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# Water Resources Planning in a Federation of States: Equity versus Efficiency

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## ABSTRACT

*Equity and efficiency are inextricably tied together since the prices used in efficiency analyses depend on the distribution of wealth. Beyond that, many equity considerations have efficiency implications when evaluated in the appropriate geographical and temporal context. In some situations, there are genuine efficiency-equity tradeoffs, but in many situations building equity into policy or project design also will enhance efficiency. Appropriate governing institutions that more closely correspond with the resource systems being governed help assure appropriate consideration of both efficiency and equity.*


## INTRODUCTION

In the post World War II period, students of economics were taught that economic efficiency and equity were separable issues, that economists should tend to the task of economic efficiency (making GDP as large as possible) while society would attend to equity in the distribution of GDP through other (generally unspecified) mechanisms like safety net programs.[1] It was also stressed (quite correctly) that equity issues were likely to be less contentious in a growing economy than in a stagnant one.

The concept of economic efficiency is manifested operationally in two forms: the concept of Pareto efficiency[2] and benefit-cost analysis[3]. A project or policy is said to be Pareto-efficient if it benefits some parties without making anyone worse off. While invoking this concept as a criterion for judging projects or policy changes avoids making

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1. *See generally* RICHARD A. MUSGRAVE, THE THEORY OF PUBLIC FINANCE: A STUDY IN PUBLIC ECONOMY (1959).

2. BRIAN R. BINGER & ELIZABETH HOFFMAN, MICROECONOMICS WITH CALCULUS 93-95 (1988).

3. *See generally* ANANDARUP RAY, WORLD BANK, COST-BENEFIT ANALYSIS: ISSUES AND METHODOLOGIES (1984).

interpersonal comparisons of well being, the concept is seldom applicable to real world projects which typically benefit some but injure others.

Benefit-cost assessment of projects or policy changes adds benefits and costs over individuals and over time to arrive at a monetized measure of net gains—the "present value of net benefits" (PVNB) attributable to the project. In typical applications,[4] the same weight is given to all benefits and costs independent of the recipient.[5] The benefit-cost test determines if PVNB is positive. A project accepted under this criterion could very well leave some persons better off and others worse off for it is based on the idea that gainers should be able to compensate losers from the project—not that they would actually do so. In many situations, adequate compensation is not paid (e.g. compensation to land owners whose land is taken for public projects but who preferred not to sell at market prices, or absence of compensation to taxpayers who subsidize beneficiaries of water projects).

The Pareto and benefit-cost criteria cannot be separated from basic equity considerations since both must be based on existing prices that depend upon the existing distribution of income and wealth. Given a different distribution of wealth, prices would be different and the assessment of the project might be different. Scitovsky[6] pointed out that, if a project or policy change were major in nature, it might be possible for a pre-project assessment to recommend the project, while an ex-post assessment might recommend against it.[7]

Does this interdependence of efficiency and equity imply that there must be a (negative) trade-off between the two? That is, must an improvement in economic efficiency imply greater inequity or *vice versa*? There are some situations where such a trade-off exists. Consider the typical irrigation system that delivers water to lands along the canal. If water is scarce, economic efficiency calls for applying more water per hectare at the head of the canal (close to the source) than at the foot of the canal. Typical patterns of land ownership (especially in Third World countries) place wealthier persons at the head and poorer persons at the foot of the canal. The most efficient allocation of water may well be unfair.[8]

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4. *See, e.g.*, W. LEE HANSEN & BURTON A. WEISBROD, BENEFITS, COSTS AND FINANCE OF PUBLIC HIGHER EDUCATION (1969).

5. *See, e.g.*, LYN SQUIRE & HERMAN G. VAN DER TAK, WORLD BANK, ECONOMIC ANALYSIS OF PROJECTS (1975).

6. Tibor Scitovsky, *The State of Welfare Economics*, 41 AM. ECON. REV. 302-15 (1951).

7. It is also true that market prices may not adequately reflect the benefits or costs (willingness-to-pay or willingness-to-accept) imposed on individuals, *e.g.* the value of a piece of property to a person who chooses not to sell at the market price.

8. Much has been written about the inequity and corruption of water distribution in Third World countries, *e.g.*, Robert Wade, *The System of Administrative and Political Corruption:*

In many situations, however, the best way of achieving efficiency in the long run may be to build equity into the project, i.e. by enhancing or protecting equity, we may generate greater efficiency gains. The remaining sections of this paper elaborate this point.

