



A Quantitative Economic Evaluation of Institutions Controlling Water Use in the San Joaquin Valley

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**A Quantitative Economic Evaluation of Institutions
Controlling Water Use in the San Joaquin Valley**

The project is a continuation of a study carried through in 1957-58 under a Faculty Research Fellowship from the Ford Foundation. A sketch of the earlier project is necessary to introduce the present one.

The original study stemmed from a still earlier a priori economic analysis of California Water law from which it was evident that the law as written precluded anything approaching an economical equimarginal allocation of waters among competing uses, such as would maximize the net social benefits from water use. It was noted, however, that the law was modified in application and that several informed observers held that actual practice achieved a tolerably economical allocation. To test the question, therefore, a quantitative study was proposed in the San Joaquin Valley.

The study was couched in fairly simple terms. Several instances were noted of sharp contrasts among average annual per acre water inputs of water-users who were not separated by physical barriers at all commensurate with the potential net benefits of transferring water. I proposed to quantify the excess of benefits over costs of several such potential transfers, the frustration of net social gains then being laid at the feet of obstructive elements in water law, which are not hard to identify.

As a standard against which to measure the performance of the institutions controlling water use, the study involved working out an economical system of allocating water. Necessarily involved in this was an economical system for laying out distributive networks, financing them, and pricing their services. Emphasis was laid on the pattern of land settlement as a factor in the economy of distribution, and the method of financing the networks in turn as an influence on the patterns of settlement.

During the project year and parts of the following data were assembled and analyzed which confirmed the initial hypothesis that water was not being allocated at all in keeping with the equimarginal ideal. The marginal productivity of water was estimated independently by several techniques: by historical correlations of water inputs with crop outputs; by the depth from which farmers pump water for irrigation; by the costs which irrigation districts are willing to assume to conserve water by storage and economy of distribution; by Experiment Station and other studies of the marginal

productivity of water on different crops in different areas; by the prices paid for water in the few instances where it is transferred; by the increase in land prices resulting from provision of water; and other methods. The results of the different methods confirmed each other quite convincingly: the marginal value of water varies sharply from place to place within the San Joaquin Valley, with the differences not attributable to conveyance costs. There are, indeed, instances of water being conveyed from areas of shortage to areas of surplus.

It was then of course no difficult task to construct a simple model of an economical integrated system for allocating and distributing water, by comparison with which the present arrangements manifest the grossest kinds of diseconomies, the joint products of the system of water law and the pattern of scattered settlement.

The conclusions are of high practical and political interest, and the temptation is to rush into print. However during the study a number of more subtle but equally significant dimensions of the problem became evident, study of which might substantially modify the practical conclusions. In fairness to the problem, to the persons involved in it, and in consideration that the published work will fall upon inflamed passions, it seems mandatory to explore these new dimensions. The interest of the Guggenheim Foundation is hoped for because these dimensions are intellectually challenging and raise several questions transcending the immediate study area and technological subject matter of the study.

A first set of new questions have been brought out by those now holding the best water rights. These, the water-surfeited, naturally tend to rationalize their position -- they cannot conceal it, as their rights are based in large part on customary use, open and notorious. Three of their more persuasive rationalizations are of such real merit as to warrant extended analysis:

One, that the water-surfeited require surplus rights in wet years and seasons to insure against the driest years and seasons; that to irrigate under less favorable conditions invites disaster.

Two, that the water-surfeited require surplus water to maintain an optimal salt balance; that constraints compelling economy of water would lead to thinning the supply per acre, bringing more land into irrigation than the available water supply could flush of accumulating salt, forcing later retrenchment or calamity; and, further, that integration of waters from different sources would pollute the pure waters and reduce the overall quality of the supply near that of the worst, or at any rate lower its aggregate value.

Three, that society is obligated and committed to recognize the prior claims of present water users, for legal, ethical, and historical reasons.

These arguments call for further analysis, and will doubtless force modification of the conclusions reached hitherto. That is not to say that I have relented in my judgement of wasteful use, but that there remain elements of considerable reasonable doubt. However it is entirely possible that the new considerations will reinforce rather than temper the judgement. There is no foregone conclusion here. Posing these therefore as intellectual problems, rather than debating issues, we may rewrite them:

One, what is an optimal social adaptation to risks inherent in variable stream flows? How would one properly measure aggregate variability in a system of water distribution; how minimize this aggregate; how distribute it optimally among different users? The answers, to judge from discussions with mathematical statisticians, as by no means trivial and call for some pioneer conceptual endeavor.

