ECONOMICS OF COMPETITION FOR WATER

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Each day something like 300 billion gallons of fresh water is withdrawn for use in homes, factories, businesses, or on irrigated farmland. These quantities are withdrawn from water courses, kept in circulation sometimes for several cycles of re-use, and then either returned to a water course, which may be a ground water aquifer, or depleted into the atmosphere. Some water is, of course, embodied in the products of manufacture. There is both immensity and great diversity in the uses we make of the water we withdraw from our lakes, streams and underground aquifers.

Other huge quantities of water are used on site for diverse purposes including transport of certain articles of commerce, carrying off wastes, maintaining sport and commercial fisheries, water fowl and furbearer populations, generating hydropower, providing the media for pleasure boating and providing pleasant scenery.

The perennial crop of economic and population forecasts makes us aware that a growing national economy such as ours will eventually be using even vaster quantities of water than we are using today. It is not my purpose here to speculate on the size and composition of our demands for water by any certain date but rather to emphasize the problems of choice which our growing demands for water pose for us. In reacting to these problems, we have choices both in shaping the future demands for water as well as in charting a course for satisfying those demands.

First, I want to establish a general viewpoint toward the competition for water in two senses, in the sense that our desires for water compete with our desires for other goods and the sense that particular water uses may compete with each other. We may call these two senses competition in the large and competition in the small.

Next, I want to set some goals for resolving both types of competition for water and to establish the public nature of our water problems. In a word, I will argue that while we have a public water economy rather than a private one, we nevertheless can adopt the goals of economic efficiency in the management of our water economy.

Finally, I want to discuss some techniques for managing the water economy against the background of a current problem in the Potomac River Basin.

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II

THE NATURE OF COMPETITION FOR WATER

Certainly the amount of water surface in lakes and streams and the run-off from our watersheds will be less per capita in the future than they are now. This may not be a relevant observation, however. Such an analysis inevitably leads to the conclusion that by a certain date we will bump against a water ceiling limiting the growth of population and economic activity. Such fears do not appear to be well grounded for the reason that man's ability to discover new technologies and to adjust his laws and institutions to new needs have been able, up to now, to prevent any significant group of natural resources from becoming so dear as to throttle our development and growth.

To the extent that there are more competing claims for water, however, a certain urgency exists over the question of how well we resolve these claims. The stakes of management become higher as water becomes less of a free good. We can see the evidence for this fact in those regions and localities where water of adequate quantity and quality is perennially or even occasionally inadequate to meet all claims. We must therefore be as careful to guard against the euphoria of over-abundance as against the phobia of dire scarcity. The problem is that there are coming to be more costs associated with the problems of getting desired quantities of water of desired quality to the right place at the opportune time. The costs may be expressed as other uses of the water which have to be foregone or impaired in some way. This is competition in the small.

The technical relations between the uses of water are an appropriate beginning for discussing the competition for water in the small, that is, for treating cases of conflicting uses for water. To get hold of this question, I will try to adopt a general framework. This is a bit difficult to do because of the ubiquitousness of water, the great variety of uses to which water may be put and the complex interrelations between the different uses. To a great extent, the interrelations between uses are so significant and complex because water tends to be a continuous medium capable of translating upstream effects downstream or pool effects laterally, and because withdrawal uses have consequences both on the quantity and quality of return flows. Moreover, since water is subject to both withdrawal and on-site uses, we must deal with interrelations between two major categories as well as relations within categories. The addition of this dimension triples the number of interrelations which can exist between uses.

There are some general categories for handling the interrelations between different uses of water. Any pair of water uses may be technical complements or technical substitutes. If they are technical complements, then one use enhances the other. The creation of a water area for a waterfowl refuge may also produce some increase in the fish population and in furbearers. Also, increase in the flow of water at one point in a stream may enhance uses downstream.

