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Research Report

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C. J. Perry, Michael Rock, and D. Seckler

International Irrigation Management Institute

Research Reports

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Summary

There is wide interest in, and support for, the idea of treating water as an economic good. However, the role of water—as a basic need, a merit good, and a social, economic, financial, and environmental resource—makes the selection of an appropriate set of prices exceptionally difficult. Further, the application of price-based instruments, once an appropriate value system has been agreed, is particularly difficult in the case of water. This is so because the flow of water through a basin is complex, and provides wide scope for externalities, market failure, and high transaction costs. While judiciously applied market tools can be expected to have benefits, in many cases the necessary and sufficient conditions, especially defined and enforced water rights, are not yet in place. Priority attention to these essentials is likely to have high returns; pursuit of economic approaches in the absence of such preconditions may have unpredictable, and possible negative effects.

Water as an Economic Good: A Solution, or a Problem?

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Introduction

The now famous proclamation that water should be treated "as an economic good" originated in the Dublin Conference (ICWE 1992). Like many such proclamations, it has the virtue of being sufficiently vague to allow agreement, while leaving the implied operational content—over which there may be strong disagreement—unstated.

The proclamation was a compromise between those, mainly economists, who wanted to treat water in the same way as other private goods, subject to allocation through competitive market pricing, and those who wanted to treat water as a basic human need that should be largely exempted from competitive market pricing and allocation.

To further complicate matters, there is an important distinction in economics between the true "economic" value of a good and its "financial" value. The two values rarely correspond, and as will be argued, for water the divergences are exceptionally complex and important. Thus it does not follow from the declaration that water is an economic good that should be allocated by competitive market prices that reflect only financial, not necessarily economic, values.

The question is not whether water is an economic good or not—it certainly is an economic good in most cases, like almost everything else we have to worry about. Rather the question is whether it is a purely *private* good that can reasonably be left to free market forces, or a *public* good that requires some amount of extra-market management to effectively and efficiently serve social objectives. The answer to this question lies not so much in lofty principles but in value judgments, and their application to different conditions of time and place. Thus we find ourselves favoring the private good side of the argument in some cases and the public good side in others. The task is to define precisely what these cases, value judgments, and specific conditions of time and place, are. This definition is, we believe, important for two reasons: First, dogmatic posturing by the proponents of each perspective is a waste of intellectual talent. Second, and more importantly, water is far too important to its users to be the basis for socioeconomic experiments. Much is already known about the nature of successful policies and procedures for allocating water; understanding and incorporating the implications of this knowledge will avoid some potentially enormous financial, economic, environmental, and social costs.

Values and Facts

That water usually *is* an economic good follows directly from the definition of economics as "the science which studies human behavior as a relationship between ends and scarce means which have alternative uses" (Robbins 1935). Water meets these requirements: it serves a multiplicity of ends (ranging from drinking and bathing, through irrigation, recreation, and environmental use, to waste disposal), and thus satisfies the condition of "alternative uses." In many cases, water is scarce in the sense that it cannot fully satisfy all its alter-native uses simultaneously.

But nearly everything we need to worry about is "an economic good" in this sense—that is why we have to worry. With his definition, Lord Robbins established the foundations of what has since been described as the "Imperial Science" of economics. But the important question is not whether water is an economic good or not, but what *kind of economic good* it is. We believe that it is both a public and a private good. If this is correct then the true "economic" value of water will differ from its "financial" value—i.e., the value based only on market prices—as any competent economist will recognize. How precisely will it differ? The answer to this question lies in two separate but interrelated domains or universes of discourse: values and facts.

In the debate over water as a private or public good, the differences between values and facts are easily defined. First, in terms of values, the proponents of water as a private good contend that water is just like any other good, that its production allocation should be determined by the overriding value of *consumer's sovereignty*—i.e., by the amount that people are "ready, willing, and able to pay" for it. The criterion of consumer's sovereignty totally ignores the distribution of income in society. If the poor cannot pay as much for a unit of water as the rich they should get less water, even if the marginal value to them in terms of other values (or utility) is greater.

This is what the proponents of water as a public good object to. They contend that safe water is a basic need that should be available at reasonable levels to everyone. They also contend that water used for irrigation can be a powerful means of reducing food costs to poor people and, under the proper conditions, should be subsidized (Chambers 1988). Others believe that water serves important ecological, environmental, and aesthetic benefits in many cases, and should not be allocated to other uses simply on grounds of willingness to pay. In the terminology of economics, this school believes that, at least up to some minimal level of availability, water is a social good whose availability to certain groups and for certain purposes at well below market prices will serve the greater benefit of society as a whole. Similarly, narcotics, tobacco, and alcohol are "unsocial" goods, priced (or controlled) at levels well in excess of the prices that would prevail in a free market.