Two, measurements of the marginal productivity of water must be adjusted to take account of the salt balance, with due consideration to variations in mineral content of different waters, the chemical composition and drainage characteristics of different soils, and recent and prospective advances in breeding salt-tolerant crops. The salinity factor must be introduced into analyses of benefits and costs of integrating and pooling water supplies of varying natural quality. When is the aggregate value reduced, and when increased by pooling? If reduced, when is it worth the cost to segregate waters of different quality? What constraints imposed on upstream irrigators would accurately reflect the social costs which they flush downstream in deteriorated water? In general the question is posed, what kinds of adjustments are in order when an input which was treated as though homogeneous is recognized as not so, but continuously variable in quality and freely miscible.

Three, in the historical background of water law and custom, what obligations has society assumed toward holders of rights of use to waters which are legally the property of the State? When, by whom and for whom were these obligations assumed? What reciprocal obligations are entailed? In the absence of unequivocal statute and precedent, what mores are controlling? Where did these originate, who bore them to California, and have they played so useful a role historically as to warrant preservation? This question calls more for interpretation than new accumulation of historical and legal materials, of which I have already a sufficiency. It demands attention not only for its own sake, but as groundwork for the

ultimate problem posed at the end of this project outline.

A satisfactory resolution of the study's original question, however, can by no means be confined to consideration of issues raised in debate. Continued contemplation of the questions and their historical background leads one into ever larger issues, of which three more appear paramount.

Let us note, in introduction, the nature of water is such that economical allocation and distribution cannot be achieved without conscious design by some intelligent agent, of an integrated distributive network. If the invisible hand is to operate in any but the crudest sense it is through such a network -- it does not design them.

Thus in seeking to recommend improvements over prevailing institutions controlling water use we must do more than fall back on the market mechanism, albeit that may play an integral role in our final scheme. We are led to ponder the overall design of distributive networks. As mentioned, this resolves itself into three paramount issues.

First, how does one determine the boundaries of integration? The Central Valley of California is perhaps as definitely bounded a hydrographic unit as one may find, yet it already imports water from the Trinity River and exports it to several counties around San Francisco Bay. It may very soon export water to Los Angeles where it will compete with water from the Colorado River, whose headwaters have been diverted to the eastern slope whence they flow to the Mississippi to mix with waters from Lake Michigan which, were they not backed through the Chicago River, would spin turbines on the St. Lawrence supplying power to New York and Canada. It may be that the "futuristic" Valley Authority concept is well on its way to obsolescence. Linkages among water users already span the continent. If the example seems forced, consider the linkages among electric power networks across the nation.

But can conscious overall integration of development and operations proceed that far? It has been a widespread opinion that such conscious direction of economic activity is at best a necessary evil, the interdependencies characterizing economic relations being too complex for any mind to comprehend. But distributors of electric power have achieved great advances over distributors of water. Continuing advances in electronic computers and associated mathematical-

economic techniques give us more and more confidence in our ability to optimize by means of simultaneous solutions to equations representing complex interdependencies. Thus the necessary evil is appreciably mitigated, and the possibilities for constructive integration expanded.

It seems that criteria could be devised for successively diminishing degrees of integration as linkages become more remote, and for distinctions between water retailers and wholesalers, perhaps several levels of them, which would permit effective integration well beyond anything achieved today. That will be the effort in the study -- not, however, across the continent, but in the San Joaquin Valley and its immediate environs. Emphasis will be laid on leaving flexibility in whatever system is established, to permit of wider integration as it becomes feasible and useful.

Then there are functional limits to set, as well as areal. Water supply networks must be integrated with other public utility and transportation networks in planning land developments. Too, there are important by-products in water supply projects. Where on the road towards universal simultaneous optimization through coordination of all related activities shall the designer of water systems settle for a workable suboptimum?

A distinction is necessary between what is possible to analyze and what is humanly possible to administer. The present study addresses only the first of these questions, leaving the second to political and administrative science. It is useful for analysis to proceed to its utmost capacity, despite administrative limitations. Thus it can provide useful leadership, discerning distant goals, scouting pitfalls, and discovering hitherto unappreciated relationships. And of course there is no assurance but what a complex analysis may produce a simple operational criterion.

In terms, then, of what can be analyzed, it has become clear that my original concept of an economic system of pricing for distributive networks, instructive as it was, was too limited to constitute a plausible approximation to the realities of the situation. At the very least, variability of supply and demand, and storage, must be analyzed jointly with distribution costs.

Storage is possible at many points in a water system: on watersheds, in major surface reservoirs at several points on the major stream, at distributive nodes, in farm ponds, in the soil, and underground, the last presenting us with high variable costs and bottlenecks both in recharge and withdrawals.