By contrast, technical substitutes are uses which conflict with each other to some degree. Some uses may be highly antagonistic. For example, water diverted to irrigation use is depleted by about 60 per cent of its volume -- of every million gallons put on the land, 600,000 gallons are evaporated from the soil surface and transpired from plants and only 400,000 gallons eventually returns to the water course. Water diverted from an industrial process may be returned to the water course undiminished in flow but its usefulness for other purposes may be completely destroyed. Other uses may be only slightly competitive. For example, power boating on a lake may impair somewhat the usefulness of the water surface for fishing or swimming; both uses may be impaired by moderate drawdowns in the reservoir in order to generate hydroelectric power or to provide water supplies downstream.

To the extent that complementarity or independence exists between uses the common phrase "multi-purpose use" may be applied without causing any difficulties. When complementarity exists and both uses have positive value it is generally desirable to develop one or the other use at least until the complementarity is exhausted and they become independent. To some extent recreational use is complementary with the creation of a reservoir for nearly any purpose but such complementarity may be easily exhausted by only a little recreation and then the uses become competitive.

When uses become competitive with each other then we cannot be glib about the desirability of multiple use. It is entirely possible that the best solution to some competitive use problems is the devotion of the water in question to a single purpose use. This may mean that certain streams are best used solely for the carrying of wastes while others may best be dedicated solely to free flowing river recreation. It may mean that some reservoirs should not be developed for recreational uses which will require the setting of limits against drawdowns but should be drawndown unrestrained by recreation interests while other permanent level reservoirs should be dedicated solely to recreation, perhaps to even certain kinds of recreation.

To grasp the problem of competition for water in the large, that is in terms of over-all sufficiency of supply, we have to elevate to some economic relations. When we do this we find that we are no longer able to discuss the competition for water, as competition for water. We are able to have as much water as we want any place we want it for any purpose so long as we are willing to pay the necessary price. The competition is not for water but for dollars, for the investable funds which any program for developing and using water might demand.

In reality all competition for water both in the large and in the small is reduced to an economic competition in which our criterion for resolving conflicts can be economic efficiency. Economic efficiency requires that we make the best use of our dollars as between water and other demands and that we make the best use of our water as between competing uses.

Resolving problems of competition between uses requires two kinds of information: Information on the technical relations between uses

and information on the additional value accruing to society from having more of either use. Resolving problems of competition between public investment in water and other public and private investments requires the same sort of information between water and its competitors. The question is what means do we have for collecting and acting upon such information?

III

MANAGING THE WATER ECONOMY

In order to find a unity for dealing with such problems of competition, we must turn to the realm of ideas to develop some principles regarding the existence and operation of the water economy. From here I propose to return to some actual problems and draw some conclusions as to how the choices might be approached, both in terms of instruments and institutions for dealing with them.

The first idea concerns the Water Economy. The water economy, unlike the steel economy or the lumber economy is largely a public economy. We do not have public meetings for the purpose of discussing the problems of conflicting uses for steel or lumber. The reason is that conflicting demands for these commodities are resolved in the market places of the private economy. Such conflicts are resolved by the active bidding of users against each other for limited supply of the material. Such bidding sets a market price which excludes all those who are unwilling to pay the market price for particular uses of the commodity. Now this may mean that all users get some of the material but none get any more than they are willing to pay for. We believe that the market works well in allocating steel, lumber, and thousands of other commodities to the best, i.e., economically most valuable, uses. The great virtue of the private markets is that they accomplish an enormous amount of decentralized calculation and decision-making that would otherwise overburden central authority.

Why is the production and distribution of water dealt with in the public economy and not in the private economy? The first reason is that those who would invest in the production of some kinds of water services cannot be assured of capturing the full value of their products. Consider the problems one would have in excluding his neighbors from enjoying the benefits of a flood protection reservoir he might erect for the protection of his property. The second reason covers the obverse case; that is, there is no way the private market can impose upon a polluter the downstream costs of his waste discharges. Together these two reasons cover most of the rationale for the existence of a public water economy. In sum, water services are produced publicly because of the common good which such services produce and because of the economies realized from coordinating upstream-downstream relations.