But even in these cases of conflicts over values, rational people can reach agreement in terms of relative quantities. No one would deny provision of safe drinking water to a poverty-stricken village that could not pay full costs, or advocate draining wetlands so that water could be obtained for swimming pools and golf courses. On the other hand, most advocates of water as a public good would agree that after a basic level of service—of drinking water, for example—is attained, additional supplies could properly be allocated by market forces. Or, in the case of food, once a nation achieves a certain level of prosperity, market forces supplemented by directed poverty alleviation programs may be more efficient ways to help poor people than general subsidies on food. Conflicts over values often depend on situation-specific facts. Unfortunately, dogmatists often control the discussion simply by virtue of their very single-mindedness.

However, even if everyone agrees on values, there can be rational disagreements on facts. This occurs, for example, in the case of "market failure," discussed below. Even if everyone would agree that consumer's sovereignty should rule as the sole value, there are several well-known conditions under which the free market will fail to effectively and efficiently serve this value. In these cases, various kinds and degrees of government intervention or other kinds of collective intervention, or both, are required to make the market perform effectively to serve the value of consumer's sovereignty.

In sum, water serves many different objectives and has properties that make it both a private and a public good. The appropriate blend of values and facts in proper policy formulation for water requires a much more sophisticated form of analysis than that allowed by the simpleminded dogmatism of proponents, either of basic needs or of free markets. Water policy must be formulated in terms of multi-objective decision making, recognizing that the relevance and importance of various values and facts will vary substantially over different conditions of time and place.

In the following pages we address the question: what does it mean to treat water in irrigated agriculture as an economic good? We focus on irrigated agriculture for several reasons. First, it is the largest consumer of water virtually everywhere that irrigation is practiced. Second, policies governing water use in irrigated agriculture are fraught with disagreements over both values (should it be treated as a purely private good, a public good, or a basic human need) and facts (what is the most cost-effective allocation policy and method if water is treated as a purely private good, or a public good, and in what instances should it be treated in one way rather than in the other).

The argument proceeds in three steps. First, we examine the economic analysis of different values involved in treating water as a private and public good. Then the facts involved in this debate in terms of the causes of both market failure and public failure are examined. Finally, we examine alternative ways out of the dilemma posed by these two forms of institutional failure and suggest a practical plan of action.

The Economic Analysis of Different Values

The difference that different values can make to the interpretation of the same facts may be illustrated from an interesting, pro-market paper by Briscoe (1996). Since Briscoe presents the basic economics needed for both sides of the discussion in a clear and simple way, this part of his paper is quoted below at considerable length.

The idea of "water as an economic good" is simple. Like any other good, water has a value to users, who are willing to pay for it.

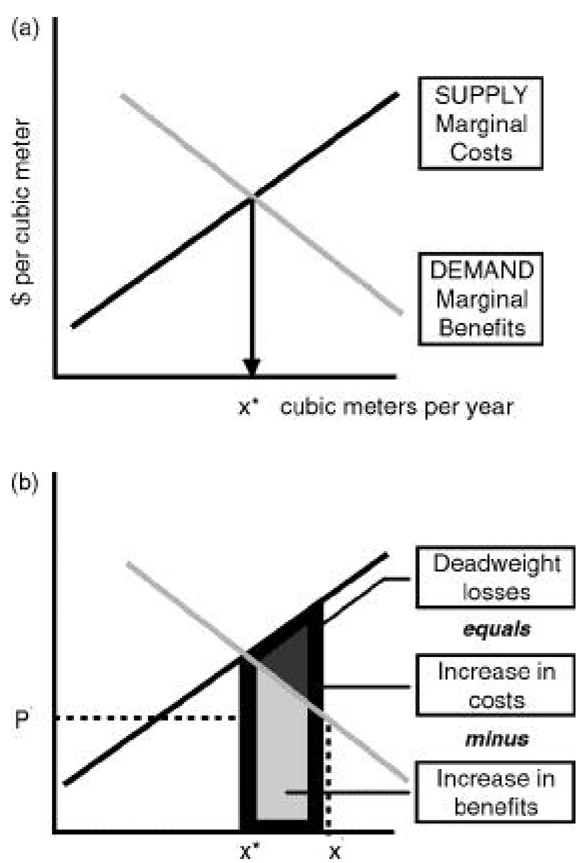
Like any other good, consumers will use water so long as the benefits from the use of an additional cubic meter exceed the costs so incurred. This is illustrated graphically in figure (a), which shows that the optimal consumption is X. Figure (b) shows that if a consumer is charged a price P′, which is different from the marginal cost of supply, then the consumer will not consume X* but X′. The increase in costs (the area under the cost curve) exceeds the increase in benefits (the area under the benefit curve) and there is a corresponding loss of net benefits (called the "deadweight loss").*

But what about groups of users, and how is welfare maximized for the group (or society) as a whole? The simple logic of figure 1 applies in the aggregate—for society as a whole, and welfare is maximized when:

- *water is priced at its marginal cost, and*
- *water is used until the marginal cost is equal to the marginal benefit.*

So far so good, but what actually do we mean by "benefits" and "costs," how are these dealt with in different water-using sectors, and what are the implications?

