

## Economic Aspects of Water Resource Policy\*

By MASON GAFFNEY

THIS ARTICLE REPORTS what I as an economist think I have learned from the experience of the western states in economizing on water, which may suggest what eastern researchers might learn by directing some of their efforts toward sifting and evaluating the western history. This is one area in which history flowed backwards: the western evolution anticipated that in the East by a hundred years. Learning from the West does not mean copying the West for the West made mistakes as well as scored successes. From the total experience I shall seek to distill what seem to me to be general economic truths bearing on water resources.

### I

WATER DEVELOPMENT is a fit subject for community action. There is little real scope for a free market in water supply systems, which involve economies of large scale all along the line, and particularly in distribution. Water supply has all the qualities of a classic natural monopoly, and usually should be treated as such. This does not mean that the community should not use good economic pricing and costing principles in planning, fixing the size, delimiting, upgrading, setting a price structure and otherwise managing its water supply system. It does not rule out consumer sovereignty. It simply means that these economic problems need to be settled in the public arena rather than in the market place.

Western water users have had long experience with community organizations at the local level—with commercial water companies, municipal governments, mutual water companies, and a variety of public districts. The most successful is a type of special service district called an "irrigation district." These originated and have their prototype in California, but have spread, with modifications, to all states.

California irrigation districts historically arose from the extremity of small farmers who needed an organization to provide them with an essential service which otherwise would, because of its large scale, be the sole preserve of giant landowners. Without districts, these giants would have dominated arid lands agriculture, an outcome which was indeed envisioned and fostered by the Desert Land Act of 1877. For their success, districts required three basic powers: taxation; bonding; and forced in-

\* This article is based on a paper delivered at a colloquium on "The Social Sciences in Water Resources Research" at Pennsylvania State University on June 4, 1968.

clusion of lands within the economical service area. Taxation let them engage in and cover the deficits of marginal-cost pricing, a practice essential to the best development of decreasing cost services. Bonding let them build large works as units, ahead of demand, a practice necessary to achieve economies of scale. Forced inclusion let them serve a compact area, a practice essential to avoid dissipation of gains in fragmentation of service area and "irrigation sprawl." In addition, it has proven vital that their tax power be limited to bare land, thus avoiding focusing of taxes on early improvers, fragmentation of demand, retardation of development, and hardship on smaller landowners and intensive farmers.

With these powers, small farmers were able to pool their economic strength and develop water. Irrigation districts now serve over 4 million acres in California. In these areas, subdivision of land into small farms has been the rule, during a half century when consolidation and engrossment have been the paramount national trends. Irrigation generally presupposes an intensive application of labor and capital to land, with close management of small tracts. Small optimal scale of the farm unit in contrast with large optimal scale of the water supply unit led to waste wherever one factor was allowed to override the other. This made it optimal to separate the two functions: hence the great success of districts.

The economies of scale achieved are in the main the following:

a. Pooling of supplies to regularize the total. Water flows are a variable raw material to their consumers, and whatever puts the supply on a firm basis is of particular value. On top of natural flow variability there is an added instability imposed on users when a river is divided among many small claimants under various historical rights of use. A district pools these various supplies and legal rights. Offsetting fluctuations counteract one another, reducing aggregate instability and uncertainty. The same pooling principle applies on the demand side as well.

b. Water storage, surface and underground. Surface storage generally enjoys large scale economies within the limits of the market, although these are limited by the qualities of specific damsites. Irrigation districts have built more and larger dams than any private agency, and are only outdone by federal agencies. Many of the federal agency dams, incidentally, provide service for the primary benefit of those same giant landowners whose size is often explained by their exclusive ability to achieve economies but who have called in government to do the big jobs for them.

c. Diversion from streams and pumping from aquifers. Scale economies to these operations are fully realized at low volumes, but they are important

in humid areas today because scale economies are usually first perceived in diversion and pumping.