## SHORTCOMINGS OF APPLIED BENEFIT-COST ANALYSIS THAT CONFOUND EQUITY AND EFFICIENCY

Policy analysis attempts to compare the state-of-the-world *with* a particular policy or project in place and the state-of-the-world *without* that policy or project. The analysis can be many-dimensional, or it can be unidimensional in terms of money, as in benefit-cost analysis. A mid-point between these is to use "multiple objective evaluation" proposed by the Water Resources Council[9] in which monetizable benefits and costs are incorporated in a PVNB analysis, accompanied by other "accounts" which contain descriptive materials relating to environmental and social changes caused by the policy change.

A "with-without" evaluation is extremely complex to carry out for it requires the analysis of physical linkages (water diversions and return flows), economic linkages (agricultural demand for inputs and the processing of agricultural outputs) and cultural and social changes that may not be monetizable. Questions of appropriate geographic and temporal scope thus arise.

### *Geographic Scope of the Analysis*

While project analyses must be terminated somewhere, arbitrary circles have often been drawn around the project site with impacts outside the circle being ignored. Such omissions may be imposed by (1) modeling and computational limitations, (2) an intent to ignore certain effects, (3) a lack of knowledge of the linkages to areas farther from the project site, and (4) the existence of jurisdictional boundaries (state or national) that fail to correspond with natural or economic systems boundaries.

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*Canal Irrigation in South India*, 18 J. DEVEL. STUD. 287-328 (1982); ROBERT CHAMBERS, MANAGING CANAL IRRIGATION: PRACTICAL ANALYSIS FROM SOUTH ASIA (1988); YAYASAN AGRO EKONOMIKA, GROWTH AND EQUITY IN INDONESIAN AGRICULTURAL DEVELOPMENT (Mubyarto ed., 1982). The PASTEN system used in Indonesia is driven by equity to deliver equal amounts of water throughout the system. *See* Charles Howe, *Equity versus Efficiency in Indonesion Irrigation: An Economic Evaluation of the PASTEN Method, in* SOCIAL ECONOMIC AND INSTITUTIONAL ISSUES IN THIRD WORLD IRRIGATION MANAGEMENT (R.K. Sampath & Robert A. Youngs eds., 1990).

9. United States Water Resources Council, Proprosed Principle and Standards for Planning Water and Related Land Resources, 36 Fed. Reg. 24,114-24,194 (1971).

Modeling and computational limitations have provided the excuse in many economic analyses for excluding all "secondary" or "indirect" effects from the analysis. Some secondary impacts contain real economic benefits or costs, such as when a water transfer from agriculture causes the failure of agriculturally linked businesses, leaving labor and other semi-mobile resources unemployed for some period of time. Other impacts take the form of price changes concurrent with the reallocation of resources (so-called "pecuniary" impacts) and do not represent real benefits or costs (although they remain relevant for the analysis of equity impacts: who gains or loses). Real benefits or costs at the secondary level are frequently omitted.

The geographical circle may be tightly drawn around the project site with the intent of diverting public attention from further downstream effects. Ignoring the salinity impacts on Mexico of the Welton-Mohawk Project would be a case in point, as would the continued expansion of irrigated agriculture in the San Joaquin Valley of California while ignoring the drainage impacts on other farmland and on wildlife areas.

Lack of knowledge of linkages to other systems undoubtedly has been the cause of many simplistic project analyses undertaken by foreign consultants in the Third World. World Bank and USAID water projects have, until the last decade, been designed and evaluated by engineers. While well-equipped to deal with structures and hydrology, the designers frequently were unaware of the complexities of the traditional agricultural, livestock and fisheries systems they were amending (or destroying). Driver and Marchand[10] identify the many values generated by African flood plains: riverine fisheries that depend on the seasonal floods; recession agriculture similarly dependent on flooding; and wildlife on which local people depend. Much less obvious are the seasonal cattle migrations that come to the flood plain from great distances during the dry season to graze on local grasses and crop aftermath. Designers of many African reservoir projects certainly did not understand these systems and failed to count their demise as costs of "modern" development. Marchand has recomputed PVNB for several major African irrigation projects,[11] allowing for the values of the traditional production systems displaced or disrupted. In all cases, the net benefits from the traditional systems exceeded those from the reservoir projects.

The existence of jurisdictional boundaries that do not correspond to the river or other natural systems is one of the greatest causes of

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10. C.A. DRIVER AND MARCEL MARCHAND, COMMISSION OF THE EUROPEAN COMMUNITY TAMING THE FLOODS: ENVIRONMENTAL ASPECTS OF FLOODPLAIN DEVELOPMENT IN AFRICA (1985). A summary also is found in 22 NATURE AND RESOURCES 13-22 (1986).