FIGURE 1.
Optimal consumption and "deadweight losses" if water is underpriced.



Briscoe directly answers this question: "The value of water to a user is the maximum amount the user would be willing to pay for the use of the resource." But those who believe that water is a social good would say that this is an incomplete and misleading economic analysis. Willingness to pay depends largely on the ability to pay. Thus even with the same basic need for or value of water, the rich will get more and the poor less. Thus the people between X* and X^1 are priced out of the market for water—if not completely, then in terms of marginal reductions in the amount they can afford. Thus, the higher the price, the greater the incidence of poverty in X.

In an enlightened humane society, well-to-do taxpayers want to help the poor obtain basic needs. Thus, in terms of figure 1, tax-payers are willing to subsidize water, effectively shifting the supply curve down to the point where it intersects the demand curve at P^1, X^1, and many more poor people get water. Who is Briscoe, they may say, to call this humane gesture a "deadweight loss?" Indeed the real loss to society as a whole would be to counter social demand by reducing water availability from X^1 to X* through competitive prices.

Many economists, and many non-economists, do not seem to understand that consumer's sovereignty is just another value judgment, like any other value judgment. Thus Briscoe can say that the value of water is measured by willingness to pay only if consumer's sovereignty is assumed to be the appropriate value system. However, if this problem can be resolved, economic analysis can help in sorting out the basic issues more precisely by analyzing different values in terms of their *marginal*, rather than their total, value. Indeed, a controversy over the value of water at least indirectly led to the development of marginal analysis (Barkley and Seckler 1972), which is one of the two or three most important concepts in economics. Markets reflect marginal values, and function best where such values are relatively stable, or change progressively. Water is not such a good.

In some cases, the marginal utility of water is essentially infinite (or very high) for all practical purposes—for example, in a drought, when people are dying of thirst, or when a reservoir runs dry at the end of the season after all inputs have been provided except the last irrigation turn. Conversely, once a person (or a crop) receives enough water sufficient to alleviate physical stress and strain, the utility of additional units rapidly plummets and can even become negative.

A case can be made that in such extreme instances, water, as other basic human needs, ceases to be an economic good under Robbins' definition. The condition of alternative uses implies alternative ends. When there is only one end to which all of the resource (and all other resources) would be applied under conditions of extreme scarcity, there is only one option and only one choice to be made—get the water or die, which closes all options. In any case, under the welfare criterion of "expanded choice," a minimum condition for an economic good would be two choices (other than death, which eliminates the dynamic choice set). Humans are choosing-animals, and if they have no choices, they are forced to live at a subhuman level.

Recognizing this fact, humane societies attempt to protect their citizens against inhuman situations (Serageldin 1996). Civilized societies provide basic rights protecting citizens against murder, imprisonment without trial, torture, and even indentured servitude. And, for the same reason, humane societies attempt to assure their citizens with a minimum supply of basic needs—starting with water, food, shelter, and medical care. Humane societies also accept responsibility for providing minimal levels of education and employment opportunities to their citizens. This distinction is recognized in economics as the difference between ordinary goods (including services), "merit goods," which people should be encouraged and helped to consume, and "demerit goods," like drugs, which they should be discouraged or prevented from consuming. Underlying these distinctions is the value of expanded choice: will consumption of this particular good now expand, contract, or not affect the future set of choices? The extent to which humane societies can actually achieve these goals, and at what levels depends on their judgments of where the marginal utility curves become too steep and their resource costs too dear.

On the fringes of these marginal curves, there is room for debate over values among proponents of the humane society. But few would argue that people below the poverty line in India, where the poor spend 80 percent of their income just to satisfy minimum nutritional calorie and protein requirements, are in a satisfactory state. Nor would anyone deny that substantially reducing the percentage of people in this miserable situation in India, China, Indonesia, and many other developing countries is one of the signal accomplishments of this century.

Water also fulfills the criteria for being considered a merit good: access to clean water for washing and personal hygiene has health benefits (reduced incapacity for work; reduced medical costs) that generally exceed the cost of providing the water.

But most proponents of the humane society are also willing to accept the rule of consumer's sovereignty, to switch governing value judgments, once the margin of basic needs has been satisfied. In other words, it is an obligation of humane societies to assure reasonable levels of water, food, shelter, and medical care to assure that basic human needs are met. But it is not reasonable to assist individuals or families in the acquisition of goods beyond this level. This is tantamount to arguing that the same goods should be treated differently at different levels of consumption. There are clear implications of this for water, including irrigation water. Supplies of water at a level of basic needs is an obligation of humane societies to provide irrespective of the ability to pay. At a higher level of supply, lower on the marginal utility curve, society has little or no interest at all and consumer's sovereignty should rule. Needless to say, both of these statements are, of course, based on value judgments.