d. Conveyance and distribution. Because aqueduct costs increase with length of line, but only in proportion to the square root of line capacity, nothing is so wasteful as parallel lines. The principle is nearly universal, and results in distributive networks of all kinds being recognized as natural monopolies. "Bundling" of small individual water lines into large ones makes it economical to carry water long distances, so much more land may be served from a given source. It also makes it feasible to supply the peak demand capacity needed to provide water at all times.

e. Financing. Irrigation districts have much better credit ratings than their component members, and can tap national credit markets through bond sales. The credit they receive is passed on to incoming settlers in an interesting way. Note, first, that the conversion to more intensive agriculture, and the payoff to the investment in water supply, presupposes immigration. The small farmers who are willing to submit to the exacting work of developing new farms are not wealthy, and they need credit. Irrigation districts pass credit along to new settlers in the form of unappreciated land prices. It is not that districts depress prices—then there would be little motive for the original landowners to form them. But they prevent gross speculative increases, and they discourage holdouts. That is because they tax land, and their bonds are liens on land. The settler thus buys land cheaper, because it is mortgaged to the district. And as he pays his taxes over many years, he pays off the mortgage.

This feature of district finance is little understood, but is probably the most important single factor in their success.

f. Synchronization of interdependent development. The development of new communities requires simultaneous risky investments by large numbers of independent decision makers. The success and viability of each investment depends on the others. Whoever gets out ahead runs more risk, and is in that sense exploited by laggards. A giant landowner can if he will (a big "if") "internalize the externalities," and proceed on all fronts at once, needing only confidence in himself. A community of independent men needs a community synchronizer. An irrigation district serves the need. By this tool, the community as a whole makes the initial commitment—and puts tax pressure on all its members to match up.

Owing to decreasing costs in water supply, and its limitational nature, the optimal water supply works are built ahead of demand. They must come first. Immediately there ensues a crisis period—will the owners of

the served lands respond fast enough to forestall bankruptcy? There must be a synchronizing mechanism to assure that they do.

g. Compactness of settlement. By forcing inclusion of contained lands, and limiting service areas, irrigation districts achieved great savings in distribution. This saving in water supply cost, however, proved to be the least of the gains. Every other distributive network—roads, power, telephone, delivery and collection systems for farm inputs and outputs, etc.—benefited as well. The purchasing power of many small farmers was brought to focus on local towns, which responded with improved storage, packing, shipping, retailing, farm supply, and so *ad infinitum*. Farmers had closer contact with one another, virtually eliminating the need for self-sufficiency and vertical integration which forces many isolated ranches and plantations to be so huge, and paternalistic or tyrannical. The way was opened for the development of “total community.”

Along with the benefits, the total community suffered some of the diseconomies of regional specialization, as land taxes forced each parcel to its highest use. There is a peak demand problem in seasonal requirements for farm labor that may be aggravated by specialization. But irrigators responded to this with a diversification to match the specialization—both are possible when a high volume comes from a small area. The classical evils of monoculture are the product of plantations, and have been overcome by intensive irrigators.

h. Management of aquifers. As aquifers underlie large areas, and as water is pooled in them, they require unified management. Irrigation (and other) districts have undertaken this. Aquifer storage is cheaper than surface storage as a rule, and with modern developments in pumping and electric power distribution, aquifer management is the vital frontier of water supply.

i. Drainage. Every water supply creates a drainage problem, usually for someone else. There is no money in water removal, but it must be done, and it is obviously best done on a large scale under a unitary system.

j. Multipurpose river development. Irrigation districts, as semi-public agencies with tax power, have been able to justify devoting some of their reservoir space to flood control power, and recreation.

k. Marshaling social surpluses to finance social infrastructure. Economic development of an area generates many spillover benefits and costs, produced by some individuals but received by others. In general, the net balance is strongly positive, that is, spillover benefits exceed spillover costs. This creates and constitutes a social surplus. The surplus is indigenous to a limited area within which economic development has occurred, and so is

in the main captured by local landowners in the form of higher rents and land values. Irrigation districts, having a first mortgage on this income, can tap it to pay for prerequisite projects of large optimal scale. Thus the surplus is harnessed to useful purposes.