Other reasons for public investment in water resources can be covered by saying that the investment requirements for an efficient scale of operation are often too large for private firms to finance

(think of TVA), sometimes they are too risky for the private economy and sometimes there are public intentions to subsidize certain regions or certain groups of water users. This is not to say that all water services produce common goods nor that public entrepreneurship always guarantees the best solutions to our problems. In fact, we can now examine some disadvantages of our public water economy and in so doing raise some issues which bear on how we might deal with emerging water problems.

In the first place, we must recognize that in the public economy the political process largely replaces the market process. While we do not want to ignore the imperfections of the market process, it is appropriate here to call attention to some of the imperfections the political process has in dealing with our water problems. The political process involves bargaining in which the ability to walk off with a purchase is not so dependent on willingness to bid up a money price as it is on ability to operate strategically. The bargaining for water resource projects in the Congress has come to be known for better or worse as the pork barrel. The water resource agencies have their own kind of bargaining process in which the water resources budget may not serve the criteria of efficiency either in total size or composition. Moreover, tradition is of enough consequence in government as elsewhere that programs are perpetuated on their own momentum long after their services have ceased to have any value.

Among other costs of our way of doing business in the public water economy, one certainly is that the initiative and the ability to plan and carry out water resource programs has been concentrated in the federal government. The federal monopoly on an impressive array of technical talent has meant that the state and the regional role in water resource management has been sporadic at best. While the federal government may be more responsive to the needs that have been articulated in water resources, and therefore justly deserving of its preeminence in this field, it also may be that greater participation in water resource planning by state and regional bodies can result in greater inventiveness in locating solutions to problems and greater fidelity to state and regional preferences.

Our approach to the flooding problem illustrates the potential role of more localized planning and action. Traditional choice in flood plain use has been between (1) flood protection and (2) bearing the loss without other adjustments. By flood protection I mean resort to dams and levees.

Increasingly there has been attention paid to other possible adjustments such as comparing costs of using sites outside the flood plain with costs of development in the flood plain. Other alternatives are flood proofing (which is a combination of emergency evacuation and changes in structures), insurance and watershed treatment. Now land use adjustments in the flood plain are particularly suited to local initiative but such alternatives will not be perceived unless there exists an organization for gathering and analyzing information at the local level. Appropriate state or regional authorities might do this and might in the process inject some healthy competition into the

state-federal planning relation.

Creating more planning initiative to countervail the federal agencies answers only a part of the problem. With the concentration of responsibility for water resource programs at the federal level of government and the separation of decisions from any market process has also come a divorce between the beneficiaries of projects and the responsibility for ultimately paying for them. This means that willingness to pay by the consumer does not carry the weight in public decisions that it has in the market place. Under these circumstances the public solution of water resource problems becomes subject to biases in which only those measures eligible for federal money are considered and at times the process approaches a bald raid on the federal treasury. To correct such biases all measures might be eligible for the same degree of federal financing and financing might be available to federal and non-federal authorities. A more important correction to such biases might involve greater use of user charges and higher charges to more nearly cover the costs of the service.

Now a word about the general goal of economic efficiency in the water economy. Efficient means precisely that we seek solutions to our water problems which maximize the net benefits of the planned expenditure, or if benefits are not measurable then we seek the least cost means of achieving a particular result. Besides adopting the goal of efficiency, I am working from the postulate that decentralization of the enormously detailed calculations necessary to achieve efficiency is a necessity in the water economy. My model here is a properly safeguarded private market.

