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Interbasin Water Transfers -- Economic Issues and Impacts*

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Transfer of water between river basins is not new to the United States. California, Colorado and New York have all completed water transfers between basins. But transfers such as the Colorado-Big Thompson diversion of 230 thousand acre-feet are small in comparison to proposals to divert Columbia River water into the Colorado which range from 2.4 to 30 million acre-feet or proposals to divert as much as 16.5 million acre-feet from the lower Mississippi River system to west Texas and eastern New Mexico. [8]

Besides their large size, these proposed interbasin transfers have other characteristics which differentiate them from most alternative projects or policies. They involve large lumpy investments that will be long-lived and have irreversible effects on environment. The long life of the structures leads to inflexibility in the water system for incorporating technological innovations. These characteristics help illustrate the special need for analyses of proposed water transfers. And in this paper I will attempt to point out some of the more important economic issues and impacts that need to be analyzed.

The exclusion of political and institutional variables is not meant to imply that they are not important. The only words of wisdom that I would like to offer concerning these variables is that they should be considered in the same context as economic variables. Because a

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decision involves political implications, this does not mean that one makes the decision without analysis of the various alternatives and their consequences. Systematic analysis can be applied to political and institutional variables although it may not be as precise as that applied to the economic variables. Still the decision maker would like to know if the politically based decision will cost him $5 million or $100 million and roughly how much of a positive or negative effect it will have on the voters. In the same context the various impacts of an institutional constraint should be analyzed and if the impacts are found to be adverse enough an attempt might be made to modify the institution.

Economic Issues

To begin with, in the framework of national or even regional economic efficiency there are two overriding economic issues that need to be resolved concerning interbasin transfers of water. First, is there an economic demand for the water that could be provided by a water transfer and second, what are the alternatives to interbasin transfers?

The importance of these two issues is emphasized by the necessary conditions for economic justification of interbasin water transfers. The first condition requires that the net value of the additional output in the importing region plus any additional output along the route of the transfer must exceed the value of any output given up in the exporting region plus the cost of building and maintaining the works necessary to transport the water. The second condition requires the cost of the water transfer to be lower than the least cost alternative

means of providing additional water. Thus besides project cost the two important conditions that should be determined are the economic value or demand for water and the cost of alternative water sources.

Economic Demand

Economic demand means the maximum quantity water users would be willing to pay for an increment of water. This amount is equal to the market value of the increment of output of goods and services made possible by the additional water, net of any other increases in production costs. Economists refer to this amount as the marginal willingness to pay for water. For example, if an additional acre-foot of water permitted the farmer to increase the value of his production by $10 without incurring any additional production expenses, his marginal willingness to pay for the water would be $10 for one acre-foot.1/

The economic demand for water delivered by an interbasin transfer will depend on the lowest valued output net of cost (the marginal uses). In other words the outputs that would have to be foregone if there were no additional water. And numerous empirical studies of the arid and semi-arid areas of the West indicate that the marginal user of water is some sector of agriculture. /11/ /12/ For example, in Arizona the personal income generated per-acre foot of water ranges from a low of $14 for feed and food grains to over $82 thousand for manufacturing uses. (see Table I)

1/ However, this does not imply that the farmer ought to be required to pay $10 for the additional water. Under an economically efficient pricing scheme, the price should depend on the marginal cost to society of providing the water.

Table I: Personal Income per Acre-Foot of Water in Arizona Sector, 1958 a/

Sector	$/acre-foot
Food and feed grains	14
Forage crops	18
High value intensive crops	80
Livestock and poultry	1,953
Agricultural processing	15,332
Utilities	2,886
Mining	3,248
Primary metals	1,685
Manufacturing	82,301
Trade, Transport, and Services	60,761

a/ Source: Young and Martin (1967), Table 1 p. 10

The order of magnitude of these differences also suggests that if water becomes limiting, industrial and municipal users will find ways to buy the water from agricultural users if State and local institutions permit such transfers. This along with the high portion of western water used for irrigation supports the conclusions that the additional water provided by western interbasin transfer will, primarily, be used by the agricultural sector or will eliminate the need to shift water out of certain low valued agricultural uses. The economic value or demand for water should, therefore, be based mainly on these agricultural uses.