Surplus-generating spillovers are of two kinds: technological and pecuniary. The technological kind is easier to understand: if my irrigation water, imported from a surface source, percolates underground, raises my neighbor's water table, and reduces his pump lifts, he benefits. The pecuniary kind is more important, more likely to be positive, more transcendent of particular technologies—but harder for the concrete mind to grasp, and therefore less appreciated. It comprises the benefits of "total community" discussed above (f, g).

Pecuniary spillover benefits are not limited to physically adjacent lands because they are transmitted not by touch but through the market. They show up mainly in towns and cities serving farm hinterlands. California's irrigation districts recognized this relationship long ago, and acquired the right to include cities and to tax their lands at market value to help finance the farmers' irrigation water. Far from resenting this, city voters have usually supported irrigation bond issues by larger margins than the associated farm voters! In a few cases they have carried them over a negative majority of farmers!

Crises of drought are socially useful in that they overcome inertia, which is the paramount obstacle to economic development. Crises should therefore be viewed as opportunities, rather than as catastrophes. The continuing water crisis of southern and south-central California has made this the most productive agricultural region in the country, and perhaps in the world. The historical theory of "challenge and response" finds strong support on the Pacific Coast, as one travels from south to north: the humidity rises, and the agriculture declines. Community institutions for irrigation are not easily accepted by complacent individual landowners where there is no great crisis, even where there is great potential gain. The community institution, when it does come, creates a man-made crisis for all slow-adapting landowners, through heavier land taxes, and thus provides challenge and provokes response.

Irrigation farming in the arid western states has had a powerful impact on national markets. The irrigation district device is the prime mover. Heavy fixed charges on land prompt rapid, intensive and compact development. This in turn fosters local markets and social life and "total community." It has made small farming economically viable, in a half century when everywhere else the trend is toward farm enlargement. In the last

decade, it is true, there has been some reconsolidation inside irrigation districts: irrigation farmers are not entirely immune from the same factors of mechanization and finance and marketing that have favored consolidation elsewhere. But a greater cause has been the retirement of old bonds, and resulting reduction of land taxes and rise of land value as an investment for absentees. Whenever new districts are formed, or whenever existing districts are revitalized by new bond issues, the tax pressure on land is renewed and subdivision becomes again the paramount trend.

Community action at the level of the giant private landowner, as envisioned in the Desert Land Act, remains a possibility. Historically, the giant owners moved at a snail's pace compared with the irrigation districts and played largely the role of parafeudal reactionaries. More recently many of them have shown great enterprise, abetted by outside income and the privilege of writing off capital investments in agriculture as business expenses for income tax purposes. Their renewed vigor has easily captured the fancy of those who prefer private to public enterprise in all cases; and it possesses a greater flexibility, thanks to the smaller numbers involved in key decisions, and the relative freedom from institutional obsolescence. I remain a skeptic, however. Most of the giants report negative taxable incomes each year, indicating quite clearly the nature of the motivation behind their enterprise, and its dependence on non-farm income. Their special skill is holding land in the path of taxpayer-financed new water projects, and lobbying for projects they prefer.

## II

OTHER LEVELS of community action are needed too. At the state level, the primary need is for the state to define property rights in water. In most states these rights are ambiguous and, to the extent they are clearly defined, not intelligently defined. The ambiguity is exploited by the possessors of superior rights to maximize their own position, often at considerable social cost. This begins by their gaining enjoyment of a public resource without ever paying the public anything for it—often euchering the public into paying them to develop it—and then denying that the valuable resource they enjoy is taxable real property. The whole structure of property rights being raised on this foundation of double-think, there is resistance at every step to economical measures designed to rationalize systems of water allocation.

In some areas the state can also serve a wholesaling function vis-a-vis irrigation districts and other local groups as retailers. That is, it builds and administers trunk lines. It probably should apply on regional levels many of the same principles which irrigation districts have made work on

micro, local levels, but no state has to my knowledge done so—a pity. This has resulted in great magnification of cost of state water supply projects, and deferment and destruction of benefits.