The goal of efficiency in water resource programs when implemented by the benefit maximizing procedure known as benefit-cost analysis to the water agencies or by the cost minimizing procedure known as "cost effectiveness" in the Defense Department induces us to follow rational behavior in our investments in water resources. Another way of describing what is involved is to say that we are economizing. To economize on water resource investments is both to make the best use of limited funds for water resource development and also to make the best use of a given water resource. The opposite of economizing behavior is squandering in a manner which does not give us the greatest possible benefit for the resource expended. We tend toward squandering when we come up with plans which say we must have X million acre feet of water for such and such a purpose in such and such an area by such and such a time. The Senate Select Committee on Water Resources a few years ago asked the water resource agencies to estimate future needs in their areas. This resulted in a congeries of requirements that say we can spend another 22 billion dollars on reclamation projects, another 8 billion on navigation projects, another 6 billion on flood control and 15 billion by 1980 on a new investment purpose called low flow augmentation, which means providing water for waste disposal and water supply during periods when natural flows are low.

Were we to completely fulfill such requirements over the next 20 or 30 years, it would be done at the expense of better schools, better

health care, at the expense of continued blight in our central cities and continued neglect of our depressed rural areas. Unless the federal budget becomes vastly larger, these are the real costs of the requirements approach to any public expenditure.

We cannot make wise decisions either in the water economy or in public expenditures of other kinds by simply proclaiming requirements. Instead we must develop information on how much it is worth to have more water in a certain place at a certain time and how much it costs to achieve the result by the lowest cost means. Such information comes only from fairly elaborate analysis which can improve our choices by such a margin that it is worth more widespread use. Even here we must recognize that information costs money and there must be a limit to the expense we are willing to absorb in order to improve decision-making. Some examples from my current research hopefully may illustrate the kind of result attainable by more elaborate analysis.

IV

THE CASE OF THE POTOMAC

The Potomac River flows through the nation's capitol from the hinterlands of Virginia and Maryland as virtually the same pastoral river known to George Washington. The growth of the Washington metropolitan area and of certain industrial areas is catching up with this natural river, however. In a matter of 10 or 15 years the natural low flow of the river will be unable to meet Washington's daily water supply withdrawal if this withdrawal grows at projected rates. Moreover, at various times over the next 50 years certain parts of the river, the foremost of which is the estuary at Washington, stand a chance of becoming obnoxious during low flows because the waters will not be able to assimilate the expected quantities of even highly treated sewage effluents and at the same time maintain a pleasing quality. The Corps of Engineers has proposed a system of 16 major water storage reservoirs on the Potomac and its tributaries in order to maintain sufficient flows during times of drouth so that water supply withdrawals can be met and water quality maintained up to standard. Flood control storage is significant in two of the reservoirs and in addition the Soil Conservation Service has proposed an extensive system of headwater reservoirs for flood control and low flow augmentation. The major reservoirs, especially, would also be expected to provide substantial amounts of outdoor recreation for the surrounding populations, so much so, in fact, that nearly one fifth of the total investment cost of $495 million would be spent on recreation lands and facilities adjacent to the reservoirs. One of the reservoirs, being very close to Washington, would be expected to ultimately sustain 7 million recreation visits annually. This reservoir is the subject of a heated controversy because it would inundate 30 miles of the C. & O. Canal Towpath and a like amount of natural river. This 30 miles currently sustains a significant amount of recreation, albeit a different kind of recreation than that afforded by a reservoir.

There is little room for disputing the Corps' diagnosis of the water problems of the Potomac Basin. The low flows of the river will

eventually be inadequate in places to accommodate withdrawal demands and water disposal requirements unless something is done. The question is what should be done? The question is a general question which applies to most of the rivers in the humid East where sooner or later these same problems will occur. Unlike the arid West where water supplies are totally allocated, if not over-allocated, the humid East has plenty of water for meeting withdrawal requirements most of the time, and with a little storage and regulation can meet demand nearly all of the time. The problem will be to minimize pollution costs in water which flows by city after city and factory after factory.