11. Marcel Marchand, *The Productivity of African Floodplains*, 29 INT'L J. ENVTL. STUD. 201-11 (1987).

inefficiency in the design and operation of water systems. "Downstream" comes to mean "beyond the state line," with downstream impacts being ignored. These problems adhere to natural resources other than water, too, as the recent killing of Kenya elephants in Tanzania has emphasized. The lack of correspondence of jurisdictional and system boundaries guarantees that one jurisdiction will impose "negative externalities" on other jurisdictions.

Howe and Ahrens[12] have calculated partial system-wide opportunity costs of water consumption used in the several sub-basins of the Upper Colorado River Basin. These are shown in Table 1.

Table 1 *Instream values per acre-foot of reduced consumptive use in the Upper Colorado River Basin*

| Subbasin | Water opportunity cost in Lower Basin | Salinity damages averted | Power value at 44 mills | TOTAL |
|---|---|---|---|---|
| 1 | $30 | $238 | $46 | $114 |
| *2,3, 6-8* | 30 | 38 | 31 | 99 |
| *4* | 30 | 38 | 72 | 140 |
| *5* | 30 | 280 | 31 | 341 |

Subbasin identification: 1 = Green River to Flaming Gorge;
2 = Yampa and White Basins; 3 = Green River to the Colorado River; 4 Gunnison; 5 = Colorado Upper Main Stem; 6 = Delores;
7 = San Juan; 8 = Colorado above Lee's Ferry

Very few uses in the Upper Basin generate net incomes as high as these (partial) opportunity costs, let alone high enough to cover project construction and operation costs. Under the Colorado River Compact, the Upper Basin is under no obligation to take account of Lower Basin values of water once the required 7.5 million acre-feet per year have been delivered. Even within the State of Colorado, appropriators of water are not required to recognize costs imposed on other state or federal entities by their consumptive uses, e.g. out-of-basin transfers from the Gunnison Basin to Arapaho County that reduce recreational opportunities, hydro-electric power generation, and salinity levels in downstream reaches within Colorado.

This raises the very important general issue of the appropriate level of decentralization of jurisdiction over natural resource systems, especially water. Current political trends in the United States favor more

12. Charles W. Howe & W. Ashley Ahrens, *Water Resources of the Upper Colorado River Basin: Problems and Policy Alternatives, in* WATER AND ARID LANDS OF THE WESTERN UNITED STATES (Mohamed El-Ashry & Diana C. Gibbons eds., 1988).

decentralized resource management. Environmental policy in the European Union[13] strongly emphasizes "subsidiarity," i.e. placing responsibility for policy and enforcement at the lowest possible level consistent with avoidance of serious externalities. While lowering the level of jurisdiction helps in incorporating local physical conditions and values in decisions, it also increases the likelihood of significant externalities. The tension between "subsidiarity" and externalities is one of the largest remaining problems of policy design.

*Temporal Scope of the Analysis*

As noted above, project analysis is typically based on a "with-without" analysis. Benefit-cost analysis usually compares the forecasted *new equilibrium* of the system with the project in place and the forecasted *new equilibrium* without the project. Such comparisons involve great uncertainty about when these equilibria will be reached, and they usually ignore the paths by which the system approaches the new equilibria. The equity and efficiency impacts during the transitional period can be important and long-lived.

The dynamics of physical system evolution are often poorly understood. The extensive behavior of large reservoirs is a major case in point.[14] Lake Kariba in Zambia first filled with water hyacinths to an extent that greatly reduced active storage and interfered with electric power generation. After the nutrient and water levels settled down over a 15-year period, the water plants nearly disappeared, and highly nutritional shoreline grasses emerged. Lake Volta in Ghana experienced large fluctuations in fish populations as well as the spread of schistosomiasis and onchocerciasis. Lake Nasser on the Nile had similar impacts. These fluctuations had major impacts on human well-being.

The displacement of human populations by large reservoirs has been given little or no weight in the evaluation of many projects. In the project plan for the Kousou Dam on the Bandama River in Ivory Coast (1960), one page was devoted to the appropriate cash payment to the displaced population. Problems in resettling these people ultimately cost the government as much as the dam itself. What many would have identified as a matter of equity (resettlement) turned out to have profound efficiency (cost) implications. The same was true at Lake Volta and is currently proving to be true at the infamous Sardar Sarovar project

13. EUROPEAN COMMUNITY, TASK FORCE REPORT ON THE ENVIRONMENT AND THE INTERNATIONAL MARKET, 1992: THE ENVIRONMENT DIMENSION (1990).