Federal action is necessary to define interstate water property questions. Other federal participation has many marks of the porkbarrel, doing for states and localities what they could and should do for themselves or, more often, what should not be done at all. There has been great obsolescence of institutionalized intent, with irrigation water supply and navigation taking priorities that today should go to pollution abatement, and perhaps mining, municipal, and industrial supply.

The riparian doctrine of water rights is not suited to conditions when water becomes scarce. As increased demands on fixed supplies make water scarce in all fifty states, the riparian doctrine needs simply to be abandoned everywhere. It fails on several criteria.

a. Initial allocation. Water is reserved for the owner of riparian land, in proportion to the area of his holding, regardless of productivity. Only by chance would these lands be those where the water was most productive.

A pernicious byproduct is a bias against subdivision, except in long narrow "bowling-alley" parcels, on the French pattern, which are uneconomical to use. It is no accident that the riparian doctrine is identified with large landowners.

b. Motive to develop. The doctrine in its original form does not contemplate consumptive withdrawals of water. They may or may not be allowed—in many jurisdictions one simply does not know until he has tried it. Consumptive use is possible only by modifying or departing from strict riparian doctrines. Generally such departure is allowed, but thenceforward the entire fabric of law rests on a principle that is being denied, leading to the kind of confusion and uncertainty that was once associated with a geocentric theory of the heavens. "Oh, what a tangled web we weave, when first we practice to deceive." Better not to base an institution on a lie.

Another problem is that water storage is not permissible under riparian rights.

In western water history, riparians have played a dog-in-the-manger role. The doctrine was used to claim the right to stop others from developing water which the riparian was not using. He felt no pressure to develop it himself. He lacked a need; he lacked a right to export to lands that had a need; he paid nothing for it; and he couldn't sell it. The combination was so anti-developmental that the doctrine had to go, and in most states it did.

c. Constraint on uneconomic use. The riparian's right to claim water is

not limited by economic use. There is more question about his right actually to use water, since that is limited by the claims of downstream riparians. But there is no limit on his right to claim that the original flow of the stream, undiminished and unpolluted, should reach his land.

d. Rationing under scarcity. When a river goes low, riparian rights are often prorated among riparians in proportion to their landholdings. Pro-rationing is an uneconomical principle of allocation, however common in many walks of life. Cut back everyone by 25 per cent and some will miss the marginal water very little, others a great deal.

e. Transferability. Riparian rights are rigid and non-transferable. They are part and parcel of a landholding in the most complete sense. They can be severed only by the owner's failing to assert his right against an adverse use which establishes a prescriptive right—but then how transferable is the prescriptive right so established? As to selling, the only thing a riparian can sell is an agreement not to assert his rights, but that is of little value to most buyers because it does not bind other riparians, each of whom has something like an absolute claim on the natural flow. There is a recent water rights settlement on the Kaweah River, California, where a block of riparians accepted money as part of a complex settlement in which they agreed not to push the nuisance value of some ancient unused rights, but that is a rare bird.

f. Pooling for cooperative community action. The riparian right is tied to the individual parcel of private land. The concept of pooling supplies in a community system is alien to that concept. In those rare cases where riparian rights have been pooled, it is by such devices as computing continually what the natural flow past the riparian land would have been under natural conditions, and supplying the owner that amount through the community system, regardless of cost and competing needs. Imagine a city water supply system in which each household had to be located on a stream, and divert and process and return its own water. Fortunately, the law gives a priority to domestic and public interest uses which lets cities override riparian constraints and avoid such absurd outcomes. But outside cities, in the looser organized unincorporated areas of the world, exactly such absurdities are forced on agriculture, industry, and mining by the riparian doctrine where it prevails.