Let's ponder how we might approach the question of what should be done in these circumstances. In the first place the predictions of municipal and industrial water shortage are based on certain projected water use rates. These are projections of physical quantities which have no relation to future costs of water. If water use projections were to be made under conditions of rising costs of supply and with the proviso that users would be expected to pay the supply price, water withdrawal rates might turn out to be significantly different from projections which assume essentially free water. When water becomes sufficiently dear industries can afford to reclaim and recirculate process and cooling water and homeowners stop using water to flush grass clippings off lawns or to irrigate lawns profusely. It is even conceivable that in certain areas dual water systems can be justified which would circulate very costly supplies of potable water for human consumption and lower grade water for other uses.

It should be noted here that the introduction of pricing policy for water to meet the costs of the marginal quantity supplied is a device which cuts two ways: It rations the supply by forcing out the low value uses and it informs the supplier of the consumer's willingness to pay for additional quantities supplied. We shall mark this use of price as the first point at which a device of the private economy might be transferrable to the public economy. In another application price might be applied to the problem of waste disposal as follows: The use of a stream for disposing of wastes is both a valuable service and an act which imposes costs downstream. If waste dischargers are charged for the costs they impose on others they will have an incentive to reduce pollution up to a point where their additional costs of pollution reduction are offset by the additional savings in effluent charges. If a rational polluter chooses to pay the charge rather than reduce his waste discharge this tells us that it is best for society to bear the costs of his pollution, whatever they may be.

A very important aspect of the demand for water services concerns the level of water quality we wish to achieve in our water courses. In the Potomac Estuary, as elsewhere, we are forced to rely upon standards in making our choices. Several aspects of our standards make it difficult to defend them as efficient choices.

In the first place, standards which say that the dissolved oxygen should be 5 ppm in the Potomac Estuary are arbitrary numbers which are arrived at without adequate knowledge of the consequences of not meeting the standard some of the time or all of the time. Nor

is there an attempt to consider what we might be losing by not having a higher standard. It might also be useful to know how much less it would cost in waste treatment plants or reservoirs to adopt a lower standard. For example, we might willingly invest $10 or $20 million but not $50 million to raise dissolved oxygen in the Potomac Estuary from 3 ppm to 5 ppm.

The second difficulty with standards is that they are largely technical judgments which are arrived at by engineers and technicians. While we are indeed fortunate to have experts who are willing to take such judgments on themselves, we must also wonder if they are basing their judgments on the really important criteria and if their judgments are really what society would prefer if it were fully informed and able to exercise a choice. Perhaps it is not dissolved oxygen but the color of the water which is of real interest to those who use the Potomac Estuary. If clear blue or green water is preferred over the turbid greenish-brown water now found in the estuary then siltation and plant nutrients are the pollutants we ought to be concerned about and not organic sewage. Moreover, we could well look for a means for making such choices that does not depend, as we do now, on the planner's choices. In this connection the regional river basin authority has some merits worthy of discussion.

Whatever water quality goal we choose, the dictates of efficiency require that we find the least cost means of achieving the goal. Low flow augmentation is the proposed remedy for the quality problems of the Potomac. In order to make the point that flow augmentation is the least cost remedy for a water quality problem, one needs to test a range of alternatives in various combinations. This our research is doing in the hope of demonstrating the value of the analytical approach. The alternatives are of three kinds: Higher levels of waste treatment; mechanical reaeration; and diversion of wastes to points where the river is more capable of handling them.

Conceivably we could discover that there are less costly systems for solving the quality problem than the one officially proposed. Such a least cost system might include using some very high level waste treatment for only short periods during the year, some diversion of wastes to other points and some reservoir storage for low flow augmentation. The question then will be why the federal planning effort did not discover such a solution. Two possible answers can be found. One is that inadequate knowledge exists on advanced waste treatment or even on the effects of redistributing waste loads in a body of water. This suggests an intensified research effort. The other answer, possibly the more significant one, is that there is neither the planning authority nor the financial incentive to give serious consideration to the waste diversion or waste treatment alternatives. There is no mechanism by which to make the decision that the local governments in the Washington Metropolitan area will operate high level waste treatment or divert their wastes from the critical parts of the estuary. Nor is there an operating authority which would coordinate such a move. Finally, the local governments have good cause to be disinterested in such alternatives for the reason that they would pay the full costs of such actions, whereas solving the same problem by low flow augmentation is 100 per cent federally financed.