Further, the value of this increment of water will vary depending on whether it is a rescue operation or just an increase in agricultural production. The latter includes increased production on presently irrigated lands (sometimes called supplemental irrigation) or on newly irrigated lands. Only if the increased water supply replaces another source of water that is being depleted or lost (a rescue operation) will the value of the water to society likely be greater than the farmer's willingness to pay. When the increased water supply actually prevents irrigated land from going out of production or dropping in productivity, there will be a possible savings in income for immobile resources or from differential productivities of inputs. If income savings to resources do accrue, these savings will be part of the benefits from the water transfer. Since with income savings, benefits exceed the farmers ability to pay for the water, a price below the cost of the

water transfer may be charged the farmer for the period when the resources are immobile. 2/

The following news release concerning water imports to western Texas and eastern New Mexico helps illustrate the importance of the nonfarm portion of these income savings benefits.

> "2. Regardless of the route, the cost per acre-foot for delivering water from the lower Mississippi River system to irrigators in the study area appears certain to exceed substantially their ability to pay for such water.
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> 3. Economic benefits of irrigation to nonfarm elements of the study area's economy are large and appear to be sufficient to warrant payment by those nonfarm elements of costs of import water in excess of the irrigator's ability to pay." [8]

The above implies that the interbasin water transfers can only be economically justified by counting undetermined nonfarm benefits. If so, these benefits should be carefully evaluated to determine the extent they arise from possible income savings from immobile resources or differential input productivities, because benefits not attributable to income savings should not be included as part of the national economic efficiency benefits resulting from the interbasin transfer.

A related issue is the need for increased agricultural production, now and in the future. High national economic demand for irrigation water will only arise if for some reason there is an increased demand on our agricultural land resources. Yet in light of our present acreage

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2/ Even if the benefits are from income savings for immobile resources or differential input productivities, a new water pricing system should be devised so that when the resources have been consumed, there is not a new set of resources dependent on water priced below cost. One means of preventing the accumulation of new resources dependent on water priced below cost would be for the price of water to remain below cost only until the initial resources have been depreciated or have found new employment.

retirement programs and a number of good studies that show these acreage retirement programs will be necessary at least through 1980, such pressure does not seem very probable. [1] [4] In addition, it appears that the developing countries have the capability and are starting to fill more of their own food needs, which reduces the likelihood of a continued expansion of U.S. food aid and other exports of agricultural commodities. [2] Consequently, the U.S. is very likely to continue to have more agricultural land available for production than is needed to meet domestic and foreign demands for agricultural commodities.

Finally, the question of regional versus national benefits is particularly important in this analysis since the major benefits from most western interbasin water transfers will come from agricultural production. To the importing region all of the agricultural production resulting from the interbasin transfer has a value equal to the net value added plus any indirect economic activity maintained or created by the production. But from the national point of view, unless the area affected is depressed, the agricultural production and indirect economic activity may be primarily a transfer from other regions. The probability of the agricultural production being just a transfer from other regions seems very high since acreage will probably have to be retired in other regions in order to maintain farm income and prices. Such a transfer may be justified on the basis of Government policy or income distribution but the regional benefits should be treated as transfers and not as additions to national income.

Least Cost Alternatives

The second major issue involves possible alternatives to investments in interbasin water transfers. These investment trade-offs or alternatives should involve not only other sources of water supply and greater efficiency in the use of water but also other uses for public funds such as education, training, and health and medical services. Too many times we who come from the arid and semi-arid parts of the West get a fixation on water investments. We assume that water is the limiting resource and, therefore, public investments in water will have the highest payoff for the region. I would argue that this probably is not so and that an investment in health care or education may have a much higher payoff in terms of regional economic growth and development. In his recent study of the importance of water resources in regional economic growth Howe concluded "that water resource developments are likely to be poor tools for accelerating regional economic growth if markets, factor availabilities and other amenities of living are lacking." [6]

But even limiting the investment alternatives considered, to alternative sources or uses of water, opens up a wide range of trade-offs. Foremost among these alternatives is the possibility of increased efficiency in agriculture. Since agriculture is by far the largest user of water in the West, small changes in efficiency will release large quantities of water for use elsewhere. In 1954, U.S. Agriculture withdrew approximately 200 million acre-feet of which 60 percent was consumed. [9] During the same year, in the Western Gulf, Upper Rio Grande-Pecos, Colorado, Great Basin, and South Pacific regions, 23 times

as much water was consumed in agriculture as in all mining, municipal, steam-electric generation, and manufacturing uses. /10/ Assuming these same proportions continue, a 5 percent reduction in agricultural uses would provide for a 115 percent increase in all other uses.