g. Management of aquifers. Ground and surface water are both water, and they intercommunicate in a grand system. The riparian right applies to the surface subsystem, and owing to its historical priority, imposes on aquifer management the responsibility of preserving the status of the surface subsystem, even where that involves much lesser values than the underground subsystem. Thus, pumped wells near a stream, especially on an

alluvial cone with coarse gravel, may effectively divert water from the stream, and be enjoined by downstream riparians. The aquifer must then be managed in such a way as to preserve the original natural surface flow. This is an increasingly wasteful requirement as it becomes realized that good aquifers are a valuable resource comparable in value to water itself.

h. Containment of service area. The riparian service area is contained, generally quite narrowly, but not in a rational way. One riparian's land extends back many miles from the stream; another may be just a few feet. There is generally a prohibition against export over a watershed line, which again serves to contain, but not necessarily economically—the best use of water may be over the line, and there are dozens of cases in point.

i. Distributive equity. The riparian system divides up water rights essentially in proportion to the prior ownership of land. Thus, a valuable public resource is given away to those who already have most resources; there is no equipoise for others. We live in a world of curious double standards and compartmentalized thinking. In discussing problems of the Negro ghetto, and the urban dispossessed, we immediately look to the suburbs and find our villains in middle-class salaried and professional people who have worked their way out of the slums. We propose and invoke redistributive taxation with a right good will. But in discussing the ownership of property, that's different. Here, few seem to question the propriety of "To him that hath shall be given." As a salaried professional person who burns a lot of midnight oil, I find this irksome. If the dispossessed have a claim on society, would this not be better asserted through a public claim on natural resources?

The appropriative doctrine of water rights is no answer to the faults of the riparian doctrine. Judging it on the same criteria, its faults are different, but no less disqualifying.

a. Initial allocation. "First in time, first in right" is the operative principle. This is clearly pro-developmental, but it goes too far and fosters premature development. The reason is that water is everywhere in transition from being submarginal to being a valuable rent-bearing resource; and under this doctrine, one seeks to capture submarginal waters in order to enjoy their later rents. To capture the waters one must invest real social capital in diverting, storing, and applying water. Capital is diverted from socially productive uses to this factitious task of capturing submarginal resources. In today's capital markets, with real interest rates on mortgages rising to 8 per cent, wouldn't it be nice to have back some of the concrete frozen in the premature and abortive Feather River Project, for instance?

b. Motive to develop. The motive to capture is clear enough, and that

involves a certain kind of development. Excessive diversion capacity is the rule. What one does with water after diverting it is something else again, and most appropriative takings of water are characterized by inadequate investment in post-diversionary aspects of development, especially those designed to save water.

c. Constraint on uneconomic use. The appropriator's motive is to use as much water as he possibly can. Withdrawing water, a social cost, is to him a private gain, because it is the basis of his claim to future water. So appropriators learn to live in an environment where it is considered socially creditable to overirrigate. Much of the water "shortage" of the arid west would disappear overnight if appropriators had to start paying an economic price for water; and it would be greatly abated if they simply started thinking in terms of a zero price, instead of, as now, regarding the price to be negative because of the gain they realize by piling up a great "history" of "use."

d. Rationing under scarcity. Under the "first in time, first in right" doctrine, appropriators are senior and junior to one another along a scale from the first to the last. When water falls low, the juniors drop out first and lose everything before the next senior appropriator loses anything. In result, there is no pooling of risk whatever. The top senior has a 100 per cent firm supply; the last junior has a supply so uncertain it is unusable. Two basic economizing principles are denied. One is marginal productivity. The junior appropriator who loses all his water obviously loses marginal units of high productivity, while the senior retains marginal units of low productivity. The other is pooling of risk. The doctrine is conceived in terms of an assumed necessity for vertical integration: that is, there is no market for the raw material, water, but every user rather owns his own supply. His supply is a piece of the larger common supply, but his piece is defined in such a way as greatly to increase the aggregate variability of supply above that which nature imposes; to increase the uncertainty as well; and, finally, to distribute these risks unequally.