Needed network capacity depends on maximum flows, which in turn depend on location and quantity of storage, in conjunction of course with natural runoff variability. The entire system calls for simultaneous optimization. And since one element is the variability of natural runoff, which cannot be long anticipated except in terms of probabilities based on the recorded past, which is a very small piece of the whole past, the optimizing analysis seems to promise some new problems that should be quite interesting, not to mention exceedingly practical.

It has also become clear that the by-products of water supply development should be included in the joint optimization. One of them, indeed, hydro-electric power, enters the scene as both output and input, being the primary means for tapping underground water reservoirs which are relatively overused because power distributors are more advanced than water distributors in the arts of system integration, taking upon themselves the brunt of variations so that their customers may avail themselves of their product on demand. Power is the tail that wags the dog of many new "irrigation" projects (the latter designation having advantages in law, taxation, and public relations.) By no means can power be omitted from consideration.

Summing up the first paramount issue, variability of supply and demand, storage, and by-products are to be included with conveyance costs in a joint optimization. How far beyond this to go before reaching an "optimal suboptimum" is a question to which I have no answer except that to find such is a prime purpose of the continuing study.

The first question is posed in static terms. Before refining the answer too far we should take account of dynamic questions which are bound to interrupt our excogitation before it has spun out a perfect solution. Not only is there a need for integrating inter-dependent activities, there is a need for synchronizing their development through time.

This second paramount problem was originally conceived, following a classic study in the field, as a lag of land settlement behind construction of major irrigation works. But in fact it is often the major works that lag behind land settlement. Again, it is often one kind of public work that lags another, or the branches that lag the trunks or the twigs. In general there is a problem how best to synchronize the development of the many structures and activities that constitute a complete community; and of how far the suboptimizing designer of water systems should go in promoting the full development of necessary complements. It is in this dynamic context that the case

is most compelling for devising means of expanding the optimizing analysis to include as many activities as possible. Costly capital improvements sunk in advance of their complements are largely or entirely wasted for long periods. Potentially productive lands lie undeveloped because no one cares to risk his savings on the dubious gamble that others may do likewise in time to let his pioneering pay out.

There is another chapter to this tale. Despite all discouragements, developments are made, although often not in the most obvious locations, nor in conjunction with one another. Here is a main canal, there a superhighway, and yonder a cluster of farms. In another study I have advanced the thesis that such failure to synchronize complementary developments in the most likely areas for urban expansion is leading the basic urbanizing transportation and utility networks slowly to proliferate over wider areas than the ultimate demand can absorb, posing a serious threat of economic instability. The same pattern and the same threat are apparent, in a rural setting, in the expansion of irrigated agriculture in the San Joaquin Valley. Nor is this purely a priori. There was in the 1920's a burst of uncoordinated, unsynchronized water development in the San Joaquin Valley reminiscent in many ways of today, which was well on its way to collapse of its own weight when the Great Depression delivered the coup de grace. It is well worth inquiring whether the current expansion is not approaching the stage of developing new irrigated land at costs higher than its long run productive value will warrant.

There remains finally a third paramount problem, of a universal sort, but in few places so sharply defined as in the San Joaquin Valley. New developments are not occurring in a desert. Grandiose new schemes are being superimposed on a patchwork of preexistent systems, most of them underdeveloped and obsolescent in terms of modern pressures on limited natural water supplies. Each in its day represented a sort of suboptimum for its locale, and superimposed itself on still smaller and older systems, parochial anachronistic suboptima which they have even yet not fully integrated. Among them these older systems control the lion's share of water flowing naturally into the San Joaquin Valley.

Should the new valley-wide system absorb and integrate the old ones, with their water? Engineering and administrative techniques have long since advanced to where this is entirely possible and would afford immense net benefits. Should the older systems remain, as they would prefer, snug little enclaves untouched by outside demand for water, while the State at great expense carries remote northern waters past their brimming wasteways and busy drainage pumps to develop

dry lands to the southwest? Or could one devise a working compromise to take advantage of their surplus water, demonstrating the joint net benefits in such unmistakeable terms as to forestall the gnashing of teeth and rending of garments that have prevailed against similar proposals in the past? To answer this ultimate question the whole study must be brought to bear.

The study would be accomplished in Columbia, Missouri, inasmuch as I have already visited the study area at length. The primary job now is analyzing data and exploring ideas.

However, I would return to the San Joaquin Valley for about three weeks for follow-up interviews which, on the basis of my present knowledge, would be more penetrating than was previously possible.