It may also be noted that in the economic evaluation of projects, the poor are discriminated against since they are not able to pay as much as the rich. One approach to this problem is to evaluate projects that help the poor on the basis of what they would be willing to pay if they were, say, middle-income consumers.

In sum, depending on the quantities supplied to individuals, water can be either a basic human need, a merit good, or an ordinary private good; it can best be allocated by the public sector or by the private sector depending on these quantities. This is an important example of how a fundamental conflict of values can be potentially resolved by facts—indeed, quantitatively!

Facts: Public Failure and Market Failure

Given the generally dismal record of the public sector in this field, one must sympathize with anyone who is interested in alternative institutional arrangements for water management. Many have understandably turned to economic instruments, market systems, and prices as an alternative on the persuasive grounds that the market works so spectacularly well in a host of other areas of economic activity. But even if one accepts the value of consumer's sovereignty without qualification, water is unfortunately a field beset with the classic problems of market failure. In this section, we first examine the rationale for privatization, the approaches that can be followed, and their appropriateness. We then turn to the question of market failure—a critical problem in the debate about the role of economic instruments in the management of water resources.

Privatizing irrigation systems

In the public sector truly, "the road to hell is paved with good intentions." While there are some notable exceptions to the rule, the public sector has generally performed miserably in all forms of water management—

whether in irrigation, or in domestic and industrial water supplies, or in protecting resources and environmental quality. The book on public failure has not yet been written in any sense comparable with the elegance and rigor of the works on market failure (Pigou 1932; Mishan 1976; Little 1950). But some of the well-known and interrelated ills of the public sector can be listed readily:

- rent seeking, either economically, in the form of direct bribes and corruption, or socio-politically in the form of empire building, high costs, and excessive supplies (Wade 1982; Repetto 1986)
- the divorce of incentives from performance—indeed, sometimes almost an inverse relationship
- capture of public agencies and funds by politically powerful interests and their clients
- administrative operations, "by the book," rather than management in terms of objectives and results

The kinds of perverse behavior that emanate from public sector entities are legendary. In irrigation, they create the notorious head-end-tail-end problem, where farmers at the heads of the system can take so much water that they actually reduce yields through waterlogging, while farmers at the tails receive only what is left over and suffer drought damage to their crops. In domestic water supplies, as Briscoe (1996) points out, the poor usually subsidize the rich—in the name of the humane society! Water projects are subject to corruption, resulting in massive cost overruns and windfall gains to favored clients—even in direct violation of the laws, even in the USA (Seckler and Young 1978).

The problems with public sector management and allocation of water have created the movement toward privatizing irrigation systems (Seckler 1993). Privatization can take several forms, from turnover of operation and maintenance to farmer associations, to volumetric or quasi-volumetric pricing at the farm level, to development of water markets and tradable water rights[1] that would allow water to flow to the highest-value uses. In each case, the aim of privatization is simple—to institutionalize a mechanism for the management and allocation of water that approximates a conventional market, including a direct relationship between service provided and charges for water that approaches marginal costs, and to a mechanism for (re)allocating water from lower- to higher-value uses.

But which kind of privatization works best in what circumstance? In terms of values, many people would agree that the privatization route should be an approach or a combination of approaches that satisfies basic needs criteria and then optimizes economic returns to water in terms of consumer's sovereignty. But this answer just requires us to ask another question: What do we know about the marginal benefits and marginal costs of privatization? The answer is some, but not nearly enough. Answering this question is therefore an important part of a research program that concentrates on the analysis and quantification of benefits and costs in the following circumstances.

Turnover

The benefits of turnover are expected to include impacts on productivity and equity, gains from freeing up of government resources for use elsewhere, and more efficient operation and maintenance (O&M).

[1]We differentiate deliberately, though there are areas of overlap, between water markets and tradable water rights. The latter requires both the formal definition of entitlements, and the specification of the conditions under which the entitlement may be traded. Water markets, on the other hand, have developed widely, for example in areas where private tube wells provide competitive services to numerous potential buyers, in the absence of the formal definition of water rights, tradable or otherwise.

The costs of turnover include organizational and transaction costs, including labor earnings foregone by farmers who participate, and those costs associated with overcoming collective action problems. Those in favor of privatization expect that the benefits outweigh organizational and transaction costs and that turnover is more cost-effective than simple user charges tied to services provided by a public sector irrigation agency.

The evidence to date (Vermillion 1996) is mixed; there are undoubtedly cases where the projected impacts (especially, reductions in government spending) have been achieved. There are also cases of failure and reduced performance. Success or failure seems to depend more on the quality and commitment of the implementing agencies and local leadership factors in the process of turnover than on the nature of turnover itself.