e. Transferability. Appropriative rights are more transferable than riparian rights, but the advantage is nothing to crow about: it is the superiority of 2 per cent efficiency over 1 per cent efficiency. The reasons are complex and lengthy. The empirical fact is undeniable. There is no market for appropriative rights worthy of the name. They simply are not bought and sold freely, despite crying needs for water transfers in every area. Anyone who comes east touting the appropriative doctrine by virtue of its greater flexibility bears examination—a very searching cross-examination in search of factual evidence.

f. Pooling for cooperative community action. In this particular, appropriative rights rank reasonably high. A public agency, formed to rationalize a multitude of individual rights, may acquire them and manage them centrally, provided they serve the same lands from the same points of diversion, and again provided that one agency does not try to acquire water from another—the flexibility is largely within agencies, and within areas of land. Most of the irrigation districts described earlier operate with appropriative rights.

g. Management of aquifers. Appropriative rights to surface water often interfere with and take priority over aquifer management, in the same manner as riparian rights.

h. Containment of service areas. Here, the evaluation is mixed. Where administered by irrigation districts, appropriative rights are applied to contained service areas. However, that is more to the credit of the district institution than the appropriative institution. Where claimed by individuals, or small individual districts, service areas from given streams open to appropriation are generally scattered. "First in time, first in right" puts the premium on jumping the gun. The farther one is from a source, and the more convenient it is to others, the greater the motive to get there first to preclude them. So, typically, the first claimants on a source are scattered; soon the supply is fully claimed, and the included dry lands can never get water from this source. They can, however, search about to tap other sources, remote to them. The results need not be imagined, they may be observed throughout the arid states.

i. Distributive equity. The amount of water that complaisant courts will recognize as being used "beneficially" is a function of, among other things, the amount of land that the user has to apply it to. So this doctrine, like the riparian, tends to distribute public water to those who already own private land, in proportion to the size of the landholding.

### III

AQUIFER MANAGEMENT presents problems. The cheapest way to store and treat water is in an aquifer provided by nature, where one is accessible. The modern frontier of water management is in unitized aquifer management: recharge, containment, and control of withdrawals, and conjunctive use of ground and surface water. Present ground water law suffers the same cultural lag as that for surface water. The law generally contemplates perfect vertical integration—in this case quite literal—between the aquifer and the overlying landowner. Of course, this is hydrologic-economic nonsense, and the result is waste of many kinds.

The failure to economize on valuable rent-bearing waters in locations

of water shortage leads to costly development of submarginal waters. There is little in the law to suggest that anyone understands that water occurring naturally in southern California, for instance, is worth just as much as water that is conveyed there at high cost, and should be priced and economized upon accordingly. The tendency is to waste local waters. This magnifies many fold the cost of water supply. Institution-builders need to take drastic steps to overcome this glaring fault in water law.

Water in locations where water is scarce is a rent-bearing resource. Developing water need not, therefore, require subsidy; on the contrary, it can yield a surplus, and should, through the imposition of prices collected by the owner of the water—preferably, in my judgment, a public body of wide jurisdiction.

A water system consists of several subsystems with different economic characteristics. While the "production" end of the business yields rents, the local distribution subsystem is a decreasing cost operation which, if properly managed with price of service equal to marginal cost, yields negative rents, or specious deficits.

It is fairly common for the management of a complete system to arrogate the surpluses from water production to cover the deficits of distribution. This is a bad practice. It results in excessive extension of distribution systems, and inadequate economy of scarce waters in arid areas of high demand.

The major cost in water supply is conveyance and distribution. It is largely a study in transportation economics. Dams and reservoirs are photogenic and have memorable names, but aqueducts, canals, ditches, pipes, siphons, checks, pumps and furrows eat up the money. Hence the overriding importance of keeping service areas compact, and exploiting local sources before ranging over long hauls for remote sources.

Very few lands and waters are adequately served with high-quality distribution systems, with pressure for sprinklers and excess capacity to supply water on demand. Limited capital funds are squandered on excessively long lines; on excessive diversionary capacity; and on premature capture of submarginal waters. Not enough is spent on raising line capacity and quality.