Clearly both situations are defects in our current planning, if, as we now suspect, there are better choices than the proposed remedy. The defects cannot be cured unless the authority and financing of the agencies is extended to a bigger arsenal of tools or unless regional planning authorities with equal scope and financial backing can be created to meet such problems.

Finally, the planning for recreational use of water presents at once the problems of a rapidly growing demand and a paucity of information on that demand. Whereas, matters of water supply, flood damage reduction and to some extent water pollution deal with consequences for which there are economic measures, there are as yet no economic measures which adequately reflect the social values of additional water for recreation. We need such measures not only to plan wisely for recreation vis-a-vis other uses of water, but also to plan for the best combination of the various recreations.

The proposal for the Potomac Basin will again serve as illustrative material for two kinds of issues in recreation planning. First of all, at least two of the reservoirs in the proposed plan will obliterate all opportunities to enjoy popular reaches of natural rivers. Our present structure for planning recreation in connection with river basin development does not permit a positive treatment of natural recreation opportunities. At best we can only avoid destroying them. Even if we were geared for positive treatment of natural rivers we would be hard put to find the data on relative values of river versus reservoir recreation from which to argue the choices.

Secondly, we have not even the feeblest means for evaluating a plan for recreation development tied to a reservoir system in a basin which has a wealth of potential recreation investments, not only on natural rivers but on the shores of estuary and ocean and in some of the most primitive mountain forests of the East.

The need for better information on the preferences of recreationists, including their willingness to pay for the recreation benefits they receive and on the costs of supplying the various kinds of recreation opportunities is apparent.

V

CONCLUSIONS

My conclusions from this discourse are that we must meet certain needs for analysis and organization -- the two are mutually dependent -- if we are to successfully meet the challenges ahead in arriving at efficient solutions to the competition for water for the public water economy. The competition we are concerned about is competition for dollars, first of all, to be invested in water resource development. It would be unwise to yield to the scarcity phobia and over-invest in water at the expense of other public or private goods.

As for competition among water uses, or competition in the small, we must be concerned first with taking full advantage of all complementary uses of water and second with allocating water among conflicting uses in a manner which yields the highest possible benefit to society. While efficiency may be our primary goal, there is room for compromising efficiency in order to serve the ends of equity or fairness.

Certain approaches merit consideration as we tool up for the job confronting us. In general, we need to examine the virtues of the decentralized decision-making that takes place in the private markets with an eye to using quasi-market devices to resolve competition in the public water economy. Specifically:

1. There may be real benefits from enlarging the state and regional role in water resource planning and management if this can be done without spreading the qualified people too thinly. Alternatively, we can expand the arsenal of tools available to the federal planners. In either case the goal is that all potential solutions to a problem be considered and not just a few which happen to be federally subsidized.

2. We must be prepared to enter into much more elaborate analyses of water resource systems in which more and better information is developed in the planning process and used to perceive a range of alternatives so that the choices available to us have some real variety and content.

3. In turn, the organization for making choices must be able to function effectively so that the planners themselves do not end up making the choices.

4. Particular information problems exist: (a) on predicting demands for various water services in a way which incorporates feedbacks from the supply costs, (b) on developing techniques for waste treatment and industrial use in response to the new problems, (c) on measuring recreation demands and benefits, and (d) on the alternative legal and instiutional conditions that affect the efficient performance of the water economy.

5. There is much to be gained from associating charges with users who benefit from a water service, be it water supply, waste carriage, navigation or recreation. Charges based on costs, and preferably marginal costs, serve to allocate water to the best uses and to put realistic limits on demands. Free water services by contrast encourage uneconomical uses and unlimited demands or "requirements."

In sum, if the goal of rational, economizing behavior is accepted then we need to continue to improve in these directions the means by which the public water economy resolves the competition for water.

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