Service-related user charges

User charges link use benefits to service delivery costs. This contributes to cost recovery and may also provide incentives for improved irrigation services with attendant effects on productivity, equity, and efficiency of resource use. Many services (electricity, telephone, buses, etc.) link the charge to the level of service (kilowatt-hours, call-distance-minutes, distance traveled). The simplest measure of service corresponds to the volume of water delivered to irrigation users, but capturing the potential benefits of service-related charges will often require differentiated charges. For example, where drinking water is supplied through irrigation canals, the level of service is usually far superior to that offered to agricultural users—priority allocations in times of drought, and regular deliveries at times of low or zero irrigation demand. This enhanced level of service has attendant costs—losses are a far higher proportion of deliveries at low flow rates, and so on. Thus well-defined service-related charges would differentiate sharply among users.

Volumetric pricing

The potential benefits of volumetric pricing or quasi-volumetric pricing (achieved, for example, by a crop tax related to consumptive use) are obvious. This is the most forthright way to link water use benefits with costs and the value of services provided. By setting volumetric prices equal to opportunity costs, water is efficiently allocated, static allocative efficiency gains are reaped, and deadweight losses are avoided. Because water rents are captured through such pricing, losses associated with rent-seeking are also avoided. The costs of volumetric pricing include the capital, administrative, and institutional costs associated with volumetric metering, billing, and collections of water charges at the farm level (Perry 1995).

Water markets

Water markets most commonly operate locally to allow agricultural water suppliers and consumers to include the opportunity cost of water in their management decisions. Usually, this involves trading water among similar uses (for example, the sale or exchange of irrigation 'turns' in a rotational system), or sale of water by the owner of a tube well to nearby farmers. The price governing in such local markets encourages diversion to higher-value uses. It should be noted that water markets can coexist with extreme levels of subsidy—for example where there is no charge for the irrigation water that farmers trade, or where there is subsidized power supply to the wells that provide water to local farmers. The costs associated with water markets are those transaction and physical system costs necessary for water markets to efficiently operate.

Tradable water rights

Tradable water rights allow the formal transfer of water entitlements among users, and as such are more likely to involve intersectoral transfers than the local water markets described above. While water markets can function in the absence of formal water rights, tradable water rights require a much more specific definition of the entitlement. As in the case of water markets, while tradable water rights are likely to result in (inter-sectoral) reallocation of water from low- to high-value uses, there is no guarantee, in the absence of other charging mechanisms, that the costs of providing the service will be recovered. (Indeed, the failure to recover costs simply increases the potential price and incentive to trade.)

Which of these privatization options is best? Again there is no simple answer to this question, but some aspects are clear. An important size-problem—the small size of most farms in most irrigation command areas in developing countries—virtually rules out volumetric metering at the farm level. In most instances, the incremental costs of the infrastructure, management, and administration required for volumetric metering at the farm level will exceed marginal benefits—especially where systems have not been designed and constructed to meet these objectives. Quasi-pricing schemes (such as a crop charge linked to evapotranspiration) can, to some degree, overcome these problems. An additional problem in existing irrigation systems is that the value of water rights is capitalized in the value of agricultural land. When water is volumetrically priced by metering or quasi-priced, full marginal pricing amounts to the expropriation of those rights (with consequent capital losses in irrigated land). Farmers who have purchased land on the basis of the accepted, if not legally specified, water entitlement will strongly oppose this.

In principle, turnover is a desirable option. It can reduce the financial burden of financially strapped public irrigation agencies. It can provide a locally negotiated basis to link services to user charges, contributing to an improvement in the quality of services. And it can simplify irrigation users' involvement in investment decisions: Two drawbacks characterize turnover. First, there is little evidence that turnover increases productivity (Vermillion 1996). Second, there are serious questions regarding the long-term sustainability of turned-over systems, because farmers may not pay their dues and the dues do not include adequate provision for replacement of major facilities (Svendsen and Vermillion 1994). And often the withdrawal of the government agency leaves important gaps in oversight areas—overexploitation of groundwater; pollution of canals, drains, and aquifers; dam safety; competition among urban and agricultural demands; and drought planning. Once these issues are appropriately addressed, it is not at all clear whether the benefits of turnover exceed its organizational and transaction costs.

This leaves water markets. At the local level of farmers trading small amounts of water on the watercourse and buying and selling water from tube wells, water markets are already thriving in most irrigation systems and should be encouraged. Water prices and markets can also serve a valuable function in larger transfers, whether within or among sectors under the appropriate conditions, noted before, and with suitable regulation, as discussed in the last section.

Water Resource Management and Market Failure

In the following discussion, we shall examine three of the major causes of market failure in irrigation and water resource management, "externalities," "transaction costs," and "property rights."