#### IV

WATER IN MOST USES evinces diminishing returns. From this follow some important corollaries. One is that user charges on water can cut back marginal consumption, and rise quite high, without driving land out of use, because the average product of water is very high. User

charges will cause water to be spread thin, and serve a great deal more land.

A second corollary is that water supply is necessarily political. "People will vote for water, but pay for power" is the aphorism. In light of the diminishing returns to water, this makes some sense. Water supply is a small tail that wags a very large dog. It is a limitational input—no water, no life—and yet a very small part of the total capital cost of developing land. This helps us understand why westerners are willing to invest in what seems like such an extravagant manner to assure themselves a water supply, but refuse to pay in user charges anything at all comparable. This is, of course, compounded by the appropriative doctrine, and as much more so by the variability of the natural supply. Hirshleifer, Milliman, and De Haven devoted a chapter of their excellent book on *Water Supply* to refuting the notion that "water is different," and made many excellent points; yet it would be hard to name an input at once so essential to life, and so variable in supply. Some stream flows jump up and down from 20 per cent or so to 400 per cent or so of their mean annual levels, in addition to seasonal patterns. Cyclical storage from wet years to dry is very costly, owing to the infrequent use of the storage space. There being no market for raw water, every city and farm or farm group must acquire its own individual source—pure vertical integration, a market structure that everywhere magnifies aggregate need for raw materials. If it wants a firm supply, it must hog enough natural flow so that the minimum expected flow will cover its needs. If it expects to grow, it must add yet more, to serve the undeveloped lands already within its boundaries (remember urban sprawl?) plus lands it hopes to annex. In light of these relationships it is to be expected that water seekers would depart widely from standards of economy.

To the extent that the problem is man-made, institutional that is, it is curable. I look forward to better and better systems of pooling water supplies. This will not come through an open market in raw water, because transportation cost is the major cost, and a natural monopoly, owing to decreasing cost to aqueduct capacity. It will come through making water a public utility over wider and wider areas, on the model of the Metropolitan Water District of Southern California. But whatever we do it will have to recognize that water *is* in some ways different, and it is these differences that will continue to make it more political than most raw materials need to be.

A third corollary is that standby capacity to serve water on demand is as important as water itself. In order to justify other investments, land-

owners need assurance that their limitational water supply will not run out. The assurance of firm water permits great intensification of land use.

The cost to the supplier of water is therefore largely the cost of supplying capacity—a fixed, not a variable cost. The benefit to the user is also a fixed function of time more than of use. If the seller has to rely solely on user charges, he finds that most of his volume sales come when water is abundant and the marginal value is low. And of course he has acute financing problems if he has to rely on periodic spurts of income to cover regular fixed costs.

And so it makes great sense for landowners to pay for water supply systems as one pays for insurance, on a fixed periodic basis, independent of use. Only at times of peak demand will there be a scarcity, either of raw water or system capacity, to ration. At other times, having the excess capacity, user charges should be very low.

A fourth corollary is that pricing of water should be very flexible. Peak demand needs can be greatly reduced by letting user charges rise to high levels when system capacity is loaded. Here I go down the line with Hirschleifer, Milliman, and De Haven. Price rationing is far superior in many respects to alternative methods; and the absence of any peak rationing leads to great waste in unneeded capacity.

#### V

THE ECONOMIC SUCCESS of water supply investments depends on the availability of multiple quantities of capital in complementary public and private investments. At a time of acute capital shortage and high interest rates, like right now, a prudent man or community should not plunge into an ambitious scheme of community development in the absence of compelling counterarguments. This is less true in the humid states, where water supply may often be viewed more as a supplemental investment in established communities than the foundation of a complete new community. But the difference is one of degree only, for artificial water supply, if optimally developed, brings a new standard of intensity to an existing community, with economic effects not unlike those in the arid states.

But life cannot stand still because of high interest rates. Rather, we must take greater pains to economize on capital. To that end, the combination of land value taxation and legal reform sketched above becomes more urgent than ever.

*University of Wisconsin, Milwaukee*