Besides improving water use efficiency in agriculture water could be shifted from irrigation to non-agricultural uses. This has already been done in a few areas and given the large quantity of water used in agriculture relative to the quantity used in other sectors, a small proportion of irrigation water shifted out of agriculture would allow other sectors to significantly increase water consumption. But in any shift in water use the net value of output foregone will have to be included as part of the cost of shifting water use. Losses of income to resources in agriculture or related industry should also be included as part of the cost of changing water use. On an economic efficiency basis, these shifts should only take place when the water's net value of present output plus potential income losses to immobile resources or from differential input productives are less than the water's net value of output in the new use.

Other possible alternative means of providing additional water include control of evaporation losses, surface water development, waste water reclamation, desalting, weather modification, saline water irrigation, water harvesting and belt tightening. Some of these alternatives are presently high cost or technically not feasible. Significant break throughs in new technologies will have to be developed before control of evaporation losses is possible on large bodies of water or before weather modification provides significant quantities of water

when and where they are wanted. Although desalting is an alternative already being used in a few instances for municipal water supplies, it so far is not the answer for supplying large quantities of low cost irrigation water.

In contrast some of the alternatives appear to be quite competitive with interbasin water transfers both in terms of cost and quantity. (See table II) For example, reductions of conveyance losses in the West could provide 20 million acre-feet of water while water transfers out of agriculture and control of vegetation both have the potential of supplying the same quantity of water as large interbasin transfers. Further, additional surface development could supply 40 million acre-feet of water and vegetative management and snow fencing could yield 9 million acre-feet. The cost of these alternative water supplies ranges from $1 to $81 per acre-foot.

These figures are summarized primarily to show that alternatives are available which compare very favorably with most water transfers. Whether they will be a lower cost source depends on the place and timing of the particular demand for water.

Table II: Alternatives to Interbasin Transfers a/
Estimated Quantities and Costs

Alternative Sources	Indicated Amount Available	Indicated Range of Costs per Acre-foot (dollars)
	(Millions - Acre-Feet)	
Reducation of conveyance losses	20	2-50
Transfers from agriculture	potentially large	9-81
Additional surface development	40	1-68 b/
Vegetative management and snow fencing	9	2-23 c/
Phreatophyte and riparian vegetative control	potentially large	2-62

a/ Source: Howe and Easter (1968) unpublished manuscript
b/ Impoundment costs only.
c/ Does not include storage costs.

Economic Impacts

The above economic conditions for interbasin water transfers were necessary but not sufficient conditions. Certain economic impacts of projects as large as some of the proposed western water transfers may be so undesirable that the projects have to be drastically modified or dropped. To illustrate, will the water transfer cause excessive stress on certain sectors of the United States' economy? Also what will be the distribution of benefits from such projects both regional and among income classes within regions? During the short-run construction period significant increases in demands could hit certain industries and labor classes while the long-run impacts will primarily fall in the agricultural sector.

Construction Period Impacts

A public investment of the magnitude of proposed water transfers could create demand in excess of that which certain industries or types of labor could accommodate. In other words, the construction demands of the water transfer might create bottlenecks in certain sectors of the U.S. economy. These bottlenecks could cause excess wage increases for certain labor skills and extensive delays in the deliveries of key industrial goods. But analysis of proposed interbasin water transfers would identify the possible areas of economic strain and allow action to be taken that would ameliorate some of the adverse effects.

Haveman and Krutilla's study of water resource investments and their impact on occupational and industrial demands provides the necessary framework to trace out the effects of these construction period expenditures. [3] Their input-output model can be used to determine in which industries and regions the primary demands will be made as well as indicating the type of labor required by skill categories.

Not only would the distribution of demands regionally and by industry and labor class be helpful in pointing out possible areas of economic strain, it would also be helpful to those concerned about shifting income distributions. If certain areas or labor classes have high unemployment levels, what are the relative impacts of alternative water development investments on their employment levels? The projects' construction demands may fall primarily in those areas and labor classes which have the highest level of employment.