Irrigation water and externalities

External effects may be defined as uncompensated costs or benefits incurred by one party by virtue of the activities of another party. There are few, if any, economic activities that have as high an incidence of external effects, both costs and benefits, as water.

One of the most important, yet least appreciated, facts about water is that in a basin, a substantial amount of it is recycled. When water is diverted from a stream (or pumped from groundwater) for use in agriculture or other activities, some of it is consumed—for example, through evaporation—and some, returns via drains or percolation to the stream or aquifer, thus becoming available for a further cycle of diversion at another time, another place, and at another quality. Eventually, as demand increases, the fresh water available in a stream is fully utilized—all outflows are of sufficiently poor quality, or to places where the cost of recovery is too high, to be justified for potential uses. Once this happens a water basin is "closed" and no usable water supply is left.

The description set out above is highly simplified but it indicates that if we wish to privatize the allocation of water, the first change that needs to be made is to base accounting not for diverted water, but for consumed water, with additional adjustments for time, location, and quality. An example should make this clear.

Let us take the case of rice. Rice farmers in Asia and elsewhere use water as a substitute for labor to control weeds, in addition to meeting crop water needs. The effect of this is to dramatically increase the volume of water applied, but the impact of this very high application of water on consumptive use of water is minimal. This is because consumptive use can never exceed potential evapotranspiration, and as long as the crop is well watered, crop evapotranspiration will be at or close to its potential.

If water applied is now priced with a positive marginal cost, farmers will substitute some labor for water and in doing so reduce the amount of water applied, yielding what looks like real water savings. But these savings are ultimately illusory as long as the excess water applied is recycled and reused. Marginal pricing of water applied will primarily have accomplished a shift in the demand for labor. Further, if the "excess" water applied in one season to the rice was stored in the aquifer for pumping and reuse in a drier season, then an external benefit will have been lost.

The importance of accounting for water in terms of consumption is well understood in the western US. There, there is substantial resistance to transfer of water out of irrigation districts because it is realized that once trading starts all of the secondary effects of recharging aquifers and recycling are disturbed.

Because of this problem, some states in the US now assign property rights on the basis of consumptive use rather than water diversions, for purposes of sale and transfer (Rosegrant and Binswanger 1994). In some instances, state laws expand this by requiring irrigation districts to document reductions in consumption at the local level before water can be traded. While this is a step in the right direction, it does not completely solve the problem of externalities. If farmers sell the consumptive use right, they will no longer irrigate. In this situation, losses in canals will tend to form a higher proportion of deliveries; the fixed operating costs of the system must be borne by fewer users; aquifer recharge is reduced, and other farmers, who depended on return flows will have to reduce their irrigation accordingly. Keeping these accounts in order presents a major challenge.

Let us now add some real-world complexities to our simplified distinction between field-level and basin-level measures of consumption. The non-consumed fraction of water applied at the field returns to the system, but it returns in an altered state. First, to the extent that the originally diverted water contained some salt, the return flow will have a higher concentration because plants consume only water. Second, as a result of the application of fertilizers and pesticides the return flows may be further degraded by pollutants. Third, if the soil in the irrigated area contained natural salts, these may also be leached by the return flows, reducing its quality still further. Fourth, the return flows may go to a location where not all can be recovered—a deep aquifer, or into a stream below the lowest diversion structure.

Finally, the return flows may arrive at a time when water is in temporary excess (diversions during the dry season returning during the rainy season), or vice versa. Thus setting the appropriate prices may be seen to be complex, and of course also dependent upon the proposed further use: farmers may be pleased to receive water that already contains fertilizers. Barge operators are concerned only about the specific gravity of the effluent, not its chemical composition, and so on.

The point of these examples is to demonstrate the need to pay attention to external effects in a water basin—that is where water is going, where it is being consumed, where it is being reused, and what is happening to salt and pollution loading, and the timing and location of return flows as water is being recycled and reused. These effects must be regulated to bring private behavior into accord with social interests and to achieve an economic optimum. Unless this is done, pricing and trading water will have uncertain impacts on economic, social, and environmental efficiency.

Privatization in water and transactions costs

The second efficiency problem associated with treating irrigation water as an economic good relates to transaction costs. In many irrigation projects, the irrigation infrastructure—both the physical and management infrastructure—required to allow delivery of water to serve market purposes—that is, to price water at its marginal cost—is entirely absent. Perry (1995) recently calculated the cost of introducing the infrastructure required to give farm-level measurements of water deliveries in Egypt. By his estimate, they were such as to more than offset the benefits that would flow from being able to set prices closer to marginal cost. Egypt is not the only example of this. In the *warabandi* system of irrigation widely practiced in India and Pakistan, while system structure permits trading of water among farmers within a watercourse, trading across water courses or between agricultural and nonagricultural uses outside individual water courses would require substantial physical infrastructure investments and institutional change. It is doubtful whether the marginal benefits of trading across watercourses would justify the investment in irrigation infrastructure necessary to accommodate it.