14. EDWARD GOLDSMITH & NICHOLAS HILDYARD, THE SOCIAL AND ENVIRONMENTAL EFFECTS OF LARGE DAMS (1986).

on the Narmada River in India.[15]

A study of the impacts of agricultural water sales from Colorado's Arkansas River Valley to municipalities found very significant long-term unemployment imposed on the area of origin, with impacts on incomes in secondary activities and serious erosion of the county tax base (Crowley County).[16]

In sum, the dynamic transitional impacts of projects are frequently not understood and often ignored. Impacts that might be identified as "equity" impacts at the time of project analysis frequently turn out to have important efficiency effects. The potential for compensating losing parties that underlies benefit-cost analysis is seldom carried out, leaving a residuum of equity issues. The transitional processes may be even more important than the new equilibria targeted by our projects or policies.

## CONCLUSION

Albert E. Utton, distinguished legal scholar and former Editor of the *Natural Resources Journal*, discussed the pros and cons of two contradictory legal philosophies incorporated in two decisions by the U.S. Supreme Court in 1982: the doctrine of "equitable apportionment" of interstate waters between states and the "commerce clause" doctrine that declares water to be an article of commerce (marketable commodity) and thereby subject to constitutional protections against interstate trade restraints.[17] The former doctrine is concerned with equity between states that share a water source, while the latter doctrine asserts that market forces should be allowed to determine water allocation among states, subject to some welfare and police powers qualifications. Utton argues that there are issues beyond market efficiency that warrant the acceptance of the equity doctrine—"to protect the balance within the federal union of states and to ensure the stability necessary for state and regional water planning." He concludes:

> "However, if there is merit to the idea of the founding fathers that it is desirable to maintain balance between member states, if there is merit to the idea that diversity contributes to a

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15. BRADFORD MORSE & THOMAS BERGER, RESOURCE FUTURES INTERNATIONAL, INC., SARDAR SAROVAR: REPORT OF THE INDEPENDENT REVIEW (1992).

16. Charles W. Howe *et al.*, *The Economic Impacts of Agriculture-to-Urban Water Transfers on the Area of Orgin: A Case Study of the Arkansas River Valley in Colorado*, 72 AM. J. AGRIC. ECON. 1200-1204 (1990). *See also* Kenneth Weber, *Communities in Decline; Water Transfers and Socioeconomic Analysis: A Methodological Note*, 6 J. ARID LAND. STUD. 45-49 (1990).

17. Albert E. Utton, *In Search of an Integrated Principle for Interstate Water Law: Regulation versus the Market Place*, 25 NAT. RESOURCES J. 985 (1985).

> strong economy, and if there is value in the suggestion that viable constituent parts contribute to a stronger federation, then perhaps it is appropriate to design a doctrine of interstate water allocation which, while limiting the territorial sovereignty of individual states, recognizes the territorial integrity of member states and equitably balances their competing needs . . . "[18]

Utton is arguing for equity as an important criterion for public policy, but, beyond that, he seems to be stating that equity must be built into our policies and projects. It will not just happen.

It was noted above that equity can have important efficiency implications. Programs, policies and projects that impose inequity on affected parties often generate social malaise that leads to high efficiency costs. Many of these costs occur during the transition from today's equilibrium to that intended by the project. Analysis of the transition is typically slighted and often ignored in project and policy evaluations.

A major cause of both inefficiency and inequity is the lack of correspondence between political boundaries and natural resource systems—especially rivers. This guarantees that full system effects will not be taken into account, i.e. that externalities (usually negative but sometimes positive) will exist. In some instances, these jurisdictional-physical system misfits have been created through attempts to deal with equity issues. A prime example is the Colorado River Compact of 1922 that, in the interests of interbasin equity, allows Upper Basin water users to ignore their impacts on the Lower Basin.[19]

Even within individual states, the laws governing water appropriation frequently allow appropriators to ignore negative downstream effects on others—especially regarding non-market amenities from streamflows.

Today's political environment seems to favor greater decentralization of decision-making (Europe's principle of "subsidarity"). While this allows a greater reflection of local values, it also increases the occurrence of undesirable externalities—the resolution of which will require more extensive negotiation. Rethinking our institutions for the governance of natural resource systems is part of the answer, e.g. river basin commissions, regional airsheds, wildlife commissions and ecosystem management agencies that span state boundaries and give consideration to both equity and efficiency on a system-wide basis.

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18. *Id.* at 986, 989.

19. The Colorado River Compact was approved by the United States Congress in section 13(a) of the Boulder Canyon Project Act. *See* 43 U.S.C. § 617 (1995).