This appears to be the case for Pirkey's Western Water Project since the labor requirements would be concentrated in the professional and highly skilled categories. [5] In addition a very heavy concentration of industrial demands would occur in the East-Central industrial belt and surprisingly little in the construction regions themselves, although industrial demands would be small relative to the relevant industrial capacities nationally. Finally, similar studies of large interbasin water transfers using the Haveman - Krutilla approach would seem to be a necessary step before a major water transfer proposal receives serious consideration.

Agricultural Production Impacts

Shifting now to the evaluation of the longer-run production impacts, it should be remembered that the primary direct long-run economic benefit from most western interbasin water transfers will be to increase or to prevent the decline in a region's agricultural production. Thus the analysis of the long-run agricultural production impacts is a key element in the evaluation of most western transfers.

To simplify this analysis of production impacts it has been divided into two parts. The first evaluates the economic impacts of additional water on the regions obtaining the water while the second considers the substitution effects on other agricultural regions. Since a region is unlikely to allow the export of its water to another region, unless the water is in excess of future "needs", the exporting region could fall in either of the above divisions depending on whether or not the transfer project delivers additional water to areas within the exporting region. 3/

To trace out all the economic impacts on the regions receiving additional water, imported or otherwise, requires detailed analysis. Regional or possibly State input-output analysis can be used to trace out some of the impacts. Our study using input-output analysis indicates that one key assumption is whether or not State or regional agriculture is a bottleneck to the expansion of those industries heavily dependent on agricultural inputs. If agricultural inputs are assumed to be readily available the State or regional economic expansion is about 1/5 of the expansion calculated when it is assumed that inputs supplied by agriculture restrict industrial expansion. Of course, with our present national excess agricultural productive capacity and extensive transportation system the former assumption seems more realistic.

3/ Floyd E. Dominy strongly emphasized this point when he said: "before any plans are developed for diverting any such quantities from the lower Mississippi River system, we intend to be sure that only water in excess of the foreseeable needs of any State involved can be considered surplus and available for possible importation into the High Plains." / 8/

Another important assumption is that input and output price levels will be constant. For large increases in agricultural production this assumption is probably not realistic. Since the elasticity of demand for agricultural commodities is less than one, farm prices will be depressed proportionately more than the increase in production. Consequently, for large interbasin water transfers the price depressing effects must be taken into account.

It should also be kept in mind that a good portion of the increase in economic activity is likely to be just an increase for the State or region. A national input-output model would have to be used to determine the net benefits to the Nation from a water transfer. In such a national framework the shifts between regions could be traced out and the increased production in water importing regions would be offset by the decline in other regions.

This brings us to the second part of analyzing the long-run agricultural production impact. Here one must analyze the Nation as a whole and take into account the substitution in production and consumption that takes place at the margin. For changes in agricultural demand or supply in one region or crop will have an effect on other regions and crops.

Tolley and Hartman have characterized the demand for U.S. agricultural production as being "like a container to which supplies from various areas must accommodate themselves." [7] And while the U.S. demand or container has grown slowly over the years, mostly in response to growth in population, our ability to fill the container has grown rapidly. One result has been the growth in farm commodity programs

designed to keep the container from overflowing and also to purchase and dispose of the overflow.

Without the commodity programs increases in the quantity supplied would cause overflows and farm prices and income would fall. The drop in price would force out those producers who have just been staying in business at existing prices. For example, increased irrigation in the arid West would probably mean a cutback in production in the Southeast and in the Plains States.

But Federal commodity programs have modified these substitution effects and tended to distribute them more evenly over the U.S. A cutback in production due to increased western irrigation will not be just in the marginal farming areas of the U.S. but will tend to be distributed rather uniformly between all farmers participating in the commodity programs. Cooperators generally have to retire 5 to 20 percent of their acreage and in some cases have the option of being paid to cutback even more. This land in most cases must remain idle and has a marginal value product of zero. Thus besides costing the Federal Government diversion payments to retire an equivalent amount of agricultural production there is also a loss in returns to land resources. Under existing commodity programs, the estimated annual Federal cost of retiring land that is equivalent in productivity to land brought into production under Federal irrigation projects ranges from a low of $39 per acre for feed grains to a high of $397 per acre for cotton. [5]

Assuming that the Federal land retirement payments are equal to the income foregone by not producing and that the retired land is idle, these payments are a measure of national income foregone. Therefore, for Federal irrigation projects to be of national economic benefit, the net

return resulting from the application of the additional irrigation water must be greater than the payments required to retire an amount of production equivalent to that conduced or sustained by the project. Since the cost of retirement and the national income foregone is external to most State, local or private water developments, they tend to ignore these impacts. Yet at the national level or even in certain western States, irrigation development in one section has meant a cutback in production in others.