For the most part, in the real world, water is allocated first to municipal and domestic use, second to industrial and commercial use, and third to agriculture. (Environmental allocations are also growing in volume and priority.) This sequence of priorities is generally consistent with social and economic objectives that many would share; the questions then are what would the incremental benefit be of fully liberating the allocation process (with agreed values structures!), and what would the infrastructural and transaction costs be.

In the terms of classical economics, one of the features of the "dead-weight loss" triangles shown in figure 1 is that, within sectors they are generally very small in relation to total benefits or costs (the areas under the demand and supply curves). Frustrating as this fact is to market advocates, it means that one cannot spend very much to eliminate them. And, in the case of inter-sectoral transfers, e.g., from agriculture to domestic or industrial use, the triangles may be large but the side effects—in terms of externalities, secondary benefits, transaction costs, changes in the physical systems, etc.—will often outweigh the benefits.

Property rights

The third point that needs to be considered is that effective water markets and water pricing are utterly dependent on secure and effective property rights in water. Yet many would agree that the single greatest problem in water resource management in the developing world is that property rights in water are very insecure and ineffective. Or said another way, a central problem of irrigation performance is the ability of some farmers to steal water from other farmers.

This fact has been extensively documented in numerous studies of irrigation performance. The most common manifestation of it is that farmers at the heads of irrigation systems usually receive far more water than they have a right to, while farmers at the tails receive less. If property rights in water formally recognize rights to diversions while denying historical rights to return flows, as has been done in Mexico and Chile (Gazmuri and Rosegrant 1994), they institutionalize theft. The same problem can occur at the level of entire water basins, as in Pakistan and Egypt. As development proceeds upstream, downstream users receive progressively less, and more polluted, water.

Since property rights in water are not, in this first instance, secure or effective, it is difficult to see how privatization will contribute to more efficient allocations of water use unless substantial efforts (and costs) are made in advance to establish and protect property rights.

In countries where water markets and trading of water have worked beyond the purely local level, there are in place: laws assigning rights, laws describing how rights may be traded; legal systems that enforce the rights and punish infringements on those rights; farmers who are accustomed to working with laws and rules that are enforced; and a physical irrigation infrastructure and irrigation management system capable of allocating water in accordance with market-friendly principles and the changing needs and priorities that flow from these principles. None of this is characteristic in developing countries—indeed most lack the first requirement, water rights—nor is it costless or easy to establish such frameworks.

This set of problems, particularly the problem of governance (and the associated transaction costs accompanying establishing good governance), is so apparent to those who work with irrigation systems in developing countries that it is difficult to understand why the proponents of privatization ignore it. Paradoxically, in those countries where these features are in place, many specialists are unaware of (or blind to) their existence. Recently, a study in Germany revealed a vast array of complex rules and traditions governing the allocation of water, responsibilities, and costs in a major river basin, whose management is undertaken entirely by very old user organizations. Specialist observers were unaware of their existence, because they had worked so smoothly and unobtrusively for so long! (Wolff and König 1997).

Summing Up

How might these considerations of water as an economic good affect water policies, particularly those in irrigated agriculture? It is important to recognize that much of the discussion of irrigated agriculture is taking place under conditions of conflict—where there is intense disagreement over values, and facts are unknown. This is what makes working in water so interesting and exciting.

If basic human needs for safe domestic water and food produced by irrigation are to be met in poor countries, some degree of subsidy may be necessary so that masses of poor people are not priced out of the market. In the case of food, for example, many Asian countries deliberately created an "oversupply" of food (in relation to market-price demand) by subsidizing agriculture, in particular irrigation investments. This policy has resulted in dramatic decreases in the number of abjectly poor farmers and hungry people in these countries and is one of the signal accomplishments of humankind in all of world history.

At more micro levels—on farmers' fields, within individual command areas, and in water basins—externalities can be internalized by paying close attention to what is happening to the physical flow of water: Where is water going? Where is it being lost? Where is it being consumed? Where is it being reused? What is happening to salt and pollution loading? Doing this requires paying close attention to hydrology and integrating the engineering of water with the economics of water.

We now know that the consequences of water movement through water basins differ significantly and that these differences have important effects on the design of water policies. In Egypt, high basin-wide efficiency and low salt loading, mean that investments to improve local, or classical, irrigation efficiencies, often have low or negative returns. In Pakistan, high basin efficiency and high salt loading, combined with recycling and reuse contribute to significant salinization and waterlogging. Here, investments in local irrigation improvement projects can yield high returns, particularly if reductions in the negative externalities associated with salinization and waterlogging from over-irrigation are counted in benefits. We doubt that market-determined prices offer guidance to an appropriate water allocation strategy in either of these two cases.

