities are managed more efficiently and equitably so that all stakeholders find the new mechanisms legitimate. Obstacles to achieving such success are formidable, but, hopefully, not insurmountable. Required conditions include

- successful economic development, which reduces the importance of the agricultural sector in the economy. This makes it less painful to redistribute water from farms to cities, while simultaneously making farmers enough better off that they can afford the necessary on-farm investments in water-saving technology;
- a legitimate political democracy, with a free press and with only moderate levels of public corruption, so that abuses are both relatively infrequent and quickly exposed;[18]
- a level of equity which is sufficient to ensure sufficient cooperation among various stakeholders in managing scarcity;
- a distribution of water rights which is perceived by most actors to be fair; and
- a well-developed, relatively efficient, and fair mechanism for adjudicating water disputes.

The bad news is that this list is long, and that fulfilling each item is a complex and difficult task. The good news is that we would wish to promote such things even if water were copiously abundant. We also know a great deal about what helps, and what impedes, attempts to implement more equitable and efficient governance. Successfully managing rising water scarcity will be an integral part of the wider search for prosperity, equity, democracy, and environmental sustainability. Rising water scarcity makes the search for better governance more pressing than ever.

[18]As water scarcity rises, a free press is likely to have an increasingly important role in the transition to more effective demand management. There is an analogy here with the role of a free press in ameliorating famine in poor countries, as stressed by Amartya Sen (Sen 1983; Dreze and Sen1989).

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