An example of the likely substitutions in other regions can be drawn from the historical experience of the Bureau of Reclamation irrigation. Increased reclamation irrigation over the period 1944-64 has probably displaced 5 million to 17 million acres of farm land in non-reclamation areas. This is approximately 8 to 26 percent of the 66 million acre decline in cropland harvested during 1944-64. On crops such as potatoes, edible dry beans and sugar beets, the direct displacement effects are substantial as reclamation served lands in 1964 accounted for almost 20 percent of the U.S. potato production, over 30 percent of the U.S. edible dry bean production and 45 percent of the U.S. sugar beet production. /5/

Examples could also be drawn from other Federal agencies. For much of what has been said about the impacts of interbasin transfers on the agricultural sector also applies to other Federal investments that increase agricultural productive capacity. Investment by the Army Corps of Engineers, the Soil Conservation Service and the Agricultural Conservation Program for flood protection, drainage and irrigation have the same substitution effects on other regions. In fact, a recently authorized project in South Central Florida, that will bring

close to 2 million acres into agricultural production, is of the same magnitude as some of the proposed interbasin transfers. Possibly, some of the experiences that will be gained from this Corps investment can be used in the analysis of the proposed interbasin water transfers.

In conclusion, large western interbasin water transfers would appear to have a potential for both creating and solving economic problems. Until extensive studies including the elements discussed in this paper are completed, it will be difficult to judge the national economic value and cost of proposed water transfers. Yet, based on our preliminary analysis, water transfers do not appear to be any panacea for the arid and semi-arid parts of the West. At best, they are just another possible alternative water source for certain sections of the United States that needs further evaluation.

Bibliographical References

/1/ Able, Martin E., and Anthony S. Rajko, World Food Situation, U.S. Department of Agriculture, Foreign Agr. Econ. Report #35, U.S. Gov't Printing Office: 1967, 29 pp.

/2/ Brown, Lester R., New Directions for World Agriculture Foreign Agriculture March 25, 1968, pp. 8-10.

/3/ Haveman, Robert, and John Krutilla, Unemployment, Excess Capacity and Benefit-Cost Investment Criteria, The Review of Economics and Statistics, Aug. 1967, pp. 382-92.

/4/ Heady, Earl O. and Leo V. Mayer, Food Needs and U.S. Agriculture in 1980, National Advisory Commission on Food and Fiber Technical Papers, Vol. 1, U.S. Gov't Printing Office: 1967, 115 pp.

/5/ Howe, Charles W. and K. William Easter, Interbasin Transfers of Water: Economic Issues and Methods of Analysis, Unpublished draft manuscript, May 1968.

/6/ Howe, Charles W., Water Resources and Regional Economic Growth in the United States, 1950-1960, The Southern Economic Journal, Vol. 4, April 1968, pp. 477-489.

/7/ Tolley, G.S. and L. M. Hartman, Inter-Area Relations in Agricultural Supply, Journal of Farm Economics, Vol. 42, May 1960, p. 453.

/8/ U.S. Department of the Interior, News Release, May 10, 1968.

/9/ U.S. Senate, Water Resources Activities in the United States: Water Supply and Demand, Committee Print No. 32, Eighty-Sixth Congress, U.S. Gov't Printing Office: 1960, Table 52-W, p. 122.

/10/ Ibid., Tables 52P-52V, pp. 109-121.

/11/ Wollman, Nathaniel, et. al., The Value of Water in Alternative Uses with Special Application to Water Use in the San Juan and Rio Grande Basins of New Mexico, University of New Mexico Press, Albuquerque, 1962, 426 p.

/12/ Young, Robert H., and William E. Martin, The Economics of Arizona's Water Problem, Arizona Review, Vol. 16, No. 3, March 1967, pp. 9-18.