Similar technical and economic problems confound the wisdom of policy advice that fails to take account of the movement and use of water through a farmer's field. For example, it has become fashionable to advise farmers to shift to wet-seeding of rice. Adoption of this technology is (from the farmer's perspective) a means of saving labor. It is also seen as a means of reducing water consumption. Wet-seeding reduces water diversions, but it may not reduce consumptive use because the large wetted area covered by the dry seeding (as compared to rice nurseries) evaporates more water. In this instance, pricing diverted water at marginal cost may actually encourage a water-inefficient practice (one with higher evapotranspiration).

Transaction costs can be taken into account by trying to measure them prior to making changes in the design, construction, or management of irrigation systems. This is likely to be particularly important where reliance on water markets is being proposed to improve the economic efficiency of water use. As we stated earlier, where markets have worked well, laws assigning rights, laws describing how rights may be traded, legal systems that enforce the rights and punish infringements on those rights, and a physical irrigation infrastructure and irrigation management system capable of allocating water in accordance with water markets all exist. For most of the developing world, these conditions do not. If they did, stealing of water from tail enders by head enders would not be as prevalent as it is—and existing systems would be managed much better than they are.

Finally, it is important to take advantage of opportunities to enhance efficiency and productivity by not letting the best be the enemy of the good. This might require recognizing, for example, that fixed user fees for operation and maintenance costs and public sector management may be more efficient than turnover in many situations, even though turnover is attractive on other grounds. Or it might require recognizing the physical limits of delivery systems, at least in the short run, that can meet only the simplest of schedules. If all of these things are done and done well, we stand a better chance of meeting our objectives. But if they are not, or if the current fad or ideology (of getting prices right in water) replaces a search for more understanding, we may find ourselves no better off, or worse off, a decade from now.

Conclusion: Toward Improved Water Resources Management

A forthcoming study of the "Support Systems" required for sustainable water resources management indicates the complexity of the institutional arrangements required for sustainable, productive water use (Vissia 1997). The study, of a project in Colorado in the western USA, also shows that such arrangements do indeed allow the rational allocation of water among competing uses through market mechanisms.

First, Colorado has a strict system of water rights. These rights are based on the doctrine of "prior appropriation," the first in use, the first in right. Maas and Andersen (1978) have argued that this system of rights constitutes an inequitable and inefficient system of water allocation. Nevertheless (and of crucial interest here) the system is legally enforced and transparent, and provides all users, favored or otherwise, with information for planning their operations.

Second, while there is an active market for water in Colorado, transactions are firmly embedded in a legal and administrative structure that carefully regulates external effects. The office of the State Engineer consists of professional engineers, hydrologists, and others who investigate all technical aspects of proposed new developments and reallocations of water.

Third, each of the seven water basins in Colorado has its own specialist Water Court, which only deals with water issues, and adjudicates all water disputes. Thus a person who feels that he or she is to be adversely affected by a water transaction can lodge a suit in these courts and the court can draw on the expert advice of the office of the State Engineer to advise on the facts of the case.

These few extracts serve to confirm the complexity of the institutional frameworks required for sound water resource management; especially when water allocation and management are passed from a centralized bureaucracy to local entities, with consequent "privatization" of water resource management. We offer these observations not to recommend an "American" approach to water manage-ment, but rather to highlight the necessary components of sustainable, productive management. Absent these basic pre-requisites—the norm in most developing countries—the more extreme variants of privatization, such as full water pricing and unregulated market allocations, are likely to do more harm than good.

But our position can be stated more positively, and to do this we define a necessary and sequential set of preconditions for the beneficial introduction of market forces into the allocation of water, namely that:

- the entitlements of all users under all levels of resource availability are defined and include specified assignments to social and environmental uses
- infrastructure is in place to deliver the defined entitlements
- measurement standards are acceptable to the delivering agency and users
- effective recourse is available to those who do not receive their entitlements
- reallocations of water can be measured and delivered, and third-party impacts (in quality, quantity, time, and place) can be identified
- effective recourse is available to third parties affected by changes in use
- users must be legally obligated to pay defined user fees through effective legal and policy procedures
- large-scale transfers of water with and between sectors must be subject to approval and relevant charges by regulatory agencies

With these sequentially interdependent preconditions in place, we believe that the privatization of water allocation would have significant benefits; in their absence impacts are uncertain. We also believe the implications of running experiments with peoples' livelihoods, especially where water is involved, to be unacceptable.

Our contention is that development and the efficient use of water will be better served by the widespread, indeed universal, introduction of the necessary underpinnings and prerequisites to good water management (assigned water rights, delivery of a defined service). With these extraordinarily difficult steps in place, further pursuit of market forces in the allocation of water will be useful.

Privatizing water, in the sense of giving farmers—and markets—a greater role in both the financing and management of irrigation, is a promising development. Its major benefits are likely to be more in the long run than in the short run, by "inducing technological and institutional innovations" in irrigation management (Hayami and Ruttan 1985).

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